The U.S. Army Corps of Engineers and the Reconstruction of the American Landscape, 1865-1885

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The U.S. Army Corps of Engineers and the Reconstruction of the American Landscape, 1865-1885

A dissertation presented

by

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to

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Abstract

The American Civil War (1861–1865) wrecked the cities, economy, infrastructure, and landscapes of the southern section of the United States. The histories of the Reconstruction Era that followed primarily focus on the efforts toward political reunification and the tragic failure to extend full civil rights to freedpeople in the wake of Emancipation. However, Reconstruction was also a time of physical acts that advanced material evidence of the nation being rejoined. As a time of extensive rebuilding and national renovation, actual construction supported the era’s overarching political metaphor. As the defining event of U.S. modernization, Americans planned and rebuilt their country in a distinctly modern way, acknowledging the twin anonymous forces of capital and nature to define their projections for the nation beyond its accursed foundation built on human enslavement.

This dissertation considers the efforts of the federal state’s engineering apparatus, the military engineers attached to the army in the occupied South, as they rebuilt the economic infrastructure ruined by war, and imposed a federally-maintained hydraulic landscape across the varied ecologies of the U.S. South. American military engineers of the mid-nineteenth century possessed the most technically-sophisticated education and training available on the continent,
and their practice, mixing applied geometry with topography, has had vast implications in the organization of the American landscape, apparent to this day.

Despite technical prowess, new techniques available due to rapid industrialization, and a vastly enlarged and powerful federal government, the actual practice of engineering at the time remained provisional, existing uneasily with an equally powerful natural world. Engineers developed design practice that took cues from the “forces of nature,” and sought to inhabit ecosystems by interpreting their “desires.” Design became an extended process of experimentation and learning from the landscape, accounting for physical, biological, and social systems already in place that could help or hinder processes of modernization. Questions of labor dominated discourse over how to organize an effective structuring of wild and remote landscapes, and colored the growing idea within the federal government that territorial management was best achieved through imposition of a mechanical model of infrastructural territory, a process that remains ongoing.
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John Davis

Mesa, Arizona
For Michelle
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Introduction

Reconstruction was a set of physical processes. It involved politicians passing legislation, newly-freed people voting for the first time, and defeated southerners creating a reign of terror and violence. The era also, and with equal importance, involved Americans rebuilding buildings, dikes, and levees; expanding harbors and laying railroad track; piecing together and making anew an economy that had been smashed by war. Reconstruction was a time of physical acts that advanced material evidence of the nation being rejoined. The accumulation of these acts of construction, some made by private actors, many by the state, supported the larger political metaphor of the time. Construction and building provided symbolic content which augmented the political project and gave some register by which to measure reunion. As one of the first modern state-building projects, Reconstruction reveals the material, ideological, and aesthetic decisions taken by actors who for the first time were confronting questions of how a republic should rebuild. Lacking a defined traditional structure or a princely figure of authority from which the design of reconstruction could flow, the officials of the U.S. government instead planned and built in a distinctly modern way, acknowledging the twin anonymous forces of capital and nature to guide their projections for the nation beyond its accursed foundation built on human enslavement.

Land and power over the territory formed the core of the state’s Reconstruction concept. The first written instance of the term “Reconstruction” was in reaction to the election of Abraham Lincoln as president of the United States, put down only a month after the polls, and several weeks before open hostilities would break out in the harbor of Charleston, South
Carolina.1 Talked of prior to the intensely destructive period, conceptual reconstruction was not dependent on war, but instead a process that extended beyond specific conflict. The notion of repeating a complex set of processes—indeed that the nation had been constructed in the first place—indicated national fissure was a flaw of the original constructors. The metaphor contained an enduring power, and the term came to dominate national discourse on the subject. Discourse on reconstruction during the war acknowledged the central fault of land and labor in the existence of the United States. In state papers the term appears in a policy memo furnished to President Abraham Lincoln in July 1863, written by the learned Boston lawyer William Whiting. Whiting’s legal reasoning strongly influenced Lincoln’s course of prosecuting the war and his program of reconstruction. Whiting placed “conquered territory” and its inhabitants at the center of his inquiry, assigning areas of land as the important legal objects in any legal structure of reconciliation.2 Lincoln’s presentation on “what is called reconstruction” to Congress on December 8, 1863, notably vague and lenient toward those who had initiated such a costly conflict, acknowledged that such politics were inextricable from the landscape they played out upon.3

After the Civil War, the federal state participated in Reconstruction by creating a national infrastructural territory that encompassed the boundaries of the United States. This “reconstruction” was both metaphorical and physical, involved design and construction work,

1 A Roane, “A Plan of Present Pacification: Or, a Basis for the Reconstruction of the Union, If It Be Dissolved,” De Bow’s Review, January 1, 1861.


and entailed political manipulation and administration of symbolic systems that projected the power of a unified republic welded to capitalist development. The state achieved this by using the military to shape the physical, political, and economic organization of the southern territory it occupied. Specifically, the U.S. Army Corps of Engineers, the state’s engineering apparatus, built infrastructure that extended federal authority into the South, and its constructions enabled further infrastructural and capitalist development throughout the landscape. In turn, the state’s use of its military engineers at such a crucial moment in its own development necessarily meant that the engineers’ own outlook on the manipulation of the natural world for economic development would shape federal epistemology and embed the engineers’ ethos into the American state’s outlook on territorial governance.

This dissertation is a study of the activities of the state engineers as they went about designing and building physical Reconstruction. The period examined spans from Confederate surrender in 1865 to the army’s reorganization of the engineer bureau in 1885, which also coincides roughly with the career spans of a generation of engineers that oversaw the tumult of change in the United States in that twenty-year period. The engineers’ activities in this period encompass a vast geographical area and range widely in scope; an exhaustive, comprehensive, and chronological accounting of all of the corps’ works would be beyond the scope of a dissertation. Instead, I have approached the vast amount of material in the army’s engineering archives in a thematic manner, using key projects to illustrate the following themes. First, the relationship the state and its engineering apparatus is examined, with particular emphasis on the political power that moved behind projects, secured funding, projected political impacts, and calculated the benefits of the state’s assumption of geographical manipulation. The second theme is the accumulation of technical knowledge within the institution of the corps of engineers, and
how knowledge, and the engineers’ own politics, affected the design decisions taken. This approach borrows heavily from the perspective of architectural history, as the visual manifestations of projects and their impacts on cultural contexts benefits from the analytical position more often taken by historians of architecture than those of technology or engineering.\footnote{I use Dell Upton’s definition of architectural history, encompassing “the entirety of what is sometimes called the built environment or the cultural landscape ... the practice of building--imaging, shaping, and interpreting a material world...integrated at all levels.” Dell Upton, \textit{Another City: Urban Life and Urban Spaces in the New American Republic} (Yale University Press, 2008), 10.} Throughout the study the question of technological change—including notions of causality and impact on human society—is always positioned in relation to how the engineers regarded the natural environments they were working within. Similarly, “engineering” is considered as labor, in which I include the intellectual labor of drawing and designing with the more brutal labor of digging, hauling, building formworks, and stacking stone that instantiate conceptual order in the actual world. This broad understanding of engineering is similarly always related explicitly to its natural context, with special attention paid to how external, non-human forces shape the conceptual limits of engineering. As the prime motivating factor of the era, capital stalks at the boundaries of all of these worksites, and understanding its effects on design decisions, small and large, remains one of the large tasks of the study. Finally, these themes are held together by the notion of landscape: both of physical place and testament to human intention written in the land. The engineers rebuilt the American landscape after the Civil War, in it is a natural record of an active, dynamic, continuous process of modernization, and renovation of concepts of both landscape and environment by a society undergoing profound change.
Reconstruction

The Reconstruction Era has a generally defined periodization in American historical writing as spanning from the surrender at Appomattox in 1865 to Rutherford Hays’s election in 1877 and the final withdrawal of all federal soldiers from occupation duty in the South. Essentially, it encompassed attempts to project a new physical and political order on the United States into an indeterminate future. Northern radical Carl Schurz, in the midst of it in the summer of 1865, makes clear that the process was not thought of as purely abstract:

As to what is commonly termed “reconstruction,” it is not only the political machinery of the States and their constitutional relations to the general government, but the whole organism of southern society that must be reconstructed, or rather constructed anew, so as to bring it in harmony with the rest of American society.  

That society operated at various levels in both abstract and concrete functions; terms like “reorganization” and “reconstruction” used interchangeably indicate that the era was one of revision of all social and material relationships.

Reorganization of American society and landscape proceeded along a general sequence that saw the decline of ideological motivation and its replacement by enthusiasm for industrial and commercial development. The great sociologist W. E. B. Du Bois characterized the era succinctly by declaring it the melding of an ideological “abolition-democracy” with “industry for private profit directed by an autocracy determined at any price to amass wealth and power.” The sequence of events occurred as follows: The victorious North, having abolished slavery, worked

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to ensure the extension of equal rights to black Americans. The federal government, firmly in the control of northern abolitionists, encouraged economic development of the prostrate South, believing prosperity would benefit unity. Northern appetite for battling white supremacists in the South faltered, true emancipation proved illusory, and planters-turned-capitalists used Jim Crow to regain political supremacy. Economic development, unfazed by the failure of Reconstruction’s social mission, continued apace, forming the foundation of the “New South.”

Like any periodization, the boundaries remain contested, with various historians and writers concentrating on more focused or more expansive lengths of time for their own reasons. And, as is particular to the period around the American Civil War, the depth and variety in the period’s historiography is significant. Eric Foner’s *Reconstruction: America’s Unfinished Revolution*, first published in 1988, remains the touchstone historical work that this dissertation refers to for the framing of the rebuilding process as primarily an “ongoing process of social and economic change.” “[I]ntimately related to the politics” of the era, Reconstruction was both a legislative challenge and a hugely intricate and complex interaction of different groups of people: blacks and whites, northerners and southerners, capitalists and agrarians, ideologues and pragmatists—all of whom participated in using whatever influence or power available to them to build a new political and economic order in the wake of the war. Foner’s indispensable work was an important component in the dismantling of the so-called Dunning School’s materialist, misguided assessment of Reconstruction: an unfortunate, cynical maligning of what was actually, as Foner came to show, an era of profound change, experimentation, optimism, and desperate
struggle that, while in many ways failed to live up to its original designs, is nonetheless a historical period worthy of close consideration. Foner’s interest in this period derived from his discovery and continued belief that ideology did indeed play a large role in the motivations of many of the actors of the period and specific ideological constructs. Finding those most prevalent derived from a “republican” cluster of ideas rooted in the early days of the American republic (and indeed, even further back than that), the war and rebuilding could be seen as a series of changes produced by an interaction between ideas and the waves of upheaval. Other historians have explored the cultural and psychological dimensions of Reconstruction, examining the impact of extended military occupation and the cultural impact of war, reunion, and increased industrialization and urbanization on class structure in the U.S. Recent scholarship continues to grapple with questions of periodization, debating whether or not the war itself marks a break in narrative continuity of the United States, or is an intensification that has been obscured by overreliance on less meaningful categories of “war” and “peace” in a consistently violent, turbulent society. Regardless, the Civil War and Reconstruction remain the great


12 I argue here against the provocation put forward by Gregory Downs and Kate Masur in their recent work: Gregory P. Downs and Kate Masur, eds., The World the Civil War Made (Chapel Hill: University of North Carolina Press, 2015). While they convincingly argue that the term “reconstruction” has been overused, and stretched to mean anything and everything in its metaphorical capacity, going so far as to urge historians to reject its use entirely, I would argue that when actually talking about physical construction processes it retains its power to convey the complexity of the era and the widespread subscription to it as a metaphor. If anything, the interaction between metaphorical political processes and actual rebuilding housed both in the same term has not been investigated enough.
transformative event in U.S. history—a bloody, tragic, and complex time that formed the modern nation.

Land-use was the central site of struggle in the postwar period, and the struggles of the era revolved around who had the authority to reorder the landscape and who would benefit from its reconstruction. As revanchist planters fought with what Du Bois called “a new and tremendous dictatorship of capital” rising in the North over the proper distribution of the South’s wealth in land, black Americans suffered through exclusion in the new economic order. Freedpeople’s bitterness over broken promises of both the federals and their former masters indicates the central role that land played: providing sustenance and legal standing, legitimacy and wealth—the control of land underpinned the majority of Reconstruction’s actors’ motivations.13 The character of the relationship between nation and territory remains a central question to the era.

The specific political transformations in the United States existed in parallel to global transformations in an age of attempts to transcend all preindustrial limits. Unprecedented economic growth in rapidly-industrializing nations of Europe and North America created a truly global economy. Technological advances, commodities markets, and innovations in credit set off spatial and social transformations on all corners of the planet.14 Both state and capital dramatically expanded their abilities to transform space by the extension of visible and invisible networks of power. The global centers of culture underwent a shift as financial centers such as


New York replaced the old loci of authority. The great transformation of labor, of which global acts of emancipation played crucial roles, had drastic impact on the way that human labor was conceived of in industry and landscape.

Historians have held up the great transportation networks constructed during the nineteenth century as evidence of the intent of technically-advanced and capital rich societies to impose order across greater and greater amounts of space and territory. Touted as the “annihilation of space,” these ordering technologies did anything but—and more often imbued the spaces they touched with new and various functions. The enthusiasm for networks, with the prime example being that of the steam locomotive and railroad, was shared by both corporations and lesser commercial actors and the state, and the assembly of energy, expertise, and capital was a joint venture of public and private actors. Railroads were emblematic of an ensemble of overlapping and mutually-supportive communications, information, and transportation networks, including new technologies like the telegraph and “older” technologies such as canals and waterborne transport, all of which played interlocking roles in sustaining life and commerce in the


industrial era. Engineering practice was crucial to the imagination, execution, and success of these networks; with engineers emerging as a coherent class that designed and built these transformative structures.

As a purposeful intervention in these global changes, Reconstruction can be seen as an imaginative act of social and physical design. Changes in the structure of the American South were as much a result of ideologically-driven intention as global technological and economic pressures. In general, federal authorities’ aim was to build a political cohesion by economic development. Reconstruction’s architects saw economic ties, the organization and discipline of labor, and the reinstatement of the pulse of commodities and capital through the landscape of the South as the best binding agent for a reconstituted nation. As such, the era entailed design of a political economy composed of various abstract and real parts, functioning in concert in furtherance of unification. Reconstruction, perhaps the most ideologically-driven period in the history of the United States, was the realization that ideology and space require a mediating infrastructure in order for that ideology to make its necessary changes in the material world.

This redesign emerged primarily as a set of acts that created territory for the production of national space. Indeed, the notion of constructing a national space of a national character occupied the governments of other industrial powers in the nineteenth century, and historians have argued that this complex process involved simultaneous construction in both physical and symbolic realms. Americans acted similarly to the French after the social cataclysm of war, and

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19 The “Continental Imaginary” had been part of American literary discourse from the early days of the Republic, see Andy Doolen, Territories of Empire: U.S. Writing from the Louisiana Purchase to Mexican Independence (New York: Oxford University Press, 2014), 1–19. I argue that the interventionist designs of the postwar era were of a different order.


21 Marc Desportes and Antoine Picon, De l’espace au territoire: l’aménagement en France, XVIe - XXe siècles (Paris: Presses de l’Ecole Nationale des Ponts et Chaussées, 1997), 69–71; Antoine Picon, French Architects and
looked to the notion of the “binding” power of public works and infrastructure, as well as the rhetorical construction of nationhood and shared prosperity that surrounded those constructions, already embedded within, and occupying a central role in, their national mythology.\footnote{22}

**The Corps of Engineers as an Institution**

Since its inception during the War of Revolution and official establishment in 1802, the Corps of Engineers had worked extensively in “civil” engineering across the early Republic. Military involvement in engineering projects that supported commerce reached a high point in the Rivers and Harbors Act of 1824, when factions within the federal government funded improvements to port facilities and navigable rivers in the hopes of retaining a competitive edge with Europe. That the government entrusted federal-level engineering activity with the military is significant in that it established a connection to European, and specifically French, models of technological empiricism and the military’s relationship to the state. The United States Military Academy at West Point adopted early a system of instruction that could trace its lineage to the innovative period of military engineering of Louis XIV’s France.\footnote{23} Marked by an intense focus on applied engineering

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mathematics and reliance on quantitative methods for describing the forces of nature, the U.S. Army’s officer corps had in 1865, to a man, received one of the most sophisticated technical and scientific educations available in North America.24

Yet during the Civil War both the world and the United States changed, and in order to function in the new technological, economic, and social order, the Corps of Engineers as an institution changed as well.25 The engineers adapted their practice to an enlarged federal state, growing technical power (more in terms of greater funding than technical advances), a repositioning of the role of the army in the federal state, vast changes in labor due to emancipation and industrialization, and a reconception of sources of energy that changed the state’s regard of the natural world. Historians have described the rise of the corps as a technical and bureaucratic force in the federal state, focusing on the intellectual link with France and portray the bureaucratic “turf” struggles as the corps consolidated national power in the context of federalist themes in U.S. history.26 Martin Reuss and Raymond Merritt have described a decline in the institutional prestige of the corps in the second half of the nineteenth century, as the army ceased to be the sole repository of technical expertise in the United States, and civilian

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engineers (and their professional organizations) rose to prominence. These valuable histories stress the continuity of the institution throughout the entirety of the nineteenth century, and cast the military engineers as a relatively isolated, jealous, and conservative institution, mired in corruption and serving as a vehicle for patronage, and declining in relevance as the nineteenth century goes on. This study aims to question this verdict by fresh examination of the state’s engineering apparatus not in the small context of civil engineering history, but in the larger political, technological, and ecological circumstances in which the engineers worked and built after the war. As testified by the entwinement of the army in virtually every wetland and watercourse in the territory of the United States today, the corps continued to play a significant role in the conception of the state’s role in territorial engineering, providing a model of an institution that could make the mega projects of the early twentieth century imaginable.

The Corps of Engineers changed as a design institution as well. Histories of the corps have tended to describe the institution and its works as a kind of monolithic production, augmenting the continuous narrative with brief biographies of individual engineers and projects, but subordinating individual actions and decisions to a larger story. This dissertation breaks with previous histories by placing the design process and the project site under construction as the central locations of historical analysis. Centering “engineering” as a design activity achieves two aims. First, it provides insight into the motivations of individual engineers as they work within their own technical and intellectual community. Reconstructing how these engineers made


28 Dismissal of the second half of the nineteenth century as an “era of corruption presided over by unscrupulous carpetbaggers and scalawags” was the precisely the tactic of the Dunning School to downplay the struggles and triumphs of the era. To disparage state engineering of the time as corrupt is suspiciously similar to the mythologizing and romanticizing of the “Old South” rampant in the historiography prior to 1980. Quote from Foner, Reconstruction, xix.
decisions, what forces and notions they took into account, portrays a picture of a nineteenth-century regard for both technical issues and larger cultural questions of the role of nature, race, class, and national sentiment that informed the design of the built environment. Secondly, analyzing engineers in their institutional context as the corps interacts with other communities at broader scales reveals the cultural dimension of design and construction of the time. Using William Goetzmann’s seminal work on the U.S. Army’s topographical engineers, in which he argued that cartographic production created “a picture of the cultural mind in action,” this study similarly seeks insight into North American culture in the artifacts of engineering design.\textsuperscript{29} Therefore, attention is paid to individual engineers as they work through problems, consult their colleagues, and contemplate their situation in the natural world and American political environment.\textsuperscript{30} Questions of the relationship between the individual and the institution, between personal ambition and that of the state, remain crucial to analysis of how these engineers construct technical knowledge and bring their own politics to bear on technical projects.\textsuperscript{31}

\textsuperscript{29} William H. Goetzmann, \textit{Army Exploration in the American West 1803-1863} (New Haven: Yale University Press, 1959), 431–33.

\textsuperscript{30} Ann Johnson, “Material Experiments: Environment and Engineering Institutions in the Early American Republic,” \textit{Osiris} 24 (2009): 53–74. Johnson’s conception of social construction of technology that doesn’t shy away from the impact of the natural world on how people work on technical problems has been a foundational framework for this study.

\textsuperscript{31} See Edwin T. Layton, \textit{The Revolt of the Engineers: Social Responsibility and the American Engineering Profession} (Baltimore, Md.: Johns Hopkins University Press, 1986); Political expression by individual engineers, be it toward freedpeople, poverty, or perceived avarice, was always tempered by the army’s overwhelming regime of discipline which curtailed acceptable behavior and expression, especially in official documents and correspondence. Nonetheless, impulses toward egalitarianism are evident, even amidst the occupation’s “military dream of society.” See Michel Foucault, \textit{Discipline and Punish: The Birth of the Prison}, trans. Alan Sheridan (New York: Vintage, 1995), 169.
Technology and Territory

This study approaches engineering as a deployment of technology in a way that reveals the values and priorities of American society in during industrialization. Each intervention made by the army in the landscape had political implications, many of which the politicians, engineers, planters, and builders were acutely aware of at the time. \(^{32}\) A large component of this study concerns how Americans used their institutions and their technical abilities to organize their vast and wild territory, and how the limits of technical and political feasibility interacted, and were pushed by various actors. Hydraulic structures are of particular interest, given the amount of political energy required to bring hydraulic systems into being, and the physical reality of watercourses, which organize vast amounts of territory beyond their banks. \(^{33}\)

The history of construction occupies a unique sector of broader study of technological change, examining the impact of scientifically-derived knowledge on human activity and the ways in which people reform their environments. Because of the increased scale between the building and device or tool (to say nothing of the difference between an infrastructural system and a stirrup), different categories of analysis are required. To understand landscape-scale engineering the historian must consider the range of experience, skill, and perspective present amongst the people on the construction site. Further, as construction is one of the oldest of human activities, the power of tradition in shaping the choices made (indeed, even warping the

\(^{32}\) Indeed, artifacts do have politics. This study is deeply informed by the scholarship around the social construction of technology that has dominated the discourse in both the history and sociology of technology for the past few decades. Informed by this, one of my aims has been to uncover as much of the political intent of construction and engineering from the rather silent engineers as possible. See Langdon Winner, “Do Artifacts Have Politics?,” *Daedalus* 109, no. 1 (Winter 1980): 121–36; see Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, Mass.: MIT Press, 1987); Wiebe E. Bijker and John Law, eds., *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, Mass.: MIT Press, 1992).

notion of rationality at some points), cannot be underestimated. Historians have approached technical change and the rise of new practices as a careful understanding of the ways in which ideas are transmitted between discrete building cultures, each with its own traditions, prejudices, and environmental problems. Adaptation of new practices usually entailed engineers, architects, and builders reconcile new technique with previously-held knowledge, forcing a reconsideration of the basis of that knowledge and a return to the fundamental question of the roles of theory and intuition or empiricism in construction. In the United States, mathematics and military training grappled with a deeply-entrenched pragmatism on the construction sites and drafting rooms of the era considered, and this struggle reveals a construction culture that is anything but simple.

This era sees the decline of the military as a source of technical authority in the engineering field that was swiftly developing specialties, such as in chemical and electrical technologies, and rapidly coming to be dominated by civilians. Yet, the legacy of military technology, the raw technical power of the army, and especially the spatial impact of the combination of the two, continued to endure. The military tradition of scientific inquiry from which the corps emerged formed their ethical and epistemic foundation, and cannot be ignored.

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34 See Antoine Picon, “Construction History: Between Technological and Cultural History,” Construction History 21 (2006 2005): 5–19; Of the many studies that consider the construction process, two stand out as holding particular importance for this study: the excellent and comprehensive Tom F. Peters, Building the Nineteenth Century (Cambridge, Mass.: MIT Press, 1997); and Amy E. Slaton, Reinforced Concrete and the Modernization of American Building, 1900–1930 (Baltimore: Johns Hopkins University Press, 2001) an excellent study of the arrival of a material and its processes having an impact on an established building culture.

35 Eda Kranakis, Constructing a Bridge: An Exploration of Engineering Culture, Design, and Research in Nineteenth-Century France and America, Inside Technology (Cambridge, Mass.: MIT Press, 1997). The approach taken in Kranakis’ excellent study would be difficult to sustain in the technical environment in the United States after the Civil War, and is discussed further below.

36 For the American context, see Merritt Roe Smith, Harper’s Ferry Armory and the New Technology: The Challenge of Change (Ithaca, N.Y.: Cornell University Press, 1977); Merritt Roe Smith, ed., Military Enterprise and Technological Change (Cambridge, Mass.: MIT Press, 1985); For an introduction to the substantial body of work on the development of military technology in France, see Antoine Picon, L’invention de l’ingénieur moderne: L’École des Ponts et Chaussées, 1747–1851 (Paris: Presses de l’École Nationale des Ponts et Chaussées, 1992); Alder, Engineering the Revolution; Blanchard, Les ingénieurs du “roy” de Louis XIV a Louis XVI: Étude du corps des fortifications; Langins, Conserving the Enlightenment; Bruno Belhoste, Amy Dahan Delmedico, and Antoine Picon,
Nor can the spatial or territorial dimensions of military technology be discounted. The state-sponsored engineering endeavors of Reconstruction were instances in a widespread practice of states imposing order and control over land through a technological process. Stuart Elden has provided the clearest anatomy of this process as a longstanding phenomena in his recent, masterful study of the social construction of the concept of territory. Elden argues that post-Enlightenment processes of territorialization were accompanied by technical projects such as infrastructure. Concluding that territorialization was fundamentally an ongoing process of state power on land, Elden makes the strong case that the concept of territory itself is a technology, deployed by those with political power. Elden’s conception of the meta-technology of territory includes what he calls “bundles” of subordinate technologies, in which he includes techniques, such as land mensuration and applied geometry; conceptual spatial structures, such as Roman military *limes*, or routes of movement; and engineered structures; all of which contribute to the broader understanding of how territory is constructed. Each component in these bundles was thoroughly military in their genesis and growth to maturity.

Historians have characterized technologies that operate at the scale of territory as being distinctly imperial. In their construction, operation, and the types of life that they support, large-scale hydraulic structures impose a certain vision on land and society that radiates outward from

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a relatively small number of people at the center of the imperial motivating power. Creation of territorial engineering necessarily requires a certain epistemological simplification as the state consolidates control over specific, named, and delineated natural phenomena, often to the detriment or complete silencing of indigenous forms of knowledge and society. Acting primarily as an extraction apparatus, these infrastructures often denude the countryside of wealth in a violent manner, with little regard for environmental impact and accumulating intensity as wealth strengthens each tentacle’s grip. These critical accounts can and should be acknowledged as appropriate for describing some of the operations at play during Reconstruction. However, in plumbing the depths of the institution, and by considering the thoughts and reactions individual engineers wrote down in their documentation and correspondence, it is less apparent that this narrative fits perfectly, or explains everything. This study provides a counterpoint: consider the figure of the engineer in the marshland, whose presence and actions could be considered imperial, yet on review this analysis fully explains neither his judgments and actions, nor the wildly different experiences of the natural world as interpreted through his practice.

Instead, engineering practice in America emerged as a complex phenomena that defies easy interpretation as either imperial and abstract, or pragmatic and earthy. The historiographical assumption of a polarity between theory and intuition in engineering practice has serious

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limitations, and relying on emphasizing distinct national styles of engineering (such as the French being theoretical to a fault) provides limited insight into the realities of design and construction of the era. In reality, the engineers were an international community who visited each others’ countries, observed works in progress, took notes on innovative use of materials, and read each others’ publications. No engineer in the second half of the nineteenth century could deny the powerful tools that mathematization had unleashed. On the other hand, none of the engineers who worked on mathematization could deny the importance of working on specific projects to their thinking and direction of their inquiry. The technical class of the era spanned the Atlantic, linked by what Antoine Picon has termed the notion of *la rationalité technique*, a shared outlook that the physical world and society functioned and behaved in ways that were ultimately apprehensible. Taking this notion into account, one of the aims of this study has been to bridge the anglo- and francophone historiographies of engineering in order to avoid spending energy on unhelpful parsing of “Frenchness” or “Englishness” of particular design decisions, and instead to understand the combination of theoretical and empirical knowledge in the production of engineering. In particular, I wish to examine how Picon’s notion of technical rationality, a dynamic, searching, forward-thinking outlook, interacted with American landscape and society during Reconstruction.

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Nature and Work

To study this type of engineering is to study the natural world. Sand, mud, flowing and standing water, cottonwoods, cordgrass, wind, and tide make up the bulk of the material examined in this dissertation, complemented by the constant question of how the engineers perceived and formed knowledge of the natural world. In their practice, there is little evidence of hierarchical thinking in which the imposition of human will descended from a higher plane to dominate the natural world. Instead, I have found that the engineers of this study saw themselves as thoroughly enmeshed in nature; their tools and forces met by an equal partner. As one of its central objectives, this study then revisits the historiographic question of the ideas and attitudes around the human control of nature. Perhaps because their natural world was thoroughly unromanticized, the historian Raymond Merritt characterized the nineteenth-century engineer’s view of nature as “the symbol of a neutral, inert reality.” But after examination of the engineers’ work, and what they wrote and said about their work, I have found this characterization to be incorrect. Nature was not symbolic to these engineers; it was extremely, life-threateningly real. Nor was it inert. As is discussed in the accounts of the design and construction in this study, the

41 This study owes much to the groundbreaking work of environmental historians, who have ensured that the natural world is an integral subject of historical study. I have made use environmental history’s method of investigating the agency of the non-human environment on human affairs and its role in producing change in the world. With this in mind, one of the major aims of this study has been to resist the allure of over-specializing either in technical or natural themes and instead to understand how important analysis of both realms are. See Ted Steinberg, “Down to Earth: Nature, Agency, and Power in History,” *American Historical Review* 107, no. 3 (June 2002): 798–820.


43 My theoretical position has been influenced by the recent and fascinating work in “new materialism,” and I believe benefitted from using a perspective that encompasses communities of human and non-human actors in understanding historical change. See Diana Coole and Samantha Frost, eds., *New Materialisms: Ontology, Agency, and Politics* (Durham and London: Duke University Press, 2010).

natural world was a forcefully present and dynamic actor that shaped the form of structures and informed the limits of human will or what could be achieved by rational practice.

Engineers gained their perspective on nature through sustained work in wild environments. They worked in the mud and on the beach, grappling with nature’s forces firsthand in the landscape. Nineteenth-century civil engineering practice was the closest to a modern, ecological understanding of nature: it isolates natural phenomena into discrete objects of study, only then to reassemble that knowledge into an understanding of the interaction of forces in a complex field. Beyond analogs in practice, feedback from complex natural systems formed the core knowledge of how the engineers made decisions about how to assemble structures that would, once installed in nature, would behave in the way they were designed. Historians have written much on the “illusory boundary” between technical systems and the natural world, and how attempts at technical control of nature are fundamentally ecological acts. To this body of work I add a closer examination of the work of design as an active process of environmental inquiry, producing environmental knowledge that is then in turn internalized by institution and state. In this way, drawings, diagrams, construction specifications, and engineering reports can all be seen as instruments by which we too, alongside the engineers, can understand the natural world of the mid-nineteenth century.

The people who actually manipulated the landscape are considered equally to the engineers at work drawing, as the laborer gets us even closer to the natural world. As Bruno

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Latour has argued, analysis of construction sites “offer[s] an ideal vantage point to witness the connections between humans and non-humans.”

Labor is considered in an expansive definition, encompassing both intellectual and manual categories, as they both critically inform each other. To this theoretical approach, the racial and class divisions of American working life of the time remain essential. White and black workers never formed a coherent working class in the American South because of deeply-entrenched racial distrust and open animosity, and a concerted effort by capitalist, both south and north, to suppress workers’ solidarity. The army played a significant role in describing the terms of labor in the postwar South, exerting its considerable influence and material power to coerce the “conversion” of emancipated person to wage laborer, and even, as is well-known, violent suppression of efforts at unionization in the latter part of the period considered. The army’s ambiguous moral position with regards to labor, both black and white, is acknowledged throughout this study. Yet considering how the army engineers worked with laborers on the reefs and estuaries—at the scale of the construction site—the free black worker exerted more influence over the processes of design and construction than is initially apparent in the larger meta-analysis. The men who wielded shovels and worked steam derricks, almost all of them black and born into enslavement, formed the forefront of the United States’ interaction with its natural realm. Their story must be told by looking at the artifacts of the construction process.

Capital was the prime mover behind these construction projects. At times welded to ideologies of political unity, at others represented as pragmatism or “common sense,” still at

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others nakedly visible as the principle that organized workers and engineering expertise to intervene in the landscape, capitalism was more than a reference to the organization of U.S. economic life: it was itself a force, and its relationship to both the military and engineering practice is considered throughout this study. However, I have taken cues from recent historical work that calls for a careful examination of infrastructure building as a complex phenomenon not easily described as economically-determined. Infrastructure relied on both the potential for profit and the state to guarantee its overextension—in this way it is difficult to ascribe purity of motivations, nor an easy causal chain between profit-seeking and the structures built in the landscape.48 Du Bois described the postwar economic transformation as an “orgy of theft,” and guarantee of concentrated wealth amongst the northern and southern capitalist class, an “oligarchy in the back of the military dictatorship.” He characterized the strength of capitalism as an organizational factor of Reconstruction as the “natural child of war.”49 As such, the internationalization and financialization of economic life of the time must be considered alongside the ideological and aesthetic narratives about “reconstruction” that the various actors in this study tell themselves. Moreover, though capitalism organizes materials and infrastructure across the globe, the American South plays an important and specific role in the construction of the global network. Historians have examined the nexus of capital, slavery, and cotton—the plant-as-commodity that defined work and landscape in the South—linking the U.S. South to global modes of production and flows of energy and material that had great bearing on human rights, work life, and the built environment.50 Engineering in this environment is inextricable

48 White, *Railroaded*.


from the legacy of the brutal economic regime that created the landscape and continued to define its postwar trajectory.

**Landscapes of the South**

The concept of landscape has proven useful in combining the many different threads of inquiry outlined above to create a picture of the complex interactions of humans and nonhumans of the era. I generally refrain from using it as a metaphor. By landscape I take to mean areas of land that can be taken in by the human eye at a high vantage point—a definition that has a lengthy historiography relating land and vision and techniques of representation such as maps and drawings. Landscapes bear the record of human intervention and inhabitation; as the historian John Stilgoe has noted, “a landscape happens not by chance but by contrivance, by premeditation, by design.”51 In my use of this term I share an understanding with the geographer Denis Cosgrove, whose widely regarded work linked social ideologies to the landscape forms their societies produced, arguing that landscape indeed itself was an ideological concept.52 The historical record written in the landscape yields concrete and abstract evidence of a society’s self-conception of place within nature and, simultaneously, the ways in which it forms scientific knowledge at its most primordial level.53 Landscapes act as vessels, holding the keys to describing the technical, societal, and environmental change at the heart of this study.


The American South has been subject to a great deal of study from the environmental approach; its landscapes have fascinated those who would interpret and describe them in the Western tradition since early European exploration. To this tradition I humbly add another investigation, admirable of the diversity of environments and conditions offered by this small sector of the globe. The South’s regional definition is a curious artifact of slavery—a heterogeneous set of environments defined by an exterior set of contingencies. For this study, I have embraced the entirety of the region because it offers the opportunity to examine engineering in the differing landscapes of Texas and North Carolina, and because the army and U.S. Government were both forced to see the South in terms of artificial unity as well. The Mississippi River, whose great basin dominates both geography and historiography of the region, plays but one part of the larger narrative of Reconstruction. In assembling a group of engineering projects from across the vast swath of the nation, I present a more comprehensive view of society and its various landscapes undergoing change.

This study is organized thematically by chapter, each of which focuses on a specific engineering project to describe the larger theme. In this way chapters have a specific physical


focus, but are not case studies, as other projects and historical material is considered as they illuminate the chapter’s central conceptual theme.

The first chapter traces the broad outlines of Reconstruction as a political and a material process, and locates the army within the ideological currents of the era. Many of the levees that protected southern agriculture and cities were destroyed over the course of the war—more from neglect as the enslaved people who had been forced to maintain them fled or refused to work than because of combat—and desperate planters renewed their efforts to capture federal aid to maintain the increasingly tenuous grasp they had on the hydraulic landscape constructed to support cotton agriculture. This chapter describes the beginnings of federal enmeshment in the great problem of the Mississippi’s alluvial basin at the end of the war.

The second chapter describes the graphic form of engineering practice at the middle of the nineteenth century. Derived from military theory, the method of landscape organization employed by engineers made use of a distinct set of mathematical technologies and epistemic view of land and society. This chapter studies the rise of these geometric theories in the context of European military and engineering culture, their transfer and mutation to American shores, and the training regime in which military engineers in the United States were taught to combine applied mathematics with whatever situation they found themselves in on the ground.

Chapter three focuses on the actual design process. Using the reconfiguration of the lower Cape Fear River in North Carolina as a touchstone project, the chapter outlines how engineers formed knowledge about the environments they were acting in, and how their bureaucracy functioned in interaction with the natural world. Design was a continuous process that involved small-scale intervention and careful accounting for how nature in turn responded, and was more akin to a practice of situation than domination.
Labor is the subject of the fourth chapter. The federal government played an overt role in reshaping labor relations in the postwar South. The jobsites overseen by federal engineers were locations where federal agents imposed the mass conversion of former slaves—mostly unskilled agricultural workers—to wage workers in the industrial landscape. This transformation is taken into account alongside an examination of the working conditions of the era, and how engineers, contractors, and workers brought their own priorities to the construction site, each contributing to the enterprise of reshaping the natural world.

The final chapter describes the process in which the Corps of Engineers reorganized itself as an infrastructure-building agency through the creation of administrative departments that were joined with watershed divisions of the American landscape. As the engineers sought to harness the energy of rivers, such as the Savannah, and the broad coastal sounds of the Gulf Coast, such as Galveston Bay, they expanded their territorial power inward, claiming more legal purview over the watersheds whose drainage so affected their works downstream. These institutional and environmental transformations that have thoroughly embedded the federal army in the American landscape to this day began with a wintertime voyage down the Mississippi to survey the state of the landscape, and the extent of damage done by a recent war.
Chapter One
The Army and Reconstruction of American Territory

Others take finish, but the Republic is ever constructive and ever keeps vista,
Others adorn the past, but you O days of the present, I adorn you,
O days of the future I believe in you—I isolate myself for your sake,
O America because you build for mankind I build for you,
O well-beloved stone-cutters, I lead them who plan with decision and science,
Lead the present with friendly hand toward the future.

—Walt Whitman, *Leaves of Grass*

A few months after Robert E. Lee’s surrender at Appomattox and the effective end of the Confederacy and the American Civil War, Maj. Henry L. Abbot was sent by his superiors to Louisiana to survey the damage done during the war to the levees along the Mississippi River.¹

Abbot, lately of the regular army and now back at his antebellum post in the U.S. Army Corps of Engineers, was no stranger to the swampy lower reaches of the “father of waters.” Together with the new Chief of Engineers, Gen. Andrew A. Humphreys, Abbot had spent several years in the decade before the war surveying the river and composing a *Report on the Physics and Hydraulics of the Mississippi River* as part of their duties as military engineers.² Shortly before the first peacetime Christmas the United States had enjoyed after four years of brutal and bitter warfare, Abbot wrote to his old surveying associates in the army who were stationed in Memphis, asking for assistance in creating his catalog of the war’s destruction. Humphreys, his old partner

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¹ A note on the use of ranks: as this study spans two decades, in which many of the officers mentioned were promoted, demoted, or left the army. Including the rank of the individual at each mention would at best confuse the reader. I therefore use the following system: an individual’s rank is noted at their first mention in the text (or note), and the rank indicated is the rank held at the time. Thereafter I simply refer to individuals by their last names, and for the sake of simplification, omit rank or title.

and coauthor, warned Abbot of the War Department’s wariness of becoming entangled in a large-scale rebuilding of the vast system of levees and dikes that lined the country’s largest river. The engineer therefore was to survey the failed levees and swamped farmland, dissolute due to neglect and warfare, and identify those places where the government might intervene to restore agricultural operations along the fertile and profitable valley bottom. Shortly after the new year, 1866, as both he and his surveying team were sailing southward aboard the steamer *Flora*, Abbot composed instructions for his surveyors to make, “as completely and methodically as you can,” a picture of the wreckage the conflict had wrought upon the landscape.  

![Image](image_url)  

Figure 1.1. Charleston, South Carolina. *Harper’s Weekly*, July 8, 1865.

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3 Andrew A. Humphreys to Henry L. Abbot, December 26, 1865, 1865 journal, Box 1, Henry Larcom Abbot Papers, Houghton Library, MS Am 1447, Harvard University, Cambridge, Mass (hereafter cited as HLAP); Abbot to Henry A. Pattison, December 14, 1865, v. 3, Henry L. Abbot Letter Books, HLAP. Abbot to Pattison, January 2, 1866, ibid.
The task would prove to be a vast one, and one that a lone surveying team could not hope to fully describe. The South’s dilapidated levee system was near a thousand miles of metonym for the political and physical state of the section. Gaining a complete picture of the extent of the national reckoning was impossible; instead, Americans varied in their approach and description of the process of Reconstruction, each sliver of experience describing one aspect of the larger processes in the landscape.

There are three critical approaches to the era and conceptual structure of Reconstruction that contextualize the different processes of rebuilding, the new order envisioned in that rebuilding, and the situation of the state’s engineering apparatus in that new order. The first approach is to understand the cultural impact of impressions of devastation, and the degree to which a national narrative of degradation and decline across the Southern landscape existed and spurred action toward rebuilding. The second thread is that of modernization, both within the army and in the larger state and economic structure of the United States. Modernization was seen as a product of war, and a byproduct of war’s destructive forces, which exerted pressures on institutions to respond to a new environment. The third thread considers the establishment of a new relationship between the republic and its territory. This relationship is not imperial, and relies heavily on the manipulation of public perception and the symbolic regime that gives the republic legitimacy in the Gilded Age: capital. These three approaches are at play in the federal foray into infrastructure construction at the Mississippi levees in the immediate postwar period. This complex interaction, which resulted in small scale physical construction but clearly described the possibilities of federal growth, touches on all three important avenues of approach taken to the reconstruction of American territory after the war.
Military Necessity and What Theories of War do to Landscapes

Beyond the lower Mississippi valley, the scope of destruction followed the area of the operations of the armies involved in the war, sending shoots of economic disintegration and domestic despair outwards, well into territory that never saw soldiers’ bootprints. An entire section of the North American continent had been subjected to a modern kind of warfare that targeted and destroyed the territory that it was fought in as much as the bodies and equipment of the combatants. The state of the political centers and trading cities of the South—their smoldering ruins portrayed to the victorious North in photographs and etchings for periodicals—were emblematic of the state of things in the former Confederacy. Southern cities had not fared well under direct attack by federal weaponry; even those not directly bombarded suffered greatly by virtue of existing in the territory of modern war. John Trowbridge, a northern visitor to Petersburg, Virginia, outside the Confederate capital in Richmond, described the “uninhabitable houses, with broken walls, roofless, or with roofs smashed and torn by missiles.” Reading in the ruins a story of the immense power of industrialized warfare he saw an architecture that bore “silent witness to the havoc of war.” Origin of the first armed resistance against the federal government, over one-eighth of the busy southern port of Charleston, South Carolina was reduced to ash under mysterious circumstances, its ruins to Trowbridge “the most picturesque of any I saw in the South”:

The gardens and broken walls of many of its fine residences remain to attest their former elegance. Broad, semicircular flights of marble steps, leading up once to proud doorways, now conduct you, over their cracked and calcined slabs, to the level of high foundations swept of everything but the crushed fragments of their former superstructures, with here and there a broken pillar, and here and there a windowless wall.

4 The historian Megan Kate Nelson has noted how important the physical appearance of the ruined South was to the sense that the war created permanent change: “Ruins seemed to capture the moment of transformation from one time to another, from one material form to another.” Megan Kate Nelson, Ruin Nation: Destruction and the American Civil War (Athens, Ga.: University of Georgia Press, 2012), 2.
Some of the southerners who remained to inhabit their ruined cities exhibited a gallows humor, claiming the smashed churches, civic buildings, and houses as the true monuments to the folly of the politicians who, in their stubborn support of human chattel slavery, brought on the depredations of war. But such circumspection was rare amongst the beaten but recalcitrant populace, and northerners looking for satisfaction that sufficient punishment had been dealt out had to find evidence in the architecture, and any public display of regret in mourning of lost cities. In Columbia, South Carolina, where eighty-four of 124 city blocks had burned to the ground, the local newspaper lamented “[h]umiliation spreads ashes over our homes and garments, and the universal wreck exhibits only one common aspect of despair.”

A widespread sense of ruin set the scene for a “constructive” solution based on idea of public intervention and governance. Images of despair, destruction, dissolution, decline, which circulated both North and South in the postwar era, contributed to a narrative that asked for reversal. This cultural production was at times exaggerated, and southerners in particular emphasized a counter narrative of restoration. The general perception that the South was at a nadir essentially created the national trajectory of creative rebuilding.

Agricultural production had largely collapsed, and with it, all capital tied up in the South’s agrarian society had largely evaporated. The effect of the war, while not as picturesquely visible or concentrated as in the cities, was nonetheless equally devastating. Trowbridge found Virginia “a level, scarcely inhabited country, shorn of its forests by the sickle of war,” and, as a Yankee, reveled slightly in finding the “great Slave Empire” reduced to “uncultivated wastes.”

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Along the Atlantic coast northern agents and observers found the varied forms of the plantation landscape abandoned and quickly converting themselves to “old fields,” well on their way to the succeeding stages of reversion to forest. Yankee observers remarked on the “weary” conditions of the land under the new growth of infant pines, briers, weeds, and broomsedge, judging that the degraded fields were a logical result of the debased practices of using enslaved people to work at their cultivation. The tone of many of the observers indicated a belief that corrupt social practices necessarily caused debased landscape organization, and that invasion by pine saplings and sedgegrass was as appropriate a form of punishment as the cannonballs and fire in Atlanta and Charleston.

Regardless of the ideological inflection of the agricultural system, it had been thoroughly destroyed. A recent accounting figured that by 1865 over one-third of the livestock was dead, half the agricultural machinery, and the majority of the South’s scant manufacturing facilities had been dismantled or destroyed. Nascent southern railroad infrastructure suffered as well; most rails William T. Sherman’s men could lay their hands on had been twisted beyond repair. By the last year of the war, two-thirds of the assessed value of property in the section had vanished. The planter and professional classes returning to ruined cotton plantations and urban centers felt the pain of the war in capital losses on their balance sheets and the dawning recognition that their way of life had come to an end. But the destruction and economic hardship across the land was total and was borne across social classes. Carl Schurz, a northern government surveyor, noted especially the plight of common southern soldiers. Most who composed the ranks of the Confederate army held no slaves nor any great purchase in the antebellum South’s sources of prosperity. Schurz recorded their dismay when returning to find “their homesteads destroyed, their farm devastated, their families in distress … an impoverished and exhausted community
which had little to offer them.” Battles and the policy of destruction visited by northern armies, especially Sherman’s traverse of Georgia and South Carolina, had indeed left swaths of intense destruction. But for the most part, the destroyed homesteads Schurz observed were not riddled with bullets nor touched by the forager’s torch. Schurtz found the fabric of southern society itself had been rent, and its tattered remains cast doubt over its continued ability to function. The unseen marks of economic collapse and social despair were more troubling than the visible scars of farms and houses reduced to charcoal. The war, the most cataclysmic event the United States had ever experienced, had traumatized both landscape and society, the wounds of one mirroring those of the other.⁶

Figure 1.2. Trestle work on the City Point and Army Railroad, Virginia. Library of Congress. As engineering and construction crews moved through the landscape they harvested building materials from areas surrounding the linear construction site.

War affected the landscape and the social structures that occupied and maintained the land, and existing antebellum organization was disrupted in varying degrees of intensity. The order of slave cultivation proved the most delicate, and crumbled swiftly with little more than the presence, or rumor of the impending arrival, of a federal army—increasingly so after emancipation in 1863. Freedmen abandoned plantations and flocked to follow federal troops and often set up encampments near federal military posts. This became a routine and well-known disruption throughout Confederate territory in the latter half of the war. The loss of labor on plantations led to quick disintegration of nearly all commercial cultivation in the wake of Union soldiers, but actual military presence was only the proverbial straw that broke the precarious, if brutal, regime of the what Walter Johnson characterized as the “carceral landscape” of surveillance and violence that the southern order was based upon. Prior to deep federal incursions into the South, landholders had resisted Confederate military efforts to press slaves into labor on fortifications to resist northern invasion, wary of the disruption of a carefully maintained coercive “routine,” developed over centuries, that maintained order in the landscape. Despite the actual instability of the situation, northern soldiers visited a more-than-thorough regime of destruction on all aspects of society and landscape in the rebellious states.\(^7\)

Symptoms of what one historian has termed a “strategy of annihilation,” the Union’s actions visited a brutal and primordial form of warfare on the landscape. Technological advances, such as rifled weapons, played a role, displacing study of Napoleon’s campaigns and rendering Enlightenment methods obsolete. Ruthlessness marked Union policy of aiming to destroy the Confederate army as well as degrade the economic and psychological atmosphere of the South.

by destroying agricultural and manufacturing capacity in broad swaths of the landscape. The “hard hand of war” theory used territorial control and spatial organization as among a commander’s primary considerations; in the case of Sherman’s March, geographical assessment and planning helped exact as much pain as possible.

Figure 1.3. Confederate fortifications near Centreville, Va. 1862. Library of Congress.

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Though the massive earthworks and other detritus were no longer scenes of open warfare, much of the South remained in a state of pervasive violence in the war’s immediate aftermath.¹⁰ Military and civil observers who assessed the political and physical conditions of the South in the summer of 1865 warned of what eventually came true: decades of political instability and racial violence that plagued (and continue to trouble) the American South were in evidence in the first shaky months of peace. Schurz, who had warned that “[n]othing renders society more restless than a social revolution but half accomplished,” found troubling amounts of violent incidents perpetrated against freedmen because of a number of factors, not the least of which was the uncertainty around whether or not the federal government would complete the job begun by emancipation and vigorously incorporate freedmen into the national polity. Racial tensions were not the only source of violence, as wartime scarcities and widespread absence of civil law authorities created a situation of desperation and chaos. Soon after the end of hostilities, Union military commanders rushed to break up and distribute their armies over territories under their control in order to prevent the outbreak of anarchy.¹¹

Reconstruction was never meant to transform the South into a “garrison state,” but years of continued federal military presence affected both the conceptual evolution of a federal role in the ordering of the landscape, and the army’s perception of itself as an institution engaged in civic organization. Though the Nation had called for the maintenance of 200,000 federal soldiers in the south for two decades, the War Department quickly drew down the enlarged army, and by


¹¹ Schurz, Report, 37, 59–60.
1866 projected having only a quarter of that number of soldiers on its rolls.\textsuperscript{12} Even diminished, the army maintained a presence in the South through 1877, given a political situation that was not open warfare, but not exactly peace. For those twelve years politicians in Washington and across the capitals of the reconstructed states questioned the role of the army in the South. Chafing under what amounted to occupation, southerners tried to reverse their status—the equivalent of a foreign territory, affording no legal bar or recourse to contest occupation. Legal ambiguity affected the behavior and outlook of northern soldiers as well. Anxieties about the legality and morality of occupation led some officers in the military to agitate, according to one historian, for a continuous “state of war.” The officers in particular were aware of how close they were to crossing one of the great taboos of republicanism: military policing in the civil realm. Personal doubt as well as public opinion wore on them.\textsuperscript{13} Yet a pervasive “state of war” was conveniently easy to find. As federal cavalry in the interior of the cotton belt struggled to tamp down the organized guerillas and progenitors of the Ku Klux Klan who terrorized the countryside, military commanders foiled plots to import ammunition and weapons through Southern ports to supply the insurgency.\textsuperscript{14} In many ways, the conflict simply subsided in the scale of outright violence, and became spatially diffuse throughout a larger area.

Effective federal control and the army’s ability to curtail violence extended only as far as marching distances from federal outposts. Networks of federal control, reflecting the progress of the campaigns of the war and reminiscent of the antebellum cordon of federal customs stations, tended to concentrate along rivers and along the urban centers on the Atlantic and Gulf coasts.

\textsuperscript{12} Summers, \textit{Ordeal of Reunion}, 86, 36.

\textsuperscript{13} Downs, \textit{After Appomattox}, 6.

\textsuperscript{14} Schurz, \textit{Report}, 59.
Postwar drawdowns spread the army thinly across a vast territory. The other federal agency of reorganization, the Bureau of Refugees, Freedmen, and Abandoned Lands, commonly referred to as the Freedmen’s Bureau, shared this spatial philosophy. Administered by military officers, and a quasi-military institution itself, the bureau placed agents in a distribution pattern with each agent responsible for impossibly vast amounts of territory. Distribution and atomization did little to help the agency’s effectiveness. One bureau agent, who remained an officer in the army while working for the bureau, described his “satrapy” as covering over 3,000 square miles and some 80,000 “souls,” an enormous territory administered solely by him from a one-room office. The Freedmen’s Bureau spearheaded the social mission of the federal government, regulating contracts and advocating for the civil rights of freedmen against a hegemonic white supremacy. The bureau was, throughout its short tenure, linked spatially and ideologically to army units who they relied on to maintain order in the face of violence. In all of these tasks, military officers wanted in preparedness. Their limited effectiveness in creating a land use revolution in the South should not discount the bureau and the army’s interpretation as a manifestation of intention to change the social and physical landscape.  

Actual rebuilding of destroyed city wards proceeded at a pace that surprised most northern observers, and even some southerners, who found the signs of life and new buildings going up an antidote to earlier despair. One refugee from Atlanta described how a month after Lee’s surrender the city was “nothing but piles of brick,” and recalled his surprise at how six weeks later that summer entire blocks of new buildings had sprung up. Richmond’s thirty-

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block “burnt district” was similarly alive with rebuilding in the summer of 1865, with freedmen carpenters quickly obscuring evidence of the fire with frame buildings. There, and in Atlanta, wood was the primary method of construction due to both lack of capital and the speed with which new buildings could be put up. Rents in Richmond that summer grew so out of control in relation to construction prices that speculators could rent new buildings with the cost of construction only slightly exceeding one month’s rent. Housing shortages and the opportunity for making money transformed Richmond as a frenzy of development caused landowners to even build tenements in their backyards. Enthusiasm for construction translated into shoddy construction and frustration with any perceived restrictions, yet northern observers consistently observed a quality of haste that could not be directly ascribed to a booming housing market. Overall, urban southerners were eager to move on from the ordeal of the war, and increased building activity was a sign of a larger desire. Schurz, after interviewing members of the urban professional and landholding class across several southern cities, observed a shared “clear perception of the irreversible changes produced by the war,” and, with that, an eagerness to construct a new civic order with a stable economic and social foundation in both the cities and the countryside. To southerners, this meant construction of replacements of the housing, warehouse space, and commercial links that moved agricultural goods—things that had been destroyed in the war. Southern enthusiasm for railroads indicated a willingness to augment replacement with improvements to the machinery of commerce. Northerners, however, took a


18 Summers, Railroads, Reconstruction, and the Gospel of Prosperity, 47.

19 Schurz, Report, 5.
less sanguine approach, as simple replacement of buildings and bridges destroyed in the war remained insufficient for the reorganization they perceived the nation to require.

Southerners and northerners believed that economic redevelopment would solve all problems of unity and strife. They also knew that the task required more efforts than a few burned blocks in Richmond or Charleston. Beyond the cities, rebuilding meant recalibration of a fallen kingdom; no easy solution to the problem of reconfiguring the labor regime across such a large section of the country was immediately apparent. Instead, southerners and northerners both again focused on that plant which had brought the first wave of prosperity to the countryside, believing fervently it would again.

Cotton remained the key economic commodity meant to fuel the reimagined economic base for the new society. A thousand miles of coastal blockades had made southern warehouses overflow with cotton, and northern industrialists and southern opportunists equally and eagerly wished to exploit this store of capital before moving into the countryside and putting the land back to work. Cotton, “our old stand-by,” was widely believed to be a panacea for all of the woes of war. Cotton would erase the war’s public debt; it would also reverse the flow of gold to Europe—a perennial anxiety in a society that had yet to embrace the greenback. Reporters speculated that the 1865 cotton crop would total two million bales, less than half the production of 1859, but with inflated prices due to supply restrictions, those two million bales were assessed as having the same potential revenue as the entire prewar crop. With the blockade lifted, cotton production was pursued with feverish intensity at all levels of society. So pervasive was the sense of communal effort that even officers of the occupying army prioritized cotton production.

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20 O’Donovan, Becoming Free in the Cotton South, 69.

A military governor in South Carolina reported with pride his administration in the fertile country east of the Wateree and Santee Rivers promised to produce more cotton in 1866 than any year previous. However, in their enthusiasm for renewed production and embrace of northern industrial methods to augment cotton yields, southerners did not fully realize the landscape transformations destined to occur after the door was open to Yankee market capitalism.22

Growing and moving cotton was capital intensive.23 The geography and environment of the South provided their own unique obstacles that required expensive solutions to overcome. First, the agricultural South was a maintenance-intensive landscape. The levee system required enormous amounts of vigilance and labor to keep the ever-encroaching salt water and prolific vegetation in the humid south at bay. The evaporation of labor discipline and the destruction from fighting had broken levees and left plantations abandoned; the river inundated thousands of prime cotton acres, and no real defense was available for those acres remaining against the ever encroaching marshlands, thistle and cocklebur. Slave labor had provided a bulwark to entropy, but without coerced labor, the state of the agricultural fields approached that of the South’s other historically problematic economic component: transport. Capitalization of transportation systems in the South had always been anemic, but destitution brought by war had degraded the infrastructure even further: wharves and piers, useless within the blockade, had been dismantled for firewood.24 A reputation for burning infrastructure, amongst other signs of instability, made the region unattractive for private investment, especially when compared to emerging

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22 Trowbridge, The South, 565; Summers, Ordeal of Reunion, 44.

23 “The Cotton Question,” Harper’s Weekly, June 24, 1865. For an expansive and important view of the imperial aspects of cotton production, the political systems that supported it, and the global reach of this commodity, see Beckert, Empire of Cotton: A Global History.

24 Summers, Ordeal of Reunion, 38.
opportunities in the West.\textsuperscript{25} Instead, southern states, especially those that bordered the Mississippi, came to clamor for massive public investment in the levee system and navigability of the Mississippi and other rivers in the form of an integrated, federally-funded transportation system.\textsuperscript{26} Levee and embankment projects would also make available (or reclaim and make available again) the fertile bottomland and bordering swamps, “containing soil of unsurpassed depth and richness,” that fringed the rivers’ bottomlands. Speaking to a northern reporter, Louisiana farmers envisioned engineering the river so that it would not simply confine the river to one chute, instead advocating for a more extensive system of mechanical influence to harvest the river’s nourishing silt.\textsuperscript{27} This capital-intensive engineering practice required an institution equal to the task, and before the war even ended, enterprising southerners had identified the wealth of the federal government and sought capital investment by appealing directly to military officers.\textsuperscript{28} As it stood, and fortunately for those who advocated for mechanization of the landscape, a war-enlarged army and eager and activist government was already occupying the ground proposed to change.

\textbf{The Old and New Army}

Compared to its European counterparts, the United States Army for much of the nineteenth century was puny, underfunded, widely-mistrusted—if not despised—and played no role in the iconography of the state. A mere 16,215 men in 1860, it had ballooned to over one million men

\textsuperscript{25} Foner, \textit{Reconstruction}, 213.

\textsuperscript{26} Summers, \textit{Ordeal of Reunion}, 132–33.

\textsuperscript{27} Trowbridge, \textit{The South}, 395.

\textsuperscript{28} Whitelaw Reid, \textit{After the War: A Southern Tour, May 1, 1865, to May 1, 1866} (Cincinnati: Moore, Wilstach & Baldwin, 1866), 125.
at the height of war and conscription, but swiftly returned to 57,072 officers and enlisted men at the cessation of hostilities.\textsuperscript{29} The peacetime army was essentially thought of as a “frontier constabulary,” as one historian described it, and was never a very serious fighting force. Instead, the army’s role in the republic had evolved as a concentration of labor and a building force, and certain exterior prejudices and interior self-conceptions, cast the institution as a repository of men who were effective in other pursuits. These, by and large, did not involve fighting. Soldiers, by virtue of their training and perceived abilities, and expected loyalty to the state, were assigned exploration, mapping, and engineering duties throughout the United States and its territories as matter of routine in the antebellum period. Officers pursued these duties with zeal and memorable success—Meriwether Lewis and William Clark, and John Frémont have been remembered for their civil duties more than their martial exploits. The army as a pioneering force had internal critics: Zachary Taylor, a career army officer and eventual president lamented that the “ax, pick, saw and trowel, has become more the implement of the American soldier, than the cannon, musket or sword…”\textsuperscript{30} But the use of the American army from its origins as a scientific and constructive force gave it an indelible hybridity of purpose and function.

The war and occupation transformed the army, including the Corps of Engineers, into a modern institution. This metamorphosis primarily entailed an increase in bureaucratic structure (and inertia), and territory of responsibility within the larger federal government. In the context of the Corps of Engineers, the prestige of victory and institutional invigoration allowed for the engineers to push the limits of their technical and political capacity. This involved an expansive

\textsuperscript{29} U.S. Office of the Assistant Secretary of Defense (Comptroller), \textit{Selected Manpower Statistics}, U.S. Department of Defense (DOD), Directorate for Information, Operations and Reports (various years); and unpublished DOD data.

sense of experimentation, both with the effectiveness of their structural alterations to the landscape as well as their desire to seek essential entwinement with the economic processes of the nation. Shedding the self-conception of a germane home for bright soldier-scientists who could maintain gentlemanly scientific practice, the army and the corps both transformed into powerful institutions that wielded technics at a higher order of ambition and territorial scope.

Construction was a routine part of military life. An officer in the American army, schooled in the writings of the great military minds of the past, was familiar with the notion that the practice of soldiering could and did consist in large part of surveying and building. The pedagogy of the U.S. Military Academy at West Point ensured that engineering practice was at the heart of the officer corps. The top tier of military leadership in both sides of the Civil War had spent their peacetime working life in construction and applied mathematics. The army’s projects were smaller in scale than those of infrastructural revolution in the second half of the nineteenth century, but similarly included the improvement of rivers, construction of locks and canals, and the siting and construction of lighthouses and coastal fortifications. Related activities comprised surveying and mapping of the territory, and technical advice for private enterprise.31

During wartime, many engineers transitioned to positions in the infantry or other branches of the army that engaged in combat. Many however, participated in the fighting by putting their engineering skills to use. The engineers were assigned to construction of bridges and railroads, maintaining waterlogged supply routes, and providing logistical and technical support in a ceaselessly uncooperative environment. Offensive engineering included strategic river


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displacement, and destroying levees to induce flooding. At the cessation of hostilities, most of the protagonists of this study returned to their professional baseline: design and construction, albeit with broadly expanded notions of territorial, managerial, and material organization.

In the “old,” antebellum army, the engineers’ were oriented professionally toward self-conception as disinterested scientists, and social stratification limited their engagement with the capitalist class. Professional engineering expertise taught to all of West Point’s graduates contributed to aspirations toward a gentlemanly social class amongst the officer corps. But the small size of the army and the vastness of the disputed western borderlands contributed to the isolated experience of being an officer or soldier in the army, and distance from the mainstream of American society. Officers also were not well paid, and struggled in harsh conditions when it was apparent that they could easily earn more income in civilian industry jobs. Life on the frontier or far-away forts was a life of privation and isolation—and even if you were stationed at a fortress near a city like Baltimore, social barriers prevented full integration into local society. Edward Coffman, in his sociological and historical study of the army as an institution, argued that this isolation created a reliance on development of professional skills (especially engineering and scientific pursuits) and cohesion to the officer corps as a class defined by a common sense of being educated men.

As a truism of American history, the Civil War changed everything. The institution underwent a social and moral transformation through the process of war. Additionally, one of the social ramifications of Union victory was changed expectations for the national army, especially

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33 Coffman, Old Army, Ch. 1.
as an agent of societal change. The officer corps retained the qualities of engineering skill and a sense of cohesion through a common feeling of being educated men. But the experience of the war necessarily changed the way the officers thought of their role in relationship to the state, and their participation necessarily changed the workings of the peaceful state. The war also changed the public’s perception of the army, including changing attitudes toward its increased visibility and increased scope of agency. Transformed from an Indian-fighting force into an almost holy “avenging host,” southerners perceived the army as powerful and meddlesome.  

Postwar military officers additionally enjoyed a surge in personal prestige as well, given the great “moral and psychological effect of the blue uniform” of the victorious army. To the thousands of men who participated, Union victory described the power of industrial and logistical might, and the orchestration of technology and ideology to effect enormous social change over large areas of territory and society.

Three broad institutional changes emerged. First, the army came to see itself as an agent that could exert influence over and fundamentally change segments of society. This newfound power came from the liberation of enslaved people and the army’s role as de facto final authority in situations of economic turmoil that emerged from emancipation. The second was the increased sense of the role of engineering in unleashing the previously unimagined transformative forces of capitalism. And finally, the flowering of a robust bureaucracy within the army that gathered and aggregated data from the entirety of the nation, increasing the government’s ability to imagine and develop a larger reach of territorial control.

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34 Coffman, 35.

Throughout the war and the years afterwards the army remained the most effective means of social engineering available to the U.S. Government. Freedpeople fled plantations and flocked to federal armies in the field, which became de facto sites for the development of federal policy toward freedmen. Famously declaring freedpeople “contrabands of war” and denying southerners attempts to draw black men and women back into slavery, the Union general Benjamin Butler jumpstarted the army’s acceptance of the northern moral ideology of emancipation as its guiding policy. The army used the fruits of their moral mission to practical advantage, enlisting over 200,000 black soldiers by the end of the war and paying black laborers wages on construction projects that supported logistics and combat throughout the South. Life in the army and interaction with military and federal policies gave freedmen a glimpse of the order of free life and impending Yankee intentions toward southern social structures. The army provided freedmen equal pay and bounties, equality under the law and a legal system in which blacks could testify, and even made efforts to teach black soldiers to read and write during their enlistments. The legal system was perhaps the most stunning change to the South’s structures of everyday life, where, according to Foner, “former slaves for the first time saw the impersonal sovereignty of the law supersede the personal authority of the master.” Though army officers varied in their degree of commitment to black equality and suffrage, and may have even hesitated at the hugeness of the project of remaking an entire social system, their belief in the viability of military shaping of social structures had serious subscription. The issues of the Civil War would dominate politics of veterans for the rest of their lives.

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Logistics—the movement of men and materials—emerged as its own specialty in the context of the first industrial war. Northern newspapers reported miles of rail and telegraph line laid alongside reports of troop advances. The railroad pushing through the landscape became a symbol of northern indomitability as images of its robustness in form and activity circulated in the public (and military) imagination. The officers, engineers, financiers, and railroadmen who built the industrial war machine enjoyed the public acknowledgement that their works made as much difference as battlefield heroics. The power of industry and capital made an impression on
the engineers assigned to the levers of the war machine, creating a shared notion of the potential that state aligned with capital could achieve.\textsuperscript{38}

\textbf{Figure 1.5.} City Point, Virginia. Library of Congress.

The army’s unique vision of order was instantiated throughout the territory through paperwork and data collection-intensive bureaucracy.\textsuperscript{39} The army transformed into a de facto

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\item Michel Foucault, \textit{Security, Territory, Population: Lectures at the Collège de France, 1977-1978}, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2007), 312–28. Foucault locates this modernization in the state’s efforts to maintain order through police: “the set of means by which the state’s forces can be increased while
\end{enumerate}
civil service in the South during Reconstruction, and though temporary, the army’s institutional proclivities affected the general bureaucratization of the federal government and the permanent embedding of an engineering mentality in the way the government viewed territory. As the army had transformed itself into an administrative apparatus during the war, its form was already suited to the task. Calling the army system of bookkeeping already a “laborious and complicated perfection,” one soldier and Freedman’s Bureau agent lamented that his tallies of the blind and deaf, a government ordered “catalogue of misery” meant to quantify the labor force, were only limited in their comprehensiveness by lack of manpower.40 Systems of gathering knowledge from a large territory and feeding that knowledge along lines to a central repository were already in place, and made easy the transition from combat reports to reporting on demographics and compiling economic statistics. But beyond being a conduit for surveillance to the North, the army found itself in a position where it was necessary to replace the local structure of governance in much of the South. Officers relied on their own discretion and determined how forceful of a hand to have in shaping local politics, but military intervention into civil affairs often had impact previously unimaginable. The military governor of Virginia divided the state into fifty-five separate districts, each with an officer who acted as local magistrate and, in effect, ultimate authority.41 With the passage of the third Reconstruction Act, military officers could even remove civil officials who had been elected but who advocated violence against freedpeople or the federals, or simply lacked the ideological alignment of the postwar regime.

preserving the state in good order. In other words, police will be the calculation and technique that will make it possible to establish a mobile, yet stable and controllable relationship between the state’s internal order and the development of its forces.” Foucault goes on to state that the object of police action is to maintain the state’s “splendor.” There is little splendid about the Reconstruction South, but the efforts to build and maintain a cotton economy do indicate a shared notion of a higher order in the landscape that was worth maintaining.

40 De Forest, Union Officer, 40, 75.

41 Sefton, The Army and Reconstruction, 93, 121.
While the army’s officers, with few exceptions, exercised their discretion in a manner that did not lead to renewed rebellion—quite possibly because of an essential distaste for too much trampling on republican principles—an emerging pattern of centralization of state authority in the national state is apparent. The existing pathways of state authority flow easily from Washington to the territory through the pathways created by the conquering, and occupying, army. As an system of control that relies on control of commerce and the mechanisms of market economics, a corps of loyal, technically-minded, and nationalistically motivated soldiers made attractive conditions for the state to seize the opportunity for centralization. We might recognize the image of the technological man, comfortable in systems, capable of building systems, and reverence for the iconography of the industrial revolution, as a familiar figure that emerges in the later half of the nineteenth century. As the federal state turned from suppression of domestic strife toward engagement with an increasingly described “world system” of flows of capital and commodities, what better group to entrust the construction of the interface with that world than the federal engineers?

**The Ideology of the Leviathan**

The American state emerged from the Civil War enlarged by virtually every measure. The politicians at the helm of the “ship of state” figured that their political aims and maintenance of the fragile political order in the war’s aftermath were best served by maintenance of the state in its enlarged form, increased array of duties, and creative expansion of legal authority. At the end of the war, the Republicans continued to use the army as a hammer to shape both the political and physical landscape for as long as they were in power to wield it. Maintenance of employees and functions, especially where they were important conduits of patronage, became a self-
perpetuating, animating force within the federal government. Today we can read the original trace of the outline of the federal bureaucracy—military spending, monetary policy, supremacy of the federal laws over state legislatures—drawn by the Reconstruction congresses, who translated a wartime regime into a lasting political structure. The war and reconstruction were, as one historian has aptly put it, the original “modernizing” process of North America—a violent emplacement of an industrial order and a government to support it. As another strand in a worldwide pattern of development, the industrial order of the northern United States dominated and then sought to reform the agrarian economy and social relations of its southern section. Postwar policy was largely conceived of as primarily to benefit economic development. The federal government then became an avenue for partisan elected officials and bureaucrats to promote their causes—namely financial and industrial policies buoyed by dreams of immense growth and wealth—through the extensive reach of the governments’ tendrils. To this assessment of postwar policy, well-developed in the literature on the era, I would add the notion that engineering structures meant to aid the industrial development are visible proof of the government doing everything in its power to support all facets of postwar industrialization policy. Prioritizing engineering, infrastructure, and economic development indicates that the war had welded capitalist and republican ideologies, now inseparable in the peacetime future.42

Those at the metaphorical helm of the ship, however, were an ideologically homogenous group and the motivation behind reorganization of the South to encourage industrial development was closely related to this ideology. Because former Confederates were barred from federal office for many years after the cessation of hostilities, the northern, anti-slavery Republican Party dominated the politics of Reconstruction for the decade after the war, and

consequently became, in effect, synonymous with the state. Though not immune to the widespread changes brought on by the war, the Republicans’ ideological core remained consistent through much of Reconstruction and its commitments affected the form and direction of the U.S. government throughout the period. At its base, Republican ideology coupled foundational and ancient ideas of representative government with a powerful and radical desire to transform society and culture. The Republicans had brought the country into a cataclysmic war over their desire to crush the institution of slavery and eradicate its evil from the fabric of American life. In their postwar vision they sought to solidify the gains of the war by protecting emancipation and raising the freedman to the status of citizen through suffrage, as well as opening the country to industrial prosperity. As such, their policies created cultural structures, both ephemeral and concrete, that narrate the interaction of this strong ideology with the material and political conditions of the postwar reality.\footnote{Bensel, \textit{Yankee Leviathan}, 2–4; Foner, \textit{Free Soil}, 4; Richard Slotkin, \textit{The Fatal Environment : The Myth of the Frontier in the Age of Industrialization, 1800-1890}, 1st ed. (New York: Atheneum, 1985), 6–7, 21–26; Michael Green, “Reconstructing the Nation, Reconstructing the Party: Postwar Republicans and the Evolution of a Party,” in \textit{The Great Task Remaining Before Us: Reconstruction as America’s Continuing Civil War} (New York: Fordham University Press, 2010), 183–203. I share Foner’s definition of ideology as able to be defined as a shared “system of beliefs, values, fears, prejudices, reflexes, and commitments—in sum, the social consciousness—of a social group, be it a class, a party, or a section…” (passim) to which I might add the promise of investigation of the belief systems of an institution, especially one that leaves evidence of that system in the built environment.}

Inheritors in both name and—though in a diminished sense—spirit, of the republican tradition that inspired the revolutions of the late Enlightenment, the Republicans were popular anti-slavery party that coupled roots in agrarianism with a growing infatuation with industrialization and modernization. Key to their thought was an attitude toward labor and livelihood, and emphasis on wages and other economic factors distinguishes 19\textsuperscript{th} century Republicans from their progenitors.\footnote{Foner, \textit{Free Soil}, xiii.} The American statesman Thomas Jefferson’s adherence to
Republican philosophy is well known; expansionism in the United States’ early republican period can be traced directly to the imperative that abundant land was the vital ingredient in the creation of a national vision of farmers beholden to no outside political or economic interest. The ideology was more than a benevolent patrician project. Small freeholds comprised the majority of the American landscape up to the Civil War, and widespread political identification with republican ideology reflected the “lived experience of millions.”

Defined by individualism and independence, republicanism generated a cosmology of imagined behaviors and aestheticized definitions of proper relationships between those individuals, which manifested in cultural forms. Cultural production, not the least of which being architecture, was summoned to give physical expression to the “order and virtue” of republican cosmology, especially in the prominent government buildings. And while the actual politics may have fallen short of the ideals depicted in the cosmology of republican images, classical forms, but more specifically, forms in which there was a simple, intelligible order, continued to have deep cultural resonance.

Republicanism in America was never stable, but had two enduring facets: questions of spatial organization, and ponderous moral weight. Aside from continued anxieties inherited from Montesquieu about a republic being able to exist in a vast territory, and pervasive righteousness, other aspects of the ideology are less apparent over the broad stretch of time. At a higher level, if there exists any other consensus, it is that historians agree that republicanism represents cultural

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45 Foner, xiii.

46 John F. Kasson, Civilizing the Machine: Technology and Republican Values in America, 1776-1900 (New York: Hill and Wang, 1999), 4; Foner, Free Soil, xiii and passim. Historians have traced republicanism in North American to roots in English libertarian tradition and parliamentary dissent in English politics and Enlightenment interest in ancient philosophy brought across the Atlantic like so many other facets of English culture. Fundamentally a political ideology of “abhorrence of the consequences of personal dependence,” republicanism flourished in the New World, where abundant land made the dream of economic and political independence imaginable
adherence and identity with an ideology amongst a populace much better known for its “alleged pragmatism,” and that ideological feeling lurked under actions that might on the surface appear to be purely economically motivated. Mocking the phrase “Locke et praeterea nihil,” social historians working in the 1970s worked to displace economic determinism and zeal for private property as the explanation of a variety of radical political and social developments in early-19th century North America. Instead, they described republicanism as a literary and utopian movement that, while easily congruent with market capitalism, was not simply anti-monarchial. Historians of the early republic have also indicated the philosophical and artistic sophistication of republican thought, which was powerful enough to motivate a collective reimagination of the way society was ordered. The historian Gordon Wood, one of the most prominent scholars in this reassessment of American ideology, wrote in his *Creation of the American Republic* that republican ideology “added a moral dimension, a utopian depth, to the political separation from England,” implying that social engineering was of moral consequence. Rhetorically, Wood and his colleagues argued, republicanism provided a more accessible set of principles and values that cohered into an utopian design for society that a broad swath of people who lived in North America could appreciate and sign on to. Wood’s, and his Harvard colleagues’, use of Clifford Geertz’s anthropological theories about ideology and systems of cultural symbols set off an explosion of scholarship investigating the motivational power of republican utopian thought in various sectors of U.S. society. Because of the amorphous nature of the ideology, however, it can be tempting to ascribe any sort of planning or projection of grand nationalistic schemes to a

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loosely-defined sense of classically-tinged propriety.\textsuperscript{49} Historians have recently questioned the general enthusiasm for widespread application of Geertz’s theories, feeling the “notion of the compelling power of a socially shared cognitive road map” became more difficult to defend when confronted with the realities of real 19\textsuperscript{th} century politics.\textsuperscript{50} There is, however, evidence that republicanism and imagery of an imagined classical era did provide an aesthetic language for communication and, by extension, a common vocabulary that could mediate between geographical sections and create locations of political identity. In the case of Reconstruction I argue that republican symbols, especially when combined with a project that proposed bringing order to a chaotic landscape, made collective civil works attractive as analogies of societal reconstruction.

Lincoln’s assassination and the deposition of his successor gave the Radical Republicans power over the direction of the program of Reconstruction, in which an ideological belief that equality, induced by prosperity, can be read. As Eric Foner has noted, Radical Republicans “were as much moralists as politicians, using political means to eradicate sin from American society.”\textsuperscript{51} Political programs were meant to have an astringent bite. Absorbing freedpeople into American society was most effectively achieved, according to Republican theory, by transforming former slaves into laborers and encouraging participation in an emerging industrial system. As a transitive property of Republican ideology, wage labor in the 1860s was seen as affording the same pathway to economic and political independence as agrarian freeholding in an

\textsuperscript{49} Michel Foucault noted the varying shades of symbolic content afforded by the “Roman model” in France: “in its republican aspect, it was the very embodiment of liberty, in its military aspect, it was the ideal schema of discipline.” Foucault, \textit{Discipline and Punish}, 146.


\textsuperscript{51} Foner, \textit{Free Soil}, 115.
equivalence that today seems forced.\textsuperscript{52} Noting the change in the economic regime from agricultural production to urban manufacturing, Republicans converted their sincerely-held positions on personal and economic liberty to fit the emerging economic circumstances.

This ideological transformation had implications for physical development of American cities and landscapes, as those who held a previously anti-city ideological strain came to see cities and industrial infrastructure as important nodes in a “republican” plan. Though it is tempting to dismiss “free soil, free labor” ideological commitments as a cloak of false consciousness, labor politics in the mid-19\textsuperscript{th} century were marked by a distance between a capitalist system and the everyday lives of most workers. White workers were largely wary of entanglements that approached “wage slavery,” and protected their own economic liberty as a political right and privilege of their republican form of government. Workers expressed this in the culture of voluntarism and contracts that enabled labor in the period, with individually-negotiated relationships between capitalist and worker being the common currency and best means of workers remaining in control of their labor.\textsuperscript{53} The voluntary participation in the capitalist system was a default mode of association, and among many laborers, was a shared experience of thousands of veterans who left the army to join the economy. The politics of this voluntarism came to mean an equation between identity of victorious Union supporter with participant in new regime of liberal capitalism.\textsuperscript{54} And for a brief moment before the labor uprisings in the late 19\textsuperscript{th} century, this voluntary identity dominated American urban politics and

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\textsuperscript{52} Foner, xxxiii.
\textsuperscript{53} Foner, xix.
\textsuperscript{54} McConnell, \textit{Glorious Contentment: The Grand Army of the Republic, 1865-1900}, 221.
\end{flushleft}
gave life to an assemblage of capitalist symbols such as factories and infrastructure works that came to dominate the urban landscape and spread outward.

Financing and pursuing the war had created economic patterns and relationships to commodities markets that had impacts on urban environments as well. Wartime mobilization efforts had proceeded along the economic lines already established in the North and the South, and produced economic systems reflective of the prewar societies of both sections. In the Confederacy, the centralized and state-directed war production effort—in an agricultural area with near no manufacturing—staggered and collapsed well before military defeat. In the North, reliance on competitive contracts between established firms and willingness to leverage future revenues on international bond markets drove an incipient native finance sector in New York into a roaring behemoth that could compete with London.\textsuperscript{55} The war’s international impact went beyond Europe and assisted in the proliferation of networked, global markets. Wartime cotton shortages had sent textile manufactures, in Liverpool, Lowell, and elsewhere, scrambling across the globe to find cotton to keep their spindles running.\textsuperscript{56} At the war’s end, this newly mobile capital returned to the southern U.S. with a vengeance. Previously sleepy southern ports experienced traffic unseen before as merchants and agents, aware of the collapse of the slave regime, saw opportunity in the interior. Economic appetite drove northerners to the South to evaluate their prospects at extraction. Other commodities also played a role in the imagined renewal of the South through capitalist exploitation. One northern traveller, after describing “iron mines and coal-fields, wood-lands and farm-lands of excellent quality…” abandoned and fallow outside of Richmond, noted:

\textsuperscript{55} Bensel, \textit{Yankee Leviathan}, x and passim.

\textsuperscript{56} Beckert, \textit{Empire of Cotton: A Global History}. 
In short, wherever I went, I became, every day, more strongly convinced that the vast, beautiful, rich, torpid state of Virginia was to owe her regeneration to Northern ideas and free institutions.\textsuperscript{57}

Those institutions: enforcement of contracts, equality under the law, suppression of violence by Federal troops, and an increasing sense that federal infrastructural support was crucial to economic regeneration, were logically a part of a Reconstruction plan.

The clearest visible interventions that come out of Reconstruction ideology were the impulses to control labor (by having the army facilitate and enforce a contract system between former slaveholders and freedmen) and the construction of transportation systems to move commodities. Labor control and infrastructure construction were also conceptually linked. Politicians and capitalists operated under the assumption that social unrest (due to class resentments and racial strife) could be obviated by employment of freedmen and spreading material prosperity. Promoting a notion of “harmony” between conflicting demands of labor and capital, their rhetoric sought to soften what they believed were the more extreme demands of both classes for the sake of promised mutual prosperity. The notion of a delicate harmony, with dire consequences immediately following disruption, was supported by the charred evidence of transgression that still covered the postwar landscape.\textsuperscript{58} The balance of northern capital moving into the South was supported by the construction of routes and ways for the commodities to be brought out to the coast. Though no grand scheme of infrastructure existed, the attitudes of the Republicans gave the resultant infrastructure a marked spatial character. This was manifest in two general geographical principles. First, free-soil Republican ideology retained a mistrust of centralized industrialization possessed by their agrarians of the previous generations. Embracing

\textsuperscript{57} Trowbridge, \textit{The South}, 422, 191–92.

\textsuperscript{58} Richardson, \textit{Death of Reconstruction}, 98–99.
industrialization, however, as a national goal, their vision included spatial distribution of industrial facilities over a larger area than what was organically occurring in northern mill towns, advocating for the equivalent production volume of Lowell, Massachusetts to be spread over twenty or thirty times the area.⁵⁹ Second, Republicans continued to contend with the inheritance of the idea that successful republics needed a small geographical area with a homogenous populace. The concept of free labor and long lines of binding infrastructure both contributed to easing this anxiety. Equating civic identity with participation in a national system of liberal capitalism held the promise of uniting and homogenizing the populace, and a distance-annihilating system of roads, bridges, canals, and railroads could effectively decrease the landmass of the U.S. and render it available as a republic.⁶⁰

Locomotives and networks of infrastructure thus became incorporated, if somewhat uneasily, into republican iconography. The Republican-led government devoted most of their attention to supporting the growth of railroads during Reconstruction, though other systems of territorial incorporation weren’t ignored. In the historiography of the era, railroads stand as the main symbol of industrial progress and incursion of a new technological order into the landscape.⁶¹ Under military control for the duration of the war, southern railroads were quickly released to civilian control in the first months of Reconstruction. Rebuilding of damaged sections and expansion of existing rail lines in southern states was pursued “with considerable vigor,” sometimes assisted by free labor of the soldiers of nearby army units. Federal support for railroad corporations could be so nakedly displayed because in the public imagination, railroads did not


represent private, profit-driven corporations but instead were understood as evidence of state-building. Republican support was, of course, not motivated entirely by noble concern for national integrity. Mid-nineteenth century railroad lines usually had a bank attached to the physical road and rolling stock, which handled the intricate business of financing its construction and operation. These financial institutions were often also funnels for speculation in real estate, and were sources of immense wealth for the financiers and politicians who eased their operation by providing charters and sweet deals on public land. Like most businesses of the period, they were notoriously volatile, and, as Republicans would find out in the 1870s, prone to plagues of corruption that could in turn diminish the political credibility of anyone caught near them. But for a nation sickened by war, railroads represented an unimaginable hope and progress—this image aided by concerted effort. Railroads became the scenes of the first mass marketing of infrastructure as a societal balm as corporations held mass meetings across the South to promote their ventures.

As the iconography and ideological core of republicanism shifted during Reconstruction detractors voiced their concerns about the government’s increasing forays into centralized economic direction and planning. Confronted with the increasing scope of activist Reconstruction policy of his radical colleagues, a congressman of the older, Jeffersonian republican stripe voiced that he was “having none of the centralism or loose latitudinous notions

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of federalism or Whiggery” he felt the party was debasing itself with. But the party’s ideology had transformed during the war to embrace spatial latitudinousness and whiggish notions of progress. Republicans believed that the republic could be healed through the binding ties of common economic interests, and that this required putting the South through the stages of progress. Barely escaping reversion to a state of nature, Republicans believed that long-lasting national unity required the South’s endurance of transformation from wilderness to agriculture to mechanized civilization. Their policy of infrastructure support resulted from the belief that infrastructure improvements could both aid in and symbolize this progress.

Reconstruction republicanism thus gained a new set of metaphors to replace the crumbling prewar imagery. In the first years of Reconstruction, at least, the idea of economic improvement and construction of infrastructure provided an imaginary cultural landscape onto which both northerner and southerner could divine some course out of the war years. Roads and bridges, canals, harbors, and railroads became acceptable and objects within a traditionally agrarian cultural landscape definition of republicanism. In this way, infrastructure received an ideological coloring distinct from a crass capitalism. As the anthropologist Clifford Geertz has written, ideology

bridges the emotional gap between things as they are and as one would have them be, thus insuring the performance of roles that might otherwise be abandoned in despair or apathy….


Infrastructure born out of this ideology had the potential to serve a symbolic role and perform an aesthetic and emotional service, indicating the Republicans’ commitment to visible progress in reconstruction.

Reconstruction was accomplished as much by the construction of a field of symbolic gestures in the South as in the political craft of state readmittance. And while historians continue to debate the unfinished state of social reconstruction and fulfillment of the promise of racial equality, the more tangible efforts to reorder the countryside and lace it through with binding infrastructure were successful in diminishing sectional feeling and creating a mood of a unified republic. Republicanism’s guiding metaphors changed, incorporating images of the movement of commodities and processes of manufacturing into the mental picture of what a republic, fueled by liberal capitalism, might look like. This picture, which includes railroads and busy harbors, plumes of smoke and the figure of the engineer, never achieves an overarching coherence, but nonetheless remains as important to the politics of Reconstruction as the actual benefits of increased transport capacity and the reopening of the southern ports.

**Theories of Territorialization**

Questions about the relationship between the federal state and territories that had rebelled were the subject of much theoretical inquiry while the war was still underway. Early in the war, the U.S. Supreme Court declared the war a “civil, territorial war” as opposed to a rebellion, placing a notion of land and space at the center of the conflict’s ultimate resolution. Theoretical speculation guided the conceptual development of what would be called Reconstruction, as secession and armed rebellion posed legal questions that had never been debated before. As early

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as the summer of 1861 government officials argued for, and coalesced around, the notion that the states that had seceded had effectively destroyed themselves and ceased to be political entities recognized by the federal government and the other states. What remained was a mass of land and people that had formerly been organized as a state. The theory, developed by congress as the war was still in its first stages, was that in order for those territories to reenter the Union, they must pass through a similar political process as states not part of the original English colonies. Territorialization, as the histories of states such as Ohio and Wisconsin could attest, was a fairly simple procedure establishing political organization and constructing a framework of governance (writing a constitution) that aligned with the communal principles of the United States. After reviewing that constitution, the United States would then admit that territory as a state. In the case of Reconstruction, however, the process became an instrument wielded by ideologically-motivated northern politicians to demand radical changes to the South, in particular, universal suffrage. As such, Republicans believed the process of ideological alignment required an astringent creation of a political (and physical) tabula rasa and a coercive means of exerting agency in the reorganizing territories. The army fit this vision, as James Doolittle, a republican senator from Wisconsin argued “it is necessary that we should send along with the armies which destroy, a reconstructing power.”

Reconstruction became a process by which a republic demonstrates its values by the manipulation of the functions of its landscape according to how both economic and visual performance conform to stated principles. Construction of the territory of a renewed republic

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69 Quoted in Belz, 50.
took place in a diminished landscape, which historians have called a “virtual wilderness.” Mere abolition of slavery was not enough, a coherent vision of societal organization must be framed and instated on the landscape. It was important that the landscape be put through the formative stages of “civilization.” The abolitionist Wendell Phillips wrote, “Reconstruction begins when the South yields up her idea of civilization, and allows the North to permeate her channels and make her over.” The army had conveniently provided space to begin anew, and the cleared space of the South was soon to be populated by enthusiastic visions of opportunity for civic and physical renewal. Horace Greely, the editor of the influential *New-York Tribune* wrote in 1866:

> My dream is of a model republic, extending equal protection and rights to all men …. The wilderness shall vanish, the church and school-house will appear; … the whole land will revive under the magic touch of free labor.

Within the theory of republican territorialization was a consequent vision for labor and the landscapes of that labor.

The mid-nineteenth century American state had its own well-defined attitudes toward territory which it brought to the question of Reconstruction. The federal state had two basic aims and used the military to further both. First was an orientation toward the support of rapid expansion westward, an effort supported by extensive use of the military for conquest (Mexico) and suppression of those hostile to the flood of agrarian white settlers (the Sioux and Comanche, amongst many others). Second was suppression of sectionalism in the effort to keep a unified

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70 Brady, *War Upon the Land*, 80; Richardson, *Death of Reconstruction*, 22.

71 Quoted in Summers, *Ordeal of Reunion*, 58.

72 Quoted in Foner, *Reconstruction*, 235.
economic and territorial base. The army was stretched thin in terms of manpower in supporting both of these efforts after the main thrust of the Civil War.\textsuperscript{73}

Topography—especially rivers—provided strong incentives to reimagine the economic and political order around the transportation of commodities. The military’s outlook at the center of infrastructure planning made certain topographies more attractive than others for development. During the war and reconstruction, the army had observed its presence formed an archipelago of influence in otherwise hostile territory.\textsuperscript{74} The lines of both river and railroad chained the wider nodes of Union territory into larger arcs or tendrils that extended into the interior. These lines were first dictated by topography but could be extended or made more efficient by the engineer’s effort. Branching inward from the coastal cities, the geography of the South assisted in creating the matrix of territory where the Union army needed to proceed to win the war, and remained in place as a spatial structure for the delivery of reconstruction. And as an existing zone of influence, the linear interior zones were thought to be places where ideology could take root and then spread further outward. Reconstruction administrators operated under the assumption that if they could make free soil and free labor agriculture and manufacturing work along their lines of influence, the practice would be seen as superior by neighbors, adopted, and spread organically outwards from the river.\textsuperscript{75} This organic vision of change would bring with it not just farming practices but a host of other Yankee virtues—and serve as what Richard Slotkin characterized as

\textsuperscript{73} Bensel, \textit{Yankee Leviathan}, 9; See also the supplementary maps of Downs, \textit{After Appomattox} In the distribution of troops and the drift westward after the more violent phases of Reconstruction one can observe the demands on the military to enforce these two territorial aims.

\textsuperscript{74} Summers, \textit{Ordeal of Reunion}, 30.

\textsuperscript{75} Bensel, \textit{Yankee Leviathan}, 15; See also E. C. K. Gonner, \textit{Common Land and Inclosure} (London: Cass, 1966) for an interesting description of the theories of “organic spreading” of land use practices described by the architects of enclosure in England.
“the industrial path of capitalization, organization, management, and discipline” believed to be the key ingredients of southern modernization.\textsuperscript{76}

Cities would play an invaluable role as nodes on these lines to the interior. Transformed by the accumulation of capital and financial institutions, untold wealth, and growing industrialization, American cities were poised to incubate institutions that could affect material changes in distant countrysides.\textsuperscript{77} The capital markets opened by federal wartime monetary policy meant the proliferation of financial instruments previously unavailable. Access to European bond markets set off an explosion in municipal investment in cities as city governments gained unprecedented access to capital. A boom in civic construction ensued, with new global liquidity financing rail stations, city halls, sewer systems, municipal parks, and lining more than a few pockets.\textsuperscript{78} Urbanization grew to accommodate exponentially increasing populations as waves of migrations hit established cities and swelled those that were popping up on the lines heading westward from the coasts.

Du Bois put it most clearly in stating: “If the basic problem of Reconstruction in the South was economic, then the kernel of the economic situation was the land.”\textsuperscript{79} Amidst this sea of change the outlines of the Reconstruction government’s distinct view of the landscape emerged. Agrarianism, one of the ideological pillars of prewar republicanism, gradually eroded as the government pivoted its state-building efforts to supporting industrialism and by extension,

\\textsuperscript{76} Slotkin, \textit{The Fatal Environment}, 290.

\textsuperscript{77} The literature is now indeed vast, but William Cronon, \textit{Nature’s Metropolis: Chicago and the Great West} (W. W. Norton & Company, 1992) remains the touchstone work in understanding the combination of urban and environmental history.


\textsuperscript{79} Du Bois, \textit{Black Reconstruction}, 307.
created the beginnings of the United States’ current industrial landscape. This departure required ideological acrobatics that continued to signal “agrarian” tropes while supporting the extension of a nationalist industrial system. One northern theorist believed that the imposition of a free labor system would regenerate the South in a way that would blot out any competing ideology, positing that any competing notion “will no longer have any cause to exist, and the southern people will be glad to recognize the American nationality without reserve, and without the sectional limitation of geographical lines.” However, the gentle encouragement to maintain private property proved limited and unable to produce the changes more radical Republicans envisioned. Turning to a more aggressive territorial acquisition policy in during Reconstruction, Republicans sought out not only land for agriculture, but increasingly sought land that could hold pieces of infrastructure that enabled a global vision of trade. Seward’s purchase of Alaska, Midway Atoll in the Pacific Ocean, and support for military survey parties to investigate a potential canal site in Nicaragua are symptoms of a United States that is beginning to nurse its imperial ambitions.

The government turned from vigorous support of homesteading to the favoring infrastructure investment and the reorganization of the landscape by capital. This most unfortunately was felt by freedmen, whose dreams of the breaking up of the plantations and the redistribution amongst the former slaves were crushed. Republicans were predisposed toward freedmen and poor white southerners acquiring land by purchase and not state redistribution. Their faith in eventual equitable distribution of the plantations by markets was further illustrated by a series of policies that aimed at economic regeneration and development of transportation.

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80 Schurz, Report, 60–61.

81 Summers, Ordeal of Reunion, 209.
routes like railways and canals and forgoing state micromanaging of land use patterns. But the infrastructure that supported land development and indicated progress of civilization’s westward and southward march enjoyed increasing popularity. Images of railroads appeared in metaphors about the economic and moral fertility of the interior. The entrusting of the army with the long-term planning project of reconstructing the nation. The war and Reconstruction had expanded the basic notion of the state and given it the ability to design.

The Levees of the Mississippi

The army’s emergency repair of the levee system along the Mississippi river serves as a prototypical case study of the changed relationships between state and landscape by way of engineering during Reconstruction. First, the army was used as an apparatus to gather information about the territory and assemble it in a centralized location where federal policy, based on federal priorities, could be planned. Second, the government’s decision to rebuild the levees indicates the collective conclusion that antebellum slavery as a labor and maintenance regime was the only thing holding the landscape and economy together. The government’s intervention indicates the belief that the binding power over the territory was economic and physically infrastructural, and in the absence of slavery, must be maintained by the state. Third, the repair process indicates the power of economic priorities—specifically the expectation of

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82 Du Bois referred to this betrayal and transition as stemming from “the wild idea that industry and progress for the people of the United States were compatible with the selfish sequestration of profit for private individuals and powerful corporations.” Black Reconstruction, 197.

83 “‘A free and living Republic,’ declared a Tennessee scalawag, would ‘spring up in the track of the railroad as inevitably, as surely as grass and flowers follow in spring.’” Foner, Reconstruction, 379.

84 Ibid., 131–32, 114. Bensel’s matrix of factors describing the “dimensions of central state authority” is a fascinating dissection of the postwar state. Though he is reticent to name the army as one of his main anatomical subjects, so to speak, the military’s institutional outline is evident.
Figure 1.6. Map of the Alluvial Region of the Mississippi, 1861, with manuscript markings by Henry Abbot. Civil Works Map File, US 309 28, Record Group 77, Cartographic Division, National Archives, College Park Maryland.

Destroyed levees are marked in red. This map was a duplicate of the map Abbot had with him in the field.
capital investment and prosperity—was symbolically potent enough to bridge sectional divides and create a political consensus. This was no mean achievement, as bitter warfare was a fresh memory, low-intensity conflict still ravaged the countryside, and the federal army was largely seen as an occupying force. That the southerners explicitly solicited their recent enemy’s organizational power and capital in a last-ditch effort to maintain their power and prosperity indicates the great unifying power of the postwar era—capitalism—was ascendant. Finally, in the process of repairing the levees of the Mississippi, the army would struggle to define its role in Reconstruction and in the United States going forward, finding itself first reluctant to take on the role of landscape regulation, but being drawn by the circumstances into inexorable entanglement with the task.

The state of the levees provided the army with an accurate, if shorthand, account of the economic situation of the section. Abbot’s orders indicated the army’s reluctance to fully engage with the scale of the destruction and the social crisis that emerged from economic disintegration. Restricted to “ascertain what temporary repairs are required to prevent great injury to the agricultural interests of the alluvial region as well as to commerce, and to take measures to make repairs as immediate exigencies require,” Abbot’s mission was constrained. Geographically, however, his assignment was immense. His itinerary stretched from Kentucky to Bonnet Carré, winding through thousands of linear miles of country. Humphreys’ orders reflect an unwillingness to fully engage with what promised to be a gigantic, continental-scale crisis. Nonetheless a sense of the scale of the problem made it from the Mississippi through the army to the Federal bureaucracy through Abbot’s pen; the landscape he evoked, and its sense of immanent crisis, triggered the process of federal entanglement in the region’s water policy.

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85 Humphreys to Abbot, December 26, 1865, Box 1, HLAP.
Overwhelmingly, Abbot’s perception of the landscape was one of a system in decay. In reports that read like a litany, Abbot described a landscape of absent levees, with stretches of cave-in that ranged in width from fifty feet to more than a mile—lone and forlorn sections remaining as the only indication that there had been a levee at some point. “The river is looking badly,” he reported to Humphreys from Memphis, “[t]he country to the rear of the bank seemed to be covered in spots with water, whether through the middle or upper break I could not decide.
The work looks very badly."\(^{86}\) This he coupled with the observation that with every trip up or down the river, more of the structure seemed to have disappeared.\(^ {87}\) Moving methodically through the landscape, Abbot’s work depicts a system in a state of slow disintegration, and the failure due to the absence of maintenance. Of the St. Francis Bottom levee down to Helena, Mississippi, Abbot reported “I hear that the levees there have been entirely neglected ruing the war, and are virtually destroyed.”\(^ {88}\) Private levees built by individual planters made up the majority of the cave-ins—structures that would have withstood any natural event had they been kept up.

The immediate postwar response was piecemeal and unsystematic, remaining primarily an information gathering mission on which full federal planning could rest. Abbot’s correspondence with Humphreys indicate that he saw his work as first to catalog and then to provide some ad hoc assistance and minimal repair work to existing structures. Drawings of the piecemeal repairs, carried out by contractors, and designed to do the bare minimum to patch the disintegrating system, indicate with what distance the federal engineers held themselves from the work that first winter. To the extent that he did any design at all, most of Abbot’s interventions were constrained to strategically consolidating levees upstream to obviate the need for those that had been destroyed below. Though he was critical of the work ethic and methods of the southern contractors, Abbot’s overall beliefs were that the planters should take care of their hydraulic landscape themselves, belied by his praise of any evidence of effort to save themselves and not

\(^{86}\) Abbot to Humphreys, February 2, 1866, ibid.

\(^{87}\) Abbot to Humphreys, May 11, 1866, Letters and Telegrams Sent, Civil War and Mississippi Duty, v. 3, Henry L. Abbot Letter Books, HLAP.

\(^{88}\) Abbot to Humphreys, February 26, 1866, ibid.
rely on federal assistance.\textsuperscript{89} Abbot’s official report was published in 1866, and combined with the devastating flood of 1867, would provide the basis for a robust federal intervention to follow.

![Figure 1.8. Plan of John Buhler, Conrad L. Chinn & W. E. Robertson Crevasses, in the Parish of West Baton Rouge, right Bank of Mississippi River about eight miles above Baton Rouge, February 1, 1866. Civil Works Map File, MD 212-2, Record Group 77, Cartographic Division, National Archives, College Park, Maryland. The old levee is indicated by the dark line at the water’s edge, the new levee “projections” are indicated in red.

The devastating flood that peaked on April 1, 1867, activated the occupying army as a information-gathering network in the landscape; their compilation of data on the landscape in crisis contributed to the force spurring federal intervention. Occupation military commanders instructed their subordinates and the agents of the Freedmen’s Bureau to submit their observations of the damage. Responses to Col. C. N. Smith, the commander of the sub-district of Arkansas, painted a landscape in a downward spiral of destruction.\textsuperscript{90} Though some cursory reports written by military agents exist in the archives, the bulk of the raw data is made up of

\textsuperscript{89} Abbot to Humphreys, February 15, 1866, ibid.; Abbot to A. W. Gloster, February 3, 1866, ibid.; Abbot to Humphreys, February 2, 1866, ibid.; Abbot to Humphreys, May 2, 1866, ibid.

\textsuperscript{90} C. N. Smith, “Circular No. 1,” April 27, 1867, Box 17, Letters Received, 1865-1870, Correspondence of Office Divisions, 1865-1870, Correspondence, 1789-1870, Records of the Office of the Chief of Engineers, Entry 25, Record Group 77, National Archives, Washington, D.C. (hereafter cited as E25-RG77, NA).
earnestly detailed letters from the affected planters themselves. The tone of their reports, ranging from the resigned to the melancholy, indicate the stress to which landscape and society had been subjected. William Hewson, writing from Friar’s Point in Mississippi, stated perfunctorily that much of the county had been underwater for several months. Rice Dulin, a planter near South Bend, Arkansas, looked out across thirty miles of inundated land, and noted that “the old levees have mostly caved in, and our private levees broken and washed down.” Minor Merriwether, in Memphis, took the opportunity to be more poetic with the army:

As to the area overflowed, it covers almost the entire Yazoo Mississippi valley embracing some 3,500,000 acres, but very few places escaped submersion and even those which did, are so saturated as to be for the present in no condition for ploughing or planting. The destruction and ruin are wide spread and general and many persons are leaving in heartbreaking despair without extraneous aid in building levees the country will rapidly relapse into wilderness…. The country is fast becoming a gloomy solitude, and many plantations which in 1860 were white with cotton and busy life, are now grown up in timber, and all vistages [sic] of former cultivation gone.

Alfred Eddington of Desha County, Arkansas, reported that the ’67 flood cost his county almost all its forty miles of levees. “Occasionally there is a small piece of the levee left standing, varying in length from one hundred yards to one mile long,” he wrote, then also described one crevasse: “it is not very long; but it is quite deep—it is about 300 yards long and looks like a small river.”

No method of assembling a national picture of the flooding had existed prior to the army’s occupation; federal presence essentially revealed how much of the operation of the landscape had resided in obscurity. The governor of Mississippi had to respond to federal

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91 William Hewson to Col. William E. Merrill, August 15, 1867, Box 17, E25-RG77, NA;
92 Rice Dulin to C. N. Smith, July 29, 1867, ibid.
93 Minor Merriwether to Maj. Miles D. McAlester, April 22, 1867, ibid.
94 Alfred A. Eddington to Capt. J. C. Proudmore, May 27, 1867, ibid.
requests for information with the wanting response “there is no Board now in existence from whom he can obtain the information you desire.”\textsuperscript{95} Much of the landscape had not seen a surveyor’s rod since the land surveys decades beforehand, and information on the changes in the unincorporated “swamp regions” of the alluvial basin existed only as vague memories of some residents.\textsuperscript{96} Indeed, vague comparisons with the floods of 1844 and 1862, based on the data available, which happened to be the memories of planters, with the precision of “enormous flood…overflowing pretty much the whole country,” was the extent of the engineers’ baseline.\textsuperscript{97}

Planters attributed both dissolution and flooding at least partially to construction and design techniques. Varying slightly as depending on the local geology, most levees were made up of a core of alluvial sand. Without careful maintenance of the turf or other planting that gave the prism tensile strength, a small breach could quickly be “cut away … with great rapidity … [and] widen to the extent of a mile.”\textsuperscript{98} Failure of the state levees prompted planters to question the design criteria put forward by their local engineers. In Desha County, Arkansas, a levee built by local authorities directly before the outbreak of the Civil War was accompanied by assurances that the design was high enough to “warrant the welcome belief of permanent relief from overflow.”\textsuperscript{99} Its utter ruin only six years later left serious grounds for distrust.

Overall, however, the planters attributed the failure of their hydraulic system to the fact that they no longer could compel enslaved workers to do the labor-intensive maintenance

\textsuperscript{95} James M. Kennard to McAlester, April 3, 1867, ibid.

\textsuperscript{96} John Lampton to William Merrill, April 10, 1867, ibid.

\textsuperscript{97} Thomas Smith to C. N. Smith, September 1, 1867, ibid; William Hewson to Merrill, August 15, 1867, ibid. Hewson insisted that though there were no written records kept of flooding, that his “observations … are mainly from memory, but generally correct.”

\textsuperscript{98} Ibid.

\textsuperscript{99} Daniel J. Murphy to J. C. Proudmore, May 27, 1867, ibid.
required to keep the system functioning. Maintenance had been suspended since the beginning of the Civil War through most of the alluvial region. The contracts of both the wage and share system neglected provisions for levee maintenance, and planters were surprised that their appeals to the freedmen to contribute free labor to protect their former masters’ lands fell on deaf ears.

Thomas Smith of Meckatro Plantation in Arkansas County complained:

Thus, the freedmen, (almost universally interested in the crop on shares) cannot be made to understand, or look to the disastrous results of an overflow, & their employers have no power to command their labor for levee purposes, although their crop may depend on its protection…. The labor employed is for cultivation with an interest in the crop, outside of that they do not feel as if their interest is concerned, & without their voluntary consent nothing can be done.

Smith, essentially throwing his hands in the air out of exasperation, concluded that the only solution was that the state would need to intervene, as he and his colleagues “cannot apply the plantation labor.” Smith, like others who complained of diminished powers to compel labor, made no mention of any thought or discussion around hiring laborers and paying wages for levee work. Minor Merriwether directly blamed the “failure of labor” on the economic and structural problems of the region, indicating the belief that manumission had rendered but one component faulty in a system otherwise worth preserving. The notion that workers recalcitrance disrupted the functioning of the landscape was closely held by the planter class, who could not countenance the idea that the rest of the system needed to adjust to the reality that they could not rely on compulsion of other human beings to keep the river at bay.

The planters’ correspondence struck a tone of despair that belied a sense that their economic regime was fraying beyond repair, putting the notion of an ordered hydraulic and

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100 William Hewson to John G. Miller, May 8, 1867, ibid.
101 Thomas Smith to C. N. Smith, September 1, 1867, ibid.
102 Merriwether to McAlester, April 22, 1867, ibid.
economic system beyond reach. A Freedmen’s Bureau agent reported that “all efforts to repair those leaks in the levee proved futile and were abandoned,” in his county, and that there was a “growing belief in the minds of the planters” that the levee system would ultimately fail.  

Planters blamed freehold farmers upstream, who denuded “every leaf of the forest every blade of grass on the prairie,” feeling that “before the above 50 million acres of land were cleared,” they weren’t subjected to such flooding. They blamed their local engineers, whose “want of engineering skill” had “all proven ineffectual.” They blamed the inaction of their peers, who had spent lavishly on building levees but did nothing once breaks and crevasses began to appear. They blamed their own impoverishment, pitying themselves and the other residents of the countryside, and the “great distress and complete prostration of this country and the utter inability of the resident population to reclaim it…” What they did not do—or at least failed to note in writing, despite its being obvious—was note that the system of labor which had maintained the order in the landscape was gone, and either reform or replacement was needed.

The army, which synthesized economic data and reached conclusions that shaped levee policy in the region, came down on the side of replacement of the slave-maintained levees with one of nebulous, but definitely federal, design. The engineers, familiar with the failures of the patchwork system, fixed on a durable design conceived to counteract “the whole flood volume of

103 James A. Walker to J. M. Mills, July 8, 1867, ibid.
104 William Hewson to John G. Miller, May 8, 1867, ibid.
105 Eli H. Mix to C. H. Smith, May 14, 1867, ibid.
107 Merriwether to McAlester, April 22, 1867, ibid.
the Mississippi.”¹⁰⁸ National design, by virtue of the army and the men who stood to design it, trended toward posing heroic as pragmatic. Abbot’s post-1867 flood report invoked the “costly, but effective and remunerative” project of reclaiming the Haarlemermeer in Holland, and how the current patchwork system was puny compared to the systems on the Po, Rhine, and Vistula rivers.¹⁰⁹ This plan entailed superseding the authority of the various states. Problems of jurisdiction were posed as counter to efficient engineering, such as the disparity of taxable wealth in Arkansas and Louisiana, where the levees of the poorer Arkansas were more prone to failure, threatening both downstream states.¹¹⁰ In this way the engineers made the case for the assumption of a maintenance regime only as long as the futility of the previous system was eliminated by the imposition of federal standards and centralized control. This transition took several years to appear as concrete policy and action, seen in the formation of the federal Mississippi River Commission in the 1870s, in which Abbot and the corps’ general hydraulic epistemology were highly involved.¹¹¹ However, the roots of federal control are located in the development of the hydraulic regime on the backs of enslaved people, the desperate insistence of the planters to maintain their property and the general order of landscape versus river, and the failure of the engineers and politicians to imagine some alternative to this scheme.

¹⁰⁸ Henry L. Abbot, “Report on the present Condition of the Mississippi Levees, and on the Floods of 1862, 1865, and 1867,” mss., February 16, 1869, Box 1, E25-RG77, NA.

¹⁰⁹ ARCE 1869, 347.

¹¹⁰ Abbot, “Report on the present Condition of the Mississippi Levees.”

¹¹¹ ARCE 1875, 400-405; Maj. Gouverneur K. Warren to Humphreys, July 23, 1874, Box 55, E71-RG77, NA; Poe, “Reconstructing the Levees,” 234–35. Poe argues that the establishment of the Mississippi River Commission, coming so close on the heels with the end of Reconstruction and the withdrawal of federal troops, was a victory for the forces of Redemption, who managed to secure a clear avenue for federal subvention of their economic system while at the same time ridding themselves of federal military presence.
The prospect of assuming responsibility for the Mississippi levees triggered an existential crisis in the engineer bureau and a full-fledged constitutional fight in Congress. Practically and ideologically the engineer bureau saw the regulation of the Mississippi as practicable. In the context of the military occupation and general bureaucratic enlargement already underway, nationalizing control of the levees under an impartial and technically-minded institution was congruent with the engineers’ self-conception. With little faith in local control, Abbot and the other engineers expressed their doubts about “success with the present system of administration, location, construction, and grading,” to face the “entire problem of protection against river floods throughout the richest portion of the territory of the United States.” Yet enforcing a design standard across such a vast swath of territory roiled age old debates of the proper level of intervention of federal agencies. The cost too caused some internal consternation. Abbot’s calculations in 1869 placed a baseline repair of the Mississippi levees at $4.1 million and a cost of $6.1 million to bring them to the various states’ proposed design height. Raising the whole system, “perfected from the head of the alluvial region, to the mouth,” to a federally-established “proper height,” Abbot calculated, would cost the treasury some $36,230,000, a figure even he could balk at.

Yet the alliance of planter and capitalist continued to advance both the economic and moral case that the levees were federal responsibility. The productivity of land linked to general

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112 Poe, 192–93.

113 Reuss, Designing the Bayous, 49–101.

114 Abbot to Humphreys, February 12, 1876, Box 81, E71-RG77, NA; Abbot to Humphreys, March 2, 1870, Box 1, E25-RG77, NA.

115 Abbot to Gen. John Parke, April 20, 1870, Box 1, E25-RG77, NA;

116 ARCE 1869, 327-328.
national prosperity was a firm truism in the minds of congressman, planter, and capitalist. Bending notions of distant federalism to provide cheap land for the fueling of the capitalist machine was routine and enthusiastically pursued.\textsuperscript{117} The rich alluvial basin, imagined safely behind federal levees, was no different. “I have long been impressed with the fact that the Mississippi bottom can be made one of the most productive sections in the world,” wrote one floodplain inhabitant to the army.\textsuperscript{118} “I hope the government will do something to reclaim this country,” wrote another, joining economic reasoning with a moral appeal.

It is too valuable to give up to a wilderness, and the people there are utterly prostrated. This flood has extinguished the last glimmering hope of protection, and starvation is looking them in the face.\textsuperscript{119}

The appeal for federal relief, especially in a time of crisis, was an old and familiar refrain from both urban and rural floodplain residents. R. C. Slaughter, the civil engineer at Vicksburg, participated in a venerable tradition of when writing the military commander to “ask your influence in procuring such aid from the Genl Govt as in your opinion the exigency of the case my require.”\textsuperscript{120} Southerners cited an array of northern depredations wrought on their landscape in building the case for federal recompense. They cited negligence in engineering projects that degraded their natural harbors; federal law, such as the 1850 Swamp Lands Act, which they argued increased the ferocity of their floods; and, of course, when the federal army destroyed levees and cut off oxbows to devastating economic effect. In asserting the extent of the damages

\begin{footnotes}
\item[118] John M. Williams to C. H. Smith, May 13, 1867, Box 17, E25-RG77, NA.
\item[119] Merriwether to McAlester, April 22, 1867, ibid.
\item[120] E. J. Pillsbury, Mayor of New Orleans to Humphreys, October 22, 1877, Box 101, E71-RG77, NA; R. C. Slaughter to Gen. Edward Ord, April 1867, ibid; Poe, “Reconstructing the Levees,” 71-101.
\end{footnotes}
the federals were responsible for, Savannah authorities even pointed to wrecks sunk as obstructions by American forces during the Revolution.\(^{121}\)

All of these justifications papered over the conservative sentiment at the core of the levee system: a desire for a powerful entity to maintain the landscape of the status quo. The planters would find the federal government would not replace slave labor on terms they could predict. Though they had secured a source of funding and gained the attention of federal authorities, who now considered their levees a national issue—federal priorities would supplant provincial desires, and a variety of new actors tried their hand at gaining physical and social ends from the proposed infrastructure. Federal entanglement produced different relationships between land and labor, which at first appeared to be radically new.

For a brief moment, the federal engineer bureau considered constructing infrastructure to reclaim a vast amount of fertile land in Missouri for freedmen to establish farms. The Memphis and St. Louis Railroad Company proposed to construct a levee to run their elevated tracks through the Mississippi floodplain from the mouth of the St. Francis River to New Madrid, a distance of roughly 150 miles. Benjamin F. Loan, a republican congressman from Missouri who sat on the committee for Freedmen’s Affairs, seized on the railroad’s plans and instructed the military to calculate how much land the wide arc of the levee could potentially protect from inundation. Abbot was of course tasked with the investigation, and his lengthy and favorable report on the project indicates he found the experimental potential for the project intriguing.

Abbot went so far as to suggest adjustments to the railroad’s plans, outlining a heavy dike on the

north end of the district and an innovative series of drains that used the St. Francis River’s natural tributary bayous as an extensive system of natural drains, increasing the structure’s beneficial “shadow,” which would increase the reclaimable area to some 6,000 square miles. This secret federal plan to use infrastructure to build a freedmen’s colony had precedent in the Davis Bend and Sea Island experiments, but never advanced beyond the planning stages. Loan did not win reelection in 1868, and Abbot was reassigned to Willets Point soon thereafter.122

This project, and one can assume, others conceived in similar vein, were subsumed by larger political tides. As the army’s role became more clearly defined under Ulysses Grant’s administration, the egalitarian impulse behind military involvement faded into the background, as capitalist development—indefinitely more politically palatable—moved to the foreground.

Immediate postwar projects show the entanglement produced infrastructure with a social mission, even if the infrastructure ultimately failed, the involvement of the army necessarily involved unionist, reformist impulse, before it was later stamped out and the postwar order realigned, relegating the military to strict support of commercial activity. But as an experiment, bending infrastructure to the support of the freedmen existed, if only briefly. The abandoning of the railroad levee marks the end of the first, idealistic phase in the engineering of Reconstruction. Federal engineers never completely lost a guiding ideological impulse. However as the institutional focus shifted to territorial development, and pushing the limits of technology in the natural world, their place as instrumental social reformers postwar order became less clear.

122 Benjamin F. Loan to Humphreys, January 17, 1868, Box 1, E25-RG77, NA; Abbot to Humphreys, January 31, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP. Saville, Work, 32–71.
Chapter Two

“All the Diagrams of Jomini”: Antebellum Military Theory and Education

We do not suppose that men differ greatly one from another, but we can think that the strongest are those brought up in the hardest school.
–Thucydides, *History of the Peloponnesian War*

La guerre est une science couverte de ténèbres, dans l’obscurité desquelles on ne marche point d’un pas assuré: la routine et les préjugés en font la base, suite naturelle de l’ignorance.
–Maurice de Saxe, *Mes rêveries*

An ignorant man, endowed with a natural genius, can do great things; but the same man stuffed with false doctrines studied at school, and crammed with pedantic systems, will do nothing good unless he forget what he had learned.
–Antoine Henri de Jomini, *Summary of the Art of War*

The meaning of a thing consists simply in the habits it implies.
–Charles Peirce, 1898

Professional soldiers in the nineteenth century learned to structure their mental conception of the landscape with rigorous geometric practice. Military theory took a top down view of topography and action in a landscape; soldiers trained at European and American military academies were steeped in a tradition of drawing used to represent both visible and invisible phenomena that structured a landscape. This mentality extended into engineering practice, where graphic methods of calculation buttressed a geometric sensibility of how landscapes could be reformed or ordered in concert with their naturally-occurring features. This geometric sensibility extended beyond combat and into understanding and manipulating the flows of materials in a landscape’s political economy—an extension that carried through into the army’s peacetime work. Military educational institutions were essential to the “formation” of this sensibility and epistemology, which took the form of a diagrammatic practice. The physical spaces of academies supported this
way of looking at the world, by providing training grounds where the joining of diagram and landscape construction could be rehearsed.

From the beginning of the Civil War, the northern press looked to works of military theory to interpret the actions of the armies and to gain insight into the mindset of the commanders. As the conflict ground on, reporters tried to demystify the army’s delays, defeats, and the otherwise mysterious workings for their readers, and themselves, by delving into the axioms of warfare taught at the military academy. Scouring the curriculum and book lists of what they perceived to be state-of-the-art military thought, journalists came up with the figure of Antoine Henri, baron de Jomini, a Swiss soldier and compatriot of Napoleon Bonaparte, and prolific writer on military subjects. Seizing on Jomini as representative of modern martial theory, northern journalists (and even a few politicians) consulted his texts when interpreting the sluggish progress of the war. In keeping with nineteenth-century enthusiasms for systems of knowledge and concrete principles that explained complex and unpredictable phenomena, the northern press was predisposed to favorably adopt the purportedly “scientific” theories of the Swiss officer, and assume his works constituted the common knowledge and language of the martial fraternity of officers. It also helped that Jomini’s work lent a patina of sophistication and intellectualism to warfare before the country became accustomed to warfare as anything but bookish. To the press at least, familiarity with the works of Jomini gave military officials a sense of intellectual dependability. In the beginning of the war, this was used for propaganda purposes, as Secretary of War Simon Cameron was sure to note to the newspapers that he had consulted Jomini when determining troop levees.¹ As an interpretive lens, Jomini was used to scrutinize individual actions of

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individual commanders. George McClellan, the celebrated but ineffective Union commander who suffered a series of humiliating defeats in Virginia at the beginning of the war, was painted as a particularly studious and erudite general, and journalists eagerly sought to find evidence of Jomini’s ideas in his actions. After his defeat at Bull Run in Virginia, a *Harper’s Weekly* writer used Jomini’s texts to calculate the amount of time it would likely take McClellan to regroup his troops.² Within a few months time, the Swiss soldier-theoretician’s name had entered into American consciousness and was a household name. So ubiquitous was his invocation in common, everyday speech amongst civilians that it became a common joke to swear “by Jomini!”; his omnipresence indicated widespread association of his name with the intellectual structure, however obscure, that drove the men prosecuting the war.³ And though the exact outlines of that theory largely remained obscure to the public, Jomini’s theory remained the ur-source of knowledge in an otherwise complicated and chaotic wartime environment. A case in point might be a southern newspaper reverently quoting in full Jomini’s thoughts on how many nails to use in shoeing a horse, or his pronouncement on the best thing for soldiers to remember when selecting their own: “look for shoes that will fit you easy.”⁴

As the war dragged on, however, and casualties mounted, the press began to take a dim view of his theoretical adherents and eventually of Jomini himself. Journalists began to see the divergence between Jomini’s theoretical diagrams and evolutions and the disorder and unforeseeable contingencies of actual warfare. At first, journalistic dismay was directed at generals who seemed to depart from Jominian orthodoxy, as post hoc analysis revealed that

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³ “Yankee Notions,” *Saturday Evening Post*, October 18, 1862.

⁴ Charleston *Mercury*, September 1, 1863.
Union generals somehow formed plans less apt than those “worthy of the best general in Europe.” Critics of the war’s conduct ascribed catastrophic Union defeats to a failure to adhere to Jomini’s *Art of War*. Eventually, this line of thinking gave way to an outright questioning of the worth of theoretical study in the first place, aided by a growing chorus of self-professed veterans of past wars who pronounced theory as a distraction at best. A veteran of the French army under Napoleon, who was probably quite old when writing, rejected the notion that warfare could be prepared for by study:

> A practical soldier will only consider Jomini a pompous, empty theorist. Strategy cannot be learned from books. If it is called science, it requires gifts innate in a physical organization possessed by only a few men. War will bring them out.

The veteran gave voice to an older way of thinking, giving weight to physical prowess and innate genius, against the prevailing nineteenth-century enthusiasm for systematized warfare which had been developing for several centuries. Popular opinion nonetheless adopted the veteran’s suspicion of theory immediately. Acquaintance with theory and familiarity with principles developed by European thinkers quickly became a professional and political liability for Union officers. Again, the clearest example is McClellan, who was pilloried for his studiousness when running for political office:

> He is, on the evidence of those best competent to judge, a theoretical soldier of the highest culture, fully equal to talking “strategy” with Marshal Jomini, or giving new views of the science of defense to the antique Vauban of France …

this attention to professional development proved a disqualifying encumbrance. As the various “theoretical” soldiers began to topple out of favor with Lincoln and be replaced by men with

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more “pragmatic” reputations, a newspaper eulogized two of them as “striking additions to the list of scholars whose star has shone in the study, but paled on the battle-field.”

Critics of the Jominian way of war (itself a nebulous concept in the discourse of the American press) consolidated around one pole of a conception of military knowledge. Briefly sketched, their position was that a soldier relied on an innate and largely indescribable talent, inborn, and located within the self. At the opposite end was Jomini: his axioms and principles, and pages of historical battles described in diagrams taught at military academies. One newspaper mocked the professors at military academies, portraying them as priests of a false religion: “They invoke the name of Vegetius [a famed Roman military theorist], hold up the diagrams of Jomini and talk of twelve orders of battle,” not failing to note that everything Jomini himself knew or analyzed was derived from the actions of men who had received no formal, theoretical training themselves. “The diagrams of Jomini” in effect became a rhetorical device to denigrate technical knowledge that came from somewhere external to the born soldier. One widely-cited and, it can be assumed, equally widely discussed letter published in the *New York Evening Post* summed the split well. Citing the English historian Thomas Macaulay’s assessment of the English Civil War, the newspaper’s editors doubtless though it applicable to the current situation:

…the military art is no very profound mystery, that its principles are the principles of plain good sense, and that a quick eye, a cool head, and a stout heart, will do more to make a General than all the diagrams of Jomini.9

The juxtaposition of these two passages (“quick eye, a cool head…” and “all the diagrams of Jomini”) would appear in a number of publications for the duration of the war.10 It is revealing of

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the age-old tensions of anti-intellectualism and undoubtedly a hangover of Jacksonian populism. The exposure of this tension in the press, and its resonance as a conundrum, illustrates another basic tension at the heart of military thought in the United States and Europe at the time. Wars were fought on a continuum between theory and intuition, but to what extent one type of knowledge should be privileged and dominant remained an open question, even if it assumed new urgency during crises.

The Civil War caused a national debate on the role and nature of theory and practice to play out on the pages of American newspapers. While interesting in its own right, the specific debate about the role of military theory mirrors a similar internal contest within the trans-Atlantic military intelligentsia that the public discourse could only but dimly reveal. Though the American press had seized on Jomini, his thought was far from dominant or monolithic, and the man himself struggled with the limits of quantitative description for such a chaotic phenomenon as war. His specific thought was also far from the sum and total of military thought at the time, and as one historian has pointed out he should be “considered in the way he always functioned: as a part of, and not apart from, the vibrant and crowded intellectual environment that produced him.”

Recent scholarship has in fact shown convincingly that for all of the invocation of Jomini’s name, his specific theories played little role in the outcome of the war, and indeed

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10 For example: “Banks as General,” *New York Herald*, June 12, 1863; D. H. Mahan, “Another Historical Example,” *Louisville Daily Journal*, October 4, 1862. The former citation is notable for Mahan’s measured, if somewhat squirrelly response to Macaulay’s proclamation, noting that there was nothing very profound in pointing out the tension between.

11 Carol Reardon, *With a Sword in One Hand and Jomini in the Other: The Problem of Military Thought in the Civil War North* (Chapel Hill: University of North Carolina Press, 2012), 8. I wish to acknowledge a debt to Reardon, as much of the discourse in newspapers around Jomini was found by using the method presented in her book.
historians who have scoured the letters, diaries, and battle plans of Civil War commanders have found scant evidence that Jominian thought played any role on the battlefield whatsoever.\(^\text{12}\)

However, Jomini, possessor of what one newspaper called “a clear, luminous, and graphic style,” represented the state of the field of military thought in the mid-nineteenth century and had impact on the form of military education. His diagrams represented habits of thought that would have been inescapably formative to anyone who attended a military academy.\(^\text{13}\)

Military education was thoroughly technical and, importantly, graphic in its epistemology. Radically different from a typical liberal formulation of education in the United States at the time, military education formed a worldview based on an understanding of the processes of war. Both the professors and the spaces of education at military academies worked to instill a graphic and kinetic understanding of the world in their cadets, and in the case of the United States, the physical environment was enlisted at an unprecedented level. Theory, or the means of grasping the physical world, was revealed to the Civil War generation of military officers in a way that combined European diagrammatic thought with lessons spoken by the landscape. Military education produced a recognizable \textit{habitus} of practices and ways of thinking that the post-Civil War generation operated within, a product of books, pedagogy, and interaction with the natural world. While it may not have apparently helped in actual battle, the “graphic style” produced tremendous impact in the landscape of the South as the officers went about reconstruction.\(^\text{14}\)


\(^{13}\) Editorial, \textit{Louisville Daily Journal}, February 5, 1865.

\(^{14}\) Pierre Bourdieu, \textit{Outline of a Theory of Practice} (Cambridge: Cambridge University Press, 1977), 72–95; Richard Harker, Cheleen Mahar, and Chris Wilkes, eds., \textit{An Introduction to the Work of Pierre Bourdieu: The Practice of Theory} (Houndmills: Macmillan, 1990), 1–22. In its most basic form Bourdieu defines his notion of \textit{habitus} as “systems of durable, transposable \textit{dispositions}” (p. 72, emphasis in the original). \textit{Habitus} in the context of nineteenth-century military engineering in America, was a set of behaviors that the engineers used to go about their business of designing and building physical structures, but also their shared rhetorical practices of justifying their
Diagrams, Plans, and Schematics

Enlightenment military theorists displayed remarkable continuity in their pathways of thought; Jomini’s squabbles with his predecessors, as will be discussed more thoroughly below, stemmed from disagreements over relatively small aspects of the larger, consistent method. The body of military theory taught to West Pointers was consistently diagrammatic: at a basic level, it employed theoretical geometric models to describe future behaviors. In this way, soldiers were taught to design future behaviors by use of graphic representations of interacting parts. The theories of design were meant to temper the chaos of war and render that chaos at least somewhat apprehensible, and manipulable. The result of the proliferations of the diagrams of the military enlightenment was a widespread habit of thought that sought to impose geometric, axiomatically-defined structures on spatial problems.15

Diagrams were complex tools in the hands of the state’s engineers as they held capacity to enlarge the scope of possibilities of state intervention and rhetorical power to justify massive change.16 At a most basic level, military diagrams were simple drawings that delineate sets of instructions or a catalogue of possible scenarios. However, in their evolution, the relationship between drawing, diagram, and graphic plan (that depicted change over time), became more

work, making the case for further interventions in the landscape, and, as a whole, imagining social and economic impacts of the networks they were engaged in building. Drawing, with the heavy use of applied geometry to guide their decisions, formed the center of that practice, and what Bourdieu described as the “conditions of existence which, in imposing different definitions of the impossible, the possible, and the probable,” and contain a naturalizing effect on the self-conception of the group’s work and ways of being (p. 78).

15 The imposition of order on the bodies of soldiers to utilize the combined powers of individuals to greater effect was precisely what Foucault referred to when formulating his definition of tactics, “the art of constructing, with located bodies, coded activities and trained aptitudes, mechanisms in which the product of the various forces is increased by their calculated combination are in no doubt the highest form of disciplinary practice.” Diagrams enabled this attempt at control to be transposed to larger landscapes. Foucault, Discipline and Punish, 166.

16 Jeffrey Hamburger, “The Diagram Paradigm: The Diagrammatic Mode in Medieval Art and Beyond” (lecture, Dumbarton Oaks Research Library and Collection, Washington, D.C., October 20, 2015). I am deeply indebted to Professor Hamburger for his thoughts on my work on military diagrams, which took on a new urgency after I saw with renewed interest just how versatile diagrams could be.
complex. The different categories of drawing were each used by soldiers and engineers for different functions—some more abstract than others—and the progression through the types of drawings connotes in each instance different modes of thought and levels of complexity. A taxonomy of the various “types” of drawing practice is therefore worthwhile.

Nineteenth-century soldiers in the Anglophone tradition referred to abstract drawings made up of lines and geometric symbols that showed relationships between various objects and forces as diagrams. This broad category was distinguished from other drawings by making no effort to be representational and was often as simplistically abstract as possible. Within this realm of abstract drawings there were two types of diagrams at use: those that conveyed a relationship between empirically-derived information, and those that provided an image of a potential resolution of some problem that could be solved by future action. An example of the first category would be a tide-chart showing fluctuations in water volume throughout the year, presented in a manner that made quick apprehension possible. The latter category provided a graphic structure in which to think about potential outcomes of and changes in the relationships between the objects that they (abstractly) represented. Jomini’s troop movement diagrams, and those of his contemporaries, all fall into this category. These drawings, while referred to by their creators as diagrams, might be more precisely understood as schematics, as they are loose, imprecise representations of potential, and are more useful for thinking, plotting, and imagining than they are for the conveyance of raw information.¹⁷ Soldiers and engineers believed in their use of graphic aids to thinking because of their ability to clarify complexity by swallowing many

¹⁷ Jean-Paul Sartre defines a schematic as a graphic structure composed of schemas: “A schematic drawing is constituted by schemas…they do not represent anything but some relations of structure or attitude.” His notion of schema is Kantian (and therefore similar to that of Gilles Deleuze) in that, though an abstract structure, the schema is an application of a higher order or transcendental category. Jean-Paul Sartre, The Imaginary: A Phenomenological Psychology of the Imagination (London and New York: Routledge, 2004), 29–34 emphasis in the original.
of the irrelevant contingencies confronted in complex operations. In battle and in building schematic diagrams provided the way to apply theoretical knowledge in a first approach.

The soldier/engineer’s diagrammatic practice contains the point where the application of theory meets reality. The drawings themselves are accounts of thought and the development of an epistemology. As models, they represent a locus of the generation of much of the experimental visions of infrastructural territory of the era. Men who were trained to think about battle diagrammatically in turn thought about engineering and landscape similarly: school and practice had the effects of instilling the habit of philosophical condensation into mental geometric systems into large amounts of powerful men who then ordered their institution and their landscape according to the outlook this education provided them.

**Warfare, chaos, and design: the legacy of Antoine Henri Jomini and the coup d’oeil**

Antoine Henri, baron Jomini, was born to a bourgeois family of Italian origin in Switzerland in 1779. With no formal military education, he worked in a commercial house in Paris while seeking an appointment in the French army, eventually securing a position on Michel Ney’s staff. Distinguishing himself as a strategist during key campaigns in the Napoleonic wars, Jomini developed a reputation with Bonaparte himself, and attracted the jealous ire of rivals. As his

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18 The military theorists considered in this study inconveniently did not conform to the foundational analysis of diagrams as “intellectual machines” developed by Foucault and Deleuze. For the most part, the diagrammatic activity of the American military engineers would most accurately be described as forming schema or schemata in the Kantian sense shared by Sartre, Foucault, and Deleuze: artifacts of a practitioner attempting to apply transcendental thought. West Point did not train soldiers to think or create in the manner that satisfies Foucault’s definition: they produced no drawings that describe a “functioning, abstracted from any obstacle.” Yet the manner of thinking, especially when considering infrastructure planning, rose above architectural schematic or plan because the thinking did indeed extend to attempts to capture forces (natural, material, and social) that make the drawings and habits of thought they inculcated “social before being technical.” American army engineers never built nor thought of their diagrams at the highest level identified by Foucault or Deleuze (certainly not at the level of “the stirrup is selected by the diagram of feudalism”), yet did display a level of thinking beyond mere plan. With these caveats, I retain their consistent use of the term “diagram” to describe their work. Gilles Deleuze, *Foucault*, trans. Seán Hand (Minneapolis: University of Minnesota Press, 1988), 27–40.
position in the army became more politically untenable, Jomini threatened numerous times to
resign. Bonaparte, fond of the young strategist and admiring of the insightfulness of his writings,
carved out a special duty for Jomini writing the history of the Italian campaigns. Preferring
administration to fighting, Jomini asked for and was assigned the duty of military governor in
Vilnius, in modern-day Lithuania, which placed him geographically in position to aide the
French army’s disastrous retreat from the invasion of Russia. Witnessing this apparently had a
harrowing effect on him both physically and mentally; one biographer states that the illness and
anguish nearly killed him. More internal politics within the French army compelled him to
eventually resign his position and defect to the Russians, where he served the tsars as a military
advisor for the rest of his life, never quite recovering from the damage the hard winter’s retreat
had done to his body.19

Jomini’s first publication was a pamphlet-length treatise on what he termed “grand
tactics”: proscriptions for the landscape-scale movement of armies derived from a study of
Frederick the Great and the history of the wars of the French Revolution. First published in 1803,
no copies survive, and Jomini was reported to have burned the manuscript, but the intellectual
content reveals the beginning of a recognizable pattern in Jomini’s work. For the next half-
century of publishing, Jomini revisited the same historical material (Frederick, the French
Revolution, and Napoleon) and tease out geometric relationships which he compiled into a
general theory, or science of warfare. Built on the original pamphlet, the 1807 Traité des grandes
operations militaires, written between 1804-06, went through four editions before 1857. In 1824,
Jomini revisited the historical work to compose the Histoire critique et militaire des guerres de
la Révolution (in a hefty 15 volumes and four accompanying atlases), followed soon after by the

19 H. W. Halleck, “Sketch of the Life and Writings of General Jomini,” in Life of Napoleon, by Antoine Henri
Vie politique et militaire de Napoleon (1827), which included as much analysis as biography. The publication of the Tableau analytique, in 1830, signaled a shift to less historical narrative and more attention to theoretical construction, and culminated in the publication of his Précis de l’art de la guerre (1837), which represents the maturity of his thought.²⁰

The Précis is divided roughly into two parts: a compact political treatise serves as a prelude to analysis of, and theories pertaining to, actual fighting, which comprises the bulk of the work. Jomini demonstrates a subtlety of thought about the fundamental political basis of warfare and outlining the commander’s relationship to the political forces that he represents and is an instrument of. Two chapters describe the configuration of the political environment that wars exist within, devoted in turn to internal and external politics to the nation state. Conceptually, Jomini’s aim was to make potential commanders aware of the variety of influences with origins outside of the political realm that would affect the business of war. Touching on issues of geography and aggression, military institutions and their varied competence of leadership, and recruitment and morale in the homeland, Jomini laid out the range of a commander’s tangible and intangible considerations. In directing his readers to assess the unpredictable cauldron of national politics, he advocated a cool epistemology, built on his earlier “profession of faith” on

²⁰ The editions I consulted in preparation of this list are as follows: Antoine Henri Jomini, Traité des grands opérations militaires ou relation critique et comparative des campagnes de Frédéric et de l’empereur Napoléon : avec un receuil des maximes les plus importantes de l’art de la guerre, justifiées par les actions de ces deux grands capitaines (Paris: Guiget et Michaud, 1807); Antoine Henri Jomini, Histoire critique et militaire des guerres de Frédéric II, comparées au système moderne, avec un receuil des principes les plus importants de l’art de la guerre, rédigée sur de nouveaux documents et augmentée d’un grand nombre de cartes et plans (Brussels: J.-B. Petit, 1841); Antoine Henri Jomini, Précis politique et militaire de la campagne de 1815, pour servir de supplément et de rectification a la vie politique et militaire de Napoléon, raconté par lui-même (Paris: Anselin et Laguyonie, 1839); Antoine Henri Jomini, Tableau analytique des principales combinaisons de la guerre, et de leurs rapports avec la politique des états, pour servir d’introduction au traité des grandes opérations militaires, 4ème ed. (Brussels: J.-B. Petit, 1839); Antoine Henri Jomini, Précis de l’art de la guerre, vol. 1 (Paris: G. Laguionie, 1838), American translations in English are dealt with extensively below.
politics: “In internal politics there are four things essentially different: theory and practice, men and systems.”

Jomini’s desire for organization of knowledge and physical phenomena into clearly-defined systems places him in the intellectual cohort of other systematizers of Europe of the age. Henri de Saint-Simon, a French theorist who advocated a highly hierarchical technocratic-utopian organization of society, stands out as the charismatic representative and inspiration to a generation of European reformers who built the first modern conceptions of industrial society and wielded great influence over European industrialization—including planting the seeds of the Suez Canal. While not known to be associated with followers of Saint-Simon, Jomini’s dabbling in social systems theory and positivist approach to societal dynamics place him on a parallel trajectory. Like many of his time and place, he too was subject to the allure dynamic models held, and his books indicate he devoted much thought to expansive sets of relationships between disparate actors in warfare and politics.

The baron’s systemic thinking becomes more evident in the section devoted to the actual “art of war.” In the following three-quarters of the Precis, Jomini divides the work of war into five distinct branches: strategy (la stratégie), grand tactics (la grande tactique), logistics (la logistique), engineering (l’art de l’ingénieur), and field tactics (la tactique de detail). The strategy and grand tactics section deal with regional scale structures of frontiers and national borders and the planning of invasions or defenses that involved many troops and large areas. Logistics entailed supplying and arming expeditions and providing a well-defended and reliable transportation system to keep expeditions supplied in the field, stressing an attention to detail.

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Engineering covered the construction of fortifications and the assistance experienced and trained engineers could provide in offensive operations, such as undermining enemy fortifications. Again, this section ranged in scope from consideration of grade angles of fortification walls to frontier-wide strategies for structuring a national defense. The final section, \textit{la tactique de detail}, dealt with the actual arrangement of soldiers on the battlefields in preparation for combat.\textsuperscript{23}

Jomini’s entire theory rested on the manipulation of what he termed “lines of operation,” a term introduced by earlier theorists but brought to a full baroque complexity by the baron. By lines of operation Jomini meant imaginary lines that crossed landscapes along which armies would move and fight—for instance, an army leaving a fortress on the frontier and moving into enemy territory to attack a city would move along a line of operation drawn from that fortress to the city. In Jomini’s conception, these lines were meant to be rigidly Euclidean: accidents of topography were to be avoided or circumscribed by adjustments to the defining endpoints, which was preferable to introducing kinks or bends. Operation lines sprang from the baseline of the frontier; Jomini tweaked his predecessor Lloyd’s theory by proposing that the optimal relationship between base and line of operation was perpendicular. Geography, as Jomini defined it was a descriptive process that abstracted the landscape and gave structure to the territory of war. Defining “geography” itself, he wrote: “…[it] consists in the topographical and strategical description of the theater of war, with all the obstacles which art and nature may offer to enterprises…” so laid down and analyzed by lines of operation.\textsuperscript{24} The geometric theory gave structure to any underlying landscape, finding voids in valleys and in between topographical


\textsuperscript{24} Antoine Henri Jomini, \textit{Summary of the Art of War, or, a New Analytical Compend of the Principal Combinations of Strategy, of Grand Tactics, and of Military Policy}, trans. O. F. Winship and E. E. McLean (New York: G. P. Putnam & Co., 1854), 52. I have used both the original and the translations of Jomini that were at use at the U.S. Military Academy at West Point—when I have quoted the West Point translations of Jomini, as is the case here, it is noted.
obstacles, seeking the landscapes of least resistance. The interaction of these lines formed a network or lattice that defined what Jomini termed the “theater” of war: a defined territory shot through with pathways defined by their potential for movement.

Lines of operation were inherent to a particular territory, but could change subtly in their precise location depending on what political, or other human-induced, winds were blowing. Looking at a map of the territory between the Danube and the Main Rivers, Jomini writes that he imagines 20 lines immediately—that they seem to jump out at him from the map. However, this rough and fast analysis of topographical data was to be supplemented by careful historical study as subtler forces than terrain may be at play. Inherent to territory, the lines existed across time: referring to a particular territory, Jomini writes “in 1796, the lines of operation are traced upon those of 1757, and upon those of 1794, but obtain, as in the preceding year, a very different result.” It may be helpful to think of these lines not as an imposed diagrammatic schema meant to give a semblance of order, but as representative of conduits that could themselves contain manifold other properties. Contingent factors constrain or expand the potential advantage of certain lines, making them less or more attractive. The influence of Euclid is apparent. The landscape diagrams indicate a relationship between principles and models in his thought: principles are always contingent and defined by buttressing adjacent principles, axioms built one on another. To read Jomini is to follow the theory’s construction. Further, as a network of contingent principles, the geometric framework has the capacity to carry dynamic forces, and that a property conceived operational structure can accommodate shifts brought on by unforeseen realignments or accidents, whether that be from political intrigue, disease, surprise, or weather.

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25 Jomini, 144.

26 Jomini, 122.
Believing that theory was meant to construct a framework across which these “speculative combinations,” his term for strategizing which implies the synthetic amalgamation of disparate forces, Jomini revealed himself as a true scientist—his interest lay in the measurement of the deviations of actual warfare from the theoretical schema he had projected from before the first shot was fired or the first march undertaken. Like the design of a truss, Jomini’s arrangement of troop combinations and trajectories in angles that laced large territories under force illustrated military power derived from landscape-scale structural configurations.

Figure 2.1. Diagrams of the theater of war of the French armies in Westphalia, Antoine-Henri, baron Jomini, 1838, Précis de l’art de la guerre (Paris: xxx) 1838, pages 180 and 183. To give some idea of the level of abstraction Jominian thought entailed: in the left diagram, the line $AB$ represents the North Sea.

Jomini’s critics, of which there were many, took issue with the rarified quality of his geometric schemes, and questioned their pragmatism and effectiveness. This was especially true in the case of their application during the American Civil War. Collective contemporary civilian head-scratching that revealed a public confounded with the complicated theories have been described above. Even initiates to Jomini’s school of thought, as recent scholarship has shown, may have lacked as much of a grasp of the theory as the Swiss general may have wished. Historians have made the case that Jomini’s thought is most evident in the obsession on both

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27 Jomini, 6–15.
sides to maintain “interior lines.”28 A central component of Jomini’s theory, wise commanders sought a configuration of their forces arranged in a convex shape around a central base of operations. Commanders were to avoid concave exterior lines, which lacked the compactness and ease of logistics and movements afforded by their “interior” counterpart configurations. Jomini cited Napoleon’s deployments at Wagram and Jena as examples; historians generally refer to George Meade’s “fishhook” deployment at Gettysburg, which the Confederates struggled to encompass, as evidence of the presence of Jomini’s theory. Other than that, however, the record provides few other instances of the ideas of the Précis surfacing during the Civil War, an absence that historians attribute to Jomini’s thought being less well-known than assumed, or a very real indictment of its practicality.29 Regardless, Jomini’s relentless geometricism is largely responsible for its skeptical reception: his tendency to describe territory as an échiquier, or chessboard (though American translators generally retained the French term), is one provocative abstraction among many. We are, I believe, justified in assuming that Jomini’s reduction of the North Sea to the line AB (see Figure 2-1) would have been viewed with the same suspicion that we see it with today. Jomini’s overly enthusiastic use of compass and ruler has cast a pall over any assessment of his influence then and now, one historian aptly assessed his tendency to “embroider” his radically abstract ideas has relegated him to the similar skepticism with which we regard Scholasticism.30


It is worth noting, however, that the application of Jomini’s thought just to battles obscures a larger tradition of applied mathematics to landscape outside of the context of combat. Focus that rests solely on the military diagram as an effective (or ineffective) tool of war omits the importance of the diagram as the 19th century military’s premier communication tool and way of interpreting intellectual structure.

**Genealogy of the Diagrammatic Mode**

The geometric mode of thinking was the result of one strain of military thinking that could be traced to the ancients, but saw significant development in the 16th and 17th centuries in Europe. The use of lines to describe the interaction of forces on complex topography springs to the forefront of military discourse in the era of Louis XIV’s wars and border consolidations in France. Louis’s prized engineer, Sebastien le Prestre de Vauban, did much to structure military perception of landscapes, as his schemes to form a *pré carré* of French territory for his prince inserted diagrammatic thinking at the scale of the state. Lines, implied from an array of frontier fortresses, emerged as the basic framework through which to view war and land in Vauban’s era—this geometric language would undergo significant development and elaboration from Louis XIV’s wars to the geometric ethos of military education at the eve of the American Civil War. It is therefore important to trace the development of this mode from its origins and describe its prevalence and incredible permeation of military thought.  

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The origin of the diagrammatic mode can be traced to the Renaissance editors of Vegetius, a 4th century Roman writer whose compilation of Roman military theory, *Epitoma rei militaris*, remained influential through the Renaissance. Widely read for centuries, one historian has likened the *Epitoma* to St. Benedict’s rule for monastic life; Charlemagne’s soldiers were reputedly required to possess and carry their own copies, and its influence on Machiavelli’s *Arte della Guerra* is apparent.32 Because it is a compilation of Roman warfare techniques that encompasses both the republican and imperial periods, scholars have struggled to fully

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reconstruct the historicity of some of Vegetius’s specific prescriptions and methods—at times Vegetius skips across history, and anachronism casts doubts on whether he described practices he saw or was simply a theorist and advocate of a return to drill and discipline of the famed high imperial period. However, many of the descriptions of the Roman army’s activities in classical sources, such as Polybius, Livy, and Julius Caesar himself, corroborate the formations and organizational methods Vegetius describes. Divided into sections on recruitment, organization, and siege warfare, the body of the treatise focuses on the organization and deployment of men on battlefields. In sixteenth-century imprints, the text is supplemented by diagrams of formations of men composed of text glyphs arranged in blocks. The printers of the 1532 edition rotated the individual glyphs so as to give a sense of direction and show an understanding of the orientation of individual soldiers within a larger, cohesive, geometric form. Though it is unknown if Vegetius included diagrams in his original manuscript, the Renaissance augmentation ensured that Enlightenment military theorists would have been exposed to this type of presentation of Vegetius’s ideas in the course of their own classical educations.

The first post-Renaissance theorist to fully embrace a theory of warfare based on graphic, spatial analysis was the Welsh soldier and adventurer Henry Lloyd. Born in 1716 and of low birth, Lloyd had a scrappy ascent into the aristocratic officer class, serving with several different European armies and in a number of conflicts. As a sort of itinerant soldier, he spent his early adulthood jumping from conflict to conflict across Europe, gaining his first foothold in military service as an engineer in the Spanish army. Fighting for the Spanish king, and then the Jacobites, he gained experience in siege warfare and engineer duties in early modern armies. During the


brief breaks in fighting he also gained as smattering of classical education, first chafing under the
dons at Oxford before fleeing theological studies for the soldiering life, then, after witnessing a
few sieges, studying with the Jesuits in Italy, where he was exposed to Newtonian mechanics and
astronomy. His big break—a commission in the French army—came when he impressed
Maurice, the marquis de Saxe, with drawings and sketches he made of the topography of an area
the famed French marshal was moving his armies into.\textsuperscript{35} Fighting with de Saxe on his resume led
to a lifetime of military service with different European powers; exposure to the courts and
intellectual centers across Europe may have compelled Lloyd to codify his experience in a
historical analysis of warfare that could elucidate war’s basic principles.

Lloyd’s military treatise, \textit{The History of the Late War in Germany}, published first in 1766
and then again in 1790, with a second volume, established the form of the historical/theoretical
military treatise that would be elaborated further over the course of the Enlightenment.\textsuperscript{36} Lloyd
built on the rich tradition of documenting warfare inherited from Thucydides and Herodotus
while instrumentalizing the chronicle by comparative analysis. From his recounting, he
constructed abstract models of the forces at play in a battle or campaign, moving both action and
topography to an abstract plane to enable comparison. These models were represented by simple
line diagrams and accompanied by historical description and enumeration of basic, fundamental
principles of warfare that they supposedly illustrated. By diagramming battles and posing
different situations alongside each other, Lloyd developed a manner of analysis that gave warfare
a historical form, and therefore made it subject to graphic and mathematical analysis. The

\textsuperscript{35} Patrick J. Speelman, “Henry Lloyd and the Military Inheritance of the Enlightenment” (Temple University, 2000),
11–40.

\textsuperscript{36} Henry Lloyd, \textit{The History of the Late War in Germany}, vol. II (London, 1766).
tradition of diagramming begun by Lloyd can be seen as an accumulation of human knowledge over many years, seen as patterns of lines across the European landscape. 

This set of abstract analytical tools gave rise to a necessary counterpart: a method of accounting for the unpredictable human factor in warfare, that would disrupt even the best-laid and diagrammed plans. This basic dichotomy—between the faith in order brought by geometry and the inevitable human tendency toward chaos and disorder—would remain a permanent component of the Enlightenment military treatise; as a fulcrum, its basic disconnect can be read in Jomini and even the uninitiated journalists, leery of too much abstraction. Lloyd, as did his successors, struggled to describe the benefits of mutual buttressing of geometric and human knowledge in the mind of a successful commander, and it is no surprise that the dichotomy is most discussed when referring to a soldier’s education. As enlightenment military theorists moved away from an idea of innate genius and sought to construct systems by which nascent talents might be developed, military education similarly took on the cast of development of skills, with importance placed on swift apprehension of different aspects of phenomena. Aspiring generals, Lloyd believed, should concentrate on the ability to reconcile complex information that had been rendered geometrically with a cultivated, intuitive sense of action.

Lloyd and other military theorists called this talent or skill by the French term *coup d’oeil*, literally “stroke of an eye,” translated as “a glance.” By this, theorists and adherents believed that the highest military skill was the ability to arrive at a situation in a landscape, to swiftly take in all of the elements in that landscape, evaluate that information, and act decisively. A sense for topography was important, as Lloyd argued a facile understanding of land provided the framework over which intuition could operate:

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It is with the ground, as with the features of men: there are not, perhaps in the whole world, two features perfectly alike, nor two pieces of ground, of a given extent, perfectly similar….Genius alone can distinguish the most minute and imperceptible difference to vulgar eyes, there is between different grounds, and occupy them accordingly….The perfection of our art would be, no doubt, to find a construction … equally proper for all kind of ground: but this being impossible, the only thing remaining for them to do, is to find such a construction…[as may]be adapted to those numberless circumstances which occur.38

Lloyd was less-than-sanguine about the amount of those who possessed the “Genius” inborn to diagnose minutia, and posited the majority of students, lacking genius, must resign themselves to trusting that “geometry, and experience, will help them to avoid gross errors.” Lloyd’s faith in the sharpening effect of applied mathematics presaged an evolving theory of education meant to give students great transformative power: “A little experience, and a certain coup d’oeil, aided by this theory, will enable a man to judge with great precision the time and space necessary to execute any evolution whatsoever.”39 More than mere analytical tools, diagrams and the thinking they engendered were meant to be powerful mental habits—and a good coup d’oeil was seen as an indicator of the internalization of this mental training.

In Lloyd’s case, the sense of intuition contained in the coup d’oeil extended to a sense of balance or equilibrium that informed his mechanistic view of the world (typical for the Enlightenment), but important to note as it implies that military diagrams were meant to be seen as dynamic indicators of potential action and reconfiguration. Evidence for this exists in his forays into economic theory, published after his military works. Lloyd’s An Essay on the Theory of Money (1771), heavily influenced by the pre-Adam Smith economists working in Milan, was foremost an early attempt to develop algebraic expressions to describe all of the various working parts of a theoretical “commercial republic,” and an early attempt to synthesize the interactions

38 Lloyd, The History of the Late War in Germany, II:xx–xxi.
39 Lloyd, II:xx, xix.
of economics, governance, and external policy that could model the complexities of the emerging nation-state. Lloyd’s mathematical abilities fell short of those of his Milanese contemporaries, and his foray into the field that would become political economy cause him to be mocked by both Napoleon and Clausewitz as an idiot savant. What his more famous critics failed to notice, however, was Lloyd’s lasting contribution to military theory: the introduction of algebraic descriptions of political and economic phenomena to a growing body of engineering knowledge of landforms at the scale of a nation. Lloyd’s enthusiasm for synthesis of concrete and ephemeral workings of the nation state expanded the purview of the soldier-engineer to promote a complex understanding of national phenomena with concerns at the scale of the vista. ⁴⁰

The expanding spatial dimension of war was picked up by the more eccentric graphic theorist of the succeeding generation. Heinrich Dietrich, Frieherr von Bülow, was a minor Prussian aristocrat who published on a variety of subjects. His *Geist des neueren Kriegssystems* (1799) sparked both excitement and derision in the military intelligentsia; its geographically-derived arguments for geometric construction of borders would have profound influence on Jomini. Historians, in that they have paid attention to this relatively minor figure, have noted his large-scale geometric constructions and grandiosity of scale (despite little formal military experience) as the source of the field of geopolitical thinking and the cause of Bülow’s own arrest for insanity and death in a prison in Riga and equal social obscurity. ⁴¹ Bülow’s smaller-scale diagrams, however, are usually passed-over. Study of their intellectual content, in their

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density and striking ability to communicate movement and inertia, however, indicates a sophistication of thought and embrace of positivism. The diagrams describe “evolutions,” or movements of masses of soldiers on battlefields. The rectangular shapes represent formations of men moving through the landscape in regimented masses; dashed lines between show the paths of potential movement, and the relationship of parts at the conclusion of the evolution. Strikingly, Bülow’s diagrams seem to give the masses of soldiers weight; one can almost feel the inertia of the units and resistance both of the plane one which they are arranged, but from the defined relationships between parts as well. Enlightenment warfare, according to these diagrams, was seen as a series of reconfigurations of machine-like components, where the configuration and relations to other components in space could be manipulated to affect the best strategic position and outcome. While criticized for being far too abstract, they nonetheless describe the dominance of the engineer’s mindset in military matters, in a strong desire for solid, graphically apprehensible explanations of the world. Bülow’s case was particularly fanatical in his desire; Jomini records his predecessor’s conclusion on the science of warfare: “que tous ceux qui ne veulent pas que la guerre se fasse trigonométriquement sont des ignorants.”

Jomini, who read both Lloyd and Bülow with great interest, and whose work clearly owes much to their theoretical developments, was nonetheless critical of geometric determinism in warfare—Bülow’s brand in particular. Dedicating several pages of the Summary to dismantling Bülow’s prescriptions for length of operational lines and governing diameter measurements from ammunition supplies, Jomini concluded that the Prussian’s schemes “ranged in the class of Utopias.” This is not to say that Jomini remained skeptical of his own diagrams, or felt that they were merely illustrations—on the contrary, Jomini’s belief in uncertainty and human passion as

42 Jomini, Précis de l’art de la guerre, 1:272–73.
equal factors of military success led him to temper his own diagrammatic thinking with a healthy skepticism.\textsuperscript{43} Citing an anecdote about an officer he encountered who was “almost a rival of Laplace” in mathematical ability, but hopeless as a leader of men, Jomini was consistently leery of the “respectable disciples of Euclid” and doubted their ability to grasp the importance of the

\textsuperscript{43} See Azar Gat, \textit{A History of Military Thought: From the Enlightenment to the Cold War} (Oxford: Oxford University Press, 2001), 130–31 though I disagree with Gat’s facile distinction between “geometric” and “spatial” analysis. If anything, spatial analysis requires geometry to envision or communicate, so the distinction is muddled. Gat’s desire to dismiss the role of diagrams in favor of arguing that the substance of Jomini’s arguments lies elsewhere is unhelpful when trying to understand the holistic geographic and humanist approach Jomini took to his theory.
role of intuition. Jomini’s skepticism allowed him to invite his readers to regard his diagrams as useful tools rather than established theology.44 A healthy intuitive sense, and study of history, would enable the student to unlock the real power of the diagrammatic models: to spot deviations from the normative construction, which was the site of learning and gaining experience, and most productive place for action:

Here are, I trust, sufficient proofs to demonstrate the necessity of suspecting somewhat, that strategy, which is treated too geometrically, and to convince one that if this science has made great progress, it can still be improved by modifying the geometrical systems by those founded upon the principles and experience of war, which counsel a slight deviation from the first.45

Diagrams, then, were models in that they provided profiles to which a student could measure a situation. A store of diagrams in the mind of the student was the engine from which to generate experience derived from the observed landscape.

The dichotomy between abstract models and intuition abetted by experience embedded in Enlightenment military theory would become the basis for the two important pillars of military education in the United States. Students would first learn how to draw, and to represent everything from landscapes to the study of physics graphically, embedding the linear construction of knowledge thoroughly. Then, they were put through extensive training outside, gaining as much of the elusive “experience” that topography could teach, their instructors cultivating that coup d’œil rapide et sûr so important to Jomini and his intellectual mentors. It should by now be clear that Jomini was but one of many in an intellectual tradition that was familiar with the weaknesses of an over-reliance on geometry, yet still strongly believed in its power to supplement a sense of action in space. The language was shared even amongst those

44 Jomini, Summary, 133–34.

45 Jomini, 94.
theorist inclined to criticize any reliance on geometry: Macaulay, so often quoted during the American Civil War, wrote of the importance of *coup d’oeil et sang froid*—concepts as important to Jomini as well, and simply a question of emphasis. In the translation of this set of ideas from Europe, the teachers at West Point for the most part invoked Jomini’s name when referring to the long trail of ideas that stretched back several generations. However, it is apparent from the construction of the curriculum at West Point that diagrams were useless without an understanding of topography, preferably one derived from experiential knowledge of land. Kinship and McClean, the two West Point instructors who translated the *Summary*, certified what they believed to be the empirical basis of the Swiss soldier’s theories: “General Jomini learned the art of war in the school of experience, the best and only finishing school of the soldier.”46 This pattern of educational formation, a dialectic relationship between diagrammatic abstraction and the seeking and harvesting of experience, would form the basis of West Point’s curriculum and outdoor ethos. The engineering course, the nexus of precise and rigorous geometrical thinking and the manipulation of landscape, formed the fulcrum of the army’s educational philosophy.

**Mahan, Poncelet, and the Transformation of Nineteenth-Century Geometry**

Nineteenth-century engineering education practice was the site of great intellectual foment and changing attitudes about the very nature of the study of mathematics. In the French state schools, where the intellectual transformations around mathematics were taking place, a tension emerged between adherents of a notion that mathematics should be taught as pure scientific investigation, without regard to practical application, and those who saw no harm in eagerly applying newly-

46 Jomini, xx.
created theory to practical applications. Across the Atlantic, the faculty of the American military academy and the corpus of West Point-educated military officers participated in this transformation of mathematics, albeit somewhat peripherally, and existing asymmetrically on one side of the scientific debate. The connection between West Point and French schools of scientific and technical education is well-known; however, historians glossed over the technical and intellectual implications of the type of mathematics that was imported and taught on American shores. Axiomatic mathematics, and the synthetic geometry that formed the base of this branch of pure math, supported a pedagogy and formation of diagrammatic thought in engineering practices, and general intellectual formation of cadets that fit neatly with, and even made more profound, the geometrical discourse already embedded in the cadets’ strategic education.

The hinge figure in this importation of axiomatic mathematics was Dennis Hart Mahan, professor of engineering at the military academy at West Point for over forty years, who had an immeasurable impact on generations of military officers and engineers. More than a mere pedagogue, Mahan labored more than any of his contemporaries to give form to the nascent body of American military thought; historian Russell Weigley has aptly put Mahan forward as the first real American theoretician of war and its attendant concerns and disciplines. All American discourse, Weigley argued, built from Mahan’s foundation, into which the professor cemented an emphasis on professionalization of officers and clearly-defined corpus of knowledge, an broad understanding of the history of their “practice,” and an underlying faith that there were basic principles which underlay both war and engineering that “remain valid in all ages.”

The pedagogical debt West Point owed to the traditions of the *écoles militaires* has been dealt with extensively. Most works in the 20th century historiography of the American military contain a chapter outlining the impact of the military academy; nearly all provide some gloss on the trans-Atlantic import of pedagogy and self-conception of the military school as an initiation into the “science” of warfare.\(^4^8\) In reality, whatever import from France was limited to the state of military discourse recorded in works of military theory in the fairly narrow timeframe of the two decades 1810-30. The vessels of the intellectual importation were largely French language published works on military theory, mathematics, and construction (which underwent translation to English by West Point professors at a variety of paces) and in human vessels, first imported professors poached from French schools, then promising native students sent to be “finished” at a school like Metz, to return to teach. Sylvanus Thayer, regarded as the architect of West Point’s pedagogy and ethos, was one of these students sent to France; Mahan was a prominent other. Both played foundational roles in the structure of the school, the epistemology of generations of graduates, and by extension, the story of technical education in the United States. American military historiography has tended to focus on the French pedigree and then move on to the particularities of the “Frenchness” or non-Francophile evolution of technical practices. This nationalist focus has tended to obscure the importance of the content of the technical and scientific education cadets received at West Point—particularly the specific school of

geometrical thought taught there that was to have widespread implications throughout the army. The choice of type of mathematics—specifically, what basic episteme in the study of geometry to teach cadets—played a fundamental role in the army’s scientific outlook in the nineteenth century.\(^{49}\) This choice was dependent on Mahan—an engineer who was trying to become an educator—and his relationship with his teacher and lifelong friend and mentor, Jean-Victor Poncelet.\(^{50}\)

Geometry as a branch of mathematics was undergoing vast changes in the nineteenth century. The combined forces of intense theoretical activity in the academies and rise of applied mathematics to mechanical and engineering design conspired to push mathematics in general, the oldest and most pure of the sciences, beyond previously conceived limits. Geometry, which had undergone little innovation since Euclid, saw the most drastic changes. With the invention of descriptive geometry, then its more rigorously theoretical cousin, projective geometry, the science of spatial relations galloped beyond industrial application and into the realm of revealing powerful new insights into nature. Intense debates in the scientific schools of Europe revolved around the continued relevance of synthetic geometry, whose proofs only needed the use of compass and ruler, in the face of new advances in algebraic analysis. Graphic methods, for their lack of precision, were regarded as crude in the face of the new precision gained by use of analytical methods, even though synthetic methods were generally sufficient for solving engineering problems in the Enlightenment. In their crudeness, however, ancient geometrical methods were believed to have a limiting effect on the capacity for mathematics to expand

\(^{49}\) It should be acknowledged here that this basic scientific outlook—one based on classical techniques of teaching geometry—does not necessarily apply for the corps of engineers (or the army in general) when considering the 20\(^{th}\) century. Charting the persistence of Euclidean thinking through the changes in science and technology and up to the age of computerized modeling in civil and hydraulic engineering is, regrettably, beyond the scope of this study.

\(^{50}\) Griess, “Dennis Hart Mahan: West Point Professor and Advocate of Military Professionalism, 1830-1871,” 172.
human knowledge. While one side of the debate touted analysis’s profundity to expand human intellectual capacity, proponents of the synthetic, graphic method sought to seek the acknowledgement of what one historian called the “permanent beauty” of the graphic proof, and the generally agreed-upon use of graphic thinking to provide deep insight. These ideas held about education by use of synthetic geometry importantly made synthetic methods seen as a particularly effective technique for teaching engineering.

Geometry was the foundation of the intellectual formation of the scientist, though by the end of the eighteenth century the ancient method of teaching Euclid’s Elements was beginning to be challenged. Originating during the tumultuous Napoleonic years, questions of Euclid’s primacy germinated in the École polytechnique in Paris, where synthetic geometry was undergoing a renaissance at the center of the curriculum. The debates played out with the Polytechnic playing the part of laboratory of the avant-garde of mathematical thought; its innovations contested by faculty of the older, more conservative military academies in the countryside.

Before 1830, the notion of the application of theory in engineering practice preoccupied the faculty of the École polytechnique and the École des Ponts et Chaussées. Picon notes that this was an inevitable conflict between the dueling professional conceptions of engineering as a science and an art. Emerging from a set of intuitive practices and heuristics, “modern” engineers and teachers realized the limits of the intuitive approach and sought to reinvigorate the discipline

51 Julian Lowell Coolidge, A History of Geometrical Methods (New York: Dover, 1963), 104; nor was the controversy constrained to France: see Massimo Mazzotti, “The Geometers of God: Mathematics and Reaction in the Kingdom of Naples,” Isis 89, no. 4 (December 1998): 674–701; teaching mathematics, especially with the widespread introduction of analysis into the curriculum, was thought to have the same expanding capacity as the learning of Latin or Greek—this the extent of the discipline’s practical application. See Charles Gillispie, “Un enseignement hégémonique: les mathématiques,” in La formation polytechnicienne 1794 - 1994 (Paris: Dunod, 1994).

by a thorough mathematicization of all aspects of the engineers practice. This drive, led by
Navier and other gifted mathematicians, was countered by conservative educators who worried
that the shift to advanced mathematics stripped the schools of their capacity to create effective
engineers. The question was largely about education and the formation of knowledge, and the
solution was to educate with a more comprehensive vision of the profession in mind. Generality
derived from analysis and knowledge of the workings of steam engines could coexist, and
consensus emerged amongst the various faculties that no real dichotomy between an analytically-
informed practice and one that acknowledged the contingencies and realities of work with
materials actually existed. Picon argues that this consensus around “technological” engineering,
which was both theoretical and pragmatic, marked the difference between the classical and
industrial ages.\textsuperscript{53} Despite the resolution of the faculty debates in the first half of the nineteenth
century, a tension between theoretical and pragmatist adherents continued to exist in French
mathematical education—a condition that arguably produced Poncelet’s work that bridged the
two positions.

Consensus existed about the central role of geometry in teaching students deductive
reasoning and preparation of the mind for a variety of scientific pursuits. In the generation before
Poncelet and Mahan, Gaspard Monge placed geometry at the center of pedagogy and scientific
knowledge at the Polytechnic. A charismatic and beloved teacher, Monge developed the sub-
discipline of descriptive geometry, and used its principles to teach a variety of subjects and
methods of scientific inquiry. The practice of descriptive geometry entails the projection of
geometric figures onto planes; its rigorous mathematical processes in rendering complex objects
was invaluable for advancing engineering design. As a practice it was believed to synthesize a

\textsuperscript{53} Picon, “Les ingénieurs et la mathématisation.”
number of foundational methods of scientific investigation into one discipline with which to train
students to think scientifically. Making rigorous drawings by use of descriptive geometry was
thought by Monge to prepare minds for a range of scientific pursuits, including defilement,
stereotomy, cartography, mechanical engineering, and architecture.\textsuperscript{54}

Monge’s teaching represented the one branch of a growing philosophical split in pure
mathematics that began in the nineteenth century and proceeded through the twentieth.
Descriptive geometry remained squarely within the axiomatic movement in mathematics, one
that emphasized continuity in mathematical method and reasoning that was begun by Euclid, and
retained diagrammatic reasoning as the basis of its logic. This movement is contrasted with the
growing arithmetical focus of analytic and algebraic geometry and an approach to pure math that
was concerned with calculation of absolute definition. The adoption of increasingly sophisticated
algebraic analysis and incorporation of calculus proved to be a source of vast insight in pure
mathematics in the late Enlightenment; practice of l’analyse was seen as a higher, more purely
scientific pursuit. The rise of l’analyse saw the displacement of Monge’s geometric program
with the teaching of new and cutting-edge pure mathematics at the École polytechnique in the
1820s. Augustin-Louis Cauchy and André-Marie Ampère, two of the most luminous minds in
the history of mathematics and physics, reorganized the school’s curriculum to promote the
teaching of l’analyse and provide foundational courses to prepare students to participate in the
extremely sophisticated course of study. Dedicating more time to l’analyse necessarily meant
less time for synthetic geometry, and undermined compass-and-ruler geometry’s central
philosophical position in the school’s pedagogy. This was not a matter of unfortunate
coincidence, as there is evidence that Cauchy himself sought to displace the educational

philosophy of Lagrange and Monge, seeing his predecessors adherence to diagrammatic teaching as limiting the potential expansiveness of his more pure mathematics. This revolution, however, was not without critics, and should be seen as a moment of division that nonetheless produced reflection on the philosophical stances of engineers and mathematicians and the relation of their practices to foundational notions of the nature of their work.55

Jean-Victor Poncelet’s intellectual formation was in this tempestuous environment, which undoubtedly had an impact on his scientific output and, as a result, caused him to occupy a curious position in the history of mathematics. Depending on the position of the writer, Poncelet appears in the historiography as two seemingly divergent people. When mentioned in the history of mathematics, Poncelet is considered an industrial engineer with a reputation for practical applied mathematics—this is especially so when considering his publications later in life, textbooks for technical drawing and design principles for students of mechanical engineering.56 This reputation is even further highlighted when compared to Cauchy.57 Poncelet, however, saw himself as the founder of the modern geometry, and sought to cement this reputation in the publication of a treatise on projective geometry he had written while in a Russian prison camp,

55 Belhoste, 22–23; Gillispie, “Un enseignement hégémonique: les mathématiques,” 36; Picon, L’invention de l’ingénieur moderne: L’École des Ponts et Chaussées, 1747-1851, 290–91. The critical voices mostly sounded from the more traditional, pre-revolutionary military academies, who complained that almost all problems confronted by engineers at the time—questions of statics, dynamics, hydraulics, strength of materials, theory of vaults, etc.—could all be competently and elegantly addressed without resort to l’analyse. Professors at the military academies, which trained officers in application of their theoretical learning to their military duties, complained that the highly theoretical education at the Polytechnique produced students who had to be re-educated once reaching the pragmatic part of their education, implying that the more theoretical the curriculum, the less likely students were to retain any of their lessons. The idea that giving students some idea of the practical application of mathematics, including a graphic methods that drew on an intuitive understanding of principles of physics, was more likely to remain with the vast majority of students who lacked the natural inclination or ability to absorb Cauchy’s lectures.


another victim of Napoleon’s ill-fated winter campaign. While imprisoned, Poncelet developed a treatise on the use of mathematically imaginary (non-real) elements in proofs of properties of projective figures—those lines between projective planes—thereby bestowing synthetic geometry with the mathematical property of “generality,” lifting it from its prosaic status. In effect, Poncelet had elevated non-algebraic geometry to the same intellectual level as l’analyse, while at the same time avoiding making explicit use of analytic techniques. Poncelet’s contribution to axiomatic mathematics relied on the parallel structure of analysis to guarantee that his work was nonetheless true, even it never made explicit use of the functions of analysis. Poncelet’s stunning advance in synthetic geometry reinvigorated the field and guaranteed its continued relevance—it played an important role in the work of the American pragmatist mathematician Charles Peirce—and, in its example of hybridity, eroded the [higher] claims of the analytical purists.58

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Figure 2.4. Poncelet’s graphic method of sizing a retaining wall, with algebraic method noted on right. From an American translation published by the Corps of Engineers entitled Substaining Walls: Geometrical Constructions to Determine their Thickness under Various Circumstances (Washington, D.C., n.d. [c. 1860s])

Poncelet’s contribution to the field was deeply influenced by the intellectual atmosphere of the École polytechnique under Monge, and his willingness to continue investigation into hybrid synthetic and analytical geometry derived from Monge’s own mathematical philosophy. This philosophy caused such derision from Cauchy because it acknowledged the primordial role of spatial intuition in thinking mathematically. Poncelet’s mathematical philosophy acknowledged that the practice of geometry was never fully theoretical, and that, as a practice, there was always the implication of an application, even if vague. This suggests also that his willingness to combine analytic and synthetic methods flows from a deep pragmatism and comfort with a mathematical heteroglossia at the center of his philosophy of knowledge.

Poncelet’s pragmatism may have precluded him from canonization as a pure mathematician, however, his teaching career had a profound impact on the conception of the profession of the engineer in the early nineteenth century, in many ways building on the outline drawn by Monge. Fluent in their language, Poncelet contributed to the proliferation and democratization of engineering knowledge, systematizing the work of his genius predecessors like Navier and Coulomb. In his reliance on graphic methods and interest in practical application for machine design, he rose to prominence in a culture of work in France where both machines and theory were appropriate subjects for a day’s work. As has been noted by Picon, this culture of talented mathematicians produced knowledge that vastly accelerated industrial development. Without the auxiliary schools of application, like Metz, where Poncelet taught for most of his early career, and their ethos of teaching both physical and pure math, the enthusiasm for scientific discovery would not have spread through so many students, and the technological boom of the nineteenth century may very well have been delayed.59

59 Picon, L’invention de l’ingénieur moderne: L’École des Ponts et Chaussées, 1747-1851, 488, 495.
Poncelet’s conceived of his teaching duties as a bridge between luminary mathematicians and those who would apply scientific knowledge as technology. In this way, he advanced the notion of “application” theorized first by Navier at the Ecole des Ponts et Chausées.\textsuperscript{60} The French organized their schools according to the division of knowledge: at the most purely scientific end sat the Polytechnic; with the Ecole des Ponts the military academies outside of Paris filling a pedagogical role that moved between pure scientific research and empirically-driven inquiry and technical training. As this division occurred, applied geometry was displaced to the schools of application, where faculty viewed abandoning applied geometry as akin to a dereliction of fundamental military duty.\textsuperscript{61} Teachers, Poncelet included, saw their role in transmitting scientific knowledge into the army as a function of how effective that knowledge was when applied in the field. This notably gave rise to frustration with the polytechniciens, who arrived from the rarified theoretical atmosphere of their preparation in analysis with little notion of how to begin to apply this knowledge. In abandoning the graphic handle with which students could grasp the transformational power of mathematics, so the grumbling faculty at Metz made it known, the faculty at the École polytechnique had, in effect, created more work for whoever the students arrived at next. Poncelet himself saw the problem of transmission not only to students but also the larger engineering community inherent in the method in which the knowledge was described. In his commentary on Coulomb’s theory of arches, Poncelet lamented the failure of Coulomb’s “beautiful and useful conceptions” to gain widespread use, which he attributed to

\textsuperscript{60} Navier, a mathematical genius in his own right, understood the importance of practical instruction and the amount of knowledge gained by working in reality, especially in matters of construction. Though Poncelet had no relationship to the Ecole des Ponts, his pedagogical and mathematical philosophy owes much to the environment created there by Navier, allowing rigorous consideration of technological “application” to develop and flourish. Picon, 15, 272–275, and passim.

\textsuperscript{61} Belhoste, “Un modèle à l’épreuve. L’École polytechnique de 1794 au Second Empire,” 34–35.
Coulomb’s steadfast resistance to provide examples of how they may be applied.\textsuperscript{62} Poncelet and his colleagues at Metz were, however, struggling against the stream of a larger tendency in mathematics, where, as one historian has written, the study consistently tends toward “the more abstract, more rigorous, more general, and more powerful.”\textsuperscript{63} To remain prosaic in defining the concerns of the engineering profession carried with it a risk of stunting the profession’s potential. However, Poncelet and his students’ triumphant return to the polytechnique in the 1850s, and their subsequent reorganization of the curriculum around the theorization of force and structuring of the basic curriculum around the study of kinematics did much to organize the engineering disciplines around this body of knowledge that existed between the purely theoretical and purely physical.\textsuperscript{64}

Mahan’s own intellectual formation, and the solidification of the foundation of West Point’s pedagogy, can be described in terms of the tensions in the intellectual atmosphere at Metz, as Mahan was present there at this crucial moment in time. Mahan was also at Metz for more than study. His mission from his superiors was to search for an educational framework to bring back to the U.S., and during his time there, he built the basis of the U.S. Army’s engineering episteme from the discourse around Poncelet.

A Virginian, bookish, slight of stature, and son of Irish immigrants, Mahan attended West Point because it was the only American college to offer a drawing course. Mahan excelled in the military and engineering environment, and was consistently top of his class—he even found


\textsuperscript{63} Gillispie, “Un enseignement hégémonique: les mathématiques,” 42, translation mine.

\textsuperscript{64} Konstantinos Chatzis, “Méchanique rationelle et mécanique des machines,” in \textit{La formation polytechnicienne 1794 - 1994} (Paris: Dunod, 1994), 102–5; The shift in focus back to material reality and the description of invisible forces on machine planning also owes much to Navier. See Picon, \textit{L’invention de l’ingénieur moderne}, 374.
himself teaching before fully graduating. Because of his promise, more in his potential to increase the intellectual capacity of the infant U.S. army than as his stature as a warrior, Thayer and the secretary of war conspired to send Mahan to Europe for further study upon graduating. Mahan traveled extensively in France and some in England, surveying engineering works and making copious notes on European practices. After several attempts to gain admission to the École polytechnique, all failing, Mahan enrolled at the military school at Metz. It was here that he met and befriended Poncelet, who, released from prison and having newly published his treatise on projective geometry, was a professor and only slightly older than Mahan. Knowing that he would be responsible for constructing the engineering course once back in New York, Mahan, with characteristic determination, hungrily absorbed all aspects of practice and pedagogy available at the school. Because of time constraints, Mahan was unable to attend the course of study of a typical Metz student, and instead devised his own year-and-a-half long course through the school. This was both to attain a comprehensive understanding of the course content and to mark the way in which progressively complex topics of engineering were taught. While perfecting his own ability to design engineering structures, he simultaneously had an eye for methods of mathematical training and effectiveness of presentation of complex material.65

Mahan’s career as a teacher and author is telling of how his pedagogical philosophy developed at Metz. According to Griess, Mahan saw his life’s work as the compilation and systematization of European knowledge of military science and the presentation of that material in English in the American context, where there had been a large gap.66 His books grew out of his lecture notes: often handmade lithographs distributed to students formed the basis of

66 Griess, 301–2.
manuscripts; his final published works ranged from civil engineering to architecture to combat tactics. The French lineage of his thought can be seen in a number of places; for example, Mahan’s tactical manual loosely follows the structure of Jomini’s treatise, uses many of the same terms, and stresses the emphasis on Napoleonic coup d’oeil. Influence of Poncelet’s thought is apparent in the lithograph on stereotomy, which is remarkably similar in content. Mahan’s written work overall reveals a similar philosophy as Poncelet, that he placed less emphasis on displays of analytic virtuosity and more on effective teaching. In the first comprehensive American textbook of civil engineering, Mahan appended a dense supplement of methods for solving engineering problems. Each method was framed first as a proof by use of analysis, followed immediately by a recommended graphic method. Likely, this presentation followed Mahan’s classroom method, where cadets read proofs, but the recitation focused on the construction of diagrams and acquisition of knowledge graphically.

The central role of drawing in West Point’s curriculum is a testament to Mahan’s belief in its pedagogical benefits and in the lineage of Monge. Mahan also knew his audience: the cadet corps, drawn from the widely-varied 19th century American society, had similar variations in basic literacy and mathematical ability at matriculation. A cadet’s academy education then took the form of unrelenting repetition; knowledge thought of as akin to the accumulation of a vast edifice of methods—graphic methods—with which a student could approach any intellectual problem. Relentless drawing, the form it took at West Point, was unique to the Americas, where

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68 Griess, “Dennis Hart Mahan: West Point Professor and Advocate of Military Professionalism, 1830-1871,” 196.

69 Dennis Hart Mahan, *An Elementary Course of Civil Engineering for the Use of the Cadets of the United States’ Military Academy* (New York: Wiley and Putnam, 1838), 250–51, 270–71. While not mentioned by name, this very closely follows Poncelet’s presentation of methods.
it seems that belief in graphic teaching approached cultish enthusiasm. Cadets were evaluated
daily by recitation at a blackboard, in which they were expected to produce solutions and
explanatory diagrams to problems without notes. Visitors to the academy under Mahan were
impressed by the amount of drawing and its purported effects. One visitor felt it had a sharpening
effect on the students, noting “[t]he mind itself, by this exercise, gains a new power over its
thoughts, and becomes disciplined and strengthened for every practical work.”

Formal instruction in the practice of drawing itself began with surveying and
topographical drawing. After constructing maps from surveys, they moved quickly to outside
scene sketching, first with the assistance of a prism and eventually unassisted. Visitors in 1855
remarked favorably on the range and skill of work displayed in the drawing room, noting that
through extensive instruction and practice the cadets, even those of middling innate talent,
learned to draw landscapes “quite successfully”—a testament to the broad effectiveness of the
program. Drawing under Mahan thus became a universal language of scientific communication,
however, it also had the power to access the student’s intuitive capacity. In their recollections of
life under Mahan, former students recalled the professor’s most common exhortation: to rely on
one’s “common sense,” and not be carried too far away by reliance on the abstract. Mahan’s use
of this phrase was apparently so frequent that students nicknamed him “Old Common Sense,”
but the emphasis reveals the structure of Mahan’s theory of knowledge. Drawing, a physical act,
draws on abstract knowledge that yet allows a physical, apprehensible presence on paper and that
may be easily projected into the world. In evaluating stresses and forces on physical bodies, the

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71 House, Report of the Secretary of War, 34th Cong., 1st sess., 1855, 244; Senate, Report of the Secretary of War,
36th Cong., 2nd sess., 1860, 275.
72 Morrison, Jr., Best School, 94–95.
West Point engineering curriculum encouraged students to fuse their intuition (formed by existence in the world) with Poncelet’s democratized graphic systems. The connection was stitched by the thousands of diagrams executed by the cadet over the course of his formation.

Graduates of the program of study at West Point before the Civil War (and for at least a decade after) were imprinted with the habit of thinking diagrammatically about the problems they confronted, specifically spatial and mathematical problems. In this manner, the practice of being a soldier and engineer learned at West Point resists the well-worn divide in the historiography between engineers who calculate and engineers who make use of heuristics and axioms. In reality, the division between the two modes of thinking may have been much more blurry, or not even applicable. The extensive use of axiomatic mathematics and synthetic methods by U.S. Army engineers also by no means indicates that they were practicing less sophisticated techniques, as notions of the progress from synthetic geometry to algebra and analysis are by no means true or a natural sequence. Recent scholarship has revived interest in Poncelet’s gift of the property of “generality” in projective geometry and the notion that all mathematics is fundamentally diagrammatic in its reasoning—the engineer’s great contribution being the continued openness of the role of spatial intuition in mathematical thinking. Charles Peirce, the late 19th century American mathematician believed that Poncelet’s school of thought introduced difference and plurality, as opposed to precision and reduction, as fundamental precepts of true mathematical knowledge. Further, the pragmatist approach saw synthetic geometry as having the capacity to construct theories about nature in complex diagrams that operated as systems of signs, and therefore could communicate metaphor or analogy.⁷³ In light of this, their drawings and constructed projects may be interpreted as something other than

technically-determined structures. Instead, we might see engineering methods as a mediation between technical knowledge and more imprecise, yet more true and useful, impressions of the forces animating nature, particular to the inflection of education and training of these military engineers.

As there was no generic system of education for engineers in the 19th century, it follows that the outlook of engineers was not necessarily equal regardless of school or experience. The West Point curriculum was unique and necessarily set military engineers apart from their counterparts that emerged from civilian schools. The focus on geography and the use of geometry to structure spaces at the landscape scale were part of the military culture at West Point; this engendered in members of the corps of engineers an expansive definition of engineering. Combined with the opportunities to experience construction of landscape-scale works (which will be dealt with below), cadets were taught to think of landscapes as complex systems whose manipulation was achieved by the crisscrossing of imagined chords. Thinking at this scale produced a specific interpretation of the natural world that the engineer encountered, and necessarily brought in forces that occurred at that large scale, and asked the engineer to take on the role of conducting these forces over vast space.

**A Continental Laboratory**

The physical landscape at the U.S. Military Academy played an important, if supplementary, role in the formation of the U.S. engineer. As a hybrid between wilderness camp and technical academy, West Point taught students that the medium of warfare was land—and that it was understood and moved by mathematics. West Point was a teaching landscape, the importance of it as an environment in which to grow soldiers and engineers has been overlooked. As such, there
were three essential components to the academy as a site of edification: the geometric parade
field, the training grounds for construction of earthworks, and the wild mountains surrounding
the academy which had been purged of any traces of civilization. The plain and training fields
had intended impacts that are apparent from the design of the spaces. Important to generations of
cadets, the surrounding wilderness was symbolically and experientially the most significant part
of the complex.

The first reference to a school for soldiers in the annals of the Continental Congress is a
cryptic allusion to both “a continental Laboratory, and a military Academy,” which requires
contextualization. In the context of 18th century warfare, a “continental Laboratory” likely
meant a place where the colonists could manufacture gunpowder and artillery pieces.
Historically, these facilities were linked to schools for professional soldiers, and the founding of
the military academy at a remote artillery outpost was a fitting conjoining of intellectual pursuit
and technical enterprise. Ballistics, a combination of physics and chemistry, required thorough
education in applying mathematics to topography. In calling for a “continental laboratory,”
rebelling colonists have also provided us with a useful metaphor for understanding the
academy’s significant reach in both continent and nation.

Created as an artillery fortress to watch what Henry Knox called “the peculiar bend” in
the Hudson River, West Point’s famed position atop a plateau related from inception to both

74 Journals of the Continental Congress, 1774-1789, ed. Worthington C. Ford et al. (Washington, D.C., 1904-37),
6:860.

75 See Ken Alder, Engineering the Revolution: Arms and Enlightenment in France, 1763-1815 (Princeton: Princeton
University Press, 1997); Antoine Picon, French Architects and Engineers in the Age of Enlightenment (Cambridge:
Cambridge University Press, 2009) for a more thorough discussion of the history of the concept of mathematics as
science of action and space.
local landform and larger strategic significance. The facility’s second life, as a college, began in 1802, when the pairing between working artillery fortress and intellectual institution was not unusual in the twilight of the Enlightenment and the beginning of the Napoleonic era. West Point’s physical development shows a clear interest in European notions of warfare as a mechanistic system that could be predicted and influenced by control of logistics, and described rationally and with mathematical precision. Further, as an accident of timing, the U.S. academy was established at a time of transition in both warfare and imperial expansion, where training men to apply classical mathematics in open spaces was both about ballistics and state building through territorial control.

West Point was designed not to produce knowledge but to proliferate knowledge. The governing principle was that knowledge might be carried in the heads of military officers and put to both abstract and practical uses throughout the republic, and that the facility functioned primarily to support this imperial project. Both landscape and pedagogy of the academy reflect this aim, and were meant to be worked in concert to affect change and bring order to the larger continent. Isolated from civilian university life, the experiential landscapes of the military academy developed dissimilarly to typical American programs or notions of what a college should look like and how it might perform. Instead, West Point’s spaces were unique in their pattern of rigid control and wild neglect. The landscape’s striations illustrate an unique ethos about education in the context of both 19th century notions of military knowledge and continental ambitions.

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The Plain

The Plain, a 40-acre level field overlooking the Hudson River, forms the spatial heart of the U.S. Military Academy. Levelled by Revolutionary War forces as a parade field, the austere and perfectly flat space forms the stage on which cadets are taught march and drill to this day. Cadet drawings that survive from the mid-19th century, many taken from vantage point on the Crow’s Nest, a mountain to the north adjacent to the larger Storm King, and looking back toward West Point, and focus on the Plain. The monumental surface—in sharp contrast to the surrounding wooded and undulating landscape—indicates the importance of this space to the identification of both site and school.

Academies in France, Prussia and England all contained a form of *campus martius*, a field for assembly and drill. The European fields, however, were always secondary to the presiding building; the Plain, in scale, form, and symbolic weight evolved as the primary space at West Point. Established in the same year as West Point, the École-Militaire Saint-Cyr occupied the building and gardens of the former Maison royale de Saint-Louis. Designed by Jules Hardouin-Mansart, the chateau had previously been a school for girls, and at least conceptually the classroom spaces and grounds were seen as sufficient for training of soldiers.\(^7\) The drill and inspection portions of the curriculum likely took place in the courtyards and near adjacent spaces of the chateau, and there is some indication that instruction in fortification happened in spaces reclaimed from the park. Many of the formal patterns and parterres however, still remain, indicating that there was not much time or effort invested in transforming the landscape to promote a martial identity that would differ from the aristocratic trappings of the existing chateau. Other French schools had a different relationship to the surrounding landscape. At the famed

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\(^7\) *Le centenaire de Saint-Cyr* (Paris: Berger-Levrault, 1908), 8–18.
école du genie at Mézières form courts and a small landscape park, render the building as secondary. At Metz, students made use of the surrounding fields and even the town for topographical drawing and some military exercises. In Berlin, Karl Friedrich Schinkel designed a school for artillerists and engineers for the Prussian state as part of a program of civic monuments in the 1820s. The Prussian academy is primarily interior space, with a modest courtyard, and Schinkel attended primarily to the façade. Notably, however, the academy faced the famed Unter den Linden, the leafy artery and focus of Frederick II’s program of monumental state buildings, and made soldiers available parades and other military displays of state power in a prominent urban space. Woolwich, the royal military school down the Thames River from London, featured a prominent clipped lawn forming a flat plain. Although the Continental Congress indicated Woolwich specifically as a model school, there is no indication that when the American version was established that this was heeded. When early West Point administrators went to Europe to seek models, they spent almost all of their time French schools, and the extent of their import seems to have been the curriculum, not the form. The architect Benjamin Latrobe’s prepared drawings for a military academy in 1800 and his notation of a ha-ha defining the exterior court foreshadowed the importance of the exterior space to the United States’ academy. Latrobe’s plan, however, went unused. For the first fifty years of the academy’s

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80 Boynton, History, 177.


Extending into the Hudson river, the flattened plain was the dominant spatial experience; even large buildings like the barracks at the southern end of the plain remain secondary to the landform’s expanse.

existence, buildings went up along the edge of the Plain as the need arose—overseen by superintending engineers without any reference to a master plan. By 1850, West Point was a haphazard collection of barracks and simple instructional rooms clustered in a much larger, wilder and diverse instructional landscape surrounding it.

An 1860 graduate believed he owed his education to “the fashioning hands of discipline, instruction, and environment,” and there is indication that the men who shaped West Point relied heavily on the teaching capabilities of the third element.\(^{83}\) Alden Partridge, an early superintendent of the academy, believed strongly in the importance of interaction with landscape in the education of the soldier. In his “Lecture on Education,” published in 1826, Partridge

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questioned the virtues of studying the “dead languages” Latin and Greek, and theology more generally, which in his estimation did little to prepare cadets for “the duties of active life.” Such pursuits were at odds with Partridge’s vision of vigorous citizenship in the republic, consisting of jury service and remaining active in shaping policy friendly to agricultural and industrial development. Partridge believed that to become good, active citizens, students needed to “endure fatigue.” “[T]o grow up puny, debilitated, incapable of either body or mental exertion” meant the student did not have the physical constitution to lead a virtuous republican life.  

Partridge also acknowledged that the role of the soldier in the republic as a significant economic agent. Surveying and practical geometric and scientific operations were to take place in the field as much as possible, and he believed the cadets should be regularly taken on excursions to climb mountains, practice trigonometry, and, of course, endure more fatigue. “Those excursions,” he wrote

> while they would learn them to walk (which I estimate an important part of their education,) and render them vigorous and healthy, would also prepare them for becoming men of practical science generally, and would further confer on them a correct coup d’oeil so essentially necessary for military and civil engineers, for surveyors, for travellers, &c., which can never be acquired otherwise than by practice.

When not on excursion, the superintendent prescribed the cadets three hours a day of “practical agricultural and scientific pursuits.” Partridge never realized the total vision of vigorous education, as his successor, Sylvanus Thayer, instituted the École polytechnique’s term system that had the cadets receiving classroom for most hours of the day in the spring and fall, an arrangement that lasted until the end of the 19th century. However, his desire to give students “a

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85 Partridge, 276.
head to conceive and an arm to execute,” endured throughout subsequent efforts to formalize and house instruction in buildings.86

Most of the cadets’ time outdoors was spent in morning and afternoon drill on the Plain. Standing in rigid order, marching in ranks, and moving in unison were soul of discipline in the early-19th century army and rigorous control of body and movement remained an important part of effective fighting. Drill was so ubiquitous in a cadet’s life from his first day at West Point that few, when recalling it in diaries or letters, mention it at all, other than to complain of hours spent at it on particularly hot days, as years spent treading the parade ground bred a weary familiarity.

The constructed Plain was an edifying space, and was joined in performance of this duty by the fortification test ground (discussed further below). As two complimentary parts of a set of educational spaces, the Plain and Engineer’s Garden outlined a spectrum of agency over the natural world. Austere, geometrically-rationalized landforms, and sites in the process of rationalization, inculcated a notion that landscape is legible, mutable, and inhabited temporarily. A Cartesian space, where buildings come and go, the Plain told cadets that landscape was mathematically perfectible, that the infinite is apprehensible, or even tangible, with enough labor and control. This skill and pursuit of technical mastery and powers of manipulation were portrayed as noble skills of a modern citizen.

The Engineer’s Garden

In 1851 the faculty expanded instruction to include more pragmatic outdoor activity by establishing a department of practical military engineering and giving cadets hands-on experience in a test ground in the woods north of the Plain. In the early years of practical

86 Partridge, 278–79.
engineering instruction, cadets learned how to construct temporary bridges and reconstructed the earthworks of the decaying revolutionary forts. Under the supervision of officers of the Corps of Engineers, they learned how to make fascines and gabions, woven structural components essential to earthworks, from cut saplings. In the mid 1850s, these activities were moved to a site north of the post cemetery called the “Engineers’ Garden,” which was originally, in part, the enlisted engineers’ vegetable garden. Here the cadets, who were to become officers, learned to direct enlisted soldiers, and used this area as a proving ground for earthwork construction.

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87 Morrison, Jr., Best School, 98. Senate, Report of the Secretary of War, 36th Cong., 2nd sess., 1860, 278.

88 See Memorandum by E.C. Whiting, February 10, 1906, file 322, Olmsted Associates Papers, Manuscript Division, Library of Congress, Washington, D.C. Whiting’s description refers to a pasture and cultivated area “called the Engineer’s Garden,” likely referring to the vegetable gardens used by the enlisted men of the engineer unit stationed at West Point. Cyrus Comstock refers to practical engineering occurring in the area near the “Soldier’s Garden,” likely referring to the same enlisted soldiers’ vegetable patch.
Enlisted soldiers stationed at West Point practiced building year-round, erecting model fortifications of earth often over a dozen feet high and hundreds of feet long. These false fortifications were then attacked and destroyed, their strengths and weaknesses of methods analyzed, and then the ground was leveled and a new series of mounds and trenches begun.  

After a few weeks of observing the enlisted engineers at work, cadets laid out earthworks for the enlisted men to complete. The cadets learned the army’s practice of constructing profiles, framed sections of the planned landform, and projected those profiles along the topography. The exercise was meant to teach the cadets to resolve complex geometric configurations of intersecting planes, reconciling ideal form and existing landscape, which often proved frustrating to cadets as they attempted to line up and connect with each other’s earthwork prisms. This work familiarized cadets with methods of structuring earth, maintaining grades, managing labor, and how quickly the landscape might be transformed. Top graduates went directly into the Corps of Engineers, and carried this military construction knowledge with them to civil works across the continent. The combination of saplings, earth, and hard labor, ubiquitous in the levees lining the Mississippi and tributaries, was first learned here in the Engineers’ Garden.  

Though the engineering course had always been expansive in scope, midcentury debates over curriculum increasingly turned toward supporting continental expansion. With skills honed in the post-graduate field schools of the Coast and Geodetic and Great Lakes surveys, the government also found that officers who had trained at the Academy went on to long and productive engineering careers; their scientific education and subsequent experienced allowed

89 Walter G. Bartholemew, “Reminiscence of Enlisted Life at West Point,” Walter G. Bartholemew Papers, United States Military Academy Library, West Point, N.Y. Bartholemew’s unpublished manuscript provides humorous insight into the Sisyphean task of continual building and rebuilding of earthworks that was the fate of enlisted men assigned to West Point.

them to find important roles in the industrializing and expanding United States.\textsuperscript{91} Congress, awoken to this resource of engineering expertise, and sought to direct the curriculum to even further civil aims, noting

\begin{quote}
the wants of this age and country, the new and fresh recurring discoveries of mineral wealth, the unexplored domain, and the partially worked mines of our extended country, demand in turn a more entire, thorough, and complete education…\textsuperscript{92}
\end{quote}

Continental expansion: mining, railroads, canals, required technical knowledge, and not just grit. West Point could create soldiers who were ideal technical citizens: useful, pragmatic, and skilled, and above all, loyal servants of the state which encouraged industrial expansion and tapping resources.

\textsuperscript{91} Hill, \textit{Roads, Rails, and Waterways: The Army Engineers and Early Transportation}, 83–84. Senate, \textit{Report of the Secretary of War}, 33\textsuperscript{rd} Cong. 1\textsuperscript{st} sess., 1853, S. Doc. 1, 201.

\textsuperscript{92} House, \textit{Report of the Secretary of War}, 34\textsuperscript{th} Cong., 1\textsuperscript{st} sess., Ex. Doc. No. 1, 1855, 243-4.
Wilderness Beyond

Topography and discipline worked to make the academy an isolated community on the plateau, and administrators worked to minimize contact between cadets and the people who lived in the surrounding hills and towns. The army, worried about prostitutes and alcohol peddlers, vigorously prosecuted squatters, hoping to protect their young charges from falling into dissipation, and to reinforce the idea of the exceptional nature of their military community. At times, however, the moral purging of the countryside approached absurdity. A cadet described the efforts of Superintendent Delafield as producing the following result:

The people here are as much afraid of him as if he had absolute authority; none of the old women will make pies for cadets, within 5 miles around, some of them are even afraid to make them for their own lest they should be suspected.

Even the locals felt the weight of military discipline. Vice, however, nevertheless made its way up to the Plain—often in the form of smuggled tobacco, playing cards, or liquor. More often, cadets made their way down off the plateau to indulge. The cadets nicknamed an inlet in the river bank near the hospital “Pirate’s Cove,” for a local who would trade whiskey and tobacco for old uniforms under cover of darkness. On holidays, some cadets summoned enough courage or determination to sneak away to Benny Havens, a notorious tavern in town, risking demerits or expulsion. The abstemious Comstock, observing how “beastly drunk” many of his classmates were on Christmas 1851, noted “We are tied down so closely here, that when the bonds are loosed, all discretion is lost.”

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93 Richard Delafield to Joseph Totten, February 16, 1839, SLB.
94 Richard Ewell to Benjamin S. Ewell, January 10, 1840, Ewell Papers.
96 Comstock, Diary, 51.
The configuration of the academy emphasized social hierarchy that was part of the officer’s education as well. Cadets, forbidden from interacting with the civilians in the town to the south, were also discouraged from interacting with the enlisted engineers, who lived in Camptown and the German Flats amongst the auxiliary and supporting facilities for the Academy on the riverbank to the north of the Plain. Though the U.S. Military Academy was much more meritocratic than European counterparts, both the regulations and spaces enforced social stratification, and cadets could not socialize with enlisted men. One academy superintendent estimated that maintenance of the grounds and facilities at West Point required the same amount of skilled labor as a city of 20,000 inhabitants. While this may have been an exaggeration, the enlisted engineers provided a wide variety of services, from maintenance, to gathering material and firewood, constructing buildings, and helping instruct the cadets in how to direct labor. Many of the enlisted men were essential to the academy’s operation, and were highly skilled in lithography, chemistry and construction. As a whole, however, this group of several hundred manual laborers was generally relegated to a life down the hill and out of sight.

Primarily, however, cadets experienced their time at West Point as drudgery punctuated by memorable moments when they were set free to explore the outdoors. Monuments were perceived as mere waypoints or landmarks in a sublime and wild landscape. Comstock and his compatriots used Dade and Kosciuszko’s monuments as rendezvous points before expeditions to go swimming in the Hudson or to gather wild cherries and mulberries abundant on the slopes.

98 J. G. Pilcher to Secretary of War, April 4, 1871, SLB.
99 Bartholemew, “Reminiscence.”
100 A. H. Bowman to Joseph Totten, May 19, 1863.
leading up to the Plain. Liberated from the rigorous schedule of instruction and drill, cadets spent their Saturdays and Sundays roaming through the forested surrounds of the military reservation, or swimming across the Hudson to the trestle works above Garrison on the opposite shore. Their diaries are filled with vivid descriptions of the natural scenery along the Hudson Valley. One Ohioan vividly remembered lounging on the “velvety green parapet” of the ruined fortress and seeing his first sailboat as it came downriver. Another recalled gathering with other cadets on the Plain at night to watch a forest fire rage on the slope of a nearby mountain, the cadets eagerly watching the progress of the volcanic illumination. The experience of the landscape was immediate, personal, and tactile. However, if cadets were reflective about the surrounding natural world, it was colored by the technical training they underwent.

Cyrus Comstock embraced the scientific education he received, and his diary reflects a hungry adolescent intelligence that increasingly took a positivist outlook on the landscape. A typical cadet in that he spent much of his free time, weather permitting, outside swimming or lounging in the forest, Comstock was atypical cadet in his voracious reading and scientific curiosity. He spent afternoons on the riverbank spent reading Voltaire, Racine, Locke, Agassiz, Boswell, the French mathematician Laplace, Dickens’s *Bleak House*, Hawthorne, Wordsworth (he was breathless about “Evangeline”) and his beloved Emerson. When not immersed in literature, he collected botanical samples and wrote notes on the plant communities around the academy. Calling the practice “among the purest and sweetest of pleasures,” Comstock made


102 Wilson, *Under the Old Flag: Recollections of Military Operations in the War for the Union, the Spanish War, the Boxer Rebellion, Etc.*, 15.


104 Catherine S. Crary, *Dear Belle: Letters from a Cadet and Officer to His Sweetheart, 1858-1865* (Middletown, Conn.: Wesleyan University Press, 1965), 50.
observations about the prevalence of Prickly Ash and flowers of the genus *Corydalis* on the slopes of neglected fortifications. In the winter, he spent days studying in the academy’s geological specimen cabinet, feeling that he did not want to be a “mere mathematician,” and so sought a rounding in the other sciences.\textsuperscript{105} This gentle and inquisitive soul went on to a career in the Corps of Engineers where he oversaw the Great Lakes Surveys and advised the government on scientific affairs through most of the late 19\textsuperscript{th} century. While for every Comstock the academy produced ten Custers, Comstock’s habits of mind and intellectual expansiveness were largely encouraged by the academy’s intellectual and physical environment.

Cadets wrote about and drew the landscape as an immediate and tactile phenomenon; the hints of melancholy were not provoked by any sophisticated romanticism. Instead, cadets internalized their experience with the landscape as an important component of an intensely personal period of transformation, and these views, especially north up the Hudson, stayed with these men for their lives.\textsuperscript{106} Drawings, such as Montgomery Meigs’s sketch of swampland somewhere near the academy, reveal both an adolescent brooding and an interest in the phenomena of the natural world. One historian went so far as to suggest that the great drawings of western rivers produced by the army surveys were all unconscious representations of the primal image of the Hudson imprinted at West Point.\textsuperscript{107} Untethered from military life, the cadets occupied the surrounding landscape and projected a sort of scientific arcadia, with a few lingering boyish pranks and diversions. Their activities reflected their transition to adulthood and

\textsuperscript{105} Comstock, *Diary*, 162–68, 152, 147.


\textsuperscript{107} Goetzmann, *Army Exploration in the American West*, 335.
indicated the kind of scientifically apprehensible landscape that they would expect the United States to become.

**From Geometry to Design**

Emerging from this murky mixture of military theory, military education, and rudimentary engineering practice are a few threads that lead to the conclusion that the army was interested in orienting its best and brightest toward confidence in their own powerful agency. Partly intentional, and partly the circumstance of military culture at the time, soldiers were taught to practice design—and this teaching formed the heart of their practice and worldview, both as soldiers and engineers. It is useful here to refer to a very old definition of design, which I quote at length:

> Design, the father of our three arts … derives a general judgment from many things: a form or idea of all the things in nature, as it were, which in its proportions is exceedingly regular. So it is that design recognizes, not only in human and animal bodies but also in plants, buildings, sculptures, paintings, the proportion of the whole in relation to its parts as well as the proportion of the parts to one another and to the whole. And since from this recognition there arises a certain judgment, that forms in the mind the thin which later, formed by the hand, is called a design, one may conclude that this design is nothing but a visual expression and clarification of that concept which one has in the intellect, and that which one imagines in the mind and builds up in the idea…

Though Vasari wrote these words centuries beforehand, the parallels between the activity of the engineer and the architect that were still present in the education of the military engineer in the United States through the era of the Civil War. Drawing united the intellectual faculties of collection of information and judgment, and asked the engineer for clarity of thought as the best

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way of pursuing success—be it in the design of a lock or on the battlefield. Geometry gave form to this process of recognition and discernment, and the mutually supporting applied mathematics, intuition, and structured work of clarification through drawing should be the picture of the process of engineering we have in mind as we move into the projects undertaken by the engineers during the tumultuous time of Reconstruction. Mostly, I would emphasize that rationality, objective language, and efficiency, though they played roles in engineer’s mindset, nonetheless remained subordinate to dynamic decision making and alignment of forces across a broad field.

Chapter 3

“To Make the Sea Do the Work”: Cape Fear and the Nature of Engineering Design

Friend D’Alembert, mind how you go, you are assuming that there is only contiguity, whereas there is continuity….

–Denis Diderot, *Le rêve de d’Alembert*

How do engineers design landscapes? What is the process of “engineering” a large-scale hydraulic system in the 1870s? What were the technological limits? What were the epistemological limits? How did the process unfold? What were the ambitions? How did notions of pragmatism or reality curtail imagined outcomes?

The U.S. engineers formed their designs through combination of a sense of the natural world and sense of political economy. Engineering was then the construction of an intervening structure in the field effected by both these forces—not representations of forces—that gamed out on that specific landscape, eventually producing an outcome. In the United States, Reconstruction was the era of the first instance of environmental engineering: where an entire environment, with ecosystems, was consciously altered at a landscape scale. The historian David Noble has noted that in the 1870s, engineering education underwent a “shift from laws of nature to principles of design.” What those principles were, however, was shaped by the continued presence of the forces of nature in the environment in which design occurred.

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1 I am speaking here largely of landscape engineering, or “civil engineering,” which differs from the advances in mechanical and chemical work that was happening concurrently in the 1870s and 1880s. Because of the large environmental component of civil and landscape engineering—one so large and manifold with so many contingencies—in which the question of “design” must be considered on different terms from the smaller-scale, “device” or controlled-process engineering that could be executed under controlled conditions in a laboratory or factory.

The central problem of engineering of the era was finding the correct interpretation of the natural world in which to intervene. Civil engineering is an imaginative process and, in the mid-nineteenth century, the possibilities prompted by the inventive process were shaped by an environment: a mass of external contingencies operating dynamically. A river, which varied widely in temperament, in its force, volume, reliability of flood and dryness, etc., was but one cluster of attributes nested in the river’s larger environment. The character of the floodplain, previous improvements upstream, agricultural activity, etc., all contributed to a larger geographic-scale context that the engineer necessarily had to address. Culture figured into the conceptual design environment equally as with any purely “natural” components. Considering sources and quality of labor, the attitudes and prejudices of the people who lived near and derived livelihood from the river, and the shifting political support for state intervention in these landscapes affected the feasibility of engineering projects, and their consideration was well-known to field engineers. Conceptualization of the environment itself was never stable in the process of design, but necessarily shifted as the forces, both social and environmental, became realigned as the project evolved, was constructed, was modified, and produced legible social effects.

Imagining the engineering project was then a process by which the engineer understood the conceptual environment and began to adjust that environment while continually monitoring the signs of effectiveness and then placing effort at various pressure points to eventually achieve the desired outcome of “improvement,” however that outcome was defined in a particular project.

Characteristic of this process was the emergence of a healthy respect for and desire to use the material and force of nature. Engineering was at this point still largely a fragile enterprise, deploying relatively weak structures. Absent reinforced concrete, the efforts of the engineer had
to be carefully balanced against the much more powerful force of nature. In this way, the community of engineering, and the imagination of engineering, and the conceptualization of nature was far from one of domination. It was more akin to a martial art that uses the existence of force in the opponent to advantage, or maneuvering to produce a different equilibrium or alignment of forces than the one found. In this way, the engineers existed themselves in this community of forces, where applied mathematics interacted with the material of nature and the social structures that were strung across it.

Two Versions of the Cape Fear River

The project for the Cape Fear River began with the comparison of two maps. The engineers, noting the drastic differences in the shape of the coastline and the discharge of the river that occurred in the one hundred years between these two maps, formed an ambitious plan for river restoration prompted by the differences in the landscape. Edward Mosely’s 1733 map of the North Carolina coast, stretching from “Barren Head,” one of the sand formations that forms the Cape Fear headland to the city of Brunswick, showed the estuary of the Cape Fear river passing southward and alongside the barrier beach, discharging into the Atlantic Ocean in a single mouth. An English map of the province of North Carolina drawn in 1738 (“Wimble’s Map”) confirmed the single body of the estuary, passing west of Cape Fear and showing the thrust of the river flowing continuously south by southwest twenty-six miles from the bend at the settlement of Wilmington toward the Florida coast. Comparing the historic form of the river depicted on the English maps with the U.S. Coast Survey map drawn from surveys made in the 1850s, the engineers found the river had changed its course and altered the coastline dramatically. In 1761, a four day “dry blow,” violent enough to be reported in London magazines, the sea surged over a
narrow barrier beach along the tidal basin. Beginning as a shallow wash, the breach widened rapidly to a half-mile in width; the force of river and tide scouring away the land. Over the intervening decades the “New Inlet,” as the pilots called it, allowed much of the flow of the river to find its way into the Atlantic through the gap, creating a new mouth.\(^3\)

The Cape Fear River meanders across the coastal plain from its source in the Carolina piedmont, passing sandy pine-barrens and through a landscape of increasing proportions of marsh, swamp, and pocosin before discharging into the Atlantic. Sitting on the Peedee formation, part of the Cape Fear Uplift primarily composed of marine clay and clayey sand, the estuary differs geologically from the ragged-edge “drowned coast” seen in Pamlico and Albemarle Sounds behind the Outer Banks to the north.\(^4\) At Wilmington, the two tributary branches meet and proceed sluggishly through the swampy and wooded plains to the dune beach formations of the coast; the engineers noted the high water table and sandy substrate retarding the river to a sluggish pace as it met the sea and deposited silt on the bar at its mouth. The river Southeast of the Cape Fear salient, the Frying Pan Shoals, an underwater formation that has been the bane of navigators for centuries, stretches thirty miles seaward, dividing the Long and Onslow Bays.\(^5\)

The wide, braided basin below Wilmington was estuarial and subject to great differences in

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Figure 3.1. Detail of A New and Correct Map of North Carolina drawn from the Original of Col. Moseley’s, 1737, John Crowley, North Carolina State Archives.

Figure 3.2. Preliminary Sketch of the Entrances to Cape Fear River and New Inlet, North Carolina, Alexander Dallas Bache, United States Coast Survey, 1853. National Archives, College Park, Maryland. Note the breach in the barrier beach that had been continuous to Cape Fear.
current and water level, shoals and small islands emerging at low tide. The engineers detected tidal action thirty miles above Wilmington even, over fifty miles from the coast.⁶

In the antebellum period the low country around Wilmington had been a mosaic of rice plantations, their product constituting the city’s main export up to the war. Like much other southern infrastructure, the leveed plantations and vast hydraulic systems necessary to maintain the rice had fallen into disrepair and disuse—the landscape succumbing to reversion to cypress swamp and the closely guarded boundary of the estuary became more porous and periodic flooding met no resistance.⁷

![Figure 3.3. Maps of the lower Cape Fear River, showing changes between 1865, 1885, and present day.](image)

The changing hydraulics of the landscape disrupted the accustomed pattern of inhabitation and coastwise shipping routes, causing those who had a stake in it to worry. The river drove into the New Inlet, a shorter route with a steeper hydraulic slope, with a force that caused a splaying of swift currents and opened a new, if tortuous, shipping channel. The new

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⁶ Craighill and Bixby, “Improvement of the Cape Fear River.”

stole volume and velocity from the old mouth, and with dismay the Wilmington pilots reported shoaling at the southern channel. Government engineers recorded that by 1829, sixty years after the creation event of the new mouth, the old mouth had grown a significant deposit of silt at its center, and the two channels on either side had been reduced to nine feet of depth, substantially shallower than it had been in the 18th century. The narrowing harbor inlets impinged shipping up the estuary to Wilmington, and a minor industry of lighterage sprang up as the harbor became less hospitable to ocean going vessels. Fleets of small boats, run by a Wilmington syndicate not known for honest business practices, first appeared in 1821, offloading ships until they rode high enough in the water to make it over the sandbar.8 These slow motion topographic changes affected commercial prospects enough that the Wilmington merchants sought relief from the state. Activities of the North Carolina state engineer, Hamilton Fulton, in the 1820s indicate that Wilmington was not the only community and commercial hub experiencing anxiety over the perceived instability of the sandy coastal estuaries of the Carolina coast. Fulton’s travels for official duty brought him often to the wide sounds behind the Outer Banks where he made a study of the dynamics of wind and tide which caused barriers to form and estuarial pressures to concentrate enough to change the coastline’s configuration. Observing that the potential force of a wild estuary was related to volume of water it contained, Fulton had proposed compartmentalizing portions of the Croatan and Roanoke sounds to give definition to the volumes of water he could work with and harness that water to blast holes, or enlarge existing channels, through the barrier islands. Fulton’s reports, however, remained reports, as the state lacked funds to instantiate them in their full complete vision. Other private but state-chartered projects, such as a canal from Fayetteville to the Cape Fear basin, failed from mismanagement or

8 Craighill and Bixby, “Improvement of the Cape Fear River.”
compounding natural disasters, designed and capitalized with insufficient robustness to survive the environment. Though the North Carolina legislature could never accumulate the capital needed to enact his plans, Fulton’s reports nevertheless exerted an influence on later federal engineers, once the Wilmington business and political community found way to access the United States’ larger repository of capital and ambition.9

The city of Wilmington had her own ambitions. Like other southern cities, representation of value toward the central government meant configuring a city’s attractiveness on terms palatable to Reconstruction priorities: this meant portraying the city and its landscape as playing a role in the economic system the Congress wished to engineer in the New South.10 Wilmington’s governing class, exerting influence from the organ of the chamber of commerce, sought to solve the problem of their silting harbor by first feeding sunny information on untapped economic potential to the federal legislature through the army’s engineer corps. As the surrounding rice plantations continued to disintegrate (one surveyor optimistically remarked that the rice operations “had not yet recovered” from the war) and rice production dwindled to nil, Wilmington businessmen attempted to revive the historic lumber and naval stores industry that had fueled the first settlement of the region, and harbored ambitions to add further paper

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9 Elliot to Craighill, May 23, 1872, Box 21, E71-RG77, NA; James H. Simpson to Andrew A. Humphreys, November 19, 1870, Box 29, Letters Received 1865-1870, Entry 25, Correspondence of the Office Divisions, 1865-70, Correspondence, 1789-1870, Records of the Office of the Chief of Engineers, Record Group 77, National Archives Building, Washington, D.C. (hereafter cited as E25-RG77, NA).

10 Joseph C. Abbott, a former Union general, journalist, lumber capitalist, and Republican senator of North Carolina from 1868-71 is credited with restarting the federal effort to rebuild the harbor in 1870. Deriving his political power largely from black voters, his reputation has been significantly muddied by accusations of corruption—being in the pay of a “ring” of business interests affecting his efforts to bring funding to Wilmington, especially the harbor. However, the close entwinement of business and political power is far from remarkable, serving to instead show how the two communities were essentially one powerful set which set the priorities of the government, regardless of how they achieved votes or the demography of their constituencies. Cotton (or at least representations of commercial activity marked by the flow of commodities) was the common communication touchstone, around which political consensus could be built. Chamber of Commerce, Wilmington, N.C., Wilmington, North Carolina. Past, Present and Future, 28; Dictionary of American Biography (New York: Scribner’s, 1964) 1: 23-4.
production, drawing on its vast resources of swamp cane. Invoking the bounty western forests in the Appalachian Piedmont, in promotional literature Wilmington reinvented itself as a headquarters of marine grade forest products: turpentine, rosin, tar, pitch, and softwood lumber. Published figures indicated that the timber industry was indeed booming: in 1870 over 18 million board feet of lumber and half a million barrels of rosin, fed by three different railroads which had termini at the Wilmington docks. Cotton too moved through the port, but Wilmington’s businessmen wished to emphasize the industriousness of distributed turpentine production at individual farmsteads in the watershed, and at least outwardly acknowledge the benefits of harbor improvement that would flow outward to the yeomen with their stills in the hinterland forests. Wilmington also sought to become a more prominent player on the shipping route that ran from the Caribbean along the southern Atlantic coast and then to British industrial cities and then onto the Baltic, seeking to use her sheltering harbor and position near the Gulf Stream to become an integral node on this international line. Further, the powers in Wilmington saw an engineering project as potentially useful in their war against the dock syndicates that “extorted” heavy tolls on the lighterage trade. Having little luck with the state authorities, the city reverted to using the desire to make international connections and federal power to clean out an environment where lower-class siphoning of money and energy was occurring.

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11 Elliot to Craighill, May 23, 1872.
15 *ARCE 1876, 1: 310.*
16 “Petition of Certain Citizens of Cumberland and Other Counties to the General Assembly on the Subject of the Charter of the Cape Fear Navigation Co.,” n.d., Box 21, E71-RG77, NA. These powerful local syndicates make their presence known in the archive largely through their power to annoy state and capital, and while the official reason as
had set political machinery in motion, drawing on a variety of motivations to assemble the political will to alter the estuary’s structure.

The federal engineers’ approached the harbor problem by looking first at the region. From the beginning, federal designs had been concerned with the integrity of the landscape, and concentrated on preventing the barrier islands from disintegrating. The Reconstruction engineers found, when surveying the department files, both the direction their design would take as well as the a measure of the futility encountered when designing in this coastal environment. Captain Daniel P. Woodbury, a fortification engineer who had participated in the construction of the to why the Cape Fear was rebuilt was one of environmental accident, removing the environment in which these semi-piratical working-class groups could operate was undoubtedly a contributing motivation.
Cumberland Road during Andrew Jackson’s administration, led the antebellum engineering effort, arriving in the Cape Fear basin in 1852. He found a landscape in flux. Maps from Woodbury’s visit portray a landscape that stretches common geographical description. Cape Fear, the prominent regional salient into the Atlantic, was really an aggregate of duned barrier islands and marshlands punctuated by prominent landmarks used for navigation. “Smith’s Island,” probably referring to an earlier contiguous island, in 1852 connoted an archipelago of low islands, emergent sandbars and interstitial salt marsh. Making up the body of the Cape Fear salient, Smith’s Island was dominated by the Bald Head dune formation at its southern end. The archipelago stretched northward, comprising the eastern boundary of the river estuary, its last outpost being a short gulf away from Zeke’s Island, another low sand formation that marked the southern edge of the New Inlet. From Woodbury’s immediate action we can surmise that Smith’s Island, already in a state of decomposition, was in crisis. His first actions were to build stone jetties arrayed perpendicularly to the coastline of the Bald Head to arrest ongoing erosion and prevent the loss of the Cape Fear landform entirely to the sea. Work then began on a small elevated railroad running from Zeke’s Island, not much more than a few low dunes at the southern edge of the New Inlet, southward through the marshes to the reinforced Bald Head, meant to assist in the construction of dikes that would close the small inlets on the estuarial side of Smith’s Island.  

Storms and the mutability of the landscape increased the urgency of the project as well as the sense of futility. Weather made work difficult, and a fall gale in 1854 washed out one of the


18 ARCE 1873, 797.
islands that made up the archipelago’s connective tissue, opening up a half-mile gap that needed to be incorporated into the project and closed. While construction was underway, the space between Zeke’s Island and the lower archipelago which defined the design dimension had enlarged from a 600 yard channel to a 1,460 yard gulf. Woodbury’s assistant engineers, on site in the mid 1850s, reported regular catastrophic erosion and reconfiguration of the natural inlets to the marshlands they were building through.\textsuperscript{19} The changing footing in which they were building gave the engineers cause to question the basis of their design criteria, and the relative scale and appropriateness of the structure to the task asked of it. But it was too late. N. Turnbull, a civilian engineer who was superintending the construction of the sea dike, described a harrowing scene in the storm of September 11\textsuperscript{th} and 12\textsuperscript{th}, 1857, when he had to make a daring rescue of laborers and their families from their camp on Zeke’s Island for fear that the entire island would give way and they would drown. Describing the scene some weeks later, Turnbull noted that the island had shrunk considerably. Of the dike, he could find nothing; the elevated railroad was lost, and the only evidence remaining were a few tools and railroad iron.\textsuperscript{20} Describing the storms of September, 1857, and the complete destruction they wrought, a later engineer couldn’t help but note the insufficiency of foresight and funds that led to the ruination of the work, speaking to a confidence not of the domination of engineering work, but of its increased properties of tenacity or resilience if given proper conditions. Local residents saw this display of government engineering as part of a long string of engineering follies, stretching from Fulton’s work in decades previous to the piecemeal and underfunded federal projects as tantamount to neglect—even intimating that underfunded and weak projects were injurious. “From the Congress,” wrote

\textsuperscript{19} ARCE 1876, 1: 324.

\textsuperscript{20} N. Turnbull to John J. Abert, Chief of Topographical Engineers, October 5, 1857, Box 31, E71-RG77, NA; Turnbull to Abert, November 7, 1857, ibid.
a consortium of Wilmington businessmen, pleading for a proper form of infrastructural relief, “we look for the means for restoring our harbor, damaged by work of public authorities, we ask a careful consideration of what we consider our just dues [emphasis theirs].” Conflation of neglect with failure in the language of tort may have not had teeth and been posed mostly as rhetoric; yet it nevertheless spoke to an increased frustration with effectiveness in the landscape that was likely shared by the professional engineers.

Figure 3.5. Topographic Survey of Zeek’s and Part of Smith’s Island, D. P. Woodbury, National Archives, Atlanta, Georgia.

Reconstruction reassessment of the project began in 1870, when Colonel James H. Simpson was ordered to Cape Fear in late July on a mission through North Carolina’s Outer Banks to both fix the scope of the Cape Fear project as well as survey the changing barrier islands with a view to improving the entire coastline for navigation. Simpson had previously been in charge of the Patapsco and Susquehanna Rivers in Maryland, and these orders extended

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the purview of his Baltimore engineering office southward. Travelling with Henry Abbot, the two engineers found that not only was Smith’s Island disintegrating, but Zeke’s as well, and fully one half of the bank of the river was threatening to fall away, exposing the entire shipping channel to shoaling and destruction. After some deliberations, where the records indicate that Simpson had to convince both Abbot and the watchful Wilmington businessmen who accompanied them on their field work, the United States adopted a plan of landform construction. Abandoning the idea of diking or damming with artificial structures, whose structural capacities were known to be insufficient, Simpson devised a plan to shift the currents and reinforce existing landforms in a way that a robust “natural” landform would emerge from the sea, forming a barrier to protect the shipping channel with structural integrity beyond any human construction. This meant encouraging fusion of the islands of the archipelago into one strand “to serve as a barrier to prevent the sea, in eastern gales, from washing into the river,” he wrote, made “but with the aid of jetties” to “collect the sand so as to make a permanent beach.” Convincing his colleagues that the entirety of the congressional appropriation would be best spent on trying to achieve a durable solution, rather than piecemeal and Sisyphean dredging, Simpson’s plan marked a shift from maintenance regime to one of constructing a vastly new topography that, while not eliminating the need for maintenance and adjustment, dramatically shifted the organizing vectors and dynamics, both of natural and economic systems, of the place.

The notion of reforming the barrier islands into a permanent, natural seawall in turn radically changed the engineers’ approach to improving the harbor entrance. Reforming a significant portion of the twenty-six mile long estuary allowed Simpson to conceive of the form

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22 James H. Simpson to Humphreys, July 23, 1870, July 25, 1870, August 2, 1870, Box 29, E25-RG77, NA.

23 Simpson to Humphreys, August 13, 1870, Box 29, E25-RG77, NA.
and force of the river itself as a giant machine to which he could achieve his objectives. “Closing the breaches” in the eastern shore would allow the engineers to concentrate much of the force of the river southward toward the old harbor entrance at Bald Head, using the increasing hydraulic force to scour away at the accumulated silt. This plan was largely in line with the principles invoked by Woodbury two decades earlier—the difference in Simpson’s plan being the scale assumed and the marshaling of surrounding landforms to assist. Simpson purportedly had

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24 Simpson, “Supplemental to the Annual Report of Colonel J. H. Simpson, Corps of Engineers, dated Sept. 26, 1870, to Chief of Engineers, U.S.A., on the improvement of the channel of the mouth of Cape Fear River, N.C.,” manuscript, September 26, 1870, Box 29, E25-RG77, NA (hereafter cited as “Supplemental”). The genealogy of the application of Bernoulli’s principle to river and harbor construction is dealt with extensively in Chapter 5—I would note here though that though Joseph Totten and Woodbury invoke the principle of concentration and scour in their correspondence in the 1850s, in application every river is different and impinging contingencies make each design unique. Simpson’s eventual realization that he was in effect building an enormous machine that altered the hydraulic pressure and velocity is not betrayed by any “eureka” moment in the archives—but reporting that he insists on Abbot and two other men referred to only as Messrs. Strausz and Ness, both government officials with extensive maritime experience, go out and look at the tides with his plan in mind, indicates that the idea of using the barrier beach to concentrate the flow occurred to him while onsite and making his survey.
trouble convincing both Abbot and veterans of the U.S. Coastal Survey on hand, but after persuading them to spend time looking at the tides and current dynamics in the estuary, the skeptics came around to support the ambitious plan. All agreed that in order to have any chance of success in rebuilding the estuary, the design must call for an engineering effort “of the most substantial character.”

To become substantial, Simpson’s plan involved a hybrid combination of both masonry engineering structures and reinforcement of the “natural” landscape structure by using the materials of nature. Simpson looked to the island’s natural structures in successfully warding off the littoral currents and tidal concentrations, forming a design that would use masonry as the seed around which a natural structure could accumulate. As the land grew, Simpson looked to his study of the matured duned barrier islands, whose accumulation of a complex corrugation of sand ridges held by vegetation lent a sense of permanence he sought, and planned to cement the new land permanently by extensive planting of rhizomatic grasses. In combination, the earth’s resistant forces could be summoned by the suggestions made by relatively small human-built structures. Simpson’s self-derived measure of success, as the project began to take shape, was a form of engineering minimalism, designed to limit the United States’ expenditure of treasure and energy in the long term. With any hope, the channel project would be self-sufficient, the “channel thereafter maintained without resort to artificial means.”

Construction of the primary jetty began in June, 1871 and proceeded rapidly; the engineers treated construction as both an act of building and simultaneous evaluation of how the

25 Simpson to Humphreys, August 20, 1870, Box 29, E25-RG77, NA.
26 Simpson, “Supplemental.”
27 Simpson, “Supplemental.”
28 Walter Griswold, “Cape Fear River Improvement,” January 16, 1871, Box 1, E71-RG77, NA.
coastline responded. Walter Griswold, a civilian engineer, and Charles B. Phillips, a captain in the engineer corps about seven years out of West Point, travelled from Baltimore to the site in the autumn of 1870 to set up workshops; Griswold dryly noting in his report that he found the remote islands little more than “barren wastes.”\(^{29}\) Labor recruitment was an issue due to the remoteness and unforgiving climate during the winter of “heavy work” of manufacturing the timber cribs for the jetty’s base, and Griswold was forced to build barracks and a mess to entice workers to hire on. In the first year, employing forty five men and a fleet of boats built specially for the project, Griswold and Phillips had laid down some 12,000 feet of jetty between the solid portions of Smith’s and Zeke’s islands. The process of construction was the linear assembly of similar components. Workers built large timber “cribs”—large reinforced troughs with sides 20 feet square by 30 to 40 feet long, open at the top. The cribs were floated into position with the supervising engineer sounding for the end of the jetty’s base, which was underwater. When floated above its final resting place, the workers then loaded the crib with stone, carefully sinking it into the sandy bottom. This linear crib structure provided the base on which a superstructure of loose but large granite blocks would be loaded, eventually raising the jetty above mean high water. As the building progressed, inhabitants noticed far reaching effects on the estuary. Pilots reported to Griswold that the “Rip,” an ebb channel at the river’s southern end, had visibly increased in velocity, and a retired mariner described a change in the general hydraulics tending in the direction of the way the estuary behaved two decades previously.\(^{30}\) The coastline itself as well responded almost immediately. Surveying the state of the work at the end


\(^{30}\) Ibid.
of the winter in 1873, Phillips noted that the “sand accumulates around it with gratifying rapidity.”

As the work neared completion in the summer of 1873, changing dynamics around the project produced unexpected results. Work in the spring had closed the remaining 4,403 feet between the two islands. Phillips noted that as the work progressed, a “sand spit” just above high water formed along the sea side of the work, running parallel and a little behind the progress of the superstructure, and varying in distance from about forty to 200 feet seaward from the work. When the spit ranged close enough, Phillips directed the workers to bridge the shallows between the jetty and the shadow landform with flats woven of discarded materials. The ponds formed between the jetty and the spit rapidly filled themselves. As the superstructure neared completion,

Figure 3.7. Cape Fear River, N.C., Comparative Sketch, Henry Bacon, 1877, National Archives, Atlanta, Georgia.

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Phillips also noted the increased rate of sand accumulation, as if the project were creating momentum in the landscape. Looking out beyond the immediate vicinity of the jetty, Phillips noted distant shoals were forming further out to sea as well.\footnote{ARCE 1876, 1: 325-6.}

Figure 3.8. Comparative Map of Federal Point and its extension over the Caroline shoals, Henry Bacon, 1887, National Archives, Atlanta, Georgia.

As the land reformed around the structure, it threatened the engineers’ mental models, and prompted a response that is characteristic of the experimental, provisional and seeking phase of engineering work of the Reconstruction era. This is not to say that the shifting landscape prompted an abandonment of theory and a reversion to “cut and try” engineering. Instead, the design process at Cape Fear meant that the combination of precedent and imagined behavior of the estuary produced not a mental model of a static system, but one that was flexible, made of interlocking parameters that could form and reform the system within certain limits. Measured against an ideal case of river and tide interaction, the lower Cape Fear presented not a unique set of circumstances, but a singular enough arrangement of forces that invited experimentation.
Because it did not conform to a simple estuary structure, the engineers saw it, in its increased complexity, as something which could provide a more fundamental insight into nature’s workings. Its unanticipated and favorable (in their eyes) response to their work indicated further secrets. Disrupting the older typology of river and tide system, the engineers pressed forward with their work, conducting “engineering science” in the best of traditions. But at the same time they replaced the mental construct of typology, or recognizable form of landscape and hydraulic structure, with one that had considerably less formal definition and instead comprised more of a notion of a matrix of hidden forces and potential masses which may be brought into existence.

As the sand accumulated, a design process emerged. Keeping one foot grounded in precedent while wading the river’s secrets with the other, and at the same time drawing and redrawing the system they were working with, both on paper and as a sort of shared mental map of the network of forces at play. Major William P. Craighill, who took over the Baltimore engineering office when Simpson was reassigned, structured the administration of the project to serve both ends. Encouraged by the favorable results his subordinates Griswold and Phillips were achieving in the field, he immediately ordered the hiring and outfitting of surveying parties to fan out in the lower estuary to document the results of the upstream engineering works. These streams of field data became important in the engineering offices, which became centers of calculation where the shifting landforms could be evaluated against a repository of past surveys, and individual landscape interventions evaluated for their efficacy and probable usefulness at

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33 See Edwin Layton, “Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America,” *Technology and Culture* 12, no. 4 (October 1971): 562–80. Though they use different terminology, the willingness of nineteenth-century engineers to dispense with formal purity of scientific inquiry in order to achieve results is comparable to Picon’s notion of technical rationality. The purity of the method is not nearly as important as the dynamism of the inquiry.
points in the Cape Fear force matrix.\textsuperscript{34} Craighill was explicit about his accumulation of data, to “study the various agencies at work to produce the changes constantly in progress in that vicinity.”\textsuperscript{35} And in his analysis and later action it emerges his idea of the hierarchy of agencies and the one most fruitful to address. From the perspective of his office in Baltimore, and no doubt encouraged by the institutional memory of the Wilmington shipping community, Craighill came to focus on the historical form of the river, emptying into the Atlantic in the channel recorded by the eighteenth-century cartographers, was the winning outcome in the long running contest of all the forces in the matrix. Restoration to the original configuration was what the river, the largest representative of “nature” in the matrix, wanted.

Bringing new land into existence dynamically reinforced the engineers’ notion that there was something ultimately correct about their intuition of managing the forces so that the river could make itself “restored.”\textsuperscript{36} Watching the “numerous shoals growing horizontally and gradually emerging from the water,” Craighill describes this restorative desire as a sense of agency that he detects in the landscape. “The are ample grounds for belief,” he wrote, “that, by steadily carrying forward the work…the New Inlet will be entirely closed in a reasonable time under the agency of the winds and waves…,” healing the violently rent barrier island breach under the engineers ministrations.\textsuperscript{37} They saw the response of the landscape as evidence of this agency, and in their application of personification indicated as well that nature and engineer were kindred spirits in a sort of metaphorical profession of movement of landform and correction of

\textsuperscript{34} Craighill to Humphreys, January 24, 1871, Box 2, E71-RG77, NA; Craighill to Humphreys, March 17, 1871, ibid.; Craighill to Humphreys, August 4, 1871, ibid.; Craighill to Humphreys, February 3, 1872, Box 15, E71-RG77, NA; Latour, \textit{Reassembling the Social}, 178–79.

\textsuperscript{35} Craighill to Humphreys, December 1, 1871, Box 12, E71-RG77, NA.

\textsuperscript{36} \textit{ARCE} 1872, 698-99.

\textsuperscript{37} ARCE 1873, 789.
imbalanced system operation. As the emergent seaward landform reached a half mile in length, Craighill reported it as “indication that the right course of operations is being followed and that nature is lending her forceful aid.”

“Construction” of nature in this way was a means of describing a façade in front of the actual destructive or creative forces. It was a way of thinking of nature with mutual professional sympathy, aggrandizing unity of purpose, but also describing force in a kinship of desire. Engineering then could be seen as a dutiful helpmeet to a larger purpose, as Phillips wrote: “Efforts will also be made to assist nature in her evident attempts to restore the old Baldhead Channel.”

The engineers adjusted their analysis to incorporate the river’s natural tendencies, adding their perception of what nature wanted to their calculations. This incorporation tended in turn to increase the scope and ambition of the engineers and by extension, the United States. Disposed against “formidable” dissolution and retrogression of the kind that was happening across the South, the success of an engineering effort was linked to its ready appearance as making some sort of headway. Steady accumulation of mass along the barrier island was a sure sign of progress. As the sandbar approached a half mile in length, Phillips observed an increase of deep-draft shipping appearing at the city docks. Massiveness of results, mostly in form, indicated economic success, even if the actual link was tenuous. But most impressive was the scale of the project, which prompted further action, increasing the engineered grasp of the river. “No one who stood on Monday upon the work” editorialized the Wilmington Journal, “can doubt the practicability or success of the work.” Economic data supported the symbolic success of the

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38 Craighill to Humphreys, August 29, 1872, Box 25, E71-RG77, NA.

39 ARCE 1873, 791.

40 Chamber of Commerce, Wilmington, N.C., Wilmington, North Carolina, Past, Present and Future., 84.
emergent beach; the two railroads terminating in Wilmington showed 76% and 27% increases in revenue, and Phillips noted increased traffic in deep-water vessels at the city docks paralleling the sandbar’s growth.\textsuperscript{41} At the end of the working season of 1874, the engineers concluded that to insure the permanence of their work, the project needed a new phase. They would move from stabilization of existing natural coastal structures to reversing the bore of the new channel. In Baltimore and on site, the engineers began the process of designing a large deflection structure, meant to exert gradual influence on the river.\textsuperscript{42} Craighill, emboldened by the trajectory of the work in progress, moved finally to enact a plan he had imagined at the beginning of the work. They would move slowly with an array of supporting structures that would divert the tides and the river to eat away at the scouring power that kept the new inlet open, applying steady pressure just to the point where a final closure would become possible. As Craighill began the design of the system of deflecting structures, he drew on two robust resources of the engineering corps. For design paradigm, he drew on Abbot’s unpublished work on river engineering, here modified to a new situation.\textsuperscript{43} And he called on his colleagues, formally convening a board of engineers to scrutinize his schematic design and provide feedback from their experience and wisdom.\textsuperscript{44}


\textsuperscript{42} House, \textit{Annual Report of the Chief of Engineers to the Secretary of War}, 44\textsuperscript{th} Cong., 1\textsuperscript{st} sess., Ex. Doc. 1, pt. 2, Vol. 2 (hereafter cited as \textit{ARCE 1875}) 99-101.

\textsuperscript{43} Craighill’s design approach, using incremental deflections to train the flow of the river slowly toward a desired behavior, is similar to that described by Abbot in the proposal for the Memphis and St. Louis Railroad Company Levee. See Abbot to Humphreys, January 31, 1868, in “Official and Personal Letters, June 10, 1867 – April 20, 1870,” Box 9, HLAP.

\textsuperscript{44} The language used to ask for a convening of the Board of Engineers is formal: “It would be agreeable to me to have the localities which have been mentioned examined by several officers of experience and ability, from whose counsel and advice and opinions much profit would be derived by myself or any other officer in charge of this work,” wrote Craighill when first taking over Simpson’s plans for the Cape Fear. Though review by the board was standard and expected for a project of this scale, the formal petition that outlines the small part Craighill himself, as the design engineer, was to play, indicates the attitude toward the larger design process, as well as forthright admission that he, nor any other individual, had mastery of hydraulics. Craighill to Humphreys, December 1, 1871, Box 12, E71-RG77, NA.
Design By Committee

Large civil projects were designed in a social way at this time in the Engineer Corps. The form and objectives of a particular project were often conceived of abstractly first, then applied to the landscape by one or two engineers. The nascent design was then brought formally before a board of engineers composed of senior officers of stature and experience and supplemented by younger officers (who often did the fieldwork) and other specific officers who may have had particular experience with a technique or unique site situation. Located in New York, the Board represented an apex in the hierarchy of the engineer corps, independent from the central organization in Washington, and acting as a key node in the networked exchange of ideas that a project passed through. A new board was convened for each project, even if the cast of characters remained largely regular. Though formal and military, the operations of the various boards indicate that experience and seniority were paramount in terms of who was listened to, but that the senior engineers listened to younger engineers and those that did fieldwork, acknowledging the importance of both new theories out of the schools and what insights the landscape and site yielded themselves. The board acted as a critical body, where the district engineer would bring his design and plead his case, as the approval of the board of engineers was necessary to secure funding. The constant stream of new projects being presented in the Army Building on Houston and Greene Streets in Manhattan ensured that it was a place of exchange of ideas. And while design by committee certainly blunted some of the more ambitious ideas, the configuration tended toward a conservative and cautious approach to intervention. This was likely by design, distributing risk through a network of engineers with considerable experience with rivers and hydraulics in aggregate.
Craighill’s interactions with the Board of Engineers in New York concerning the Cape Fear project were indicative of how the board functioned generally during Reconstruction, and describe the process of design distributed across both the landscape and many minds. Zealous B. Tower, a lieutenant colonel in the engineers and former professor of engineering at West Point, chaired the review boards that were assembled for the Cape Fear project in the 1870s.\(^\text{45}\) Tower first visited the site with Craighill and Quincy Gillmore in the winter of 1872, when with “many prominent citizens of the place” they toured the river aboard the steamer Seward and Tower formed his opinion in support of Craighill; that “closure” of Smith’s and Zeke’s Islands “will form an integral part” of the solution.\(^\text{46}\) The site visits, along with the board’s recorded deliberations in New York, made a bulk of reference material in which the data gathered from the landscape, as well as the accumulated opinions of various experienced engineers who were available to comment in New York, filled volumes which later engineers might consult.\(^\text{47}\) This standard engineering practice reflected the replacability of any individual actor and also served to reinforce a project’s autonomy and momentum as one individual engineer could not exert too much influence on the project overall. Exteriorizing the design process into a mass of data and opinion may have blunted sparks of genius or an innovative run outside of one dedicated individual or group’s desires. But this exteriorized design process defined the concept of the intellectual group within the army and colored the way the military conceived of engineering practice.


\(^{46}\)Zealous B. Tower to Humphreys, January 26, 1872, Box 15, E71-RG77, NA.

\(^{47}\)Craighill to Humphreys, August 4, 1871, Box 2, E71-RG77, NA. These map files formed the material basis for design precedents of the corps’ works. Housed originally in Washington at one central location, this core of spatial and technological ideas has since been broken up and distributed to the National Archives’ various regional repositories.
The Corps of Engineers formed an intellectual community around engineering knowledge that was contingent on the application of that knowledge in the context of the landscape and the state. Pure knowledge of how to achieve an engineering outcome was only one component of the institutional knowledge; the real defining body of knowledge housed by the corps was ability to negotiate the various levers or contingencies of government and the realities of construction on site that meant projects were actually built and had some effect. The code word to describe this aspect was “practicability.”  

Physical feasibility, defined by the landscape and the structures of forces that created the engineering problem was one aspect that any engineer was expected to know. To secure funding, pose projects in rhetoric amenable to congressmen, judge political palatability of projects, to bring personal and military authority to bear on contractors, local powers, and labor were all other crucial aspects of engineering knowledge that were implicitly activated in the design process. The core group of uniformed military engineers protected this more full version of institutional knowledge and used it to define the boundaries of their group: federal authority bestowed by the uniform allowed access to a network of powerful offices within the larger institution of the government. But this did not lead to insularity, as engineering knowledge derived from the successful construction of projects necessarily relied on connections between individuals to those in other places and outside of the military’s hierarchy and organization. Access to the connecting strands of knowledge of “practicability” both in terms of judgment and social capital to execute projects, defined engineering practice. One must consider

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48 Of the many examples in the archives, I offer these examples: “To Ascertain the Practicability of Steamboat Navigation between the Mississippi River and Lake Pontchartrain,” ARCE 1867, 38; determining that the cross-Florida canal would not be “practicable” without locks, ARCE 1882, 1205; the House committee on Freedman’s Affairs was “desirous of information about the practicability” of building a railroad levee, B. F. Loan to Humphreys, January 17, 1868; Abbot’s opinion that the “construction of levees in a manner to secure the safety of the lowlands of the Mississippi in the opinion of competent Engineers entirely practicable,” Abbot to Humphreys, February 12, 1876, Box 81, E71-RG77, NA; etc. Even local businessmen made use of the formation when touting their pet projects, see Chamber of Commerce, Wilmington, N.C., Wilmington, North Carolina, Past, Present and Future., 84.
a heterogeneity of actors, both in uniform and out, working at various scales along the concept of practicability, to understand engineering design at this time.\textsuperscript{49}

The mechanism of design was therefore repeated iterative action between various members of the engineer corps and the data, the form of a project changing as it went through several feedback loops. Embodied knowledge in the individual engineers, particularly those like Tower, Henry Abbot, and Gen. Quincy Gillmore, all with significant civil and war experience, left its mark on the trajectories of the various projects. Civilian assistant engineers, usually hired locally and employed on one project or region, were listened to as well, particularly if they had established a reputation for insight or long service. Representations of the particular character of the landscape carried inflections of intent from the site to the board room in New York, and it is particularly through drawing that the ground-level engineers were able to exert direction over the project. But because of its centralization, the board tended to downplay much of the particularly tailored engineering solutions in favor of a practice that was becoming standardized. The interactions of design in the context of the board of engineers was primarily between the individual and the growing body of published precedent. The last half of the nineteenth century hosted an explosion of publications, on both sides of the Atlantic, of successful solutions to civil engineering problems. Ideas made their way from engineering books and periodicals, as well as from the corps’ own archive, into the design process in New York where the then were modified to fit the various landscapes of the United States. It was from the board of engineers that the “force” of precedent on design projects was most heavily felt.\textsuperscript{50} In this process the various


\textsuperscript{50} I use the term “force” here as a way of pointing to the agency of the two nebulous bodies of knowledge that I have defined as “practicability” and the notion of precedent. I am using John Law’s formulation of force to action exerted by a non-human actor, in this case, an archive of data. See John Law, “On the Methods of Long-Distance Control: Vessels, Navigation and the Portuguese Route to India,” \textit{The Sociological Review} 32 (1984): 234–63.
typologies were evaluated in terms of “practicability” and the loop between New York and the peripheral projects was established as an ongoing flow of information.

Civilian engineers, hired for one project and working directly under the military officer, were the primary contact of this design mechanism with the ground. The education level of these civilian engineers varied widely; some possessed no formal training and became engineers through experience on railroad construction. Others had attended civilian engineering schools in Europe or America; some had attended West Point and had retired from active military service. More than a few were former Confederate officers whose political beliefs barred them from reentry into the army but whose social connections enabled them to get hired by their antebellum peers, often with controversy. Performing the bulk of the work, from surveying to supervision of labor and day-to-day operations on site, the civilian assistants needed to be reliable given how much autonomy and control they were responsible for. The two long-serving assistants at Cape Fear came to be trusted and their hand is visible on the outcome of the projects. Walter Griswold, the civilian engineer who oversaw much of the early work on the river when still under Simpson, had previously worked on several harbor improvement projects on Lake Erie.\(^{51}\) On the Great Lakes projects use of Bernoulli’s principle—that of forcing the lower river into a concentrated jet to scour the bar—was widespread.\(^{52}\) It is likely Griswold’s knowledge of the efficacy of applying this theory affected Simpson’s early conception of the project. The project was completed by a

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51 Simpson to Humphreys, August 13, 1870, Box 29, E25-RG77, NA.

52 See ARCE 1875, 35-6. Humphreys’ insistence that use of jetties to concentrate flow of rivers on sandbars, essentially use of the principle of Daniel Bernoulli first published in 1738. In his Hydrodynamica, Bernoulli describes an increase in velocity of an incompressible fluid simultaneous with a decrease in pressure. Utilizing the resulting kinetic energy of the fluid flow is the underlying principle of narrowing the width of a river at its mouth; a perfect example of Bernoulli’s principle in action, though the Swiss mathematician is never named in the engineering documents. Further elaboration on the debates over the origin of using this principle in harbor design, and more specifically, how Humphreys’ public statements about the longstanding use of it in harbor design to refute the claims of James Eads, is covered more extensively below.
civilian engineer named Henry Bacon, who had worked on the Illinois Central Railroad before assuming supervision of the Cape Fear works in 1876.\(^{53}\) Bacon, who for the first years he was in charge lived with his family out in the swampy estuary near the construction site, developed his own problem-solving philosophy made necessary by scarcity of materials and labor and harsh environmental conditions. His experience, insight and design choices made him integral to the project’s success. In the eyes of the army engineers in Baltimore and New York, he became a trusted authority, consulted by uniformed engineers of the highest level before any action was taken on the project.

There were a variety of actors and institutions outside of the army who sought to influence the design and found the ideas of the army engineers malleable and the engineers themselves receptive to input. Receptiveness however was often contingent on similar social status, perceived collegiality in a scientific community, or voices that represented practical experience of such a deep nature that to ignore it would be fallacy. The two primary national institutions that the engineer corps interacted with the most were the Smithsonian and the Coast and Geodetic Survey. Correspondence indicates that information sharing between the Smithsonian Institute and the Corps of Engineers, of maps and data, was enabled by social connections established in Washington and then activated through the army’s bureaucracy, moving information into the field when needed through regular correspondence, reports, and map-sharing. The engineer corps’ interaction with the Coast and Geodetic was more collaborative. Alexander Dallas Bache, the famed director of the Survey, was a frequent correspondent with the army engineers on technical matters, and had consulted with the army on

various boards and projects, including an earlier examination of the Cape Fear River. While relations remained cordial, there was no attempt to consolidate all government data in one repository; the rationale being that different epistemes led to different methods of data collection and therefore different results. The engineers, despite the prestige of the competing scientific organizations, retained their own prerogative to gather data as they saw fit and was commensurate with their sense of autonomy. Data itself was relatively scarce, and if the engineers refused collaboration or rejected unsolicited opinions of Coast Survey operatives in whose territory they overlapped, it was likely to avoid confusion brought by a cacophony of opinions of hydraulic behavior derived from intuition. Within the army itself, different divisions maintained their own data troves. The rivers and harbors division of the Corps of Engineers traded information and methods of gauge construction, etc., with their colleagues in the Great Lakes Survey, which was under the titular chief of engineers. Distance and different objectives had erected a boundary between the two similar organizations, but a prevailing collegiality allowed exchange and access to diversity of engineering data and approaches.

The engineers made extensive use of a network of civilians with an amateur interest scientific matters in assessing site conditions and even in data collection. This practice extended to the beginnings of both the Corps and the republic, where social class and a common

54 ARCE 1873, 804; Phillips to Craighill, January 16, 1874, Box 47, E71-RG77, NA. Bache’s reputation seems to give his input weight in the assessment of the material in the archive, Phillips seeming to trust evidence bearing Bache’s name more than other material, even that submitted by Bache’s subordinates or successors.

55 Correspondence between Henry Abbot and central command in Washington about in-house development of methods using barometers in topographical surveys shows Abbot actively discouraging trust in the data the Smithsonian published; he trusted neither the Smithsonian’s computational methods nor their ability to keep the empirical data free of taint of scientists’ theorizing. Abbot to Humphreys, May 1, 1867, Box 1, E25-RG77, NA.

56 Phillips commented on a treatise submitted unsolicited to Humphreys, putting forward a theory about the behavior of the tide and the river’s discharge. Phillips, dismissive of the theory that seems to have been obtained mostly from looking at charts, wrote that if Mitchell’s theory is correct, “then is New Inlet not only a blessing in disguise, but our labor and outlay at the Cape Fear for the past three years, have been worse than thrown away.” Phillips to Humphreys, November 26, 1873, Box 47, E71-RG77, NA.
enthusiasm for national enterprise, led to the more professional engineers gladly accepting the help of local civilian experts, even if the results were “amateur.”\textsuperscript{57} Postwar engineers like Abbot retained a network of correspondence with amateur and professional scientists across the United States and rest of the globe, connections they developed while on field duty, even if those contacts were caught on opposing sides of the civil war’s ideological divide.\textsuperscript{58} At Cape Fear, the government engineers made use of Henry Nutt, a businessman who was also something of an amateur botanist, to research the various species of plants that would be most appropriate and effective in structuring the accumulated sand. Nutt, lauded in the newspaper as a “great friend of the work,” played the role of boosting businessman whose interests in the more scientific aspects of civil construction demonstrate a public fascination, at least within a certain social class.\textsuperscript{59} The lower Cape Fear pilots, whose intimate knowledge of the river bottom and currents was essential for the engineers to formulate an effective plan, seemed less enthusiastic in helping the federal engineers. Their reticence nonetheless did not effectively hinder the project once it got going.

\textsuperscript{57} Humphreys acknowledged how a Professor Forshey, who assisted in data collection for the Delta Survey in the 1850s, was “entitled to great credit for the zealous and intelligent manner in which he devoted himself … to observing and collecting facts relative to river phenomena, without aid from any source whatever…. When it is considered how difficult and costly perfect observations are, of the character of some of those made by him as an amateur, it is a matter of surprise that so much should have been done by the unassisted enterprise of a private individual.” Humphreys and Abbot, \textit{Physics and Hydraulics of the Mississippi River}, 3; See also George S. Pabis, “Subduing Nature through Engineering: Caleb G. Forshey and the Levees-Only Policy, 1851-1881,” in \textit{Transforming New Orleans and Its Environs: Centuries of Change}, ed. Craig E. Colten (Pittsburgh: University of Pittsburgh Press, 2000), 64–83.

\textsuperscript{58} See, for example, Abbot to Theodore Lyman, January 10, 1866, “Letters and Telegrams Sent, Civil War and Mississippi Duty, 1862-1867,” HLAP. Abbot, writing from a New Orleans that is frantically preparing for flood season, writes to his army colleague and scientist Lyman, a former student of Agassiz who likely saw Abbot socially in Cambridge. Abbot is writing to report of the death of another colleague of theirs, a New Orleans physician named Benedict, who died during the war, and how all of his specimens and data had been lost or destroyed during the war as well. Abbot knew Benedict because he had consulted with him when doing field work for the \textit{Physics and Hydraulics of the Mississippi River}; Benedict had specimens from boring an artesian well and had been analyzing the strata the bores contained in trying to determine the age of the delta.

\textsuperscript{59} Chamber of Commerce, Wilmington, N.C., \textit{Wilmington, North Carolina, Past, Present and Future.}, 62–69, 84.
despite “the usual sneering criticism and hostility on the part of pilots and others, and opposition to what has been proposed,” as reported by Craighill in 1875.⁶⁰

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⁶⁰ Craighill to Humphreys, April 7, 1875, Box 69, E71-RG77, NA. Economic and social class seems to have played a role in creating a gap in enthusiasm for federal projects. The “sneering criticism” Craighill observed could be read as arrogance born of superior local knowledge in the face of federal bumbling. But when observed in the same letter that the Cape Fear works had reduced the lighterage industry at Smithville, which employed many of the pilots and watermen in question, by some 50% at that time, the hostility likely had origin elsewhere.
professional military courtesy. Word had a way of getting around through the trans-Atlantic military engineering world, particularly when one state engineering project enjoyed success. American engineers closely watched periodicals such as the *Annales des ponts et chaussées*, an official French state engineering publication, to keep abreast of the cutting-edge engineering work done in Europe. But trading information, in the early 1870s, remained a personal pursuit by individual engineers, and was curtailed by language. For those who retained their French from West Point, the intellectual developments of the French state engineers were open and available to the Americans. Lieutenant Frederick Mahan, son of the famed professor at West Point, personally brought designs of a new type of movable dam to the Ohio, Monongahela, and Wabash river projects. Based on his examination of gate type movable dams designed by an engineer named Boulé in France, Mahan proposed adoption of the first movable water retention structure in the United States. Mahan visited the Port à l’Anglais dam, a few miles upstream on the Seine from Paris, in the company of Boulé, who gave him a personal demonstration of the operation of the drum wickets. The subsequent design of the Davis Island dam, based on his personal contact with Boulé, and translation of his thesis to English, which eschewed the normal “needle” weir structure in favor of Boulé’s gates, was due to this personal initiative, as opposed to formal bureaucratic adoption of norms in design.\(^61\) Technological transfer began to flow backwards toward Europe at this time as well. An engineer named Lavoinne of the French Corps des ponts et chaussées, who had been a delegate to the Centennial exhibition in Philadelphia in 1876, wrote to Craighill in a personal capacity after seeing an exhibition of drawings of the Cape

\(^{61}\) *ARCE* 1876, 1:89, 2:15-24, 2:28-54. Needle dams in use in the United States were based on Poirée’s design, which in turn had built on Chanoine’s 1850 design for a trestle bridge over an adjustable weir. Boulé, in his thesis, describes how his modification of the designs of the wickets, or adjustable portions of the dam, is based on this lineage of design research carried out within the corps des ponts et chaussées.
Fear project, asking for copies of Craighill’s design documents, for which the American was flattered, and happy to oblige.⁶²

A growing body of published literature was increasingly acknowledged by the engineer corps but failed to fully penetrate the bureaucracy. Design standards were still socially determined by individual engineers negotiating within the context of correspondence or military hierarchy, or in the board room at the Army Building in New York. Ideas published in books or periodicals could provide the nucleus of a design concept, and were made use of, but these ideas found their way into the design process because of an interested individual as opposed to institutional acceptance as canon. The only exception to this would be Humphreys’ and Abbot’s *Physics and Hydraulics of the Mississippi River*, but, in their discussion of ideas for designs, the engineers were aware of other published sources whose impact had a wider base if it was published in English.

The main American repository of engineering publications was David Van Nostrand’s publishing house and bookshop, located on Murray Street in Manhattan during Reconstruction. Van Nostrand, a New Yorker with no technical training, had befriended the military engineer J. G. Barnard of the U.S. Topographical Engineers during the decade in the 1840s when both lived in New Orleans. His friendship with Barnard led to his acceptance into the technically-minded intellectual set of the upper echelon of the antebellum army’s intellectual leadership; Van Nostrand’s social circle included William T. Sherman, H. W. Halleck, Quincy Gillmore, and George W. Cullum. After his return to New York and decision to get into the publication of technical literature, his print shop and bookshop was in the 1850s an institution for the technically-minded, the bookshop a meeting place of scientists, engineers, and military officers.

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⁶² Craighill to Humphreys, November 10, 1876, Box 89, E71-RG77, NA.
They came to browse Van Nostrand’s eclectic title list, which, besides engineering texts, included treatises on warfare (Van Nostrand published the first American translation of Jomini), military law, geology, geometry, and mechanics. Despite the eclecticism, Van Nostrand published all of the most eminent American engineers, both civilian and military. Texts by Gillmore, Abbot, and Humphreys appear next to the treatises of Squire Whipple and John A. Roebling. Van Nostrand’s decision to remain the publisher of engineering science led to larger inclusion of advances in electrical and chemical engineering that came quickly after the Civil War, and the establishment of a periodical; *Van Nostrand’s Engineering Magazine* would remain an influential organ of the New York engineering science community well after the man’s death in 1885.63

On the hydraulics of tidal estuaries, however, the designing engineers relied on specific works published in Scotland. David and Thomas Stevenson, brothers and civil engineers, published treatises derived from projects they supervised improving various rivers of their homeland.64 Their conceptualization of rivers into compartments based on a gradient of tidal influence, and principle of removing impediments to velocity as to concentrate the river’s force and utilize every last joule of energy is apparent in coastal projects of the American corps of engineers to varying degrees from the mid-1850s onwards.65 But not only their design principles


65 In the engineer department’s correspondence, explicit references to the authors of engineering treatises are less frequent than references to the various European river improvement projects used as precedent. There is evidence that the Stevensons’ ideas were in circulation amongst the American engineers by at least the mid-nineteenth century. “Stevenson” is mentioned definitively as an influence by Gillmore in 1875 (see *ARCE* 1876, 456); however, the technical language used by Joseph Totten and others in the 1850s indicates that David Stevenson at least was
Figure 3.10. Improvement at the mouth of the River Wear. From David Stevenson, *Principles and Practice of Canal and River Engineering*, 2nd ed. (Edinburgh: Adam and Charles Black, 1872), 291.

Figure 3.11. Jetties at the mouth of the Danube River. From David Stevenson, *Principles and Practice of Canal and River Engineering*, 299.

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read in America soon after the publication of the first edition of *Remarks on the Improvement of Tidal Rivers* in 1845, see Totten to Jefferson Davis, July 10, 1854, Box 12, E25-RG77, NA.
were apparent in American practice. Their method of conveying of information emphasized analysis of a complete, geographically-specific project. Their theory of engineering heavily emphasized precedent utilized by an experienced engineering mind. David Stevenson, in his *Remarks on the Improvement of Tidal Rivers* (1845), centers precedent and topographical specificity as the cornerstone of design practice, both filtered through indispensable experience on the ground:

Although *general* views of the nature of these operations may be given, the precise details of such works shall be best suited to particular localities can, in the present state of our information, be determined only by Engineering experience.\(^{66}\)

Historical exegesis of the failures of those who came before you, and acquaintance with the multitude of contingencies that could doom a project were essential parts of any pragmatic project of improvement. David Stevenson took this as license to skeptically evaluate the works of vaunted predecessors, such as John Smeaton’s work on the Clyde at Glasgow, and to include in his treatise critical comparative studies of John Rennie’s projects alongside his own.\(^{67}\)

Stevenson believed that understanding real interaction between engineering works and specific place precluded reliance on theory, and that an assemblage of a body of precedent was perhaps time better spent in coastal hydraulics:

> In all these matters we must, in each particular case, be guided, in great measure, by experience, there being, as expressed in the quotations from Professor Robison and Mr Rennie, no universally acknowledged laws, founded on mathematical investigation, or practical experience, which we can call to our aid. It is therefore impossible to specify works which shall be of *universal* application; but I am desirous of directing attention to certain works which have, in some cases, been beneficial; the more so, as experience has convinced me that their adoption will be found to be more generally productive of benefit than is perhaps at present acknowledged.\(^{68}\)


\(^{67}\) Stevenson, 11–12.

\(^{68}\) Stevenson, 17.
“Certain works” of precedent displayed the outcome of those interventions in a complex landscape, leaving a definite result inscribed in the landscape. Stevenson advocated compiling a record of these inscriptions, a body of experiments that would not produce some universal scientific truth, but instead would feed the intuition of an engineer by expanding his vision to a variety of outcomes.

The Americans were not as leery of mathematical derivation as the Stevensons; nor were they as interested in limiting their manipulations to hydraulics alone. Engineering precedent should be seen as both individual projects and as a body of outcomes, essential interactions between the natural world and intervening structures. The “experience” portion of the design process was then an understanding of an animating political economy and the way that conceptions of development, progress, flows of commodities, etc., impinged on a design and made it appear more or less feasible. This operation made up the bulk of “experience” an engineer would need to exercise judgment over practicability. When describing the character of institutional knowledge within the Corps of Engineers, it is necessarily a product of the interaction between precedent and the skills embodied in the individual. This combination entailed a design process that first relied on a human network of heterogeneous actors, each emphasizing different aspects and bringing different components of knowledge to bear on the communal design of a project. Coverage of all aspects of practicability was essential and bureaucratic practices were in place to ensure distribution of risk amongst engineers with variety of experience. In this way, precedent could be interpreted as both a means of becoming more effective in making changes to the landscape, as well as a mechanism to consolidate knowledge within the state, and further, within the army nested in the state.
While this knowledge was institutional, it was formed essentially by interaction with the American landscape, and therefore as a sort of distributed intellectual repository, was necessarily spatial. Advancement of engineering knowledge relied on the individual officers, their own self perception as having a “scientific” bent or avocation within their profession as military officers, and their own aspirations for recognition by the larger civilian scientific community. This more than a few of the officers achieved. But the distributed nature of the officer corps, and the rough life they lived on the frontier or in the less cosmopolitan places in the territory of the United States shaped their empiricism and therefore colored the body of institutional knowledge that would mean it is not simply a repetition of the data and conclusions of a civilian counterpart. Recognizing the unique nature of their achievement and the knowledge they developed, in the summer of 1885, a member of the board of engineers, James Duane, proposed that the corps publish a series of case studies of successful projects so that “officers and others may know the original condition of the place before the works were begun; the history and character of the works; the annual appropriations; the total expenditure to date; and the results obtained.” The monographs were to be stripped of any pretense and to be the most pragmatic of resource: “No discussion of theory is advisable;” he wrote, “simply a statement of what has been done, what results have been accomplished, and at what cost.”69 The infrastructure for printing and a nascent engineering library had already begun in New York, and Duane and the other engineers sought to contribute to the army’s own small nucleus of knowledge outside of the academy.70 The first project to be treated and used as a model for the series of monographs was Cape Fear.

69 James Duane to John Newton, Chief of Engineers, August 7, 1885, Box 297, E71-RG77, NA.

70 The engineering library in New York was first housed at the Army Building at Houston and Greene Streets in Manhattan, presumably for ease of access for reference needs of the various boards. At some point after 1868 the library was moved to the application school at Willets Point at Abbot’s request. Abbot to J. G. Barnard, January 2, 1868, “Official and Personal Letters, June 10, 1867 - April 20, 1870,” Box 9, HLAP.
Willets Point, Intellectual Center

During Reconstruction, New York became the center of the army’s research activities and an intellectual repository of engineering and scientific knowledge largely due to the efforts of Henry Larcom Abbot. Abbot was born in Massachusetts and graduated from West Point in 1854. Immediately assigned to the Topographical Engineers, he gained his first engineering experience in the Pacific Railroad Survey laying out the route between California and Oregon. In 1857, the twenty-five-year-old Abbot was reassigned to the Mississippi Delta Survey under Andrew A. Humphreys, and departed for Louisiana where he was to live, conducting fieldwork and studying the Mississippi, until the outbreak of hostilities at the beginning of the Civil War four years later. Thus began his lifelong association with Humphreys, who would become Chief of Engineers at the end of the war and remain so until 1879. Abbot and Humphreys would be eternally linked by their shared labor on the compendious Report on the Physics and Hydraulics of the Mississippi River (1861), but Abbot’s relationship with Humphreys, who Humphreys took to be a trusted colleague and consulted often on all manner of technical and scientific matters. Abbot therefore retained vast influence over the scientific inflection and pursuits of the state’s engineering apparatus and, playing the role as the most trusted scientific advisor to the head of


72 First published as Humphreys and Abbot, Physics and Hydraulics of the Mississippi River; the subsequent edition, Andrew A. Humphreys and Henry L. Abbot, Report on the Physics and Hydraulics of the Mississippi River; Upon the Protection of the Alluvial Region Against Overflow; and Upon the Deepening of the Mouths: Based Upon Surveys and Investigations Made Under the Acts of Congress Directing the Topographical and Hydrographical Survey of the Delta of the Mississippi River, with Such Investigations as Might Lead to Determine the Most Practicable Plan for Securing It from Inundation, and the Best Mode of Deepening the Channels at the Mouths of the River (Washington, D.C.: Government Printing Office, 1867) is more commonly found in libraries, but omits much of the technical data, including discussion of the evolution of hydraulic theory, included in the 1861 edition. References to the report in this text are to the 1861 Philadelphia edition, unless otherwise noted.
the engineering corps, consolidated the army’s scientific activities around himself at his postwar post at the artillery fort at Willets Point in present-day Queens, on Long Island.

Abbot’s success organizing the fieldwork of the Mississippi Delta Survey was the first step in assuring his place in the intellectual leadership of government engineering. First organized by an act of congress in 1850, Andrew Humphreys, then a captain in the engineers, organized a number of parties to fan out over the vast territory of the Mississippi’s delta to gather information. The parties were given specific purviews: one each to attend to the topography, hydrography, and hydrometry of the region; and were composed of a mix of civilian and military engineers, and academic scientists. Humphreys fell ill in 1851 and was forced to return to Philadelphia to recuperate, and lacking the energy of his personal direction the survey essentially stalled. Humphreys travelled to Europe on a research trip funded by the army to study examples of engineering of river deltas there, and on returning in 1854 was assigned to the same Pacific Railroad Survey as Abbot, likely where he met the younger engineer and came to admire his competence. On regaining control of the slumbering Delta Survey in 1857, and protesting that his time and attention was overtaxed by other duties, Humphreys requested Abbot be put in charge of oversight of the Survey in the field in Louisiana. This sort of delegation seems to be the hallmark of Humphreys’ management style and indicates that he was willing to devote time to developing his subordinates and give them considerable autonomy, and comfort with being detached from day-to-day operations and work of engineering. That Abbot became co-author of the compendious report they issued at the Survey’s conclusion was, according to Humphreys, Abbot’s “great industry, energy, sagacity, and skill in analysis, the fruits of which, to be found in every part of the report,” an indication of how indispensable Abbot had become to Humphreys.

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73 Humphreys and Abbot, Physics and Hydraulics of the Mississippi River, 17–22.
“[P]erusal of the report will convey a more forcible impression of the extent and value of Lieutenant Abbot’s labors,” Humphreys wrote, implying how much of a hand Abbot had in guiding the work while Humphreys was busy in Washington—indeed, how much of the intellectual labor was Abbot’s.\(^74\)

The report itself was a significant piece of scientific work; its physical description of a landscape coupled with theoretical description of the forces that created it and continued to sustain the dynamic system of river and landscape were unparalleled in the literature of the United States at the time. The report begins with a description of the various tributaries that flow into the main trunk of the Mississippi and contribute to the formation of the delta. The Red, Arkansas and White, St. Francis, Missouri, Upper Mississippi, Ohio, and Yazoo Rivers are compartmentalized and assessed in terms of hydraulic contribution and behavior as well as general description of the character of the geography of each watershed.\(^75\) Thus the beginning of the book treats a large section of the territory of the United States with evaluations of soil quality, topography, and botanical description. Assessment of the main branch that forms the delta region incorporates description of the historical leveeing, describes the potential effects of these anthropogenic factors, and treats briefly the tangle of legal and administrative fiefdoms that, often at the scale of a few parishes or counties, create a formidable mosaic of effects on the lower river.\(^76\) Description of the litany of historic, and catastrophic, floods is quickly followed by a launch into the history of hydraulics, mathematical attempts to understand rivers and avert disasters inherent to their temperamental nature. Describing from the seventeenth-century Italian

\(^74\) Humphreys and Abbot, 28. Other sources in the archives depict Humphreys as a rather aloof and distant administrator, especially when projects did not involve the Mississippi. See his extensive delegation to Gillmore, Humphreys to William Belknap, August 24, 1872, Box 22, E71-RG77, NA.

\(^75\) These were the “natural divisions of the Mississippi Basin,” Humphreys and Abbot, 34–89.

\(^76\) Humphreys and Abbot, 151–67.
engineer Torricelli’s parabolic theory of flowing water, through to David Stevenson’s work, Humphreys and Abbot communicate deep familiarity with the succession of European theorists of hydraulics, mentioning in turn Bernoulli, d’Alembert, Bossut, Belidor, Dubat, Prony, Poncelet, and Lombardini. The point of including the long range of more practical construction-minded engineers like Bossut to the theoreticians, like Prony, was to situate their own work as another evolution of the labor of scientific description, an attempt to find a workable formula rather than a pragmatic political solution. Their conclusion, after hundreds of pages of descriptions of alterations to the coefficients and parameters of the hydraulic laws they wished to derive from the expansive data, was that the mouths of the Mississippi were best maintained for shipping by simple dredging.

Humphreys and Abbot’s staid (and it turns out, flawed) theory was to, for better or worse, have impact on federal engineering practice and outlook on water resources well into the twentieth century. For this study, however, it is more important to consider how finishing the project launched Abbot’s career and how years of tedious work in the delta placed him in a position to affect the intellectual structure of the army, and even the infrastructural politics of the Western hemisphere. Though the work would become a piece of theory to which Humphreys clung, perhaps too tightly, at the expense of considering more accurate ideas, Abbot’s

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77 Humphreys and Abbot, 184–200.
78 Humphreys and Abbot, 456.
79 To one historian, the inaccuracies of Humphreys and Abbot’s method led to an overall decline in the prestige and reach of the Corps of Engineers given the spectacular public relations failure engendered by the Eads controversy over the use of jetties at the mouth of the Mississippi River. See Reuss, “Andrew A. Humphreys and the Development of Hydraulic Engineering.”
80 Abbot’s long career and involvement with the controversies over where to locate the canal that would eventually cross Panama are woefully understudied. See Henry L. Abbot, Problems of the Panama Canal: Including Climatology of the Isthmus, Physics and Hydraulics of the River Chagres, Cut at the Continental Divide and Discussion of Plans for the Waterway (New York: Macmillan, 1905).
contemporaries rightly recognized it as significant piece of American science. The mathematician Benjamin Peirce saw fit to write Abbot personally to praise his advancement of hydraulic science, stating “you have opened yourself a mighty harvest of rich investigation to the full development of which a whole life time must be devoted”; the letter’s balance written for the most part in mathematical notation. Charles Eliot, the mathematics and chemistry professor and future president of Harvard College, in thanking Abbot for a copy, noted that he had heard of the report’s warm reception amongst the scientific faculty. Throughout his postwar career, Abbot found himself writing with far-flung correspondents, though he was more reticent about the general applicability of the formulae derived from the study of the great river. Nevertheless in the federal legislature, the report remained a sought-after document for the basis of policy and infrastructural expansion well into the decade after its publication.

The success of the report and the respect it garnered cemented Abbot’s position as an arbiter of questions of hydraulics within the army’s engineering department. Though his official postwar duties consisted mostly of research into ballistics, electronic operation of marine explosives, and torpedoes, Abbot seems to have relished the chance to return to civil work, enthusiastically answering an inquiry on hydraulics and stating “my interest regarding rivers is as

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81 Benjamin Peirce to Abbot, December 29, 1861, Folder 3, Box 8, Henry Larcom Abbot Family Papers, Manuscript Division, Library of Congress, Washington, D.C.

82 Charles W. Eliot to Abbot, January 17, 1862, ibid.

83 In a letter to one of these correspondents, Abbot is careful to state that the report “was not a text book on hydraulics; and being a demonstration of the special problems upon which we were engaged, it was badly arranged for general reference.” Abbot to Hiram Mills, March 31, 1868, “Official and Personal Letters, June 10, 1867 – April 20, 1870,” Box 9, HLAP.

84 Hon. James M. Hanks to Secretary of War, December 11, 1871, Box 16, E71-RG77, NA; Hon. John Beattie to Humphreys, February 28, 1872, Box 17, E71-RG77, NA.
strong as ever.” Humphreys, busy running the entire engineering operation of the U.S. government, took advantage of his former colleague’s eagerness and amenability. After the war, most questions of theoretical hydraulics or materials sent to the corps of engineers passed through Abbot’s hands with Humphreys trusting his colleague to evaluate the content and provide expert assessment, often providing mathematical assistance to inexperienced engineers or those not possessing his own ease with algebraic analysis of fluid flows. Abbot possessed a critical eye and could be cutting; commenting on a manuscript of J. J. Révy’s “Hydraulics of Great Rivers,” Abbot wrote, “It’s most distinguishing feature is vagueness.” Corps publications on hydraulics or scientific papers on their way to publication that touched on the Mississippi went first to Abbot at Willets Point for correction and comment before the final type was set. Members of congress, too, approached Abbot for advice, and the engineer corrected the language of more than one house bill. From this position of power, Abbot used his influence to push for increased and continuous surveying of the Mississippi, and development of some kind of broadly deployed standards. Calling for a “system of registers,” or stream gauges, be they mechanically automated or human-operated, Abbot wished to extend the reach of the work already begun by

85 Abbot to Hiram Mills, June 2, 1868, “Official and Personal Letters, June 10, 1867 – April 20, 1870,” Box 9, HLAP.

86 Abbot to Humphreys, July 11, 1867, ibid; Abbot to G. F. Warren, April 15, 1868, ibid; Abbot to Hiram Mills, June 6, 1868, ibid; Abbot to D. Farrand Henry, March 5, 1869, ibid; Abbot to Senator M. Jeff. Thomson, July 15, 1869, ibid.

87 Abbot to Humphreys, May 25, 1874, Box 52, E71-RG77, NA.

88 Abbot to John G. Parke, February 13, 1875, Box 66, ibid.

89 Abbot to Humphreys, January 24, 1873, Box 30, E71-RG77, NA. This letter concerns markups Abbot made to House Bill 3419, sent to him by Frank Morey, chairman of the committee overseeing the Mississippi levees. Abbot’s remarks included with the bill’s language interestingly touch on finances and land use, specifically which areas the government would be best served concentrating on—issues well beyond hydraulics but indicative of how Abbot saw essential connections to other domains.
the Delta Survey to install a blanket of continuous data collection over the region.\textsuperscript{90} His reasoning was that more and more accurate information would dampen the effects of the already chaotic region by allowing wiser decisions to be made from a viewpoint that may foresee catastrophe before it struck:

> it is only necessary to call to mind the intense interest in the condition of the upper rivers always felt throughout the alluvial region, particularly in the flood season of the year. Upon the exactness of such information depend, the economical use of the steamboats plying upon the main tributaries; the method of construction adopted by levee contractors engaged in repairing extensive breaks in the levees; the efforts of individual planters in putting their own levees in a fit state to resist the annual high water; and, lastly, the works to be undertaken by the levee engineers when, as is usually the case, the funds available are limited, and they are compelled to adopt a judicious economy in their disbursements. In other words, large money interests are always dependent on correct reports….\textsuperscript{91}

When Abbot advocated for design standards derived from a massive data-gathering operation. His experience on the Mississippi, surveying the postwar chaos of decaying levees and conflicting practices, convinced him that the data would be useless without close association with an actual space where practice and execution might be considered in tandem.

Abbot’s foresight in creating a data repository and library conditioned his approach toward transformation of the disused fortress at Willets Point into a school of application and emergent intellectual node in the army’s peacetime infrastructure. At the war’s conclusion, the combat engineering units and all of their equipment were assigned to a fortress and barracks outside New York City on the north shore of Long Island in Queens County. Abbot, assigned command of the engineers at the end of the war and in charge of the construction of Fort Schuyler on Throgs Neck, saw an opportunity to create a school when surveying the abandoned

\textsuperscript{90} Abbot to Humphreys, March 2, 1870, Box 1, E25-RG77, NA.

\textsuperscript{91} Ibid.
medical buildings on the site soon after arriving. In sketching his ideas for the school of application, Abbot explicitly mentioned the European model of post-graduate “application” education, clearly referencing the French state school at Metz. He also stressed the composition of the school as a repository of intellectual human capital in the form of a concentration of the scientific men of the army who are in the business of refining practical application: “practical and practice instruction and have large staffs of professors in the several important branches.”

The army as an institution benefitted at this time as well from a guiding hand that saw the professionalization of the officer corps as benefitting from the increased emphasis on their intellectual output. William Tecumseh Sherman, who had been a college president before the Civil War, sought to impart his “cerebral” approach to military professionalization on the culture of the officer corps. As supreme military commander during Reconstruction under a series of uninterested and ineffective secretaries of war, Sherman fostered the development of the postgraduate school model that created pathways to multiplying, specialized disciplines housed within the army. As West Point ceased to be under direct control of the Corps of Engineers in 1866, and became more of a generalized undergraduate education that prepared cadets for further specialized training before assuming official duties in the army, postgraduate application schools were created across the territory of the United States, taking advantage of local resources to promote the particular school’s mission. Sherman created a cavalry school at Fort Leavenworth in Kansas, and encouraged Abbot’s dream of an engineering school be located at Abbot’s depot of engineering materials at Willets Point. Thus Sherman’s intellectualization of the army had a

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92 Abbot to Richard Delafield, Chief of Engineers, November 28, 1865, “Letters and Telegrams Sent, Civil War and Mississippi Duty, 1862-1867,” HLAP.

93 Abbot to J. G. Barnard, January 2, 1868, “Official and Personal Letters, June 10, 1867 – April 20 1870,” Box 9, HLAP.

94 Weigley, History of the United States Army, 273.
spatial effect, which was to atomize the army’s intellectual center, historically located at West Point, and to distribute it across the United States. Bound together by the intellectual and social connections of the officer corps, the intellectual network was sustained by compulsive sharing of ideas among the officers in an almost competitive nature. This was in turn supported by the existing bureaucratic culture of reports and documentation, and intellectual production quickly found form, distribution, and longevity in the army’s internal publishing and infrastructure dedicated to circulation of printed material. Abbot’s installed a printing press and trained enlisted engineers in lithography and printing, ensuring he had an organ through which to transmit the school’s research and findings.  

But primarily Willets Point, under Abbot’s design, was to serve as a place of human modeling and reproduction of consistent engineering methods through a form of mentorship. Citing the army’s practice of placing graduates in the field under one supervising engineer, and the potential for bad habits to be replicated if the supervisor was inexperienced or lacked skill or talent for engineering, Abbot advocated a centralized place where this form of mentorship could occur under controlled conditions and where competence could be ensured to be transferred. This meant the accumulation of intellectual capital at Willets Point for such periods of time as necessary to transfer the skills and methods to a newer generation.

In addition to managing the engineering troops, Abbot was began using the fortress arsenal to conduct ballistics experiments, and his research activities prompted him to transform the place into an environment more conductive to science. Abbot sought to equip Willets Point with all the various apparatus necessary to make it a center of production of knowledge in the

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95 Abbot to Humphreys, September 26, 1867, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.

96 Abbot to J. G. Barnard, May 3, 1868, ibid.
various branches of military science. This involved renovation of the buildings and landscape to accommodate the accumulated instrumentation necessary, in Abbot’s mind, for such a scientific center. The army had originally conceived as Willets Point as a simple depot for matériel leftover from the war, but under Abbot’s supervision the junkyard of engineering supplies became a place of experiment and investigation and prototype for the military proving grounds of the
twentieth century. Almost immediately upon arrival, Abbot requested funds and equipment be diverted from West Point to set up an observatory at Willets Point, and requested that copies of all government surveys and technical literature also be sent to the post’s “Book Room.” Though appearing haphazard, Abbot’s transformation of the post from fortress into a combination school, laboratory, logistics depot, and celestial survey station reflected an attitude of empiricism in professional activities of soldier-engineers. Primarily this empiricism was exercised through practice of duties, and the form of accumulation of scientific knowledge was shaped by the military’s discipline of the bodies of its members. Formation of soldier-engineers involved human models and then the drilling of neophytes into the form of those more knowledgeable engineers. Skill then was imprinted through repetition and learning through simulation of activity, which in turn was similar in activity to the accumulation of scientific data. “Application” was interpreted as practical experience with men, a technological and labor unit. Abbot’s plan for the school was meant to accommodate this method of education, by providing the full array of tools needed to practice: “All the officers have every opportunity to learn practically the details of service with troops, practicing drills, records, reports, returns, and methods of supply and accounting for property in time the routine of garrison duties of the officers of the line of the army.”

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97 Aside from the arsenal of artillery at the fortress, the variety of equipment that landed at Willets Point covered every conceivable engineering endeavor of a 19th century army, ranging from pontoon boats to sandbags to surveying and construction equipment, concentrating in one place all implements for the execution of any conceivable heavy construction pursuit in the era. For details of types and volume of equipment, see, for example, Craighill to Humphreys, August 28, 1872, Box 24, E71-RG77, NA; Newton to Humphreys, December 10, 1872, ibid.

98 Abbot to Humphreys, July 6, 1867, Box 1, E25-RG77, NA; Abbot to Humphreys, October 24, 1868, ibid. Abbot was less sanguine about the possibility of his post rivaling the French schools: “Unfortunately Metz is quite different in potential for improvement from Willets Point.” Abbot to J. G. Barnard, January 2, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.

99 Abbot to Barnard, January 2, 1868, “Official and Personal Letters, June 10, 1867 – April 20, 1870,” Box 9, HLAP.
supplement the engineering instruction received at the academy, with the emphasis placed on use of enlisted soldiers to confront a variety of problems, not all of them strictly civil engineering.\(^{100}\) Abbot’s requirements for promotion outlined milestones young officers should achieve in administration and discipline, as well as familiarity with instrumentation, mastery of geodetic and hydraulic engineering, and fluency in military theory, notably “Jomini, Dufour, Dupareq”—essentially a deeper delving into the underlying structure of the West Point curriculum they came from.\(^{101}\)

Research into ballistics and hydraulics in the 1870s was marked by similar methods: tabulation of data and extensive practice with manipulating geometry over topographical space. Abbot’s overarching design for the school was to support these two similar spatial practices, where field experimentation was supported by an infrastructure of calculation and tabulation of data. Abbot’s correspondence network served as a net with which he solicited and collected both hydraulic and ballistic data from across the country and world.\(^{102}\) In soliciting scientific publications for the Willets Point library, asked for raw data as well: “any exact measurements in rivers which may professionally come into your hands,” was his request of a Boston engineer and frequent correspondent.\(^{103}\) Again, standardization of data played a role in Abbot’s method. Knowing that the quality of data collection varied across the region, the establishment of the data repository at Willets Point meant that he could exercise some control over the way the data was

\(^{100}\) These other duties included periodic destruction of illegal distilleries in Brooklyn, the suppression of rioting after an election in 1870, and the railroad labor protests in 1877. Henry L. Abbot, “The Corps of Engineers,” December 8, 1893, Letter Press Book B 1893-1895, Box 10, HLAP.

\(^{101}\) Abbot to Barnard, January 2, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.

\(^{102}\) Abbot to C. H. Morgan, January 27, 1870, “Official and Personal Letters, June 10, 1867 – April 20, 1870,” Box 9, HLAP; Abbot to Morgan, February 5, 1870, ibid; William E. Merrill to Humphreys, June 10, 1872, Box 20, E71-RG77, NA.

\(^{103}\) Abbot to Hiram Mills, June 2, 1868, ibid.
interpreted in the service of forming policy. The extensive and well-kept records of the Cairo, Illinois city engineers could be balanced against the amateur, spotty, or sensationalized data that came through the network of individuals or the various regional newspapers that carried river data. Abbot’s repository served even as a background collection service for the more official government surveys. Though Abbot had no official role on the board when the joint civilian-military Mississippi River Commission was formed, all of the commission’s data found its way through the army’s bureaucracy to Abbot.

Abbot’s position overseeing the army’s digestion of all of this river data enabled him to apply standardization of river data in a graphic, diagrammatic form. Though hydraulic engineers had plotted the vagaries of river systems, and especially tidal estuaries, in the form of graphic curves as an established practice, Abbot came to be enamored with this method of data condensation because of its exemplary use in one of the many reports that came across his desk at Willets Point. Admiring Col. Williamson’s report on barometric surveying, Abbot wrote of how the engineer’s “immense labor in computation” was “exhibited very ingeniously to the eye by his diagrams.” Systems in constant fluctuation, Abbot reasoned, were more quickly communicated and disseminated in curves than in tabulated data; the work of the calculation best described by a diagrammatic mode: “The correctness is most ingeniously presented to the eye by the elaborate diagrams illustrative of tables, too long and numerous to be examined by the general reader.” Diagram makes for “unmistakable evidence of a most thorough scientific

104 ARCE 1869, 342.

105 Gouverneur K. Warren to Humphreys, July 23, 1874, Box 55, E71-RG77, NA.
Abbot’s push toward graphic representation for ease of *coup d’oeil* was largely in line with the army’s information policy, originating in the West Point’s engineering curriculum.

Willets Point was well-positioned to take advantage of both the rotating engineering personnel and the army’s permanent concentration of experienced senior engineers in New York. Quincy Gillmore, a decorated general after Civil War service, was in charge of military and engineering operations in the Department of the South but discharged those duties from Fort Tompkins on Staten Island. A walking repository of experience and a distinguished empiricist, Gillmore epitomized the sort of embodied knowledge and towering moral bearing Abbot sought to have in the orbit of Willets Point. Gifted in mathematical ability, Gillmore came from a modest background of farmers in Lorraine County, Ohio, to West Point where he graduated head of his class in 1849 and joined the engineering faculty. After graduation he taught much of the Civil War generation earthworks and practical military engineering. Gillmore’s war service began in the “soft, unctuous mud” of the tidal marshes outside Savannah, Georgia, where in 1862 he supervised the construction of artillery positions in the marshlands to support the Union assault. Severely wounded in fighting in the Virginia tidewater, Gillmore spent his convalescence researching rifling and devised a way to utterly pulverize Confederate defenses of Charleston. Gillmore returned to his research into strength of materials and manufacturing of Portland cement immediately after the war’s end. Experience with “exhausting and unwholesome labors” of swamp work motivated Gillmore’s research into the advantages

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106 Abbot to Humphreys, May 1, 1867, Box 1, E25-RG77, NA.


afforded by concrete’s monolithic construction and advances increasing tensile strength. At Fort Tompkins, Gillmore carried out extensive materials testing and published his results, becoming the army’s unofficial but undisputed expert on concrete. Visiting the works of Coignet in France in 1871, and publishing extensive notes on material properties, architectural potential, methods of manufacture, Gillmore became an early proselytizer of béton aggloméré in the United States. More than technical manuals, Gillmore incorporated notions of geology and geographical ability in his projections for construction of a new construction material industry in the United States, compiling data about the relative strength of limestones from different sections of the country, from which he could extrapolate the relative efficiencies of constructing Hoffman kilns in strategic locations across the United States. The engineer’s practical interests extended to maintenance of urban systems such as roadways and sewers, and his research benefitted from proximity to New York City’s municipal authorities who were in the process of developing their own expertise in construction and maintenance of urban systems. With curiosity and knowledge that extended beyond the parochial boundaries of strictly military concerns, Gillmore’s presence as an engineering eminence contributed to the kind of environment conducive to engineering research and institutional development Abbot was building at Willets Point.

The technical and social life at Willets Point indicates a culture of intellectual activity turned toward maintaining relevance in civilian domains and uninterested in distinct boundaries between ballistics, electricity, and material properties. The range of intellectual activity is shown

\footnote{Gillmore, 37.}

in the diversity of subjects treated by Abbot’s Essayons Club, a regular meeting of army
engineers, and occasional civilian guests, meant to foster exchange of research and venue for
discussion of “professional subjects.” Papers presented in the decade of the club’s existence
covered subjects as diverse as tunnel and suspension bridge construction, theory of batteries,
New York City’s fire alarm system, manufacture of explosives, and photography. Since the
divorce of the Corps of Engineers from supervision of West Point in 1866, and subsequent
waning of primacy of engineering in the curriculum, Abbot’s “organization of a kind of
voluntary club” at Willets Point became both the de facto center of engineering education and
exchange of ideas as well as locus of construction of military engineers’ identity. The
clubbiness was meant to socialize junior engineers into an intellectual community, balancing the
apprentice-like relationship with just one superior engineer that developed out of geographical
isolation in field-work assignments. In the club atmosphere, Abbot and other senior engineers
could cultivate the practitioners of the generation graduating after the Civil War, and impart
upon them values of public service, integrity of construction, and fiduciary duty that was
increasingly incorporated into the corps’ ethos. As the nature of engineering duties expanded
to political battles and navigation of a complex social and political landscape, as well as

111 Abbot to J. G. Barnard, January 2, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.
Press, 1882).
113 Abbot to J. G. Barnard, January 2, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.
114 Abbot to J. G. Barnard, May 3, 1868, Official and Personal Letters, June 10 1867 – April 20, 1870, Box 9, HLAP.
115 Though never explicit, a creeping sense of ethical responsibility underlay decisions of military engineers engaged
in or evaluating the potential of civil works. This is apparent especially because of their visibility and exposure to
suit as agents of the United States, but also out of a growing sense of professional responsibility that paralleled
developments amongst their civilian counterparts See, for example, Abbot to John Parke, April 20, 1870, E25-RG77,
NA, which discusses “great abuses” of unsupervised and cheap construction.
technical competence, the rubric through which potential younger engineers were measured changed. Complexity of the worksite these young engineers would encounter had increased in political dimensions, and management of labor, especially in the South but in all sites of the United States in the 1870s, became questions to grapple with that tested engineers skills more thoroughly than technical problems they might encounter. Evidence of the success of Abbot’s method, from the standpoint of efficiency, is anecdotal. William H. Bixby, one of the first products of Abbot’s school, before it was formalized, earned praise for his “marked good sense,” as “he is very well equipped as to theoretical preparation and it is believed he will exhibit an unusual amount of the savoir-faire in administration,” when he presented himself to Craighill upon assignment to the Cape Fear project in 1884. Perhaps more telling is Craighill’s praise of Bixby as “acceptable to all concerned,” noting the seamless and inoffensive way the trained and finished government engineer might fit into the racially divided but commercially united worksites of the South.\textsuperscript{116}

It was at this time also that Willets Point caused a shift in the center of gravity of what constituted “military” engineering, shifting the focus to control systems, mechanized warfare, and electricity and magnetism that would become electronics. If Bixby represented the social shaping of the military engineer, William Rice King represented the change in the trajectory of research and interests of military engineering. King, who shepherded the Muscle Shoals project through the last half of the 1870s, possessed research interests that lay elsewhere than earthwork. King had graduated from West Point directly into the war in 1863, and spent five postwar years working directly for Humphreys overseeing experiments in torpedoes in Washington, D.C.,

\textsuperscript{116} Craighill to Newton, September 23, 1884, Box 270, E71-RG77, NA.
Figure 3.13. “Lt. Colonel William Rice King, U.S. Engineer Corps. Willets Point Long Island. His famous magnet the largest in the world made of 3 guns and rails.” King is visible at left front. William Rice King Papers, Special Collections and Archives, U.S. Military Academy Library, West Point, New York.

Figure 3.14. King’s magnet in operation. Photographs Division, National Archives, College Park, Maryland.
before assignment to Willets Point. A favored student (on consideration for an assignment, Abbot wrote of him, “nobody could be better”), King would return to command the school at Willets Point on Abbot’s retirement. His published works include treatises on mechanized and electrified city defense systems, his unpublished papers and manuscripts indicate a deep, and almost esoteric fascination with magnetism and the potential of the invisible forces of electricity.

While Willet's Point remained an effective center for exchange of ideas and a catalyst for concentrating and allocating the corps’ dispersed engineering knowledge from its position in New York, trends in research, changing in accord with developments in professional societies of civilian engineers, were moving away and branching outward from origins in the traces of Vauban.

**Landscapes of Experimentation**

Engineering design occurred through a social network that touched on specific topographies. The process of design transformed those landscapes because the engineers practiced design through large-scale experimentation. Information on the success or failure of those landscape-scale experiments was then fed back through institutional channels into a durable institutional record in the form of precedent and forms of practice. The small constellation of nodes in New York where design occurred, opinions were formed, and notions agreed upon formed what Bruno

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118 Abbot to Craighill, January 23, 1870, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.

Latour has termed a “center of calculation”—a sort of origin point where ideas are processed and then affect transformation elsewhere. But in the context of the U.S. Army, especially when acting as an occupying force and given the constraints of communication at the time, it is best to view these nodes of calculation as a sort of distended network. The cluster in New York, as has been discussed in the previous section, was in reality a relatively unstable group of people, military units, repositories, temporary addresses, and instruments. If we wanted to truly locate where the transformative calculations that affected the American landscape during Reconstruction actually occurred, it is best to zoom out and consider the design and feedback loops as they travel out along the countryside, pass through regional command centers, and cut in and reform broad swaths of the landscape in the military departments. The engineers reconciled their general ideas about natural force with the specificities of place by using the material of the landscape. Technical change and the contours of the institution are therefore written in that material.

In this way the slow, methodical form of innovation was made available to be practiced over a wide range of territory. “Innovation” is a difficult word to use in this context as much of the theoretical underpinnings of the work as well as practices of construction, were in fact quite old and established. If we contrast innovation with its close cousin, “invention,” we achieve a clearer picture of the technical and imaginative process at work. Invention indicates a wholly new method or machine; an idea of technical advancement. Innovation is the more difficult process of widespread instantiation of a new technology. Little was invented by the Corps of Corps of.

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121 See Picon, *L’invention de l’ingénieur moderne: L’École des Ponts et Chaussées, 1747-1851*, 363–88. As Picon and others have noted, innovation could never be the product of the actions of one man. Technological change worked through multiple actors, each contributing a component to the process. The importance of the worldwide and regional technical community, especially when it was formalized in a school or an institution, cannot be underestimated.
Engineers or their civilian counterparts in these experiments. Most of the principles and theories at use were at least a century old; the general intuition about the behavior of rivers stretched back to the dawn of engineering. What changed was the perception that the state could achieve the correct balance of scale and commitment of capital to industrialize its harbors on a national scale. This meant coordination of knowledge and resources and evidence to prove that the capital expenditure by the legislature would ultimately be worthwhile. The experimental landscapes of Reconstruction engineering are evidence of the state engineers “choosing their problems” to work on, hydraulic experimentation necessitated a wide reach. State standardization of engineering practice was by no means new, but Reconstruction represented a unique moment for increased territorial expression of engineering power in the United States.

The geography of the United States, in its distance and variety in materiality, shaped the engineers’ process loop, forcing practices to adapt to necessary distention. The landscape itself beckoned the engineers come out of their offices and behold themselves the constant transformation. “Considerable changes are reported as taking place in the channels near the mouth of the Cape Fear river,” wrote Craighill in the spring of 1872, “about which I wish to make personal inquiries on the spot and examinations as far as possible.” Frequent mail service and the army’s bureaucratic culture made it possible for an engineer sitting in main nodes in Washington, D.C. or New York to, with a perusal of the files and maps, gain a fairly

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123 Craighill to Humphreys, April 15, 1872, Box 15, E71-RG77, NA.
comprehensive view of the state of any of the army’s projects, distance not mattering. The circulation of drawings and the practices they told of was efficient enough that even in regional nodes like Baltimore, Craighill could request materials on other experimental structures and have them lent for a period of study. But the institutional norms required a shuttling of all of the engineers, even the most senior, between the board rooms of Washington and New York and the field. The engineers themselves moved through this distended loop, recalled to Washington or New York to provide testimony or make their locally-gained knowledge available. More often than not the field engineers welcomed the chance to return from the social isolation of the field; their superiors happy provide the relief of a recall. Railroads and telegraphy had done much to shorten the perceived distances of the United States, and assisted greatly in the administration of the state. But even this increased mobility could not prevent Craighill from pitying the field engineers living out in the marshlands near the Cape Fear works, calling the lower river a “wretched place.” Still, the structure of the engineering process reinforced the continual revisitation of the site and evaluation of the changing landscape. Contractors were thought to be unable to form “intelligent bids” without firsthand knowledge gained by standing at the river’s edge, and the army’s bidding process required proof of a site visit. Service of practicability implied a process with frequent contact with the ground.

124 “It is presumed that the Engineer in Charge of works of improvement at the above mentioned locality is now in possession of sufficient information derived from personal observation and from newly prepared charts to enable the Board better to comprehend than they could have done when first convened the nature of the sea and tidal action at the mouth of the Cape Fear…..” Tower to Humphreys, October 30, 1872, Box 27, E71-RG77, NA.

125 Craighill to Humphreys, April 3, 1873, Box 33, E71-RG77, NA.

126 Craighill to Wright, December 19, 1881, Box 190, E71-RG77, NA.

127 “Specifications relating to the Extension of the Federal Point Jettee at the New Inlet, near the Mouth of the Cape Fear River, N.C.,” May 22, 1875, Box 72, E71-RG77, NA.
The Cape Fear builders acknowledged experimental stage explicitly, and with more than a little anxiety, as the energy required and possibility of frustration mounted. Craighill wrote in 1873, “the work is now at the point where we are about to enter upon the second stage of its progress, which is more experimental in character than the preceding.”\(^{128}\) Contrasting with laboratory work, experimentation in construction was a struggle with the environment. It was much more difficult to find an effective position with in the matrix of forces with so many uncontrolled contingencies. Experimental practice entailed establishing a “nucleus,” or foothold structure or intervention, around which the general design of the larger project could evolve in the context of forces made clearer by the establishment of the nucleus structure. At Cape Fear, the original jetty between Smith’s and Zeke’s Islands was the nucleus of further development which allowed the project of rebuilding the entire barrier beach to come into focus.\(^{129}\) Successful practices then moved through the bureaucracy and were tried out in other locations. In 1883, Craighill recognized the design for brush jetty foundations being built in Galveston as the design he developed at Cape Fear. Impressed with the work, he noted in a letter to the chief engineer that his successful design and implementation in North Carolina had allowed for establishment of further experimental structures to contest the sea in Texas and South Carolina.\(^{130}\) Though Craighill’s specific design had spread, experimental structures were largely a struggle requiring multiple adjustments to the original “design.” Finding the correct place within the matrix of forces to maximize the effectiveness of a structure while balancing investment and labor effort

\(^{128}\) Craighill to Humphreys, April 16, 1873, Box 34, E71-RG77, NA.

\(^{129}\) Craighill to Humphreys, March 10, 1876, Box 82, E71-RG77, NA.

\(^{130}\) Craighill to Wright, June 12, 1883, Box 235, E71-RG77, NA.
was a delicate balance, and not necessarily easily translatable across different landscapes with their attending differences in forces.

The task of landscape-scale experimentation was made even more difficult by the rather primitive construction methods of the late 19th century, where basic structural integrity constantly remained questionable. Failures generally manifested as an overall lack of tensile strength in the large-scale structures, and a subsequent overall brittleness or tendency to disintegrate that was inherent to the building practices and structures, like levees and jetties, which tended toward slenderness already. Experiments by the engineer corps therefore coupled strategies of reshaping forces with an interest in developing technical knowledge of how to imprint structures with more tensile strength to prevent their crumbling. Engineers experimented with various methods, all involving using plant material as a supplementary structure to the works. Using plants to stabilize earthworks evolved out of a long military tradition, where the use of a tough rhizomatic grass commonly known as “Bermuda grass” (Cynodon dactylon) on the glacis of fortifications was in widespread practice.131 This species, originating from Central Asia and one of modernity’s first true invasive species, was by the nineteenth century used in civilian applications such as stabilizing the sloped sides of levee and canal prisms.132 At Cape Fear the engineers used a combination of light tensile structures in the form of extensive fencing with experiments with native plants. As C. dactylon had been used extensively in New England, and Congress had approved appropriations for its use in shore stabilization in several projects in the nineteenth century, the engineers first began with their tried-and-true material. However, as

131 For a thorough discussion of military efforts to stabilize earthworks, and the use of both living and dead plant material to structure soil, see André Guillerme, “La cervelle de la terre: la mécanique des sols et les fondations d’ouvrage de 1750 à 1830,” History and Technology 7, no. 3–4 (1991): 211–54.

132 Abbot to Humphreys, January 31, 1868, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.
the work progressed and the *C. dactylon* proved inadequate to the forces against it, the engineers turned to the cordgrasses already lining the marshlands around the works. Henry Nutt found one species fit the properties they were looking for and described both its botanical and structural features:

> a stout, rigid, cane-like culm rising three to five feet above ground, long, flat leaves, and spreading panicle, putting out strong, lateral roots from every joint as soon as the sand reaches it; in the meantime the culm is pushed upward, and is consequently always out of the way of an extraordinary drift of sand.\(^{133}\)

“Carolina Beach Grass,” likely a variety of *Spartina* from the description, was transplanted and encouraged to grow amongst the existing dunes and those that accumulated along the government works. However, the displacement of sea oat plant communities, acknowledged as the true native dune-stabilization plant, by the grasses planted by the engineers, can be seen in the landscape today.\(^{134}\)

Structures in the Southern environments were also beset by a variety of biological forces which made maintaining integrity an ongoing process. The engineers on the Cape Fear River used wooden crib structures for submerged construction. Essentially timber boxes, varying in dimension from thirty to forty feet lengthwise and twenty feet across, the cribs were filled with stone, concrete, and debris through their open top end and sunk in place on the sea floor. An accumulation of cribs then provided necessary underwater structure allowing the engineers to build above the surface at high tide. Cribs were standard design elements and in use by the federal engineers from New England to the Gulf Coast to the Great Lakes. However, the

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emergence of the *teredo*, an infestation of wood-eating sea worms that menaced the warmer waters of the Atlantic and Caribbean at the time, made working in this manner precarious and was the cause of great anxiety amongst the builders.\textsuperscript{135} Fear of the worm caused frantic action: in 1873, the engineers at Cape Fear, anxious that a protective layer of sand was not accumulating fast enough to protect the cribs from the worm, frantically placed over 30,000 sandbags to protect the underwater structure until the action of the tides could cover it.\textsuperscript{136} The worms


\textsuperscript{136} ARCE 1873, 790.
eventually forced the engineers to abandon crib structures entirely and adopt Craighill’s design for woven mattresses covered in stone. Lacking exposed sides, the ribbon of woven brush along the sea floor could be quickly covered by stone and accumulating sand, and still provide the flexible structural element that bound the structure together and prevented individual components from sinking into the mud.  

These experiments in developing flexibility in structure found analogy in the corps’ development of a flexibility in their design doctrine. In these landscapes nature forced the army engineers to have loose governing principles, and accept an elastic provisionality in their work. Design became a project of correctly inhabiting the prevailing forces of the place. Designers then always primarily looked to accept whatever forces nature was willing to provide.

To Make the Sea do the Work

By the fall of 1874, shipping traffic had switched to the original mouth of the river at Baldhead Channel and few ships ventured through the New Inlet. As the flow of traffic changed, the engineers increased their goals to reshaping the coastline to close the New Inlet for good. At the beginning of the working season of 1875, Craighill issued specifications for a jetty to extend westward from Federal Point into the Cape Fear River, reaching a few hundred yards into the current before tacking southwestward with the current to form a deflecting shield around New Inlet; its object to massage the river into a desired shape and prevent the river from encouraging the inlet to stay open. In the fall of that year, Eli Bangs and Moses Dolby, northern contractors who won the bid, worked “energetically and successfully” to connect Federal Point with Zeke’s Island, building a submerged “apron” from the end of the Federal Point Jetty the 4000 feet across

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137 Phillips to Craighill, June 24, 1875, Box 74, E71-RG77, NA.
the inlet to the smaller island. This construction and the dredging of nearby Horseshoe Shoal were meant not only to be done in conjunction to save labor but were meant to aid each other through the realignment of forces in the estuary. New Inlet had contracted significantly, but not entirely closed. But the engineers were hopeful that, given these new works, it would either become so substantially diminished as to be insignificant, or slowly close up in entirety.\textsuperscript{138}

As the shipping lanes changed, Henry Bacon, a civilian civil engineer, took over supervision of the project as Phillips was reassigned elsewhere. Bacon’s reports indicate that he took a comprehensive view of the estuary and saw the potential of directing the project to manipulate the river in a more holistic way than his predecessor. In his 1875 report, Bacon noted he had been studying the effects of the works, the narrowing New Inlet, and the volumes of water trapped behind the works, on the tides. He believed, though he acknowledged that it required more study, that the complete closure of the barrier beach, and rationalization of all of the islands into one, regular landform, would greatly increase the “reservoir” capacity of the estuary, and therefore increase its scouring power.\textsuperscript{139} Assuming charge of the apron construction, Bacon modified the process of construction so as to limit any further deepening of the already existing channels. Cribs, already at disadvantage because of the teredo, were done away with entirely, as construction using them caused deep scouring along the leading edge of works as they reached seaward. Bacon’s eventual design for the apron conceived of the jetty as a slow accumulation of stable structure rising indomitably from the sea floor.\textsuperscript{140} Thus the specific

\textsuperscript{138} Craighill to Humphreys, October 8, 1874, Box 58, E71-RG77, NA; “Specifications relating to the Extension of the Federal Point Jettee at the New Inlet, near the mouth of the Cape Fear River, N.C.” May 22, 1875, Box 72, E71-RG77, NA; \textit{ARCE 1876}, 308.

\textsuperscript{139} Ibid, 316-317.

\textsuperscript{140} Craighill to Humphreys, March 10, 1876, Box 82, E71-RG77, NA.
Figure 3.16. Detail of untitled sketch of Federal Point and Carolina Shoals, ca. 1880, National Archives, Atlanta, Georgia.

Figure 3.17. Henry Bacon’s Diagram of simultaneous Tidal observations, Cape Fear River, N.C. June 21, 1876, Annual Report of the Chief of Engineers, 1877, 316.
components of a structure, as well as sequence of construction, were informed by a broad view of the environment in which they were to be constructed.

Bacon’s conception of the design environment, shared with his military colleagues, as a precarious balance of forces posed the question of design as one of negotiating a near-impossible tangle of contingencies, where a misstep could lead to cascading failures. In their reports, the engineers struggled to convey to Washington the delicate balance and close management the estuary required. Craighill, in describing progress in 1876, relayed the multiple simultaneous and mutually-supporting works undertaken to achieve the grand object of the job, and that “the suspension of either of these works is dangerous not only to itself but the stability of the other.”141 In the matrix of pressures and structures at work in the estuary, relief in one place could be found as troublesome pressure in another; failure at one point in the landscape, not necessarily even in the engineered structure, would put the entire work in danger.142

But that same conceptualization allowed for invitation of and manipulation of forces incommensurable with the apparent scale of the structures involved. Bacon, in particular, was able to describe the large-scale inhabitation of the forces to achieve the object of design when he wrote Craighill in 1881 that “[m]y study has been to make the sea do the work.”143 The engineers’ attitude played well rhetorically to the businessmen of Wilmington, who saw riding with the forces of nature as legitimating the expenditure of treasure and energy. “The progress of the work is steady,” wrote Henry Nutt, “and from the gradual formation of sand beach on the outside, almost keeping pace with the work itself, that Nature is doing her part fully in securing

141 Ibid.
142 Craighill to Humphreys, August 31, 1876, Box 87, E71-RG77, NA.
143 Henry Bacon to Craighill, August 1, 1881, Box 182, E71-RG77, NA.
the structure, and this fact assures us of the permanency of the work.” In casting the historical alignment of forces as creating a “long lost harbor,” and the silting up of New Inlet, as “Nature seems disposed to close it anyhow,” Nutt similarly legitimated the object of the design.\footnote{Chamber of Commerce, Wilmington, N.C., \textit{Wilmington, North Carolina, Past, Present and Future.}, 24, 49–50.}

As the project became a large effort supplemented by many small adjustments toward an abstract object, the form of the project reflected the accumulative nature of this process. The main thrust of the deflector jetties being worked by contractors, Craighill employed smaller crews who sounded the sides of the structure and built barnacle-like spurs off of the main trunk to locally stay any potential scour or disintegration.\footnote{Craighill to Humphreys, December 19, 1876, Box 90, E71-RG77, NA.} Material availability, and the constraints of weather and season, contributed to an overall bricolage form, one that emerged from the process of construction. “[T]he Engineer in charge does not confine himself to this particular plan,” Bacon wrote in the specification calling for stone, “and will require the stone to be distributed over the work at such points in such proportions, and with such slopes and widths, as shall seem to him to be proper at the time of delivery.”\footnote{“Specifications Relating to the Farther Prosecution of the Work for the Closure of New Inlet, near the Mouth of the Cape Fear River, N.C. Including the Delivery of Stone to be Used on Said Work,” July 20, 1878, Box 112, E71-RG77, NA; Craighill to Wright, October 16, 1879, Box 132, E71-RG77, NA.}

Though unconfined by a definitive design, the jetties and accumulating sand came to be referred to as a dam. The change in terminology reflected Bacon’s conceptual consolidation of the project as unification of the lower Cape Fear into one basin that greatly increased the concentration of hydraulic power against the sandbar at Baldhead.\footnote{ARCE 1877, 336.} By the summer of 1878 the work extended entirely across the inlet and varying in width from forty to seventy feet. The next working season Bacon estimated that 40,000 cubic yards of material had been laid down, and to
raise the half-mile long structure above the high tide, another 50,000 was needed. At the cost of $1,067,500, the government had unified the barrier beach for the first time in a century. In his report at the end of the decade of work, Bacon compared the state of the estuary to the report of a British captain of the *HMS Fury*, which came into the Cape Fear in 1769. Zeke’s Island, concluded Bacon, was no longer an island but might be more aptly referred to as “Zeke’s Point,” and that the beach, which he called “Carolina Shoals,” has extended from Smith’s Island to the mainland. “The final result of the dam,” he wrote, “may be the conversion of the bay into a sound.” Bacon’s understated reporting of the entire recategorization of a geographic feature is telling. He also pointed out that the natural action of the waves is better at building the beaches than any “expensive artificial work,” and that the dunes and supporting vegetation are building up satisfactorily as well. The following summer, Bacon noted with equal satisfaction that the current entrance to the river conformed exactly to the original outlet that the *Fury* entered a century before.

“The Cape Fear River has but one mouth properly speaking,” wrote a triumphant Bacon to Craighill in 1879. Both the structure and Bacon’s conceptualization in his reports of the estuary as a sound, integrating the estuary hydraulically, began to have reverberations through the United States’ scientific and shipping communities. Craighill reported to Washington on the substantial completion of the project, stating that “anyone may now walk dry-shod from Federal Point to Zeke’s Island,” the site having been a busy shipping channel just a few years

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148 *ARCE 1879*, 558; “Specifications Relating to the Farther Prosecution of the Work for the Closure of the New Inlet, near the Mouth of the Cape Fear River, N.C. Including the Delivery of Stone to be Used on Said Work,” July 20, 1878, Box 112, E71-RG77, NA; *ARCE 1879*, 561.

149 *ARCE 1880*, 700.

150 *ARCE 1881*, 925.

151 Bacon to Craighill, May 9, 1879, Box 124, E71-RG77, NA.
previously.\textsuperscript{152} That same summer the army notified the Coast and Geodetic Survey that they would need to modify their charts to reflect the change in the environment.\textsuperscript{153} New York ship brokers, having heard of the drastic changes to the river’s mouth, made inquiries with the federal government, looking to recalibrate the shipping routes as the Cape Fear River could now accommodate larger vessels.\textsuperscript{154} Wilmington’s Chamber of Commerce, on recognition of “so decided an improvement” in their shipping channel, lost no time in agitating for further deepening and the U.S. government’s assumption of responsibility of maintaining deep water up to the Wilmington city docks.\textsuperscript{155} Wilmington’s elite sensed that something drastic had happened, and sought to capitalize on the unique achievements in their estuary. “This work being of a National character and producing beneficial results,” wrote the mayor of Wilmington, “it cannot be doubted that Congress will further appropriate such amounts as may be required…” to take the project a further step in ambition.\textsuperscript{156} The U.S. engineers, however, remained “less sanguine,” knowing both the cost in effort and how ultimately precarious was the arrangement they had brought river and beach into—likely, in their experience, to be temporary.\textsuperscript{157}

\textsuperscript{152} Craighill to Acting Chief of Engineers, June 20, 1879, Box 127, E71-RG77, NA.

\textsuperscript{153} C. P. Patterson, Superintendent of the U.S. Coast and Geodetic Survey, to Wright, June 27, 1879, Box 127, E71-RG77, NA.

\textsuperscript{154} C. P. Patterson to Craighill, June 11, 1880, Box 147, E71-RG77, NA.

\textsuperscript{155} Ibid; Craighill to Wright, April 28, 1880, Box 144, E71-RG77, NA.

\textsuperscript{156} A. H. van Bokkelen to Executive Council of the Wilmington Chamber of Commerce, March 10, 1880, Box 142, E71-RG77, NA.

\textsuperscript{157} Craighill to Wright, March 29, 1880, Box 142, E71-RG77, NA. For the decade after the “dry-shod” moment in 1879, the engineers would remain busy plugging holes in the beach as they developed with “inexpensive work of round piling, sheet piling, sand bags and timber.” Bacon, whose correspondence after 1880 could be mistaken for that of a man fighting a war, developed a rhetoric of “lines of defense” running at increasing depths in the barrier beach, so determined he was to hold the sand formation that they had brought into existence. Craighill and Bixby, “Improvement of the Cape Fear River”; Bacon to Craighill, August 18, 1881, Box 183, E71-RG77, NA; \textit{ARCE 1882}, 939.
What had begun as a channel protection had become a different type of hydraulic project. What emerged was a collaboration between the engineers and the Cape Fear itself. Incremental, filled with struggle, and obscure in easy assignation of origin of its form, and absent a consistent guiding principle from beginning to end, this inaugural project of engineering at environmental scale defies a typical analysis of causality in a history of design. While it is true that the forces of nature changed the response of the engineers in technical matters, the evolving interaction of technology and brute force work, on the part of both the river and the laborers, in turn continuously bent the political economy of the environment and belief in the project’s success. While a range of social factors determined support or resistance to the project, the river, including its biotic communities, provided the shifting substrate upon which a flexible alliances of engineering knowledge and social and political will could be assembled. Rebuilding the estuary was a technical accomplishment. However, rebuilding the estuary in the context of a politics dependent on divining “what nature wants,” or what she would “support,” was a skill of a different character.

**Conclusion: Design between Doctrine and Process**

The best means of understanding the military engineer’s approach to the engineering and environmental design in the 19th century is to look at his language. The language of the design documents, pervasive even in mundane reports, is that design occurred as a present tense process. The engineers projected forms and objectives into a future of a short horizon. The verb “to project” was used itself by the engineers to connote different activities, and have different shades of meaning. At some points it referred to the casting of plans or geometries onto a landscape. Its other meaning is the undertaking of a project, connoting the undertaking of a plethora of
consuming details and necessarily entailing the process of construction. But these “future” projections lacked a sense of finality or completeness. In analysis of the documents produced during design and construction, the engineers focused on a loose order of procedures to guide action they described to themselves in the present tense as “problems” were encountered and the reach of the project formed slowly in front of them in time.\(^{158}\) The lack of a rigid, long-term plan meant that the feedback from the environment had a more powerful effect on the project outcomes and specific design decisions, and that any visionary planning was subordinated to what historians have referred to as a “second-order cybernetics” that constituted the design process.\(^{159}\)

Design was a continuous process of constructing typologies of engineering structures and then relating those types to emerging knowledge of typologies of landscapes, such as river estuaries, in turn housed in the larger realm of “nature.” The engineered structures themselves were instances that represented milestones in the construction of effective engineering practice, and the fact that they too were in continual adjustment from conception through “completion” and well into service meant that they continued to be valuable sources of data. Seen as an intellectual and material process in which nature is an essential partner, we come to see engineering in a light that resists the typical narratives of design and construction as the imposition of human will. The reality was far more complex. If we, for a moment, set aside notions of domination of nature, analysis of the historical record instead opens other avenues of interpretation. Engineers saw their job as seeking ways of inhabiting forces present in a

\(^{158}\) Craighill to John Newton, December 18, 1885, Box 301, E71-RG77. Focus on “order of procedures” is mostly raised in the context of engineers’ griping about varying funding year-to-year from Congress, making the intricate sequence of operations more subject to failure from inconsistent funding.

landscape, occupying those process, and developing forms of knowledge in order to gain access to those processes.

In turn, it is important to note that the engineers did not ignore the less material forces present at the site. The watchword practicability connoted an agreed-upon concern, one that rivaled structural feasibility, with the limits of the driving political economy. Commodities, and a sense of their flow did more to increase the spatial ambitions of the U.S. Government than notions of political or military hegemony over Southern spaces. It was capitalism that pushed the government to send out its military engineers to uncover the imperial *limes* slumbering under Southern foliage—not fully formed but known to be present and waiting for animating inhabitation.

In this process we find one of the origins of a governmentality of natural force; one that sweeps up landscapes and biotic communities.¹⁶⁰ I distinguish this as its own category of governmentality, as it impacts surrounding social structures and economic activity secondarily. The outlines of the ways in which the government exercised control over natural forces, however, are not easily distinguished. This is a result of an engineering ontology that is necessarily blurry—in the context of the Reconstruction South, or even the mid-nineteenth century in general, there is no clear *res cogitans* behind the operations of the engineer corps, and no clear schema that found easy imprint on the natural world. The engineers employed mathematics (geometry, for the most part) that was not a sort of “social construction” or abstract representation of force, but instead as a kind of cogitation. In the case of the Cape Fear, geometric manipulation of the river translated the river into a material instance of a vector, eventually making it a dominant and somewhat predictable force in the preexisting matrix.

Chapter 4

Muscle Shoals: Labor and Landscape

Labor has always been a defining parameter for engineering projects at landscape scale; in the Reconstruction Era, labor underwent a definitional transformation. Some four millions of formerly-enslaved people stood as a question of how to legally, technically, and culturally define the work of human muscle in the postwar context. The effort to transition to a free labor political economy—at least nominally—destabilized almost all of the relationships present on the prewar jobsite. Many of these relationships—between engineer and mechanic, worker and foreman, worker and material limits of his work—would largely be reconstructed in a similar image, albeit with changes, some more obscure than others. The cumulative effect of these millions of changes produced a new work environment. The historian Thomas Andrews has termed the “workscape” as the venue for realignments between social and natural realms that occurs in the places of work. ¹ For this study, I wish to keep Andrews’ notion in mind, but retain the more commonly-used term “jobsite.” Changes in work culture similarly put pressure on the engineers and forced changes in design priorities. Thus the jobsite is the place where social priorities of engineers become clear, and the common project of engineering, as it barrels forward, shows the strains of both the old and new systems.

The limits of the human body were well-known and acknowledged factors in the limits of an engineer’s ambitions.² But in the environment of the ebullient rhetoric of the postwar era, and the moral victory of free labor, the old pragmatic limits seemed not to hold as much power to


² Quincy A. Gillmore, A Practical Treatise on Roads, Streets, and Pavements (New York: Van Nostrand, 1876), 37.
temper outsize enthusiasms. Transformation of the entire South into an free labor jobsite was seen as solving both the problem of economic reinvigoration in no small part by pumping wages into the workingman’s pocket. Congress, especially under Redeemer control, was particularly interested in the army’s involvement, even though combat troops had been withdrawn and Reconstruction officially over. The chief of engineers in 1878 outlined how the corps could be instrumental in the spread of relief over the landscape of the working class:

Congress has shown its interest in the material development of the resources of the country, and especially in reviving trade and relieving the working class, by liberal appropriations for river and harbor improvements.3

In seeking to provide relief and stability from the economic downturn of 1878-9, the federal government turned to its most efficacious method of direct social engineering: the manipulation of labor through the manipulation of large swaths of its territory.

However, focusing on labor as a lever of policy would be to consider only a small gain in economic efficiency as opposed to understanding how attention paid to labor transformed in some cases overtly, in others, subtly, the practice of engineering and the relationship of the limits of engineering to the natural world. Class and racial divisions made engineers confront a fraught and complex problem beyond economic priorities or material limits. Though the remoteness of their projects tended to flatten class distinctions amongst all on the jobsite, racial divisions surfaced, were dealt with, and reemerged elsewhere over the course of the work. The engineers displayed the political prerogatives of the state in imposing the army’s labor policy as an extension of the federal free labor policy, and even extending their own moral righteousness into issues that arose on the jobsite. In the eventual transition from a contract system to a system of hired labor, there was a moral transformation born of frustrations with encroaching attempts to

resist any sort of progress on behalf of the freedman worker. This progress was in turn accompanied by a widespread restoration of paternalist attitude toward black workers, in many ways indistinguishable from conditions before the war.

These changes in the jobsite in turn made engineers reconsider their notion of work and how manipulation of the natural world could be achieved beyond the brute force marshaling of human powers. This new knowledge was generated from the new labor environment, where work in nature produced knowledge of the relative fragility of human-scale structures in the face of the landscape. Engineers sensed the natural world through the thousands and millions of shovel cuts and wagon loads moved on the earth’s surface. The contingencies of both labor and nature forced the engineers to develop a managerial skill and ethos through which they guided the successful resolution of their design. This trajectory required more control over more people and things, the thickening of skills which embedded the engineering operation even further into the landscape.

**Muscle Shoals**

In the late summer of 1867, General Godfrey Weitzel received notice that Congress had allotted $85,000 to improve the Tennessee River from Chattanooga to its meeting point with the Mississippi. Weitzel, an engineer of some distinction and classmate of Cyrus Comstock at West Point, was at that point supervising the construction of a ship canal around the Falls of the Ohio River. From his office in Louisville he ordered surveys and planned contracts for improvement of the river bed to allow passage over and around the numerous rapids that appeared as the river descended through the Alabama highlands from Chattanooga to Decatur. Over the winter Weitzel signed contracts for work to begin blasting and forming a ship channel at Ross’s Tow
Figure 4.1. Perspective drawing of the “Suck” obstruction on the Tennessee River, ca. 1867. T-126-3, Cartographic Division, National Archives, College Park, Maryland.

Figure 4.2. Plan of the “Pot” obstruction, Tennessee River, ca. 1867. Note the indication of strong eddies. T-146, Cartographic Division, National Archives, College Park, Maryland.
Head, Burrough’s Bar, Tumbling Shoals, Kelley’s Shoals, and Gunter’s Bar, assigning the work to contractors who would improve the river around their assigned obstruction. Over the winter Weitzel personally visited two roiling spots in the river near Chattanooga, named “the Suck” and “Boiling Pot,” noting that the low level of the river allowed him to see more of the river’s rocky bed and the challenges posed in blasting out channels deep enough for vessels of larger draft. These smaller shoals and rapids however were extraneous to what emerged from the survey as the main obstruction to linking the upper and lower Tennessee to navigation. The main block was extensive shoaling near the small city of Florence, Alabama, where a failed canal had been built a generation previous but sat disused and overgrown. Taking a cue from the freshwater shellfish that grew on the limestone outcroppings in the shallow river, locals called the place Muscle Shoals.4

The obstruction below Florence had been the site of previous attempts to force navigation to the upper river, but its size and difficulty had gained the area a regional notoriety. Army engineers had made attempts to improve the river, one expedition led by Col. Stephen Long in 1832, and another by Col. John McClellan in 1856.5 Both interventions consisted for the most part of small wing dams off the river’s banks to “pile the water up” in a navigable channel. Neither scheme had worked well and evidence of any work was difficult to find after decades of

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4 House, Report of the Secretary of War, 41st Cong., 2d sess., Ex. Doc. 1, pt. 2, vol. 2 (hereafter cited as ARCE 1869), 278-280; Godfrey Weitzel to Andrew A. Humphreys, Chief of Engineers, August 29, 1867; Weitzel to Humphreys, September 20, 1867; Weitzel to Humphreys, October 23, 1867, Box 34, Letters Received 1865-1870, Entry 25, Correspondence of the Office Divisions, 1865-70, Correspondence, 1869-1870, Records of the Office of the Chief of Engineers, Record Group 77, National Archives Building, Washington, D.C. (hereafter cited as E25-RG77, NA).

5 Long was a towering figure in the early history of the army’s Topographical Corps and had extensive experience with early railroads. See Goetzmann, Army Exploration in the American West; McClellan suffered an unhappier fate, dying while in the midst of his duties on the Tennessee in Knoxville. Cullum, Biographical Register, 1:367.
lack of maintenance. A small canal had been built around part of Muscle Shoals, funded by the internal improvements Congress of 1828 and begun construction in 1831. The original plan had called for damming the river to create three pools, one at Brown’s Ferry, one below Elk River Shoals, and one below Campbell’s ferry. A canal dug on the northern shore of the river then connected the pools. To fund the project Congress authorized the sale of 400,000 acres of federally-held public land in Alabama and placed the state government in charge of the work with the only stipulation that the canal begin in Florence and proceed upriver as far as the money allowed. Funds lasted only one section, and in 1838 the state engineer, Thomas Williams, noted that boats that successfully navigated the canal often got stuck at the Little Muscle Shoals or Elk River Shoals at either end. Congress proved unwilling to finance a larger project and the financial crisis of 1837 essentially forced abandonment of the canal altogether. “The lock-gates rotted and fell to pieces,” wrote Major Walter McFarland,

leaks occurred, the dams across the creeks became broken and disintegrated, quantities of sediment washed into the bed of the canal, and now, over forty years since the work was begun, tow-paths, banks, and bed alike of this great work, which cost the country nearly $700,000, are overgrown with trees and heavy masses of shrubbery, while glimpses of the fine masonry of its seventeen locks are to be caught here and there through the occasional openings of the dense growth which envelops them. McFarland concluded that reopening navigation required a redesign of the canal that loosely used the outlines of the old, but in terms of labor, was essentially beginning anew.

“The canal is now in a ruined condition,” read the specifications for the work, and accumulation of political and financial capital had to contend with the enormous and labor-

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6 House, Report of the Secretary of War, 42nd Cong. 2d sess., Ex. Doc. 1, Pt. 2, vol. 2 (hereafter ARCE 1871), 502; Weitzel to Humphreys, Feb 16, 1871, Box 26, Letters Received 1871-1886, Entry 71, Correspondence of the River and Harbor Division, Records of the Office of the Chief of Engineers, Record Group 77, National Archives Building, Washington, D.C (hereafter cited as E71-RG77, NA).

intensive task it had become. A full scope was difficult to determine; even years into the work contractors discovered full (but ruined) navigation locks hidden in the forest that the surveyors had somehow missed. Horace Maynard, the Tennessee unionist congressman who penned the legislation naming Muscle Shoals for funding, framed the project as a “great historic work,” worthy of completion. However, interest in these Southern routes stemmed from enthusiasm for economic development, an enthusiasm that built to a head as the engineers approached the problem in 1871. "The Tennessee itself is a broad, deep, and beautiful stream," wrote McFarland after the initial survey, “with more water than the Ohio, and with a permanent bed…with little or no sand or gravel,” making it superior to other western rivers, whose muddy bottoms meant taming them was more energy intensive. As Congress focused on transportation routes in the South, projects like the Tennessee River, tried and abandoned in the past, emerged as priorities as if federal funding and army expertise could overcome the problems that impeded progress of the states. Enthusiasm carried through even if it meant saddling the federal government with dysfunctional projects.

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8 “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” September 28, 1875, Box 78, E71-RG77, NA.

9 William R. King to Humphreys, August 23, 1876, Box 86, E71-RG77, NA.

10 Walter McFarland to Humphreys, July 1, 1872, Box 21, E71-RG77, NA.

11 This enthusiasm can be measured by a proliferation of surveys assigned to the Corps of Engineers, seeking routes through this landscape. In 1871 alone Congress called for survey of the Tennessee, Warrior and Coosa Rivers in Alabama, and the Cumberland in Tennessee, and several routes for connecting canals in between. Congressmen pushed their pet projects with assistance of the army’s data. McFarland to Humphreys, April 8, 1871, Box 5; E. J. Holladay to Humphreys, Feb 28, 1872, Box 17; House Resolution, March 11, 1872, ibid.; W. C. Whithorne to Humphreys, April 9, 1872, Box 18; E71-RG77, NA.

12 ARCE 1872, 497.

13 A similar encumbrance that fell to the U.S. by default occurred at the Falls of the Ohio Canal where Weitzel was working before Muscle Shoals. The canal had been built before 1840 with both public and private investment and the state had amended the company’s charter to allow it to use revenues from tolls to purchase outstanding privately-held shares of stock. This was done in the interest of reducing the amount of revenue paid in dividends to private
local people along the Tennessee meant the entire project was expedited, even if there were also lingering questions about if the United States even owned the land it proposed to build on.\textsuperscript{14} The political divisions within the federal legislature had melted away when it came to “internal improvements” which the local newspaper had noted Democratic politicians had “set their face like flint against” in the antebellum years. It seems that if anything, the vision of “what a grand river the Tennessee will be, when navigation is unobstructed from its mouth... to its head waters,” could assemble political will by appealing to both ideologies.\textsuperscript{15}

The Reconstruction canal work was essentially a redesign and expansion; though the route followed essentially the same lines as the 1830s design and differed little conceptually, the increase of certain dimensions drastically enlarged how labor-intensive the project was. Design work began as the surveys were completed in June 1871, and McFarland submitted the final drawings in the spring of 1872. His design called for a canal one hundred feet wide at the surface with enough capacity to keep six feet of water over the mitre sills at each of the locks. The dimensional increase of almost forty percent over the 1830s design meant significantly more excavation work and construction of levee walls where the river bank narrowed below the limestone cliffs. McFarland estimated the total cost of construction at $3,676,000. Its final cost would exceed $8,746,638 and be substantially complete twenty years later.\textsuperscript{16} The U.S.

interests and eventually to make the canal free of tolls. Purchase of all outstanding stock was completed in 1855, and the U.S. government, being the remaining majority public stockholder, authorized the canal company to use revenue from tolls toward expansion, with a specific provision that they could not leverage the faith and credit of the U.S. to raise money. Eventually the canal went bankrupt while attempting expansion and the U.S. assumed control of the project, whose revenues essentially covered the debt service on the loans taken out for expansion. The situation essentially forced the U.S. to make a large investment to continue to keep the canal functional. \textit{ARCE} 1869, 278.

\textsuperscript{14} The engineers reported that it was general knowledge that the U.S. had deeded the river’s bottomland to the state for sale, but could find no actual paper evidence. McFarland to Humphreys, July 1, 1872, E71-RG77, NA.

\textsuperscript{15} Lauderdale County (AL) \textit{Times}, July 30, 1872.

Figure 4.3. Map of the Tennessee River and Muscle Shoals Canal, 1872.

Figure 4.4. Partial Map of Muscle Shoals Canal, showing the Head to Section 1, 1879, National Archives, Atlanta, Georgia. Sections of the old canal route had to be redesigned to accommodate the larger design parameters, disrupting the old line.
government financed the construction wholly through appropriation, apportioning on average ten percent of the estimated cost per year and requiring, at first, that all work be done under contract. Contractors and their crews had begun by clearing debris from the river bed and making what efforts they could outside of the canal project, and in 1875 began the canal work in earnest. Over the course of the project, laborers worked over the strip of landscape, preparing the ground to receive the canal and its attendant infrastructure. The foundation work often exceeded the actual digging, as contractors were required to dam any streams that crossed the canal’s line far uphill, divert runoff and freshets from flooding the worksite, and erecting coffer dams within the stream to protect workers as they built foundations. The locks themselves were substantial masonry structures, being sixty feet wide, three hundred feet in length between mitre sills and chamber walls that varied in height but were at least thirteen feet tall. Workers had to demolish any remnants of the old locks and excavate pits for the new down to the limestone substratum and perhaps even blast some of the riverbed if it proved too faulty to handle the load. The undertaking required the assembly and management of a workforce that numbered in the thousands.

The Muscle Shoals worksite became a microcosm of the larger picture of work during Reconstruction. Its stratification by both race and class reflected recognizable patterns of labor and race relations throughout the rest of the U.S. South of the era. Muscle Shoals became the site of a familiar drama, the parts defined, and the setting could be in Texas or Georgia. White political and economic elites act as the prime movers of the project, their objectives economic and driven by ideological fixation on what C. Vann Woodward characterized as “New-South

\footnote{ARCE 1872, 478; McFarland to Humphreys, September 28, 1875, Box 76, E71-RG77, NA; Weitzel to Humphreys August 27, 1870, Box 41, E25-RG77, NA; “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” September 28, 1875, Box 78, E71-RG77, NA; “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” February 7, 1876, Box 82, E71-G77, NA.}
romanticism…the impulse toward industrialism, recantation, and speculation.”\textsuperscript{18} The chorus: a mass of Black workers whose heterogeneous ambitions and desires are masked by the historical obscurity of those whose lot is toil. The white engineers acted in an ambiguous and intermediary role, serving the elites yet tending their own priorities. The lasting legacy of projects like these was to define the place of the emancipated slave in the system of labor in the New South, which in turn would “vitally condition” the status of white workers and manual labor in general.\textsuperscript{19} Class struggle during Reconstruction was further split along racial lines, where white and black laborers emerged as two divided and competing factions. However, government projects themselves were sites of resistance to the relentless division wrought by free market ideology and the contract system, which individuated classes of labor along skill and racial lines. Even in Radical Reconstruction, the federal government had difficulty spreading economic justice across racial divisions.\textsuperscript{20} However, the army was able to bring a small degree of racial egalitarianism to bear on situations where it could wrest control from those who would have market forces validate subjugation of black workers. Thus the drama at Muscle Shoals was different in that the engineers, mostly out of pragmatism, over the course of the project changed the labor system to shield African American workers from the worst excesses brought out by the contract system.

The federal engineers intervened in the labor system as a direct result of the complexity of the operation they were overseeing, embedded as it was in an equally complex social and political environment. McFarland established an administrative center in Florence soon after the design was approved as it became clear that the operation required his transition into a more

\textsuperscript{18} Woodward, \textit{Origins of the New South}, 188.

\textsuperscript{19} Woodward, 205.

labor-intensive supervisory role. This was standard practice in the army’s construction policy, as administration of the contract system of the time was akin to attending a rickety machine that was prone to catastrophic failure. The region’s racial strife and influx of carpetbaggers attracted to the laissez faire free-for-all made this “machine” even less predictable.\textsuperscript{21} “This work requires very close watching,” wrote McFarland as the contractors’ crews spread across the miles of line.\textsuperscript{22} Logistics and choreography of materials occupied time not spent closely watching the contractors for compliance. The location of two railroads and a steamer line, Decatur, Alabama, twelve miles upstream from the canal terminus at Florence, became the location of the engineers’ supply depot and main staging area. To keep material moving, the engineers built a supply railroad along the length of the site, and kept three locomotives in service along the line. Bad roads and the excessive expense of wagon drayage caused the engineers to build and operate fleet of flatboats to move men and materials. The plant grew to encompass steamboats and rolling stock of various types, various buildings, mules to run derricks and haul cars, at least one large steam-powered derrick, a number of centrifugal pumps, and an electrical system to power blasting charges. Workers dug quarries as the geology permitted; Portland cement was brought by steamer from manufacturers as far as Louisville.\textsuperscript{23} The complexity of work and transport entwined to make the project more than a canal. Major William Rice King, who would take over from McFarland when the original officer was assigned to finish the mapping project of the

\textsuperscript{21} McFarland, “Report of Operations in Improving the Tennessee River, for the Month of May, 1873,” Box 39, E71-RG77, NA. McFarland had been an experienced administrator of marine construction contracts on the Great Lakes prior to assignment to the Tennessee River, presumably contributing to his selection for the project. McFarland to Humphreys, June 2, 1868, Box 18, E25-RG77, NA.

\textsuperscript{22} McFarland to Humphreys, April 21, 1876, Box 84, E71-RG77, NA.

\textsuperscript{23} King to Chief of Engineers, July 17, 1878, Box 112; King to Chief of Engineers, March 10, 1879, Box 122; King to Chief of Engineers, June 25, 1879, Box 127; King to Chief of Engineers, June 19, 1880, Box 146; B. Wilson to Chief of Engineers, April 13, 1881, Box 171, E71-RG77, NA.
Southern Route, would assess the combination of river and various modes of technical transport in a different way from his predecessors in the era of internal improvements. What emerged to King was a system of components: of linear mechanical controls maintained by organized labor of human muscle, all animated by the river’s energy. His conceptual shift is evident in dispatches back to Washington, where he writes of the object of the canal’s hydraulic system in a way that strikingly anticipates the concept of the Tennessee Valley Authority (TVA), whose massive Wilson and Wheeler dams would flood and conceal the canal forty years later. King largely served as an efficient executor of McFarland’s plan, and his speculations on design changes never occurred, but are largely revealed in his emphasis on mechanization and flair for administering to the processes of construction and system maintenance. It is not surprising, therefore, that his successor at Muscle Shoals, Lt. George Goethals, would bring a similar conceptual framework to the execution of the Panama Canal.

What emerged at Muscle Shoals and other corps projects throughout the South was a sort of technocratic administration of labor based on Republican free labor principles. This was not the first foray of the federal government into the murky waters of Reconstruction labor markets. The Bureau of Refugees, Freedmen, and Abandoned Lands (commonly known as the Freedmen’s Bureau) had assisted in the forging of contracts between capital and freedmen,

24 King to Humphreys, October 17, 1876, Box 89, E71-RG77, NA.

25 Tom Peters places this shift in the “order of magnitude” in “site organization, system configuration, component manufacture, and erection procedure,” rightfully at the American assumption of control of Panama. I would, however, point out the roots of these practices at Muscle Shoals. Peters, Building the Nineteenth Century, 295.

26 This is not to imply competence. Du Bois characterized the administration in this way: “Reconstruction was a vast labor movement of ignorant, muddled, and bewildered white men...” Du Bois, Black Reconstruction, 285.
usually for agricultural work, and consistently to the advantage of capital. Yet the relationship between the federal government and black labor on the engineering jobsite was different from the Freedmen’s Bureau manipulations of labor relations. The engineers, who sought and achieved status as direct employers of labor, extended the egalitarian ethos of the army regarding the role of black labor formed during the war. Though not treated as equal, the Army had recognized the freed soldier and laborer as something other than abject servitude. Couched in the rhetoric of efficiency and pragmatism, the engineers sought change from the contract system to the direct hire of black workers because they both got better results and were not as interested in the politics of subjugation as white southern contractors. Doubtless some of the freedmen encouraged this shift with what little political power they had, finding more refuge of autonomy in the payroll of the government engineers. Yet it is equally important to remember that freedmen were largely uninterested in wage work. Historians have shown that freehold ownership of land was, by general consensus amongst freedmen, seen as the only way to insure autonomy. Wage work was likely seen for what it was: an instrument of northern capital, and accepted grudgingly, and only because it might allow a man to earn cash to buy land later, or out of present desperation.

A shift in the theory of black labor occurred in the sector of government construction occurred in the decades after Reconstruction. Engineers and other employers conceived of labor in terms of effectiveness in contributing to project completion, and held various prejudices about


28 Du Bois, Black Reconstruction, 32.
the various classes of labor: black and white, skilled and unskilled. The two main poles around which questions of labor occurred during Reconstruction were first that of compulsion, and second of skill. Former slavers struggled with the transition to wage labor; many of them maintained willful ignorance of incentives to work having been so reliant on violent compulsion. The struggles over reconstruction of the emancipated black worker, historians have argued, were largely symptomatic of the planter class’s continued desire for domination of the labor force, at all cost. The question of the supposed “laziness” of the Black worker has been well-documented, as well as the Yankee willingness to use vagrancy laws for “forcibly inculcating the habits of free labor.” More often, it was simple unwillingness on the part of capital to provide sufficient wages that prevented workforce retention, likely among other disincentives. The notion of skill, especially in a labor environment in a transition to more mechanization and increasing scope of engineering projects, figured as well in the minds of the engineers especially. At the outset of Emancipation, Black laborers were generally assumed to possess no skills whatsoever. Relegated automatically at first to agricultural and unskilled (and usually dangerous) manual labor, Black laborers, many of whom possessed superior artisanal skills, eventually earned recognition and higher wages on the jobsite. These advances were hotly contested by their white counterparts who guarded jealously the privileges of skilled status. The labor force effectively bifurcated because of resentment of white workers, and a society of black labor,

29 White labor was even further divided by nationality, as relentless division of working people in opposing groups characterized the era. See David R. Roediger, The Wages of Whiteness: Race and the Making of the American Working Class (London and New York: Verso, 2007), 133–56.

30 Wiener, Social Origins, 4.


complete with its own hierarchy of skill, emerged in parallel to white labor.³³ On the jobsites of the South there were instances where black and white laborers worked side by side. However, in most of the works—and at Muscle Shoals especially—the army interacted primarily with the black labor society. As black labor emerged as its own complex, the “theory” of the officers changed from a condescending paternalism to a dependency, especially as their structures retained only a tenuous grip against the natural world, and relied on the input of their labor to maintain their projects in the landscape.

The Contract System

The statutes that governed government construction in the nineteenth century were designed to prohibit graft and the enrichment of public officials by requiring all work be done by contract and a blind bidding process resolved in public view.³⁴ In effect the law required the engineers split the projects spatially and materially by contract. After the preliminary design was complete, McFarland divided the canal into contract-sized sections, each about a mile in length, opening the project to piecemeal bidding.³⁵ Bids were based on calculations of the mass and volume of the structures to be built and contractors paid by delivery—the United States being charged literally by the wagon-load of stone.³⁶ Antebellum engineering projects used this system, and the engineers found themselves often frustrated by its constraints. What was supposed to free the


³⁵ “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” September 28, 1875, Box 78; McFarland to Humphreys, July 10, 1871, Box 8, E71-RG77, NA.

³⁶ McFarland to Humphreys, July 31, 1872, Box 22, E71-RG77, NA.
government engineer, and install him in a supervisory role that provided only the most general
guidance to commercial firms instead caused the proliferation of a laborious system of inspection
for compliance. A familiar chorus of complaint emerged from many of the worksites across the
South from engineers chafing under the cumbersome system. The engineers’ protests and
attempts to wrest back control over their projects reveal a thinly-veiled contempt for contractors,
whose profit motivation made them of questionable trustworthiness. William Craighill strongly
protested lending government-owned machinery to the Susquehanna River contractor, as “it
would be very undesirable to place it in the hands of a contractor to work it for his own gain.”
Weitzel shared his colleague’s fear of sloppiness or guaranteed disaster when asking to build the
Falls of the Ohio canal with hired labor: “I consider this too delicate and important a work to be
intrusted [sic] to contractors.” When firms did successfully land contracts with the U.S., the
engineers fumed at the frequent “vexatious delays,” and their “extremely dilatory” working
habits. Enforcement of contract timelines was difficult as the contractors seemed to know they
could ask for extensions with impunity, knowing that the engineers would balk at the prospect of
having to reopen the bidding process which could entail the loss of a working season. Merely
transferring a contract from an incapacitated contractor to another willing to take up his work
could entail a thicket of litigation. Beyond these very basic obstacles, graft was widespread and
an individual’s trustworthiness almost impossible to gauge. The engineers took numerous

37 William P. Craighill to Humphreys, March 15, 1867, Box 8, E25-RG77, NA.
38 Weitzel to Humphreys, August 4, 1868, Box 36, E25-RG77, NA.
39 Weitzel to Humphreys, September 16, 1870; Jacob Stevenson to William W. Belknap, Secretary of War,
September 29, 1870, Box 41, E25-RG77, NA.
40 McFarland to Humphreys, June 20, 1872, Box 21, E71-RG77, NA.
41 King to Humphreys, August 22, 1876, E71-RG77, NA.
measures to protect their work from malfeasance, but projects usually suffered losses directly attributable to contractor incompetence or sleight of hand. Weitzel, with no great fanfare, reported to his superiors his practice of employing “secret agents” within the contracting firms to keep a handle on the situation. The “faithful contractor” was an elusive and rare figure.42

Who were these contractors, and in what societal stratum did they operate? From the engineering records a picture of this particular class appears. The engineers solicited bids from “all parts of the land,” but the vast majority of contractors hailed from northern states.43 Manuscript records of the bidding process record potential contractors from towns such as Manlius, Fulton, and Oswego, New York; Haverhill, Massachusetts; Keokuk, Iowa; and Joliet and Chicago, Illinois.44 These men generally belonged to the influx of Yankee businessmen and would-be planters “depicted in traditional accounts as individuals of limited virtue,” though this depiction has undergone significant revision by recent historians.45 Known by the “carpetbagger” epithet, these men were seen as opportunists, yet the men who worked on Muscle Shoals differed from Yankees with political ambitions in that they generally lacked interest in establishing residence. Contractors came from an occupational spectrum between mechanic and capitalist. Some owned established firms, possessed equipment and could demonstrate skill in building. At

42 Weitzel to Humphreys, November 12, 1870, Box 41, E25-RG77, NA.
43 McFarland to Parke, October 8, 1875, telegram, Box 76, E71-RG77, NA.
44 Weitzel, “Improvement Tennessee River, Report of Operations for the month of September, 1868,” October 1, 1868, Box 36, E25-RG77, NA; McFarland to Humphreys, October 9, 1871, Box 11; McFarland to Humphreys, November 16, 1875, Box 78; McFarland to Humphreys, March 23, 1876, Box 82, E71-RG77, NA.
the other end of the spectrum was the opportunistic man with access to credit by virtue of his newly-acquired government contract. It is needless to say which sort fared better.

Established contractors generally came from cities and towns along rivers or along the coast, where presumably they had developed skill in maritime or riverine construction. Most, however, adapted general know-how to whatever construction project the federal government initiated. There was a significant amount of crossover from railroad contractors, whose operations in manipulating grades and assembling and directing large gangs of labor were similar to the canal work. Quarry operators sold stone but also took contracts for excavation.\footnote{House, \textit{Letter from the Secretary of War in Relation to the Papers in the Claim of George Williams}, 46th Cong., 2d sess., Ex. Doc. No. 56, March 8, 1880 (hereafter cited as \textit{Claim of George Williams}), 84, Box 145; Deposition of William Davidson, January 24, 1881, Box 202, E71-RG77, NA.}

George Williams, proprietor and president of the Keokuk Elevator Company and the Iowa Coal Company, presumably brought his experience in heavy machinery and material logistics to his contract at Muscle Shoals. In addition to these interests Williams had in antebellum years built and maintained railroads. Since 1868, however, he had switched to “doing work for the United States Government under contracts for the improvement of the navigable waters of the country.” Working all over the upper Midwest, Williams had worked contracts at Rock Island, Dubuque, St. Genevieve and Cape Girardeau, and had built a large portion of the locks and canal around the Des Moines Rapids.\footnote{George Williams to John G. Parke, July 19, 1876, Box 86, E71-RG77, NA; \textit{Claim of George Williams}, 17.} Specialized contractors found themselves in high demand. Benjamin Maillefert, an underwater contractor who specialized in demolition and salvage of iron wrecks, profitably worked the Eastern Seaboard, taking multiple contracts for removal of war wreckage.\footnote{Quincy Gillmore to Humphreys, July 23, 1872, Box 22, E71-RG77, NA; Gillmore to Humphreys, September 16, 1872, Box 25, E71-RG77, NA; Craighill to Humphreys, November 19, 1870, Box 9, E25-RG77, NA.} Maillefert too is an example of a contractor who used his connections to the military
made during the war to create business for themselves in its aftermath. Rice and Reid, two partners who worked as commissary agents for the canal workers, eventually bid on and contracted a section of the canal themselves. R. C. McCalla, who had been periodically employed as a surveyor with the army, submitted a section bid himself, attempting to use the funds to start his own firm. Yet the search for “experienced and driving contractors,” who could be assured to complete the work, was difficult if the only information available were figures accompanying a blind bid.

Business under the occupation entailed maneuvering of different groups as federal money flowed to infrastructure sites throughout the South. Field engineers bore some of the brunt of powerful and angry congressmen who imagined that securing an appropriation for their district entitled them to direct the project, even if it meant upending the best practices of the engineers. A general expectation of pork and log-rolling hovered like a cloud over the appropriations process and the construction projects themselves. Southern politicians and contractors angled to divert some of the appropriations toward themselves, and sought ways within the War

49 Hume, “Carpetbaggers,” 320. Hume connects military service with an idealistic view impulse toward racial justice as characteristics of young veteran “carpetbaggers.”

50 Florence Gazette, April 2, 1875; McFarland to Humphreys, November 16, 1875, Box 78, E71-RG77, NA.

51 King to Chief of Engineers, July 11, 1877, Box 99, E71-RG77, NA.

52 Weitzel to Humphreys, September 26, 1870, Box 41; King to Chief of Engineers, July 10, 1880; G. G. Dibrell to Horatio G. Wright, Chief of Engineers, July 10, 1880, Box 149; E71-RG77, NA.

53 W. Rogers Hopkins to Joseph Henry, Director of the Smithsonian Institution, October 14, 1876, Box 89, E71-RG77, NA; C. B. Heyward to Hon. John A. Logan, December 5, 1879, Box 146, E71-RG77, NA. “Log-rolling” was openly spoken of as a legitimate procedure by everyone from President Grant downwards. Heyward’s letter to the congressman is a thinly-veiled threat that if Logan does not exert pressure on the engineer corps to pay an illegal subcontractor, the Joliet Sun will be used to exert pressure on Logan if he failed to remember his “friends.”
Department’s bureaucracy to find their way into the stream.\textsuperscript{54} Northerners and southerners alike sought berths in the government projects, which perhaps, excluding the supervising engineers, were seen as vehicles of patronage. Weitzel was so inundated with applications from civilians of varying experience to be hired on as assistant engineers that he finally had to write Washington to put out the word that had “no positions to distribute.”\textsuperscript{55} However, when officers did have positions to bestow, they looked to the population of veterans to populate their drafting offices and jobsites.\textsuperscript{56} Veteran and civilian alike found themselves facing desperation in the economic depression that stretched through the mid 1870s, and saw the government works as both normal operation of political patronage and a welcome source of relief. “I am in deep pecuniary trouble,” wrote an unemployed but eager civil engineer in his letter of application for a job at Muscle Shoals. Powhatan Robinson, a Tennessee railroad engineer, pleaded directly to the Chief of Engineers in Washington. “If you can give me work elsewhere—\underline{any where}, I should say—I shall feel myself under great obligation,” he wrote.\textsuperscript{57}

The engineers sought contractors and civilian assistants in communities where they believed skilled workers to live, and used political loyalty to the Republican administration as a measure of fitness as well. Their ideal labor pools for high-level jobs thus were Yankee urban centers and immigrants. The engineers blanketed the landscape with advertisements soliciting

\textsuperscript{54} M. J. Saffold to William Belknap, Secretary of War, February 25, 1875; M. J. Saffold to Parke, March 9, 1875, Box 68; McFarland to Humphreys, November 16, 1875, Box 78, E71-RG77, NA. Saffold asked for figures of how much had been expended and how exactly Alabama-based contractors could be considered for government work.

\textsuperscript{55} Weitzel to Humphreys, April 16, 1867, Box 34; Weitzel to Humphreys, March 25, 1870, Box 39; Weitzel to Humphreys, April 18, 1870, Box 39, E25-RG77, NA.

\textsuperscript{56} McFarland to Humphreys, June 16, 1868, Box 18; L. A. Morrison and others to McFarland, June 3, 1868, Box 18, E25-RG77, NA.

\textsuperscript{57} W. Rogers Hopkins to Joseph Henry, October 14, 1876, Box 89, E71-RG77, NA; Powhatan Robinson to Humphreys, August 18, 1872, Box 25, E71-RG77, NA.
bids but evidence suggests that they concentrated on urban and trade-oriented newspapers in major commercial centers like New York, Brooklyn, Philadelphia, Baltimore, Cincinnati, Louisville and Cleveland. Moreover, these newspapers had to be on the army’s list of approved and proven “loyal” newspapers. The engineers advertised in German-language newspapers throughout the Old Northwest, printing advertisements in both English and German. This was an attempt to tap into the influx of skilled and educated immigrants from Northern Europe. Oswald Dietz, who applied for a position on either the Tennessee or Hiwassee River in 1877, was an example of the kind of technically-skilled immigrant they wished to procure from these communities. Formally trained as a “civil & hydraulic engineer” in Germany, after emigrating to the United States Dietz worked as a “constructor” on the Crystal Palace and had done drafting in the Coastal Survey under Alexander Dallas Bache. German immigrants were also seen by the engineers to align with the free labor ideology of the Republican administration and the army. Advertising in German-language newspapers, who Weitzel certified “I know to be intensely loyal,” alleviated the troublesome prospect of political strife within their offices and on the jobsite.

Political trouble, however, proved inevitable as the Army instantiated federal free labor policy and attempted to rehabilitate the former Confederates that sought federal employment. Working with former enemies was to a degree pragmatic, such as the hiring of the Confederate officer who built the obstructions at Cape Fear to help disassemble them. Though it was never

58 McFarland to Parke, telegram, October 28, 1875; McFarland to Parke, telegram, November 3, 1875, Box 77, E71-RG77, NA; McFarland to Humphreys, August 7, 1871, Box 8, E71-RG77, NA.

59 Oswald Dietz to Karl Schurz, Secretary of the Interior, April 30, 1877, Box 97, E71-RG77, NA. Dietz included a copy of his diploma and transcript of his courses, in German, in his application.

60 Weitzel to Humphreys, August 2, 1869, Box 38, E25-RG77, NA.

61 Craighill to Humphreys, August 18, 1875, Box 76, E71-RG77, NA.
official military doctrine, the army carried out ideological purges and scrutinized its civilian employees for evidence of dissident behavior. William Gaw, a civilian engineer and Union veteran who led early surveys of the Tennessee Valley under McFarland, had his personal politics come under intense scrutiny as a measure of his continued employment with the War Department. Accused of Copperhead sympathies and refusal to endorse suffrage for freedmen, Gaw was interrogated by his superior Weitzel, and forced to certify that he voted for Ulysses Grant in the presidential election. Gaw’s opposition to the black vote, however, and chumminess with Democratic-Conservative partisans, cost him his job.\textsuperscript{62} Even clerks were fired for expressing “bitter” opinions against the Grant administration.\textsuperscript{63} In the atmosphere of “vindictiveness and personal hatred” in the wake of the war, northern officers were wary of southerners’ intentions. Most former Confederates embraced defeat and concentrated on acquiring wealth. McFarland’s assistant at Muscle Shoals was John Burtwell, a planter near Florence and a former classmate at West Point. Their personal connection was enough for McFarland to trust a man who had commanded troops in the recent rebellion, enough to collaborate on planning the canal.\textsuperscript{64} In other locations southerners worked to undermine and

\textsuperscript{62} Weitzel to Humphreys, March 7, 1870, Box 39, E25-RG77, NA; Weitzel to Humphreys, March 11, 1870, ibid.; H. P. Rathburn to Weitzel, March 10, 1870, ibid.; William Gaw to Weitzel, March 11, 1870, ibid. Gaw’s case is interesting in that the accusations bordered on spurious but the racism uncovered during Weitzel’s investigation proved fatal to his employment. Gaw had commanded “colored” troops during the war, and had been wounded at Chickamauga. In a spirited defense of his character to the Secretary of War, Gaw speculated that his accusers were angry subordinates at Chickamauga who blamed him for some calamity and possibly the death of their friends. Weitzel found the whole situation strange and that man who had commanded colored troops would have “made queer timber” for a Copperhead. However, Gaw’s vehement opposition to both the vote and education for the freedmen was enough for Weitzel to dismiss Gaw summarily.

\textsuperscript{63} Weitzel to Humphreys, March 16, 1870, Box 39, E25-RG77, NA.

disrupt the occupiers through skullduggery, as when contractors conspired with congressmen to have James Simpson, the designer of the Cape Fear project, removed from his post at Mobile.\textsuperscript{65}

Machinations and underhanded practices were pervasive throughout the contracting system, beginning with the bidding process. Within the design process and the parameters that existed on the jobsite, engineers fretted over their ability to provide what King called “specific data upon which to have reasonable and equitable bids.”\textsuperscript{66} King here was speaking about acquiring enough data and being confident enough about the extent of the project to avoid the pitfall of contracting with firms who made it a practice of significantly underbidding the project and then milking the contract in an escalating series of extra charges. In the summer of 1877, King dealt with a full-blown fiasco brought on by underbidding. Kimball & Slaughter, the firm who had vastly underbid their work on two locks only to withdraw at the last minute, throwing the project into chaos. In his remarks to Washington, King noted that he suspected foul play and that the two men had pulled the stunt perhaps at the behest of someone else who stood to profit, as being marked a “failed bidder” gave the engineers legal excuse to exclude individuals from bidding on future projects.\textsuperscript{67} Contractors were not above forming “rings” to manipulate the bidding process and undercut other bidders. In a long letter of complaint thatbordered on paranoia, F. H. Ingerson, an unsuccessful bidder on the Cape Fear project, alleged that the firms Bangs & Dolby and French & Ross had felt him out about forming a ring “to make it hard sledding” for other bidders.\textsuperscript{68} The engineers largely tried to stay clear of the networks of

\textsuperscript{65} J. T. Snead to McFarland, October 7, 1872, Box 27, E71-RG77, NA.

\textsuperscript{66} King to Chief of Engineers, August 1, 1884, Box 259, E71-RG77, NA.

\textsuperscript{67} King to Chief of Engineers, July 11, 1877, Box 99, E71-RG77, NA.

\textsuperscript{68} Craighill to Humphreys, February 8, 1877, Box 93; F. H. Ingerson to Henry Bacon, June 20, 1877, Box 99, E71-RG77, NA. Ingerson also made sure to include the information that Eli Bangs had been convicted of perjury as part of the famed Canal Ring bust in Albany a few years before.
malfeasance that were the nineteenth-century construction industry, but their aloofness still yielded headaches.

The engineers came to resent the contractors because normal accidents and contingencies of construction, such as weather, were rendered catastrophic because of ineptitude and irresponsibility. Mechanical or financial incompetence on the part of one contractor could cause a cascading series of failures throughout a project and subject the entire process to lengthy delays. A brief litany of the accidents and contractor failures that incurred costly delays: Curtis, Forbes and Co. broke the rudders off all three of their tugs while trying to dredge in an a submerged, petrified forest. A dam built by one J. H. Dennis inexplicably collapsed into the channel at Colbert Shoals in July, 1874, stopping all navigation on the river. Rice & Reed failed to do any work whatsoever in the spring of 1876, citing high water and “a large quantity of heavy work which was not anticipated.” M. G. Kennedy found it impossible to complete his contract in the allotted time because his work “has been submerged.” Others underestimated the tenacity of the grade, complaining “our contract was to excavate [sic] dirt and not hard pan gravel + loose rock.” William Davidson ran one of his steamers aground above his section and abandoned it there (in the most “imbecile of manners,” according to King), only to complain when the engineers built a cofferdam just downstream, trapping the wreck on the upper portion of the river. Albert Blaisdell simply “absconded” with the $6,000 paid at the start of his contract, having never even begun work on his section. J. H. Dennis similarly disappeared without finishing his contract, leaving the work “unfinished and ragged.”

Encumbered by debt, even diligent contractors faced the

69 Curtis, Forbes and Co. to Craighill, February 19, 1876, Box 82; McFarland to Humphreys, July 21, 1874, Box 55; Rice and Reid to King, May 30, 1876, Box 85; M. G. Kennedy to King, May 29, 1876, Box 85; Rice and Reid to King, August 14, 1876, Box 88; Deposition of William Davidson, January 24, 1881, Box 202; Deposition of Edward R. B. Sawyer, February 17, 1881, Box 202; King to Chief of Engineers, June 3, 1882, Box 202; McFarland to Humphreys, February 10, 1873, Box 31, E71-RG77, NA; ARCE 1872, 477-8.
prospect of one accident causing slow failure at the squeezing hands of their creditors. Bankruptcy was common among the contractors, and the U.S. would step in and modify contracts to keep struggling firms afloat until they could finish the project.\(^{70}\)

At Muscle Shoals, the engineers felt the work suffered from the interference and logistical difficulties of many competing parties working on the same site. Contractors found it impossible in some situations to move workers and machinery and stage material without interfering with their neighbors. The practice of each contractor building his own set of infrastructure to feed materials into his section compounded this, as multiple and redundant rail lines crowded the already narrow riverbank. Conflict over the ground between contractor sections prompted the U.S. engineers to hire their own crews to work the transitions and maintain continuity over the length of the project.\(^{71}\) Frictions were not always purely logistical. In more than one instance on the Muscle Shoals project contractors cheated others by foisting the completion of their contract on an unsuspecting counterpart, concealing that completion was nigh on impossible. Joseph Henry was duped by a contractor named Kimball, who took payments from the government on his section before (illegally) selling his contract. Only after Kimball disappeared did Henry discover that his predecessor had misrepresented the progress on the section, having done little work whatsoever.\(^{72}\) As with most malfeasance, King and the engineers had little legal recourse or powers to compel completion of the work, and the appropriation had to absorb the extra cost.

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\(^{70}\) Weitzel to Humphreys, November 12, 1870, Box 41, E25-RG77, NA; Craighill to Humphreys, February 9, 1877, Box 93, E71-RG77, NA.

\(^{71}\) “Statement of George Williams,” July 27, 1876, Box 85; King to Humphreys, December 6, 1876, Box 90; King to Chief of Engineers, July 3, 1878, Box 111, E71-RG77, NA.

\(^{72}\) “Deposition of William Davidson,” January 24, 1881, Box 202; King to Chief of Engineers, June 3, 1882, Box 202, E71-RG77, NA.
The engineers spent an inordinate amount of time protecting projects against what they perceived as contractors’ enthusiasm for misfeasance, and the energetic pursuit of any advantage that could be taken against the government for money. This usually took the form of exploiting ambiguities in the contract documents and using torts (or even just the threat of tort) to their advantage. After fighting a contractor who, using the language in his contract to get the government to pay for his transport of fill excavated from one part of the project to the embankment construction, essentially charging twice for the same material, McFarland worried that the defeat would further embolden the others, who would become “troublesome.” “Be extremely particular about your measurements,” wrote McFarland to his subordinates who were supervising the project, “and watch your benchmarks.”73 In another instance, the contractor Timothy Ford was forced to dig deeper than the twelve feet he estimated to find solid substratum. He presented the engineers with a bill for several thousand dollars, citing damages as his horse-powered cranes had to lift excavated soil above the agreed-upon dimension, which took longer, and subsequently cut into his profits. King’s rebuttal included laborious calculations, determining that the extra cost of hoisting would amount to less than a cent per cubic yard per linear foot. Contractors were also fond of using the patent system and claims of intellectual property to extort monies from their employers. M. A. Bryson of St. Louis sued the government, claiming that Craighill had poached the idea of a woven apron substrate for marine construction, even though Craighill protested that the concept had been “freely used … many years before Mr. Bryson was born.”74 Eli Bangs and Moses Dolby, contractors on the Cape Fear, took out a patent

73 James Long to McFarland, January 9, 1876, Box 90; McFarland to Long, January 11, 1876, Box 90, E71-RG77, NA.

74 Craighill to Humphreys, January 4, 1876, Box 74; M. A. Bryson to Belknap, December 20, 1875, Box 74; Craighill to Humphreys, August 11, 1875, Box 74, E71-RG77, NA. Bryson’s claim that Craighill had tried to “throw the contract to Bangs and Dolby,” however, seems less specious from the evidence in the archive.
on the mattress construction that officers of the corps had designed and they had build on government specification years before. The contractors noted that the government had been using “their” patent in work all over the Southeast, and in lieu of charging royalties, simply offered the patent for sale in a lump sum. Incredulous, Craighill and Quincy Gillmore decided to ignore this impertinence and seek help from the U.S. Attorney General “to prevent a suspension of work under any injunction,” that Bangs and Dolby might seek to pressure the government into paying them off.\textsuperscript{75} Craighill spoke for many of his colleagues when referring to the “clan” of contractors, who characteristically sought “always to make every edge cut against the U.S.”\textsuperscript{76}

Hired Men

The litany of difficulties in managing the contract system undoubtedly pushed the engineers toward advocating the army adopt a system of direct hire. The rhetoric they used to advocate for this transition, however, indicated that there were motivations beyond pragmatism. Hiring men directly fit better with the army’s institutional makeup and mechanisms of control, and included a moral dimension as well.

Military officers were accustomed to the availability of a large pool of labor and the ability to exercise fine-grained control over their operations. When estimating the time and effort required to rebuild levees in the immediate postwar period, Henry Abbot based his calculations on the assumption that local garrisons would provide labor. Soldiers, Abbot asserted, worked faster and more reliably than civilians—a quality attributed to military discipline and being

\textsuperscript{75} Bangs and Dolby to Wright, December 27, 1880, Box 163; Craighill to Wright, January 15, 1881, Box 163; Quincy Gillmore to Wright, January 24, 1881, Box 163, E71-RG77, NA.

\textsuperscript{76} Craighill to Humphreys, March 10, 1877, Box 93, E71-RG77, NA.
accustomed to hardship and fatigue.⁷⁷ As the ranks thinned as most common soldiers mustered out, this preferred labor pool ceased to be available. The engineers, however, worked around statutes and regulations that pushed government work into private contractors in an ad hoc attempt to reassemble the directly-controlled workforce they had enjoyed commanding during the war. The transition to hired labor began by piecemeal assembly of groups of specialized workers who would work in the seams between contractors and in areas where the work was too small in scope to justify a full bidding process. At Muscle Shoals, both McFarland and King employed crews of rivermen for blasting and quarrying stone when contractor quotes for the same work proved “absurdly” high. Most of the instances where the engineers stepped in involved deficiencies in skill on the part of the contractors, making the only viable alternative assumption of direct control by the corps of engineers. Contractor failure made assumption of direct control a matter of practicality.⁷⁸ In seeking approval from oversight in the War Department, the engineers justified bending the rules as a matter of convenience, and that slavish adherence to the letter of the law would prove “manifestly injurious.” That they had previously developed a reserve of skilled crews made the “practical” aspect of granting an exception to the law more attractive. The economic depression that lingered through the latter half of the 1870s depressed prevailing wages, making the contractor appear more as an unnecessary middle-man, impeding the “vigorous prosecution of the work.”⁷⁹ As contractors went bankrupt and abandoned


⁷⁸ McFarland to Humphreys, August 22, 1871, Box 8; McFarland to Humphreys, July 21, 1874, Box 55; “Notice to Contractors,” August 3, 1872, Box 26; McFarland to Humphreys, October 15, 1872, Box 26, E71-RG77, NA.

⁷⁹ King to Chief of Engineers, May 15, 1879, Box 125; King to Humphreys, August 30, 1876, Box 87, E71-RG77, NA. Humphreys underlined the following passage in King’s letter: “As a general reason in favor of the immediate prosecution of all the works herein referred to, it may be stated that owing to the scarcity of other employment, all
kinds of labor (including skilled and professional) are comparatively cheap, and the work should therefore be done at rates advantageous to the government.”
their canalside plants, the government attached machinery and material as way of recovering losses due to contract breach. The accumulation of equipment, which included “all the railroad track, locomotives, cars, derricks, buildings, &c.,” essentially made the U.S. government a highly capitalized firm that was in a prime location to execute the work called for in the legislation. 80 Ignoring the advantages of work with “hired labor” would have been irresponsible, as the engineers characterized it.

Frustrations with the intransigence and caprice of contractors belied an ethos toward labor that eschewed managerial aloofness in favor of workmanlike ownership of the job. Walter McFarland put it most succinctly, when questioning the government’s disposition toward construction: “Why not, in matters of work, do its own work!” 81 By consolidating labor under the conscientious government engineers, the engineers worked to mitigate what they saw as the abuses of the free-for-all contract system. When they witnessed it, the army engineers were disgusted by many of the ways the contractors treated their workers. King expressed revulsion at the contractors’ practice of paying laborers in “whiskey and other trade,” noting that the work was done more cheaply when the government paid workers in cash. 82 Having seen several instances of a contractor disappearing and “swindling all his workmen and many other creditors out of their pay,” the engineers lamented the destabilizing effect of a distributed operation reliant on actors of questionable ethics. 83 After an experimental phase in which work was carried out by

80 King to Chief of Engineers, May 15, 1879, Box 125; King to Chief of Engineers, June 19, 1880, Box 146; King to Chief of Engineers, March 9, 1880, Box 146, E71-RG77, NA. In 1880, King estimated the government had “on the ground ready for immediate operations $40000 or $50000 worth of boats, machinery, buildings, tools, &c.,” much of which was acquired from contractors who sold or abandoned it over the course of the project.

81 ARCE 1872, 479.

82 King to Chief of Engineers, June 19, 1880, Box 146, E71-RG77, NA. Undoubtedly the workers preferred cash payments as well.

83 ARCE 1872, 478-479.
workers hired directly, McFarland attributed the increase in productivity directly to the manner in which workers were treated:

> It will be observed that all the work done by the Government on the Tennessee River during the past year has been done by hired labor. The results are most satisfactory, for, while the work is better done in every respect, and is done promptly with no loss of time, while the workmen receive the best wages given in this region, are rationed and worked but eight hours a day, they have actually done more per day than the contractors ever accomplished, and have done it on an average at much lower rates…. It will be observed that the amount of work done in this one year is about the same as that accomplished in three years under the contract system.\(^8^4\)

As the engineers pressed the War Department for exemptions from the statutes governing contracts, the bureaucrats responded generally by approving a substantial amount of the requests for the regulations to be waived, and modified the language of the military regulations to allow for looser interpretation of the sort of “exigencies” that would allow field officers to bypass the contract system.\(^8^5\)

The increased scope of control in turn expanded the managerial responsibilities of the site engineers, and greatly increased the amount of tasks they had to complete in a given day. McFarland’s contingent during the survey period included three assistant engineers, one clerk, a transitman, a leveler, and a timekeeper; two rodmen, two flagmen, a chainman and a cook; three men equipped with axes who cleared vegetation from the surveyors lines; four blacksmiths, a handful of carpenters, and nearly one hundred day laborers. As the workforce expanded to over one thousand men, and spread in simultaneous operations along the large site, McFarland instituted a system of monitoring, installing qualified engineers along the line who “should be constantly on the ground so long as work is going on.” Besides supervising the foremen and

\(^8^4\) House, *Report of the Secretary of War, 43\(^{rd}\) Cong., 1\(^{st}\) sess., Ex. Doc. 1, Part 2*, vol. 2 (hereafter cited as *ARCE 1873*), 545-546.

Figure 4.7. Lock “A” under construction, August 1884, Muscle Shoals Canal. 77-2911P-71, Photographs Division, National Archives, College Park, Maryland.

Figure 4.8. Section 8 under construction, August 1884, Muscle Shoals Canal. 77-H-2911P-41, Photographs Division, National Archives, College Park, Maryland.
ensuring compliance to the design, the field engineer’s duties included monitoring the works in relation to weather, especially masonry work which could crack in cold temperatures, and coordinating efforts so that progress could be made regardless of environmental conditions. Overall, the engineers were tasked with maintaining continuity of the “lines of work” over a large geographical area. McFarland acknowledged the increased scope “of course means harder work for the officer who is responsible for its execution,” but noted optimistically that “it means also a better school for his assistants.”

Whether the assistants appreciated the paternalistic efforts toward their education is ambiguous; but what is known was how hard they were expected to work. F. J. Hampton spent much of 1872 “constantly travelling” between various jobsites along a 30 mile stretch of the river below Chattanooga, supervising work and delivering supplies, provisions, and payroll out of his canoe. Noting the hardships many of the civilian engineers endured, both McFarland and King periodically advocated for modest raises in pay and that the government provide housing. Those of managerial rank were permitted to bring their families to live in their riverside house cum drafting office. Enforcing class lines, these outposts of the managerial class were kept separate from the camps the engineers built for manual laborers, distributed in a different sequence along the line.

The civilian assistants belonged to a class of itinerant individuals with varying degrees of skill that was slowly in the process of professionalization. Moving between the railroads, mines, and urban construction sites of the era, these men brought different perspectives to the federal

86 “Return of Officers and Hired Men at Improving the Tennessee River for the month of March, 1873,” Box 39; McFarland to Humphreys, April 21, 1876, Box 84; King to Chief of Engineers, December 9, 1876, Box 90; King to Humphreys, December 28, 1877, Box 103; E71-RG77, NA; ARCE 1872, 479.

87 McFarland to Humphreys, October 14, 1872, Box 26; McFarland to Humphreys, April 21, 1876, Box 84; King to Chief of Engineers, October 29, 1878, Box 116; King to Chief of Engineers, December 26, 1878, Box 118; E71-RG77, NA.
projects, and historians have characterized them as generally more innovative in methods than the military engineers. This can be at least partially attributed to freedom from overarching bureaucracy of army life, which by nature discouraged improvisation. Powhatan Robinson, a civilian assistant working on the survey of the Tombigbee River, eschewed using a boat and crew for his survey, and instead took the train that ran alongside, sketching landmarks and estimating distance with his watch and reckoning of the train’s velocity. Among the civilians were individuals who were more reflective than their military counterparts, as there was less of a social expectation of the projection of gravitas. R. C. McCalla, felt free to embroider his description of the character of the Cumberland River’s drainage with poetic landscape description remarkable in an engineer:

Frequently the cliffs rise not less than 500 feet above the bed of the river, in vertical sections, beautifully escarped from bottom to top. The scenery is picturesque, and occasionally grand. Practically, this portion of the river has no valley or bottom-lands, the high, rugged precipices encroaching generally upon the margins of the stream. Here and there the bluffs recede, and the river is fringed with a narrow belt of débris and deposit, covered, where not in cultivation, with a dense growth of scrub timber and vines. The cliffs are occasionally indented with deep gorges, lined with high mural precipices, which serve to conduct the surface drainage of the adjacent table-lands into the river.

McCalla’s appreciation for the setting of his work provides a glimpse of the attitude of his class regarding the natural world, where practical concerns could be superseded by appreciation for pastoral and even picturesque regard of the object of quantification.

Assistant engineers and draftsmen were occupied by the concurrent labor of drafting and production of drawings that preceded a project and, used as a tool of assessment and monitoring, carried on throughout construction. Field surveys generated voluminous graphic data that then needed to be translated into accessible and accurate drawings at various scales and available both

88 Merritt, Engineering in American Society, 1850-1875, passim.; ARCE 1873, 551-552.
89 ARCE 1875, 796.
onsite and in Washington. The survey of the Muscle Shoals canal route entailed running two parallel “lines” across “very difficult ground, filled with swamps, sloughs, dense cane-brakes and underbrush, and rugged and precipitous cliffs,” all while maintaining meticulous paper records. One laborious process begat another. The office work period of the canal survey had to be moved north to Ohio so the engineers could work with relief from the outbreak of malaria at the canal route.\(^90\) Beyond the tedium of compiling data, military tradition dictated that standards of artistic production were high. Paul LeHardy, a draftsman, was sought after by several of the engineers, who wanted his hand on their maps before submission to Washington. In the days before it was customary that the government produced high-quality maps, the army found its project documents in high civilian demand, with the chief of engineers complaining to congress that there was no Congressional appropriation to compensate the engineers’ labor and decision to enable widespread distribution of their work.\(^91\)

The engineers’ systematic approach to the landscape largely consisted of spatial allotment of labor, and the calculations required to run a large, concurrent, and optimized system across large topographies. The cost of labor defined the spatial limits of the canal, which McFarland estimated at $55,000 per mile in 1872. The engineers’ training and outlook caused them to equate units of labor with units of distance across topography and units of material. The majority of the calculations were to translate the daily cost of human muscle into volume of materials removed, moved, or shaped, which then could be further translated into miles of

\(^90\) \textit{ARCE} 1872, 495-497; Abbot to Humphreys, May 1, 1867, Box 1, E25-RG77, NA. Generating accurate topographical representation was essential to estimating feasibility of engineering projects, and accuracy entailed what Abbot characterized as “immense labor in computation” before the first line could be put to paper.

\(^91\) McFarland to Humphreys, December 29, 1873, Box 46, E71-RG77, NA; \textit{ARCE} 1876, 4. All of McFarland’s work was destroyed in a catastrophic fire on the night of January 13, 1874, that consumed the entire building housing the rolls of drawings and field data for the entire canal project. What must have been excruciating anguish at the loss of so much work is concealed in McFarland’s stoic report. McFarland to Humphreys, July 31, 1874, Box 55, E71-RG77, NA; \textit{ARCE} 1874, 570.
transportation lines opened and tonnage of goods moved. More often, the translation went the other way; the engineers assessed volume and estimated the amount of laborers needed to accomplish the task. Calculation had a flattening effect; the figure of days multiplied by men appearing in the ledgers in a peer relationship to the materials and dollars input.\footnote{Arce 1872, 500; Arce 1871, 502; Abbot to Humphreys, January 6, 1866, Letters and Telegrams Sent, Civil War and Mississippi Duty, vol. 3, HLAP; King to Humphreys, January 2, 1877, Box 91, E71-RG77, NA. As the army transitioned to hired labor, food became another input to the calculations; see King to Chief of Engineers, June 19, 1880, Box 146, E71-RG77, NA.}

African-American men made up over nine-tenths of the thousands who worked on the Muscle Shoals Canal—a proportion mirrored in the makeup of the labor force in all the federal projects considered in this study. In the surrounding Lauderdale County, free African Americans made up one-third of the population (numbering some 5,170 individuals) in 1870, and postwar migration is indicated by the overall decline in population, both black and white, since the beginning of war. Though slavery in the area around Muscle Shoals had not been as concentrated as on the seaside rice and sugar plantations, records indicate that there were at least twenty-three plantations in the county that had worked more than 50 enslaved people.\footnote{United States. Census Office., The Statistics of the Population of the United States Embracing the Tables of Race, Nationality, Sex, Selected Ages, and Occupations. To Which Were Added the Statistics of School Attendance, and Illiteracy, of Schools, Libraries, Newspapers and Periodicals, Churches, Pauperism and Crime, and of Areas, Families, and Dwellings. Compiled from the Original Returns of the Ninth Census (June 1, 1870,) Under the Direction of the Secretary of the Interior, vol. 1 (Washington, D.C.: Government Printing Office, 1872), 11; William Lindsey McDonald, A Walk Through the Past: People and Places of Florence and Lauderdale County, Alabama (Florence, AL: Country Lane, 1997), 14.} Working-age former slaves from the local population made a large contingent of the manual labor force. At the height of the project, King estimated some 1,900 men were at work on the canal, with the local newspaper reporting that “the laboring force is entirely colored.”\footnote{King to G. G. Dibrell, September 24, 1879, Box 131, E71-RG77, NA; Florence Gazette, April 2, 1875.} The size of the workforce likely exceeded the available working-age men in the immediate county, indicating that African-American laborers
Figure 4.9. Lock No. 10, Muscle Shoals Canal, August 1884. 77-H-2911P-13, Photographs Division, National Archives, College Park, Maryland.

Figure 4.10. Workers at Gilchrist’s Quarry, May 1889. 77-2911P-82, Photographs Division, National Archives, College Park, Maryland.
came to Muscle Shoals to work. Most likely came from the surrounding counties, but there is indication that some skilled crews came from the area upstream of Chattanooga. The strength of the workforce fluctuated with available funds from Congress and weather, but during the working season the engineers sustained a force in excess of 1,000 men.95 The canal fell under what C. Vann Woodward referred to as the expansion of “Negro-job” industries such as sawmills, coal mining, and railroad construction, where hierarchy indicated that nonagricultural but also non-mechanical jobs (jobs where one wasn’t required to operate machinery) were relegated to black workers. The makeup of the thousands who worked at Muscle Shoals, white engineers, foremen, skilled mechanics and quarrymen likely never numbered more than one hundred.96

Before the economic downturn in 1873, contractors strained under labor shortages that inflated wages and indicated the extensiveness of heavy construction projects in the region. A day’s labor before 1873 paid $1.50 a day, and the typical pay difference between white and black workers was eliminated—for a brief time parity reigned. A clerk remembered labor shortages being so severe that they were compelled to send agents to regional cities to recruit workers, and pay their fare to the canal site as competition was fierce. At times these agents were successful at luring workers from the nearby railroad line that was under construction, but had to pay premium wages because of the malaria epidemic. Contractors preferred hiring white laborers, citing their ability to “perform such work as the colored laborers were not skilled in,” but found white workers were willing to strike for higher wages, where as African-American laborers, in their experience, were not. Payroll clerks noted the emergence of a migrant workforce, one that

95 King to Chief of Engineers, July 8, 1879, Box 127; King to Chief of Engineers, December 6, 1879, Box 132, E7-RG77, NA. King lamented having to reduce his workforce from 1,872 men to 617 that winter, due mostly to failure of the legislature to continue funding the project. The engineers found it frustrating how their experience crews would scatter when the work was put on hold, and worked to retain skilled workers over the winter.

96 Woodward, Origins of the New South, 360.
worked for a few weeks before moving on to chase higher wages at other regional projects and avoid the onset of seasonal heat and malaria. King noted that the workers were attuned to the regional funding situation, beginning to arrive back at Muscle Shoals after newspapers published news of new appropriations. From payroll accounts we can reconstruct when this migratory wave hit Muscle Shoals and what a year might look like for one of the migrant workers. The workforce doubled from April to June of most years, when most activity took place along the site, falling back to roughly 750 men employed through the Fall and early Spring. It’s conceivable that workers did three-month stints before moving along. A depressed payroll in December indicates that most men quit work and went home for the holidays, returning to the circuit in the new year.

Both black and white workers knew the prevailing wages on government and other regional projects, and succeeded in resisting contractors’ efforts to suppress wages whenever and however they could. During the labor shortage, $1.50 was the prevailing wage for a day of work, for both black and white workers. Contractors attempted to suppress wages to $1.25 per day for black “laborers of inferior capacity,” but when they tried to suppress all common laborers to this same rate the workers protested and threatened to walk off the job, forcing retention of the higher rate. The U.S. government’s established wage of between $1.30 and $1.50 per day helped buoy this figure, and the government made no distinction between black and white workers. The scale of the operation seems to have had effect on the wages, as while McFarland got away with paying his unskilled survey workers on average $1.00 per day, the larger mass of workers

97 Claim of George Williams, 80-81; Woodward, Origins of the New South, 208; King to Chief of Engineers, July 16, 1884, Box 258, E71-RG77, NA; Wiener, Social Origins, 40, 43.

assembled for the construction of the canal proper would not stand for it. The only means of suppressing wages, as the contractors learned, was to coordinate amongst themselves. After conspiring to control wages, the contractors effectively split the workforce along racial lines. A strike at George Williams’s section in 1876 failed, and after the white workers walked off the job, Williams found the black workers would settle for the reduced rate. According to Williams’s clerk, this precipitated a further depression in black workers’ wages, sliding down to $1.00 per day for black workers in the winter of 1877. This represented a full 50% reduction in earning power over two years. Though still better than sharecropping, where a man could expect between $.50 to $.75 per day of work, the living made on the canal was hardly comfortable and barely livable.99

A day’s labor reflected work in the environment at the cusp of widespread mechanization: with some assistance from machines, men and animals toiled largely with their muscles and small hand tools—their object to move massive amounts of material relatively short distances but in adverse environmental conditions. The first task on the canal site was “clearing and grubbing”—the difficult task of ripping out all organic material from the ground, including trees and their root systems, to expose the soil for excavation. Excavation then proceeded with the aids of derricks and some steam-powered machinery, but mostly was hacked out of the landscape by hand. King recorded that in the productive month of May 1876 the workers removed 38,229 cubic yards of material.100 Extra pay “obliged [one] to work in the water all day long,”—sometimes even up to waist or chest, but elicited little sympathy from their overseers,


100 “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” September 28, 1875, Box 78, E71-RG77, NA; Florence Gazette, November 3, 1875; “Report of Operations for the Month of May, 1876 in Improving the Tennessee River below Chattanooga,” June 6, 1876, Box 85, E71-RG77, NA.
Figure 4.11. Lock gates at Muscle Shoals Canal, 1889. 77-H-2911P-54, Photographs Division, National Archives, College Park, Maryland.

Figure 4.12. Lock No. 8, August 1884. 77-H-2911P-14, Photographs Division, National Archives, College Park, Maryland.
though in the winter, King was moved to spend some of the congressional appropriation on rubber boots.\footnote{King to Chief of Engineers, June 19, 1880, Box 146, E71-RG77, NA; King to Chief of Engineers, February 19, 1878, Box 105, E71-RG77, NA. King’s justification for buying 42 pairs of hip-height rubber boots: “…during the winter season especially, it is impossible to hire men to work in the water, and do a fair day’s work, without supplying them with rubber boots.”} Work lasted eight hours of the day—a reduction from the customary workday of the South, which often lasted ten or longer, simultaneously to the protests gathering momentum in other parts of the United States. “[A] happier lot of workmen don’t exist,” wrote the canal’s resident physician of his observations of the workers in April, 1875. Yet the doctor’s attribution of “their songs and cheering refrains,” likely missed the singing’s function as a way to break up the monotony and the toil that many of the workers found similar to their lot under antebellum bondage.\footnote{Florence Gazette, April 2, 1875; Florence Gazette, April 10, 1875.}

Working conditions, both during the work day and in time off were generally miserable and hazardous; though the government provided housing, the accommodations were little more than rough and dangerous camps. The supervising engineers had from time to time rented land and secured rights to cut wood and quarry on parcels near the canal prism or quarry site for laborers to build rough cabins and cut down on their travel time to work. Camps were set up to avoid the increasingly steep prices of boarding laborers with locals, who took over half a workers wages before payday, directly from arrangement with the federal paymaster. Black workers avoided the boarding system altogether (though it is not clear if this is because they preferred their own makeshift camps or if they were barred from boarding—and likely a combination of the two).\footnote{King to Humphreys, August 28, 1877, Box 103, E71-RG77, NA; Claim of George Williams, 81.} The makeshift camps at contractor sectors were lawless zones at the worst end of the spectrum of company towns. A prominent camp near the Blue Water section, described as “Hell
“Hell Town Bar” which was “salon, whiskey lightning, drinking, supply house” all under one roof. This den and surrounding encampment burgeoned with activity until the “company went to pieces” and was abandoned. Surviving the hell towns meant risk of death or being maimed on the jobsite. Andrew Ware, a laborer at Elk River Shoals, had his leg crushed by falling rock while at work. The government physician examined him and then had him transported the agonizing distance to Chattanooga where another physician amputated the leg. Felix Murfee, a blacksmith, had his leg meet a similar fate. The government felt complicit enough to pick up physician bills, but little was done to ensure workers’ safety. The river was a dangerous place, as periodic reports of discovery of drowned deckhands and canal navvies confirmed.

Employment directly by the government presented a dilemma for the freedman. Former slaves generally resisted the conversion to wage labor, citing even worse working conditions and wages than their white counterparts, little difference in the danger and fatigue of the work, mistrust of labor brokers and a general and correct sense of the exploitative nature of any arrangement that they might make. Some freedmen eschewed travel to work on far away construction sites, preferring to remain in agriculture and presumably close to their families and communities, preferring cultivation works “rather than upon those of the Government.”

104 P. M. Le May, untitled manuscript, September 12, 1924, Wilson Dam 1.2 Folder, William Lindsey McDonald Collection, Archives and Special Collections, University of Northern Alabama Library, Florence, Alabama.

105 King to Chief of Engineers, October 28, 1879, Box 132; King to Chief of Engineers, October 13, 1885, Box 299, E71-RG77, NA; Lauderdale Times, March 26, 1872.

106 Statement of John Peterson, n.d. (1864), folder 1841-73, Box 2, Correspondence Files 1842-1873, General Correspondence Files, New Orleans District, Corps of Engineers, Record Group 77, National Archives, Ft. Worth, Texas.
labor became a necessary evil when freedmen needed to accumulate cash to acquire land.\footnote{B. B. Spier to O. O. Howard, January 13, 1869, Folder HR40A-F10.5-8, 40th Congress, Committee on Freedmen’s Affairs, Records of the United States House of Representatives, Record Group 233, National Archives Building, Washington, D.C. Spier was a freedman living at the Great River Settlement near Newbern, North Carolina. His heartbreaking letter, in which he describes the desperate quest to acquire cash in order to purchase the land that they are squatting on, is transcribed here in part: “We as freedmen wish to beg it considered that we could keep our children massed together as much as posable [sic] that they would be beter [sic] attened [sic] to by schools we are not abel to bu [sic] but we are willing to try and do the best we can towards it but we are fearfull that some one who is more abele than we our selves will come and buy us out my reasons then is for writing you is to ask you could you prevail in any way with the U.S. gov [sic] to beg for us + give some time for payment…. People many of them have a good little farm on this track of land witch they have been planting for the last 3 years and sence the land have been bought in the owner have refuse to Rent but will Sell but not in small lots not lest then the hole or half the winter season is passing…Gen. you will please give this some attention as the season for planting is coming on + we would like to have the same use of the land…”}

When selling labor, however, working for the federal engineers provided some benefits. The engineer officers were generally even-handed in racial matters, and as supervisors were likely a marked difference from being under the hand of contractors who cut their teeth in hard-driving antebellum railroad construction. Federal troops were more willing to suppress racial violence and enforce the law, moreso than many of the local constables, and federal projects held an aura of sanctuary. But given the choice between working for the government and returning to plantation life that differed little in terms of misery or prospect for future improvement than before the war, the unattached freedman chose the former. The commander of the dredge ship working the entrance to the Mississippi requested permission to take two black firemen on, who “wish to come on board and work without payment—except their living.”\footnote{E. A. Mansfield to C. W. Howell, June 29, 1870, Folder: No Record Card 1870-1881, Box 2, Correspondence Files 1842-1873, General Correspondence Files, New Orleans District, Corps of Engineers, Record Group 77, National Archives, Ft. Worth, Texas.} Beyond the pale of the federal project, grim circumstances pushed people to the modest security of the government wage.
A Hostile Environment

From the beginning of the survey of the Tennessee River valley, the engineers complained of how the floodplain’s dense foliage so impeded their use of instruments that they were essentially blocked from working on the actual landscape. This metaphor, of a dense entanglement of mysterious impediments and obstacles, their entwinement signaling a will to resist the works of progress at every inch or yard, is a useful framing of the struggle that work was in the southern environment. Natural forces certainly resisted; political and social vectors, mostly coalescing around resistance to the social progress of African Americans, abraded and impeded the efforts of both white engineer and black laborer. Working in the landscape revealed the disposition towards nature of those, at all levels, engaged in the activity of engineering; an atmosphere infused with hostility colored all of those interactions.

The concept of a hostile atmosphere was readily supported by the waves of disease endemic to the areas in which the engineers worked. Malaria, at that time still thought to be caused by proximity to the bad air of swamps and wetlands, was by far the most deadly and widespread of the diseases encountered. It struck across the class and racial lines of the division of labor—even clerical workers and engineer officers in the drafting offices had difficulty avoiding the disease’s reach. Before beginning work, the engineers knew that hiring men to work Muscle Shoals would be difficult and require more pay as “the service will be severe and in a sickly region.” McFarland was proven correct almost immediately, as Lieutenants Gregory and Greene, the officers supervising the canal survey, became so ill with malaria they were forced to complete the drafting in a location hundreds of miles north of the epidemic region. The common

109 Weitzel to Humphreys, October 30, 1867, Box 34, E25-RG77, NA.

canal laborers had not the luxury of retreat. Low water on the Tennessee and the best time to work coincided with the “unhealthy season,” and King estimated that between ten to twelve percent of his workforce was incapacitated from illness at any given point during low water. The engineers made efforts to have physicians on site and issue prophylactic medicine to the workers, but these efforts merely blunted slightly the force of the disease. Contractors folded or lost money on contract extensions, complaining that the disease “greatly crippled” their workforce, and the inability to attract new workers to the site touched by the plague. Fatal and pervasive, malaria was a part of life on the canal; “almost every employé, who has been on the work more than one season, having been attacked,” wrote King. Yellow fever ravaged the southern region as well, disrupting operations, causing quarantines, and killing men at their posts. The engineer conducting the survey of Galveston Harbor found the men on his boat falling ill at an alarming rate, before he himself was incapacitated by the disease. Three men had died before the vessel made it back to port.111 Ubiquitous malaria and yellow fever were supplemented by epidemics of other no less fatal diseases, such as an outbreak of small pox in the engineer camp on the nearby Coosa River. Similarly, an outbreak of cholera in Nashville in 1873–1874 reinforced the notion that disease was endemic to the postwar environment. A combination of attitudes—that disease was a result of latitude as well as backwards, unindustrialized ways of living in and keeping landscapes—painted the southern environment as a whole with menace.112

111 Capt. Charles Howell to Humphreys, September 20, 1870, Box 14, E25-RG77, NA; Howell to Humphreys, telegram, September 24, 1870, ibid.; Howell to Gen. James Parke, October 18, 1870, ibid.; Howell to Humphreys, November 5, 1870, ibid.

112 McFarland to Humphreys, July 22, 1872, Box 22, E71-RG77, NA; ARCE 1872, 496; King to Chief of Engineers, August 18, 1878, Box 114, E71-RG77, NA; King to Chief of Engineers, September 30, 1879, Box 131, E71-RG77, NA; Foster, Wiehl, and Jackson to King, September 15, 1876, Box 88, E71-RG77, NA; King to Chief of Engineers, December 6, 1879, Box 134, E71-RG77, NA; King to Chief of Engineers, January 25, 1883, Box 225, E71-RG77, NA; ARCE 1874, 577.
Figure 4.13. Dam at Milton’s Bluff, Muscle Shoals Canal, November 1887. 77-2911P-89, Photographs Division, National Archives, College Park, Maryland.

Figure 4.14. Dam at Milton’s Bluff, 1889. 77-H-2911P-47, Photographs Division, National Archives, College Park, Maryland.
Climate and weather always factored into the difficulties of outdoor work, but Yankee contractors and engineers complained of the ill effects of what they considered extreme conditions in the southern environment. Contractors complained most often of the torrential rains, which transformed the length of the canal site into an unworkable morass. Rain and excessive heat made the labor intensive work nearly impossible. At the opposite end, engineers expressed frustration when the workers protested handling stone in freezing conditions. The contractors saw climate as a component of labor in that it functioned as a variable in their calculus. George Williams, a contractor at Muscle Shoals, warned the supervising engineer that his agent onsite “will use every exertion [sic] but finds it impossible to make anything like full time of men [in] this severe weather.” In ascribing the coefficient of friction to the weather or prejudice against certain classes of workers, the contractors elided what likely was resistance amongst workers to the force of capitalist discipline to make them gratuitously expend energy in a work schedule needlessly out of sync with the rhythms of nature.113

Workers, both engineer and common laborer, perceived an environmental violence to their work in the slow consumption of their equipment by the environs and sudden personal disaster. The worm infestation endemic to the South consumed every stick of wood that touched water eventually, and dredges, barges, and floating construction platforms had to be repaired often as they were gradually consumed. Machinery towed from the North seemed to undergo an accelerated process of decay as it passed the latitude of the Chesapeake Bay, astounding contractors who were forced to ask for contract extensions and to undergo costly repairs of their

113 King to Humphreys, July 21, 1876, Box 86, E71-RG77, NA; King to Humphreys, September 11, 1876, Box 88, E71-RG77, NA; Bixby to Chief of Engineers, April 17, 1885, Box 290, E71-RG77, NA; George Williams to King, December 16, 1876, Box 90, E71-RG77, NA.
“badly wormed” equipment. Gales and hurricanes destroyed machinery and killed people.\textsuperscript{114} It was common for workers to lose their lives while at work on projects, or simply while walking home at night through the treacherous jobsite. Brushes with death were common as to merit only perfunctory comment. In a brief entry in his 1872 annual report, McFarland notes how in August of the previous year the boat he and another engineer named Fillebrown were surveying from capsized in a place called Devil’s Race on the Coosa River. Fillebrown drowned; it is unclear how close McFarland came to meeting his fate that day.\textsuperscript{115}

This period marked a generational shift in which engineers spoke of the natural forces of an environment, involving a tapering off of the practice of ascribing moral qualities to natural phenomena. Engineers of James Simpson’s generation, who was fifty-two years old at the end of the Civil War, were more likely to name an engineering problem, like a flood, as “an evil,” and to characterize their actions as “arrest of the evil.”\textsuperscript{116} The engineers of King’s generation proved more willing to understand the rhythms and systemic fluctuations as an inherent part of engineering practice and passed no judgment on the inconvenience of nature to their work. At the sight of 1,400 men working in the bed of the river run seasonably low, King rhapsodized about

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\begin{itemize}
\item \textsuperscript{114} Joseph D. Barton, a worker at the Galveston Breakwater, described his ordeal while in the corps’ service: “I, with many others were swept into the sea by the violence of that terrible storm [September, 1875] which visited that latitude. I lost everything I had, not even bringing off enough clothing to cover my person. I also contracting a most virulent form of rheumatism from the exposure and hardship which I endured by being tossed about in that awful sea until next morning, and from which disease I still suffer.” Joseph D. Barton to J. Donald Cameron, Secretary of War, June 28, 1876, Box 85, E71-RG77, NA.
\item \textsuperscript{115} Curtis, Fobes and Co. to Craighill, November 16, 1875, Box 76, E71-RG77, NA; Rittenhouse Moore to C. M. Shelley, Congressman of Alabama, December 16, 1884, Box 281, E71-RG77, NA; \textit{ARCE} 1872, 511.
\item \textsuperscript{116} Simpson to Humphreys, November 22, 1875, Box 78, E71-RG77, NA; see also Savannah \textit{Daily News and Herald}, February 29, 1868; \textit{ARCE} 1865, 42; \textit{ARCE} 1879, 740. For an interesting argument that “conceptions of good and evil” would remain “final standards of judgment” in engineering up to the Progressive Era, see John M. Jordan, \textit{Machine-Age Ideology: Social Engineering and American Liberalism, 1911-1939} (Chapel Hill: University of North Carolina Press, 1994), 23.
\end{itemize}
}
the urgency he felt at pressing the advantage to get work done in the opportunity afforded by the cooperating river.\textsuperscript{117}

Reconstruction of labor relations in general produced conflicts between white engineers and contractors and their black employees as vestiges of compulsion of slaves to work suffused negotiations and project management. A general attitude prevailed that all the newly free should get back to work without delay. The historian Mark Lause has written that this was characteristic of the “shallow rhetoric” around free labor that clouded the “deep assumptions of laissez-faire” read in the government efforts to push workers into labor, even if the relationship was far from fair. This created an atmosphere of coercion, reinforced by the infamous Black Codes but supported as well in general by free labor ideology.\textsuperscript{118} As such, reasonable impediments to hard outdoor labor, such as weather, took on moral and racist overtones when evaluated by white engineers. The stamina of workers in the face of adversity was often overestimated; the typical endurance and productivity of classes of workers (often based on racist rubrics) and downplayed the force of adversity. There is little evidence the engineers at all considered the factors that prevented the black laborer from living up to their constructed ideal; the hangover of work practices of slavery, the eerie similarities of the working conditions, the drudgery, the surrounding Klan-terrorized landscape of “dark and bloody crimes” figure only tangentially in the engineers’ records. However, the engineers’ infrequent but marked frustrations with the supposed quality of black laborers, based on their own misjudgment and suffusing their

\textsuperscript{117} King to Humphreys, August 28, 1877, Box 101, E71-RG77, NA; King to Chief of Engineers, July 8, 1879, Box 127, E71-RG77, NA; \textit{ARCE} 1874, 571.

administration with prejudice, only compounded the already difficult task of working in the
nineteenth-century jobsite.\textsuperscript{119}

The convict lease system, an insidious “curse to the soil” that rose from the ashes of the
old regime, poisoned labor relations and made worksites toxic. Convicts were leased by the state
to contractors in varying numbers, their gangs worked on projects throughout the South in an
atomized penitentiary system with outposts “deep in forest or swamp or mining fields, or
windowless log forts in turpentine flats.”\textsuperscript{120} Convict labor was explicitly prohibited on federal
projects, and the engineers patrolled their purviews zealously. Outrage provoked by an incident
on the Muscle Shoals Canal gives some insight into the officer corps’ disposition toward this
shady but pervasive system. In 1877, a contractor named Matthew Kennedy had “sublet” 200 of
his 450-man workforce to a Colonel Gordon, who mysteriously was able to supply workers at
$.50 less than the going rate per day. Kennedy protested that he hadn’t known Gordon drove a
gang of convicts, but this did not stop McFarland from stopping all work immediately and
refusing payment to Kennedy for work done on grounds of breach of contract. When the
contractor protested that the government’s refusal to pay constituted a “hardship,” McFarland
outlined his justifications:

Because the only labor contemplated in letting the contract, was that everywhere
employed on public works conducted by the U.S.; that is, free labor,—and the contract
gave no permission to use convict labor…. Because the use of convict labor was a wrong
to the other contractors and an injury to the whole surrounding neighborhood….and lastly,
because such labor is a scandal and a disgrace to civilization; a relic of barbarism which,

\textsuperscript{119} Craighill to Humphreys, February 9, 1877, Box 93, E71-RG77, NA; Abbot to Humphreys, January 6, 1866,
Letters and Telegrams Sent, Civil War and Mississippi Duty, 1862-1867, vol. 3, HLAP; Lauderdale \textit{Times}, February
13, 1872.

\textsuperscript{120} Woodward, \textit{Origins of the New South}, 180, 213.
however favored by legislation in some states, ought never to be allowed to disfigure the records of the general government.\textsuperscript{121}

Though framed as unwillingness to let government practices be tainted by what was perceived as generally unsavory practices of the time, McFarland nonetheless reveals his own belief that employment of freedmen and the construction project in general were the forays of civilization. The moral struggle that animated Union military struggle seems to have carried beyond even the hopeful period of Reconstruction, where construction could be seen as militating against dark forces still present in the environment.

Instead, dark and impeding forces were more readily apparent in the human society that lined the shores of the Tennessee River. Various motivations amongst the populace stimulated resistance to the federal engineers’ projects, with differing degrees of aggression. Instances of outright sabotage, such as deliberate ramming of the government works or surreptitious removal of stone from sections of the jetty to allow the passage of small boats were likely the result of individual watermen frustrated by changes to their traditional ways of navigating the river.\textsuperscript{122}

Other more subtle acts of resistance indicate the larger design of resistance to the occupying army and the social change the army aimed to inculcate. This rarely took the form of outright hostility and violence against Federal agents or property itself, and instead can be seen in pervasive resentment and opportunistic exploitation of the military’s operations. An analogy might be mosquitos on a large and blundering beast. Absentee landowners reappeared to assert their claims over land the army had occupied and worked on for the decade since the close of the

\textsuperscript{121}“Tennessee River Improvement, Muscle Shoals Canal, Specifications,” February 7, 1876, Box 82, E71-RG77, NA; J. Y. Cantwell to George Creary, Secretary of War, May 28, 1877, Box 98; McFarland to Humphreys, October 12, 1877, Box 98, E71-RG77, NA.

\textsuperscript{122}ARCE 1870, 385; ARCE 1874, 570.
Boarding house operators pressed their rates to excess, figuring the government as a limitless, though transient, source of funds that needed to be pumped while present. The most outright act of piracy was the robbery of the federal payroll on the Muscle Shoals Canal by members of the James Gang in March, 1881.

Jesse and Frank James, former Confederate bushwhackers turned bank robbers and cold-blooded murderers during Reconstruction, were already enjoying a folk-hero reputation at the time that they stole $5,200 in gold and greenbacks destined for laborers on the Bluewater section of the canal. After kidnapping and releasing Alleck Smith, the federal paymaster, they made sure he related to the local newspapers how they were only after “Federal funds,” and let him keep his watch, gun, and the $40 of personal money he had on him. Dramatic actions of this sort, more symbolic than materially effective against encroachment of Yankee capital and constraint against full-blown white supremacy, used the backdrop of the Federal engineering project as a means of framing resistance against the concretized ideology of the public works.

That the engineers perceived an inherent conservatism amongst whom one contractor referred to as “semi-civilized inhabitants of these cane breaks,” that was an expression of resistance against the changes wrought in the environment. Local elites such as businessmen and planters were enthusiastic about investment in their area until the construction process

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123 King to Chief of Engineers, April 20, 1881, Box 171, E71-RG77, NA; Alex London to Henry Bacon, April 21, 1882, Box 100, E71-RG77, NA; Wright to Robert Lincoln, Secretary of War, July 13, 1883, Box 237, E71-RG77, NA.

124 Claim of George Williams, 80-81.

125 Tuscumbia North Alabamian, March 18, 1881; Florence Gazette, March 19, 1881; Leland Ross Johnson, “A History of the Operations of the Corps of Engineers, United States Army, in the Cumberland and Tennessee River Valleys” (Vanderbilt University, 1972). King and other engineer officers pursued the bandits on horseback into Tennessee, but only one was eventually captured. Participation by the James brothers themselves in the raid remains disputed legend in Northern Alabama to this day.

126 Paul Le Hardy to King, November 3, 1876, Nashville District Engineering Studies, Historical Reports, Entry NA-1666, Record Group 77, National Archives, Atlanta, Georgia.
impeded on their immediate prosperity. A group of “citizens of North Alabama” wrote the
engineers about the “serious losses and inconvenience they are now sustaining…by the dam
placed there in November for the purpose of aiding the workmen in their operations”:

> If suffered to remain during the winter season, the whole commercial, agricultural and
mechanical interests of the country, lying above the shoals, will be injured to an amount
scarcely calculable. The cotton cannot be moved, our merchants cannot meet their
obligations, the supply of groceries and provisions cut off, our lumber market to a great
extent destroyed…there are now thousands of bales of cotton awaiting shipment….¹²⁷

“Inhabitants” of the capitalist class shifted allegiances quickly if their class benefits tied to the
status quo were threatened by the engineering operations. By and large, however, the capitalist
class stood to gain from the environmental change brought by engineering, as the environment
was aligned to assist their livelihood. Those lower in the economic hierarchy, who stood to loose
more from change in the hydraulic and biotic environments, expressed dismay at the potential
that their economic habitat could be altered physically and, by extension, biologically. The
engineers found this fear of what they saw as improvement and progressive change puzzling. In
the case of widespread resistance amongst the pilots at Cape Fear, Craighill remarked thusly:

> Some of the pilots on this river are opposed to any change whatever in the old beaten
paths to which they have become accustomed. This is the case in all river improvements.
It is not to be wondered at. Pilots are most valuable citizens, but all of them gain their
knowledge of the bottoms of rivers by long feeling them with the line. An improvement
is a change. It takes away for a time from them their stock of knowledge, upon which
their livelihood depends. Some of them therefore oppose any change whatsoever.¹²⁸

Grasping to maintain the environmental status quo went beyond custom and economic inertia.
The slave-maintained landscape enveloped a developed culture; both poor and rich white
interpreted attendant structural and biological change as destabilization. Stability enforced by a
violent regime had been the cornerstone of antebellum southern civilization. Olmsted and others

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¹²⁷ W. B. Wood et al to Weitzel, December 27, 1870, ibid.

¹²⁸ Craighill to Acting Chief of Engineers, May 14, 1879, Box 124, E71-RG77, NA.
saw the marks of this violent order in the fields and rivers of the south, as did its inhabitants when romanticizing plantation agriculture in later generations.

The environment of hostility was just one manifestation of the widespread struggle over labor and land-use policy in the Reconstruction South. Multiple actors conspired to create an atmosphere of coercion that was meant to solidify vestiges of the antebellum land use organization of the territory. By extension, the transformation of freedman into wage laborer and not freehold farmer served this goal, and was shaped by thousands of small actions. The planter class conspired to make the plantation the persistent organizing unit of the south, and used legal and extra-legal means in the surrounding physical and political environment to achieve that goal. Canal work, a only barely tolerable alternative, had the advantage of paying in cash—something the cash-starved planter class could not offer—and therefore at least posed a pathway to eventual land ownership. The reality, however, was an extension of antebellum ways with a fiction of “wages” overlaid. The war had destroyed one “environment,” and the Black Codes and Jim Crow extended the regime of degradation so that no brighter future might emerge from its ashes. There is too little written evidence on the federal engineering camps to definitively describe them as relative safe havens from the malignant countryside; unfortunate as these sites likely were occupied by black women, whose perspective is underrepresented. Though beyond the scope of this study, these islands, among the first laboratories in which the black proletariat was formed, likely formed a root of the Great Migration—a tree that came out of a ground of adversity. Social forces, in Alabama and elsewhere, were simply too invested in the disruption of black communities for the environment’s hostility to ever abate. Both the war and Reconstruction
fused of social violence with a general landscape of hardship, poverty, privation, and ecological change that made it difficult for those experiencing it to easily separate.129

**Ordering and Managing the Material World**

In the army’s pre-Taylorist organization of labor, engineer officers relied on the embodied knowledge of the material world in their employees to guide their design and expectations of time it took to complete tasks, and even if a task were possible. Management of a project was effective only if an officer was skilled at gauging the skills and knowledge that his workers possessed. Officers who were most effective in developing this skill often were predisposed toward knowledge of nature, materials, an intuitive understanding of complex structures (such as those woven out of willow branches), and a keen sense of the work it took to reshape topography.

In describing phenomena beyond his direct and total control, Craighill usefully equated “[u]nmanageable labor and bad weather.”130 Labor, with its deep knowledge of the microphysical properties of an immediate environment, was at its base a force that could be directed and worked with. Engineering became an extension of a specific kind of knowledge through the embedded knowledge in the aggregate of massed workers. An approximate process, this was generally the practice that reshaped the natural world.131

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130 Craighill to Newton, July 8, 1884, Box 255, E71-RG77, NA.

131 The framework of tacit and embodied knowledge I reference here is explicitly based on Harry Collins, *Tacit and Explicit Knowledge* (Chicago and London: University Of Chicago Press, 2010); see also Michael Polanyi, “The Logic of Tacit Inference,” *Philosophy* 41, no. 155 (January 1966): 1–18; Michael Polanyi, *The Tacit Dimension* (Chicago: University of Chicago Press, 2009); Harry Collins and Robert Evans, “The Third Wave of Science Studies: Studies of Expertise and Experience,” *Social Studies of Science* 32, no. 2 (April 2002): 235–96. The jobsite, where the river’s hydraulics, the strength of local materials, and the vagaries of the angle of repose of the banks were all laid bare, was the site of what Collins calls *ostensive knowledge*—that knowledge which is too complex to be realistically conveyed in text or spoken, and is best transferred or made explicit by reference to the object. Collins
includes not only the object that must be observed, but also the practices that have accumulated around it, as the root from which explication of that tacit knowledge can spring. See Collins, *Tacit and Explicit Knowledge*, 93.
Engineering during Reconstruction relied heavily on the accumulated tacit knowledge of southern environments in the bodies and minds of its workforce, largely composed of black men who learned these skills under slavery. The fruits of engineering that relied black empiricism and black knowledge have been well-studied in other landscapes structures through the South, with some historians drawing attention to the importation of certain landscape technologies from West Africa.132 For the purposes of this study I want to concentrate on the knowledge produced through interaction between humans and materials under the engineers’ direction at this moment in labor and technological change. On the Tennessee River at Muscle Shoals, the engineers developed teams of men skilled at “rock work”—that combination of masonry and hydraulics in the dangerous pursuit of reshaping the underwater contours of the river. Major King had a hand in giving these groups of men autonomy to develop their own practice of work and whose growing skill and prowess made the argument for hired labor over contract work more forceful.

Rock workers, who included skilled quarrymen, were never mentioned by King as being African American, but photographs King made indicate that, with the exception of a smattering of white foremen, these skilled workers were black.133 Though the discussion of skill begins with the men who worked stone, this is only because explicit reference to skill in the archives relates to these men. I believe this to be more of a result of the recording engineers’ priorities, and argue that the engineers codified their notions of natural phenomena through not just the masons and


133 King to Humphreys, August 30, 1876, Box 86, E71-RG77, NA; King to Chief of Engineers, August 25, 1877, Box 101, E71-RG77, NA; King to Chief of Engineers, February 19, 1878, Box 105, E71-RG77, NA; King to Chief of Engineers, July 8, 1879, Box 127, E71-RG77, NA.
quarrymen, but through the hands and minds of all the other workers as they struggled with various materials. As they possessed knowledge of both the engineering works and the natural world surrounding those works, the workers were more valuable and valued than the records indicate at first glance.

The varying geography across the South caused the engineers and workers to reckon with constraints of the inorganic substrate that necessarily embedded their projects specifically in their own locality. Muscle Shoals cut through a fractured limestone bed, mixed with flint, and bearing the scars of ancient glacial activity that left erratics that needed to be dealt with in the engineers’ plans. The lack of any stone of sufficient structural characteristics at Cape Fear meant increasing logistical acrobatics to bring granite from places as far away as New England to the site. Material scarcity necessarily imposed a design constraint, making the sizing of a structure, or the force of the river possible to counteract, a function of freight rates on both rail and coastwise vessels. In conjunction with quarrymen, the engineers became accustomed to assessing landscapes for how much structure they could extract from them. McFarland became so good at this he could survey from the surface an area of exposed rock and estimate the dimensions of a dam that could be built from it, taking into account structural parameters in his estimation. Stone cutters and quarrymen were the last to be laid off in time of constrained finances; their skill and the constant maintenance the quarries needed to keep them in working condition proving to be the crucial nexus of the project.134 Though the engineers had learned rudimentary stereotomy at West Point,

134 Walter McFarland, “Notice to Contractors,” April 20, 1872, Box 19, E71-RG77, NA; Craighill to Humphreys, October 19, 1872, Box 26, E71-RG77, NA; Craighill to Humphreys, October 26, 1872, Box 27, E71-RG77, NA; Craighill to Humphreys, February 9, 1877, Box 93, E71-RG77, NA; Craighill to Wright, January 2, 1880, E71-RG77, NA; McFarland to Humphreys, July 31, 1872, Box 22, E71-RG77, NA; King to G. G. Dibrell, September 24, 1879, Box 131, E71-RG77, NA; King to Chief of Engineers, December 6, 1879, Box 134, E71-RG77, NA.
the masons’ skills—of different quality and across geological regions—afforded any action desired by the engineers.

The perennial problem, both from a structural and labor perspective, was the mud. The Southern landscapes the engineers worked in were often semi-liquid, changeable, and difficult to achieve integrity or tensile strength both for the structure to rest upon, and for the operations to build it to be carried out. Military engineers had long dealt with the longstanding environmental enemy of mud, and brought their practices to the jobsite. Gillmore, who first encountered Southern muck during the war, described his frustrating experience in Georgia:

Jones Island is nothing but mud marsh, covered with reeds and tall grass….It is a soft, unctuous mud free of grit or sand, and incapable of supporting a heavy weight. Even in the most elevated places, the partially dry crust is but three or four inches in depth, the substratum being a semi-fluid mud, which is agitated like jelly by the falling of even small bodies upon it, like the jumping of men, or the ramming of earth. A pole or an oar can be forced into it with ease, to the depth of twelve or fifteen feet. In most places the resistance diminishes with increase of penetration. Men walking over it are partially sustained by the roots of reeds and grass, and sink in only five or six inches. When this top support gives way, they go down from two to two and one-half feet, and in some places much further…. This labor is of the most fatiguing kind. In most places the men sank to their knees in mud, in some places, much deeper. Unsteady ground was not only a military concern, and the search for tensile strength embedded within plastic materials like soil occupied various builders and engineers from antiquity through the advent of reinforced concrete, intriguing some of the most luminous minds in Western science. Fundamentally it remained a material problem, one that was addressed with


traditional heuristics. Some iron pieces were used to reinforce important masonry structures, but the vast majority of the work entailed the tedious process of brute force assemblage of fibrous plant material—in any shape and configuration that worked—onsite and as the product of many hands.\textsuperscript{137}

The engineers built these projects with local materials which dictated adaptation to local construction practices. Beyond adaptation to existing landforms, and as a consideration of practical design, the engineers brought a “desire to utilize the materials of the country” to their projects—a product of a construction world that lacked logistical structures necessary to impose global or even national building practices across large swaths of territory.\textsuperscript{138} Construction therefore entailed botany, and use of the agricultural networks and wild resources of the countryside to procure supplies needed to keep the projects running. George Williams’ checkbook reveals a network of provisioners who provided the timber and brush for construction, while also supplying food for workers and animals. Corn and sisal rope made up significant contributions to the structural and energetic composition of the project. Specialized local knowledge of botany played an important role in landform construction and maintenance. The varieties of species in the genus \textit{Spartina} were identified by locals at Cape Fear and supported by the government engineers in selecting which species to encourage. The engineers asked that this plant material was apportioned in the ancient form of fascines, indicating that this botanical

\textsuperscript{137} “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” February 7, 1876, Box 82, E71-RG77, NA.

\textsuperscript{138} McFarland to Humphreys, November 29, 1875, Box 78, E71-RG77, NA; Craighill and Bixby, “Improvement of the Cape Fear River.”
knowledge, though not immediately explicit to the engineers, had retained persistent form since 
the early Roman period.\textsuperscript{139}

The engineers made a few attempts at experimenting with biotic structures and the 
maintenance-intensive work of continuously molding the muddy landscape, but more often these 
 attempts produced frustration and left a desire for a more permanent solution. O. M. Poe, an 
engineer in charge of the shipping channel through the Saint Clair Flats near Detroit, dutifully 
tried to maintain a muck dike with mats of marsh sod cut from surrounding wetlands. He found 
the practice frustrating:

\begin{quote}
It can only be done at great expense, and the effect of loading the sides of the channel 
with the great weight of the dike-filling is undoubtedly to assist any tendency of the sides 
to run into the channel. This is especially the case where any quicksand occurs … [the] 
thousands of yards of material dredged from the canal, a considerable portion of which 
will eventually finds its way back into the channel and can only be gotten out of the way 
by dredging.\textsuperscript{140}
\end{quote}

Scaling the smaller practice of biotic structure and manually-intensive maintenance regime failed 
to cope with the larger demands of industrialized economics. The wakes of steamers of 
increasing size pounded the primitive mud structure into dissolution. Poe even indicated a note 
of sadness at the passing of a Dutch-inspired infrastructural aesthetic, writing, “[t]he dike-filling 
adds greatly to the appearance of the work; indeed the dikes, with the growth of willows upon 
them, look beautifully, but I have indicated at what sacrifice.”\textsuperscript{141}

The combination of material inefficiency and reluctance of labor to contribute to an 
exercise that was always tedious and now increasingly futile caused the engineers to begin

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\textsuperscript{139} Ibid.; Craighill to Wright, March 27, 1880, Box 142, E71-RG77, NA; Chamber of Commerce, Wilmington, N.C., 
\textit{Wilmington, North Carolina, Past, Present and Future},, 63–69.; “Improving Cape Fear River, Below Wilmington, 
N.C., Proposals for Furnishing Materials,” July 2, 1883, Box 237, E71-RG77, NA.
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\textsuperscript{140} \textit{ARCE} 1872, 223.
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\textsuperscript{141} Ibid.
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looking at their materials anew. An increased awareness of the circulation of materials of construction followed the rise in availability of Portland cement as a fungible commodity in the late nineteenth century. Regional variations existed, but increased standardization meant that the engineers could, in the absence of naturally-occurring stone, begin to imagine manufacturing masonry units on their own, as experiments at Cape Fear and Galveston indicated.\textsuperscript{142} Rammed hydraulic concrete was widely used at Muscle Shoals to solidify faulty bedrock substrata and make monolithic structural plinths for masonry locks and bridge pilings.\textsuperscript{143} But the engineers, often in their spare time or as part of experimental projects, pushed the material beyond compressive service. This “research” outlines a desire to solve a social and spatial problem with a technology of infinite plasticity and strength, and can explain the zeal with which the civil engineering profession embraced modern concrete construction. It would be another generation before steel-reinforced concrete made large-scale landscape retention an industrially-feasible prospect.\textsuperscript{144}

While purely technical or material solutions were unavailable, the skills of the mass of workers enabled engineering to occur. Payroll records reflect worker specialization and the importance of certain classes of workers to the project’s ongoing integrity and possibility of ultimate success. Levee work in particular—shaping large swaths of water-saturated muck into prismatic form, reinforcing an impossible angle of repose, and at times doing this in waist-deep

\textsuperscript{142} Craighill to Acting Chief of Engineers, June 20, 1879, Box 127, E71-RG77, NA; King to Humphreys, August 14, 1876, Box 87, E71-RG77, NA; B. Wilson to Chief of Engineers, April 13, 1881, Box 171, E71-RG77, NA.

\textsuperscript{143} “Tennessee River Improvement, Muscle Shoals Canal, Specifications,” February 7, 1876, Box 82, E71-RG77, NA.

water—paid the equivalent of skilled masonry, indicating perception of levee maintenance as requiring skill and exceptional toil. The engineers cultivated skilled groups of workers, recognizing these companies as a “force” to be managed like any other naturally-occurring phenomenon. Direct management by day labor exemption allowed them to spend time and effort in developing skilled workers, and the gains in efficacy supplemented the gains in continuity of operation. Skilled outfits, particularly marine construction crews, which one engineer characterized as “capable and efficient men, much sought after in other sections of the country,” could derail progress if they left for other jobs. Where the contract system still reigned, the engineers tried to use the bidding system as a way of encouraging the development of certain skills. Craighill believed that by advertising and essentially baiting construction firms to work on parts of a larger project “develops view of men likely to engage in such a work and will give valuable data for guidance in future efforts to accomplish the end aimed at.” The engineers knew that their own view and knowledge of both the landscape and tacit skill and material know-how had limits. Engineering practice could join with skilled labor to enhance leverage and efficacy over the material world that neither practice could achieve on their own. This concept was an unspoken principle of the engineers’ practice; the majority of their on-site work being to fit and refit the two systems together, requiring vigilance, adjustment, and deep knowledge of the social structures of a jobsite and labor community.

The skilled labor community in the South possessed skills and social structure that had grown along the contours of the natural systems they came from and contended with. These

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145 Claim of George Williams, 81-84.
146 Craighill to Humphreys, April 14, 1875, Box 70, E71-RG77, NA.
147 Craighill to Humphreys, May 14, 1875, Box 71, E71-RG77, NA.
Figure 4.17. Shoal Creek Aqueduct, May 1889. 77-H-2911P-Folder 1, Photographs Division, National Archives, College Park, Maryland.

Figure 4.18. Lock No. 8., November 1887. 77-2911P-67, Photographs Division, National Archives, College Park, Maryland.
natural systems were primarily rivers, forming what the sociologist Harry Collins has termed the *ostensive* object around which knowledge, and subsequently, technical community, was formed. The workers—steamboat captains, levee maintainers, rock workers, salvage divers, rice farmers, lumbermen, etc.—derived their knowledge from the river. Its currents, sands, beds, banks, reedy fens, open estuaries, and town levees taught succeeding generations of “practical river men” an accumulating body of unspoken knowledge.  

This “collective tacit knowledge,” which extended from knowing which grasses are best to plant to hold the slope, to what season is best to dig, or where the treacherous sand formations tend to be each spring, formed the pathways in which “river men” were able to successfully inhabit their environment and operate, both socially and technically, in their community.  

Mark Twain’s famous passage, purportedly from the mouth of a riverboat captain, excoriating the officers of the corps of engineers for their ignorance of this collective knowledge, underscores the existence of this technical community based around the river.  

What Twain neglects or simply omits is the extent to which engineering and construction integrated the practices of engineer and waterman, de-emphasizing the river work’s continuity across class and race. Because engineering was so reliant on real, actionable knowledge of botany, geology, and hydraulics, existing in workers’ minds and not yet made explicit by those terms, nor available for domination by technical competence, the work of

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148 James L. Sloan to Secretary of War, August 8, 1878, Box 113, E71-RG77, NA. Steamboat masters offered their opinion in writing in several instances in the army’s archives for this period: J. B. Sleeth to L. C. Overman, April 1, 1874, Box 55, E71-RG77, NA; J. V. Rice to L. C. Overman, March 28, 1874, ibid.

149 Collins refers to this as “Social Cartesianism,” which (briefly) means that any action made from this kind of tacit knowledge can only be “executed successfully by a person who understands the social context.” Collins, *Tacit and Explicit Knowledge*, ix, 164.

150 “Four years at West Point, and plenty of books and schooling, will learn a man a good deal, I reckon, but it won’t learn him the river. You turn one of those little European rivers over to this Commission, with its hard bottom and clear water, and it would just be a holiday job for them to wall it, and pile it, and dike it, and tame it down, and boss it around, and make it go wherever they wanted it to, and stay where they put it, and do just as they said, every time. But this ain’t that kind of river. They have started in here with big confidence, and the best intentions in the world; but they are going to get left. What does Ecclesiastes vii 13 say? Says enough to knock their little game galley-west, don’t it?” Mark Twain, *Life on the Mississippi*, [1883] (New York: P. F. Collier & Son, 1913), 236.
engineering is best seen as a continuity of activity that extends from the pencil point to the shovel blade—its workings only understood as a mass of social mechanisms feeling dumbly at the edges of vernacular knowledge.

**Conclusion: Paternalism and the Curse to the Soil**

Historians have rightly framed the relationship between white overseers and black laborers as an ugly form of paternalism that spanned Emancipation and formed a continuous state of labor relations well past the Civil War and Gilded Age.\(^{151}\) It would be wrong to underestimate the strength of this disposition as a tradition. Combined with the widespread, crushing poverty of the 1870s in the South, it would be equally wrong to say that the U.S. Government and the Corps of Engineers were free from the taint of exploitation and white-supremacist subjugation that governed labor relations of the era.\(^{152}\) The white engineers were complicit, and inextricably involved. However, among the officers and in their practices, there were glimmers of an ethos that contrasted with the convict-lease system and revanchist plantation regime. As a class, the engineers found distasteful many of the more brutal aspects of Southern work culture, and outright rejected practices when they could. In the formation of the Federal jobsite, their personal politics affected the relationship between a management echelon and black workers. This was a function of both moral suasion and the need to gain and manage knowledge of the natural world—a unique set of moral circumstances at the heart of nineteenth-century engineering practice in the Reconstruction South.


\(^{152}\) Stanley, “Beggars,” 1269.
Though most often couched in subtle reference, the military engineers recognized the effects that their design and management decisions had on the social fabric of the countryside surrounding their projects. An extended purview of engineering management went along with the increased scope of engineering works—creating the Tennessee Valley as a Federal jobsite meant that McFarland and others needed to develop techniques of management that directed labor across a wide territory. Professional ethics and moral disgust with what was considered affronts to civilization led men like McFarland to think of governing the local “class of labor,” as a task not accomplished by overt coercion.\(^\text{153}\) Instead, class relationships were considered as one more function of engineering design, normally expressed through an aloof paternalism and sheltered behind dry legalism. If the building process could be shown to be fair, Weitzel reasoned at the Louisville and Portland Canal, then morale, followed quickly by efficiency, would be improved.\(^\text{154}\) As such, the engineers resisted larger labor and economic trends of the Gilded Age. Frustrated by fluctuations in funding and progress of the work, the engineers worked to create a more stable jobsite, using their professional and military leverage to dampen the wild swings in unemployment of casual labor rampant during the era.\(^\text{155}\) Though this could be seen as wholly pragmatic, the engineers’ lack of monetary stake in the works’ progress indicates that advocating for a stable jobsite wasn’t entirely heartless.

Taken as a whole, the engineers were ill at ease with unfettered free-market ideology represented by the contract system, and made clear their preference for careful management of

\(^{153}\) King to Chief of Engineers, June 19, 1880, Box 146, E71-RG77, NA.

\(^{154}\) Weitzel to Humphreys, November 12, 1870, Box 41, E71-RG77, NA.

\(^{155}\) Stanley, “Beggars,” 1269.
both the project’s administration and the resulting effects on the social landscape.\textsuperscript{156} Their model of aloof administration meant officers were meant to conform to a model of disinterested and non-partisan technocratic factor. Outward appearance was important, and McFarland probably cultivated the image that allowed the Alabamians near Muscle Shoals to praise him as “modest, energetic, sympathetic, honest,” though an agent of a conquering army.\textsuperscript{157} Disinterest was enforced through the ranks—Weitzel writing of one of his subordinates “If [he] has in his management of river affairs, in the least meddled with politics, has been against my expressed wish.” But this discipline was a façade. Officers exercised the paternalist impulse against the reigning white supremacy of the countryside through various activities, all supported by the army’s grander mission. Gillmore’s school projects for the sons and daughters of freedmen, Weitzel’s participation in the army’s ideological purges, McFarland’s naked rage at the employment of convicts, King’s efforts to hire more physicians, build hospitals and institute a large-scale vaccination program—these all were the actions of men motivated beyond the completion of a canal.\textsuperscript{158} The officers’ general resistance to the “Gospel of Progress” of the era, and differing vision of a managed economy based on a sense of equanimity and technocratic efficiency, along with other groups and counter-narratives of cooperation of the era, remains understudied.\textsuperscript{159}

\textsuperscript{156} McFarland took a dim view of profit as motivation to adequately assume the risks involved in this kind of construction, believing that hired labor and the fiduciary responsibility of the officers as U.S. agents were superior, possessing “a fixed view to the interest of the whole community interested in it rather than to that of any one individual.” \textit{ARCE} 1872, 479.

\textsuperscript{157} Tomlinson Fort to Humphreys, April 22, 1876, Box 84, E71-RG77, NA.

\textsuperscript{158} King to Chief of Engineers, January 25, 1883, Box 225, E71-RG77, NA.

\textsuperscript{159} Woodward, \textit{Origins of the New South}, 251.
American infrastructure projects, especially those whose origins were in the landscape of slavery, must be considered in the light of race and the politics of labor involved in their conception, finance, and execution. Though the era is infamous for “pork barrel” and “logrolling” episodes, the politics of job creation during Reconstruction are neither orderly nor transparent. The cynical answer to *cui bono*—that planters turned industrialists, but capitalists all—benefitted from congressional appropriations and siphoned off the lion’s share of the funds only tells part of the story. Seeing instead the black worker as the crucial nexus between material world and state engineering practice casts Reconstruction as a different set of processes. The story of what Susan Parrish has called the “dissident assessment” of the work—though unfortunately incomplete compared to the engineers or capitalists—shows that the laborer who worked with mud, rock, and cane and reed knew better than the powerful men who commanded him how fleeting that natural world would be.  

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Chapter Five

Constructing the Breathing Coast: Savannah, Galveston, and the Expanding Territories of Engineering

In the mid-1880s the army reorganized its engineer corps, delineating engineering districts around river basins as opposed to assembling adjacent projects under one engineer, who happened to be located in New Orleans, or Mobile, or Baltimore, etc. Instead, the engineer corps slowly began establishing divisions divorced from a single officer, whose purviews were coterminous with a river’s watershed. The re-envisioning of the countryside emerged from an organic process in which the army’s traditions, predisposition toward spatial organization, and engineering successes since the end of the war each played a part. First, the U.S. Army’s curious habit of naming grand military units after rivers (see the famed Army of the Potomac, or Army of the Tennessee) carried forward from the war into the organization of Reconstruction military departments. A loose organization around major watersheds, occupation military organization provided a clear template for the military’s conception of the country going forward. Eschewing arbitrary political boundaries, and showing a fine sense of topography, rivershed organization appealed to a military sense of terrain and territory. The most famous contemporaneous example of this sense of organization was drawn by the Union veteran John Wesley Powell when analyzing his data for the fledgling U.S. Geological Survey.¹

The engineers’ reorganization stemmed from a desire to unite territorial control with functional process derived from a river’s energy. This was neither new nor unique: water’s potential energy had been, throughout civilization, a lens through which riparian terrain had been

assessed and fought over. However, in the twilight of Reconstruction and in the context of mounting and blaringly apparent evidence of the power of capital to reshape the categories of both urban and rural, American estuarial rivers and the U.S. state engineers operated in a specific manner. First, cotton as the quarry of increasingly powerful, mobile, and global capital made riverine organization a different beast from squabbles over mill ponds and irrigation rights. Second, the engineers’ success at applying Bernoulli’s principle at Cape Fear and other ports of

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call previously believed hopelessly shallow increased the scale of the government’s ambitions by grooming confidence in the engineer corps’ technical effectiveness.

Driven by strong desire to abet the movement of cotton from the branch to the Atlantic Ocean, both Reconstruction and Redeemer governments exerted pressure on the engineering corps to keep pace with the internationally-determined demands of the textile market. This pressure caused the engineering corps to seek the means of draining the material from the countryside, which, as practice evolved, caused the engineers to optimize existing and potential routes. With no jurisdiction over the rail lines, the engineers focused on the crucial linkage of rail and trans-oceanic travel—the deepwater port. Maintaining that deepwater quality—the criterion shifted as iron hull sizes increased—meant that the engineers had to extend their purview further and further upstream to secure the volume of water necessary to maintain the channel.

This territorial expansion, which created what Susan Parrish has termed the “abstract national assemblage” of water, structure, landscape and regulatory apparatus visible today, combined technological imperative with institutional ambition.³ Their work is one of the more materially-visible (if fluid) instances of state territorialization.⁴ The ability of an abstract notion, such as cotton freight, to seize and shape popular imagination of the infrastructural landscape flows from a strong, shared notion of commercial progress among the elites who used media to promote the benevolence of these landscape forms. Construction and technological justification were only a small part of the popular acceptance of a landscape of engineered territory.


The Savannah Cross Tides

As military governor of the Department of the South, Gen. Quincy Gillmore’s purview extended across the coastal low country from the Florida Keys to the border between North and South Carolina. To the engineer/governor, the landscape presented design and hydraulic regulation problems that can be seen as variations on a theme. The low country rivers such as the St. John’s, the Savannah, and the Brunswick, became sluggish and braided as they approached the sea islands and the eventual debouchment into the sea; the major cotton ports sat on the edge of a zone of intense rice cultivation behind clay dikes and a band of estuary and impenetrable swamp. Warfare and neglect had blocked old routes of circulation through the landscape, and by the end of the war watermen were redrawing the routes through the coastal zone, bypassing existing and customary ports in favor of other more accessible places to transfer agricultural goods. The Reconstruction military authorities attempted to exert regulatory authority over the movement of cotton throughout the zone; piracy and lawlessness in the region emerged, indicated by the need for Federal gunboats to protect large shipments of cotton as they passed through the marshes. Gillmore himself, with his well-known sympathies for the plight of freedmen, was treated warily by the local elites in Savannah, who sought to have him replaced. Despite this, Gillmore’s priorities for engineering the region reflected the desires of the planter and capitalist class. The ports of Savannah, Georgia and Charleston, South Carolina, would under Gillmore’s planning receive significant upgrades as a result of Federal attention.\(^5\)

Harbor planning remained the same conceptually across the South, with the engineers prioritizing maintaining deep water from the open ocean to the docks, over the continually

\(^5\) Gillmore to Humphreys, March 24, 1871, Box 4, E71-RG77, NA; Savannah Daily Herald, August 29, 1865, February 4, 1865, February 6, 1865; Belknap to Savannah Chamber of Commerce, September 17, 1872, Box 22, E71-RG77, NA; Gillmore to Humphreys, telegram, February 26, 1876, Box 82, E71-RG77, NA; Gillmore to Humphreys, March 1, 1876, Box 82, E71-RG77, NA.
accumulating sand and silt that formed treacherous obstacles on the harbors’ floors. Charleston harbor was a wide tidal basin with a narrow entrance between Sullivan and Morris Islands. Littered with wrecks, both placed as obstacles or sunk during fighting, the harbor’s dynamics were closely watched by local pilots, who noted changes throughout the system and ascribed the changes to accumulated maritime debris. Gillmore and the engineers’ work largely consisted of salvage and clearance of obstructions to ensure the smooth flow of water and maximize the
power of the ebb tide to clear the channel. In this way, the Charleston project was representative of the most basic function the engineers wished to shape the river into: the orderly, diurnally-pulsing, sand-clearing engine.⁶

Though conceptually similar, the transformation of the Savannah River estuary proved more complex and involved. Clogged with “cribs, piles, scows, vessels, and other property,” the long estuarial approach from the Tybee roadstead to the city docks made for “difficult work” even “in calm water.” After dormancy during the wartime blockade, the military occupation reopened the port—the local newspaper likening the flood of returning ships brought by Sherman’s occupation to Aladdin’s lamp. However, the dissolution of the rice levees, the neglect of the channel by city authorities during the war, and wartime destruction had caused the river to technologically regress. “It is a turbid stream…always carrying large amounts of mud and silt in

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⁶ “Specifications Relating to the Construction of a Jetty at the Harbor of Charleston, South Carolina,” July 29, 1878, Box 113, E71-RG77, NA; Gillmore to Humphreys, January 30, 1871, Box 3, E71-RG77, NA.
suspension,” wrote Gillmore’s surveyor. Crowded conditions acted upon by tides made the harbor the site of collisions. Upstream, shallow and unmaintained, the river was only pliable by light boats; watermen brought about a “revival of the primitive style of boating.” Fleets of “Petersburg boats”—sixty to seventy feet long, flat-bottomed, and only seven and a half feet wide at the beam—plied the marshy backwaters. Laden with cotton and manned by black crews who lived and worked onboard, the simple and distributed infrastructure was perceived as inadequate and unmodern. Federal funds of a substantial enough nature to change the estuarial environment and make it more amenable to modern shipping arrived in 1870. Wresting an active power out of these types of rivers and landscapes, which Gillmore described as “a wide sluggish sheet of water, more resembling a lagoon than a river,” required heroic intervention.7

Figure 5.4. Coast Survey chart of Savannah River and Tybee Roads, Georgia, with ms. markings by Gillmore, ca. 1870. National Archives, Atlanta, Georgia.

7 Gillmore to Humphreys, February 3, 1868, Box 12, E25-RG77, NA; Savannah Daily Herald, March 23, 1865, June 10, 1865; ARCE 1872, 655-659; ARCE 1879, 750; Savannah Morning News, February 1, 1869, March 17, 1870; ARCE 1869, 266.
The search for more power pushed the scope of the project outward in area and volume. Gillmore, who was originally instructed to only consider the river from the roadstead to the city docks, soon extended his surveys roughly another eight miles upstream to where the Savannah split into the “Front” and “Back” branches. The river slowed as it approached the sea, and the different branches of its braided forms had gained names. The Front River, the segment used for navigation, flowed southernmost and past the city docks. The Back River flowed roughly parallel and north of its sister, separated by Hutchinson’s and Elba Islands, among others, all occupied by rice plantations. Gillmore concluded the Back River posed the problem: it stole water from the Front River, diminishing its usefulness “by reducing its flow … [and] decreas[ing] its capacity to maintain its proper depth.” To apprehend the scope of the landscape problem Gillmore launched a massive data-gathering operation on the delta, “consisting of measurement of two ~700’ bases, erection of tide gauges, 30 days tidal observations, 61 signals built and determined by 311 angles, 6847 soundings taken, 708 sextant angles measured, 500 current observations.” Geometricizing preceded the abstraction and manipulation of the braid. Modifications were justified from the calculations, which were plotted and published for public view within a month of the survey.⁸

Different factions of delta inhabitants conflicted over the altering the river’s existing hydraulic system. Shipping interests and the engineers agreed on preferring the Front to the Back River, and altering the structure to increase the volume at the stream that passed the city docks. In their design, the Federal engineers built off existing proposals to close of the “lateral outlets” of the stream for as much of its length as possible. As the design took shape with input from city engineers and Gillmore’s colleagues in the Federal engineer corps, consensus built around the

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⁸ Gillmore to Humphreys, August 28, 1872, Box 24, E71-RG77, NA; Gillmore to Humphreys, July 8, 1872, Box 21, E71-RG77, NA; Quincy Gillmore, “Report of Operations Connected with Resurvey of Savannah River, Ga,” March 4, 1873, Box 31, E71-RG77, NA.
Figure 5.5. Map of Savannah River from the Cross Tides to the Head of Isla Island, 1852. National Archives, Atlanta, Georgia.
Figure 5.6. Chart of the Junction of Savannah River at the Cross Tides, showing the location of the dam, 1875. N91-1, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.

Figure 5.7. Sketch of Proposed Temporary Dam at Cross Tides, 1875. N91-3, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.
conception of the braided landscape as a branching network of sluices that simply needed more valves. Gillmore decided to place the first control “valve” where locals had historically agitated for one: at a small watercourse between the Front and Back River at the north end of King’s Island, called the “Cross-Tides.” Calculating that two-thirds of the total flow of the river went through the Back River at this point, Gillmore aimed to flip the ratio. Savannah residents, who lived on the southern, Georgia side of the river, applauded the Federal decision. They had long considered the Back River a menace due to its power to draw water an “obstruction to the natural flow” in the direction of the city. The first structures erected by the engineer corps merely deflected the river’s flow and encouraged the ebb tide to choose the southern branch, but as was typical of their process, the engineers soon began to consolidate and strengthen the structure as to approach permanence. In keeping with the idea that the flow of water was dynamic and that a fine-grained level of control over the volume produced by the landscape was desirable, Gillmore’s final design, under construction in February 1876, was of a type of needle dam with removable segments to shape the volume of water allowed to pass.⁹

On the north side of the river, the planters’ reaction was swift. Gillmore’s structure’s alterations to the hydraulic system had dramatic effects on both the economic and ecological landscapes downstream. Planters and small-time farmers had historically calibrated the size of their levees to periodic freshets and flooding that completely submerged the wild marshlands and came near the tops of their protective dikes. Gillmore’s hydraulic manipulation upset the balance

between the preexisting engineered landscape and wild ecological zones that existed in tension, threatening both. Too much water interrupted the rice crop more than once in the few years after the war’s end, and the prospect of even slight agricultural damage consistently triggered panicked responses from the capital-starved planter class. “The tidelands cannot again be overflowed,” was the definitive statement of the Savannah city government upon directing repairs to be made in the Central Railroad levee which failed catastrophically in the summer of 1871. Landowners were accustomed to pursuing remedy for damages (or potential damages) through the legal system, and the local courts were more sympathetic to agriculture than to
transportation and freight. Soon after commencement of construction of the Cross Tides structure, the courts sided with the chorus of angry planters supported by the state of South Carolina, issuing an injunction against the corps’ work at Cross Tides and naming Gillmore himself in the order. The planters argued that the U.S. works considerably damaged the functioning ecosystem of the valley, linking the destruction with a more abstract violation of their territorial rights. Abetted by Georgia cotton interests, Federal priorities prevailed, and the injunction was lifted, contributing to the precarity of rice cultivation and planter lifestyle further downstream. Though Gillmore specifically noted in his papers concerning the lawsuit that he and Post, the on-site supervising engineer, endeavored to make adjustments to the hydraulic system gradually and with an eye toward not disrupting the planters’ operations, the limits to Federal control were inevitably met. It is impossible to reconstruct the exact proportion that projects like Cross Tides assisted in the decline in rice cultivation in this ecological zone. The general volatility of the landscape, told by the plight of freedman homesteaders on sea islands, may have played more of a role in the decline of an agricultural mode that required slavery to maintain adequate levees. That the planters seized on the Cross Tides dam, and a blue-coated federal military officer as the objects of their rage may be more telling of a projection of the causes of devolution as a matter of convenience.


11 Supreme Court of the United States, No. 8 Original, Term 1875, State of South Carolina v. State of Georgia, Alphonso Taft, Secretary of War, A. A. Humphreys, and Q. A. Gilmore [sic], Box 80, E71-RG77, NA; ARCE 1876, 433-7; D. H. Chamberlain, Governor of South Carolina, to T. J. Robertson and S. L. Hoge, March 18, 1876, Box 83, E71-RG77, NA; “Statement in the matter of Obstruction in Savannah River, Sent by J. J. P. Smith, in behalf of Planters,” n.d., ibid.

12 The geographer Craig Colten highlights the Cross Tides case as a key moment in the shift from legal prioritization of navigation over traditional riparian rights derived from English common law. See Colten, Southern Waters: The Limits to Abundance, 136.
Solving the problem of the Front and Back rivers may appear as a two-dimensional problem—best solved with a compass, ruler, and a map—but this conception conceals the actual aim of the design process, which was volumetric. As the object of the design linked force at the harbor mouth with volume of supply in the watershed, increases were seen as proportional, and the engineers looked to the geometry of the volumetric vessel upstream of the object they wished to force. Soon after the injunction was lifted, Gillmore, the supervising engineers, and the local city authorities began the process of rationalizing the flow of the river from the Cross Tides down past the city docks and out to Tybee Roads. Construction of a series of training walls that extinguished as many of the lateral outlets as possible concentrated the flow of the river and disconnected swaths of tidal marshlands. Categorizing the creeks into the marshlands as “gaps” in the constructed line, the corps worked progressively downstream from Hutchinson’s Island, adjusting the volume of flow in a sinuous, gentle curve that followed and hardened the river’s gesture. The concentration used both ebb and flow tides, transfiguring the stream into something akin to a large, pumping piston. Federal control of the river for navigation purposes would extend upstream past Augusta by the end of the decade. Gillmore’s statement in 1882 indicated that the corps had developed an “enlarged plan of improvement,” considering the river as one entire project, consolidation sought “to render said improvement practically permanent.”

**Landscapes of Volume and Force**

Antebellum Federal engineers had sought the use of the “tidal wave” in clearing coastal ports, and the principles of velocity of an incompressible fluid behind such schemes were well-known.

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13 Gillmore to Humphreys, January 30, 1871, Box 3, E71-RG77, NA; Gillmore to Humphreys, March 19, 1879, Box 122, E71-RG77, NA; *ARCE* 1880, 933-940; Gillmore to Chief of Engineers, October 23, 1880, Box 150, E71-RG77, NA; *ARCE* 1882, 1143.
intuitively—though accurate scientific description remained obscure. In the decade before the war, the chief of engineers, Joseph Totten, had discussed with Jefferson Davis, then the War Secretary, “Mr. John Scott Russel’s experiments” on harnessing the “tidal wave” in Glasgow harbor. “[T]he ebb current, acting as it would with a greater momentum,” he speculated, “due to its greater volume and velocity, would deepen the outlet.” The relationship between channel restriction and “scouring force” was well-known, even in the non-trade press. There is some indication amongst the engineering harbor reports salvaged and scrutinized by later engineers that Alexander Dallas Bache, head of the Coast Survey, had framed harbor surveys around analysis of hydraulics specifically to this end. This way of perceiving the lower reaches of coastal rivers spawned an engineering conception that was to have effect on the form and scope of the engineering projects. Captain Charles Howell illustrated this mindset best, writing: “The river banks are natural jetties, concentrating the outflow of the river and forcing it to work in a given direction.” It was with relative ease, therefore, that the engineers at Savannah could declare that a survey “at least as far up as the town,” was deficient, as effective power needed to be gathered much further upstream than the city docks. The engineers realized that small-scale “examinations” were “necessarily incomplete.” An increase in scale and the projects’ territorial reach was linked with a similar conception that nature too worked on a larger scale. Working at the scale of a map, the engineers interrogated the forces in the space preventing that “the approach to Savannah would have become a marsh, instead of a ship channel.” As the ambitions grew, skepticism emerged about the ability of engineers (especially in the context of antebellum funding and the state’s ability to command labor) to maintain control over an entire harbor or

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14 The relationship between upstream volume and correct sizing of the “tidal prism” at the harbor entrance would only be determined in the late 1930s by an engineer named M. P. O’Brien. See Willard Bascom, Waves and Beaches: The Dynamics of the Ocean Surface (Garden City, NY: Anchor, 1964), 248–49.
Figure 5.9. Sketch of tide gauge stations along the Savannah River, ca. 1875. N113, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.

Figure 5.10. “Velocity curves at Dr. Reed’s place, Ebb Tide, July 17, 1878. N113, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.
river. George McClellan, who in 1853 surveyed the Aransas Pass and Corpus Christi Bay in Texas, was doubtful the United States could make much of a difference in such a sandy place. Yet after the war, both engineers and previously-skeptical locals were confident in the federal government’s ability to transcend material limits.¹⁵

After the war a shift occurred. As the process of engineering rivers for capacity expanded upland, engineering ceased to be the design and construction of a discrete hardened device that manipulated nature, to a process of assembly of devices and regulations that formed a territorial regime. In the American context, this could not have occurred in Southern landscapes without the perception of chaos, lack of capital, and presence of the occupying army. As the solution to the harbor problem became territorial, the army necessarily found itself embroiled in conflicts from the small-scale drainage of individual farms and the dynamics of tidal action in large swaths of the Southern coast. Evidence of the large-scale and conscious efforts of the federal government to manipulate “that which was formerly left to God or nature” in this era are not as materially prominent as 20th century assertions of power after explicit federal authority extended over the land after the 1927 flood. The process that embedded federal authority, epistemology, and territorial outlook at river entrances (poised to spread upstream) has been obscured. The “fall” of riverborne transportation from passenger steamboats to barges that work the dirty industries of coal and petroleum shifted the romanticized view of American transportation systems to the

¹⁵ Joseph Totten to Jefferson Davis, Secretary of War, July 10, 1854, Box 12, E25-RG77, NA; Savannah Daily Herald, July 15, 1865; William Ludlow to Gillmore, April 20, 1871, Box 6, E71-RG77, NA; Howell to Humphreys, December 15, 1869, Box 14, E71-RG77, NA; Gillmore to Humphreys, March 24, 1871, Box 4, E71-RG77, NA; Ludlow to Gillmore, November 28, 1871, Box 13, E71-RG77, NA; Anderson Report, 3-4; George B. McClellan to Totten, January 13, 1853, Box 129, E71-RG77, NA.
railroad. Consequently, the historiography does not reflect the quiet work of Federal agents to lay
the foundations of watershed control, driven by a desire for more and more volume and force.¹⁶

Repeated mechanical failures pushed the engineers to consider solutions larger than the
scale of the machine and what even groups of machines could realistically be expected to
achieve in the landscape. At the Southwest Pass of the Mississippi the engineers witnessed a
succession of amateurs who had sworn their patented machines would finally solve the silt
problem of the Mississippi delta, only to meet with failure after spectacular failure. Horace Tyler,
who had purchased a license to build “Bishop’s Improved Dredging Machine,” successfully
received a contract for dredging, despite engineers’ protests, after reviewing his drawings, at the
doubtful “stability” of his vessel. Tyler ran into trouble immediately. Aside from “the necessity
of inventing every part of the machine” conveniently left out of Bishop’s patent drawings, the
two enormous iron screws fitted to the front of the vessel essentially assured the dredge would
nose into the first mud bank it encountered and stay there. “Twenty years ago he got a screw on
the brain,” wrote Captain Charles Howell, one of the witnesses to the debacle, of Bishop’s naïve
idea. “It came in a dream and has been a dream ever since.” Other ship-mounted mechanical
solutions were equally optimistic and proved inadequate just as swiftly. A contractor named
McClintock proposed using a centrifugal pump to power water out of submerged hoses, twelve
inches in diameter and held close to the bottom of the river, to counteract the Mississippi’s silt
deposition. There is no indication that Humphreys even responded to what was likely a mirth-

¹⁶ William Hewson to John G. Miller, May 8, 1867, Box 17, E25-RG77, NA; Howell to Humphreys, April 4, 1871,
Box 5, E71-RG77, NA; Coole and Frost, “Introducing the New Materialisms,” 23; Woodward, Origins of the New
South, 125.
inducing proposition. However, the would-be contractors perceived correctly the federal engineers’ own equipment and approach was undersized to the task.\(^{17}\)

As the engineers reconceived their task as stabilizing and amplifying the “axis of scour”—a hydraulic manipulation in large area—they worked to build an internal bureaucracy that could ensure effective management on a geographical scale, and have reach and power enough to making lasting changes in the landscapes upstream. “[T]here must be a general system,” wrote Abbot, when corresponding with the central engineering office in Washington. Abbot went on to suggest that the core of this administrative system be based on structure and principle of the engineering boards in New York, already in use for fortifications and harbor works. “This is the theory,” explained Abbot, citing the distended information gathering networks and consensus-building nature of the committees, “+ I believe it to be sound.” Abbot’s idea of a spatialized bureaucracy that given a mission of acquiring more and more agency over its purview provided the seed for the later Mississippi River Commission, as well as providing a template for watershed governance that would eventually evolve in the corps’ district system.\(^ {18}\)

The construction of administrative capacity largely followed engineering and construction processes that were already underway and had built momentum. George Elliot, the civilian engineer who in 1872 led the surveys to evaluate the upper Cape Fear and Deep Rivers,

\(^{17}\) “Proposals for Deepening and Maintaining a Channel across the Bar of the South West Pass at the Mouth of the Mississippi River,” mss., n.d. (1866), Box 16, E25-RG77, NA; “Bishop’s Improved Dredging Machine for Deepening the Channels of Rivers and Harbors, With a Full Description of the Machine, its Principle and Uses; together, With testimonials from Scientific Men in its favor, such as army officers, civil engineers, &c., &c., from 1859, down to 1866. Patented April 1858,” n.d., ibid.; McAlester to Humphreys, November 15, 1866, Box 16, E25-RG77, NA; McAlester to Humphreys, January 29, 1867, Box 16, E25-RG77, NA; McAlester to Humphreys, March 29, 1867, ibid; Howell to Humphreys, June 13, 1870, Box 14, E25-RG77, NA; McAlester to Humphreys, November 24, 1866, Box 16, E25-RG77, NA, E. B. Bishop to Secretary of War, May 30, 1870, Box 14, E25-RG77, NA.

\(^{18}\) Major Samuel M. Mansfield to Chief of Engineers, March 19, 1884, Box 249, E71-RG77, NA; see Chapter 3 for a further discussion of the engineering boards system; Abbot to Parke, April 20, 1870, Official and Personal Letters, June 10, 1867 – April 20, 1870, HLAP; Cynthia R. Poe, “Reconstructing the Levees: The Politics of Flooding in Nineteenth-Century Louisiana” (University of Wisconsin-Madison, 2006).
reported favorably on the volume afforded by the land within the river’s reach. “The entire country drained by the Deep river, comprises an area of 1000 square miles,” he wrote, “affording an abundant supply of water for a slack water navigation and for mill purposes.” In a shift from the era of designing for flat-bottomed boats on canals to iron-hulled steamers, “abundant supply” became not as much a measure of how many mills could be run, but how much aggregate force could be summoned at the seacoast bar. However, the practice of building rivers for the sole purpose of increasing velocity had its detractors, including both Humphreys and Abbot, who held high positions in the engineering bureaucracy. In his report on one of the many suggested schemes fielded by the engineering corps after the war, Abbot strongly protested cutting through the Mississippi’s meanders to increase the velocity in one straight channel. “The bends in the river are the efforts of nature to reduce the slope, and hence the velocity, to the limits of endurance of the banks,” he wrote. Yet the engineering community, both within the military and those members of the increasingly socially prominent civil societies, seemed less interested in natural “limits of endurance.”¹⁹

Instead, successes at Cape Fear and the Mississippi delta gave credence to the idea that the increase in hydraulic slope and velocity presented a generic and universally applicable solution to the harbor problem. Gillmore was explicit about basing his design for Charleston harbor on the Cape Fear project, and Cape Fear is cited as precedent for Galveston as well. Construction specifications and even the contractors were the same across these projects.²⁰ James Eads’ success in building a narrowing device in the Mississippi delta dislodged that river from its

¹⁹ George H. Elliot to Craighill, May 23, 1872, Box 21, E71-RG77, NA; ARCE 1870, 401-402.

²⁰ Gillmore to Humphreys, March 9, 1878, Box 106, E71-RG77, NA; Tower to Parke, June 9, 1880, Box 146, E71-RG77, NA; “Specifications Relating to the Construction of a Jetty at the Harbor Charleston, South Carolina,” July 29, 1878, Box 113, E71-RG77, NA; Gillmore to Acting Chief of Engineers, October 3, 1878, Box 116, E71-RG77, NA; Post to Gillmore, July 1, 1879, Box 181, District Office, Charleston S.C., Reports re: Exam and Survey of River and Harbor Project, Entry 1142, Record Group 77, National Archives, Atlanta, Georgia.
status as a unique and ungovernable phenomenon as well. In their public and ugly fight, Humphreys had opposed Eads’ plan on the grounds that the geology of the Mississippi basin was uniquely composed of a hard blue clay and that Eads’ structure would dissolve before the river bottom would submit to concentrated scour. Thus the engineers had treated the Mississippi as a special case, one that would simply not submit to the efforts at permanent restructuring carried out at other ports. Eads’s success, which captured the public imagination after extensive lording it over the military officers, cemented the idea that even the mighty Mississippi might be rationalized like any other river. Port Eads and the South Pass were the fall of the Mississippi to the status of general applicability of generic methods, removing any cognitive barrier to the subjection of the entire valley to a semi-standardized global transformation under capital. The transformation of the center of the country into what one resident called “the profound canal,”


22 Humphreys explained his theory of geomorphology to John Ellis, Chair of the committee on Mississippi Levees of the House of Representatives: “Some thousands of years ago, when the mouth of the Mississippi River did not extend further seaward of the diluvial or tertiary coastline than the site of the City of New Orleans now is, the river occupied an entirely different position from what it does now, and the bed of this lower portion lay many feet lower in the thick stratum of hard tertiary clay than it does now. One of the errors of Dr. Carroll [a physician who had suggested what Humphreys took to be an overly-ambitious canal scheme] lies in his assuming that if he could bring the mouth of the river now to New Orleans that the bed of the river would at once sink into an resume the position of some thousands of years ago, in the stratum of tertiary clay. But it would not, The bed would remain where it now is, for the clay is so hard that it wears away very slowly, almost as slowly as if it were of stone, while the banks, which are in great part of soft materials, not coherent, would yield under the greatly increased velocity of current, and at for some distance, above the new mouth. This would give a largely increased width of cross-section of the river in the portion of its length mentioned, and in order that its usual volume should be discharged, an increase in the slope of this section would be required. This is the way in which the lowering of the river surface by another outlet would be best at no great distance above the outlet.” Humphreys to John E. Ellis, February 29, 1876, Box 81, E71-RG77, NA.
and subsequent ecological transformation, resulted from the dispelling of the great river’s aura of exceptionalism.²³

Hydraulic shaping of harbors had become a global phenomenon by the third quarter of the nineteenth century, enabled by increased experimentation and implementation fueled by pressures from capital and circulation of technical documentation of efforts worldwide. American engineers could draw on a wealth of precedents from a variety of geographical areas. The systems engaged at the mouths of the Po, Rhine, Maas, and Vistula rivers in Europe were well known and envied by the U.S. engineers, who in the immediate postwar period did not believe the Federal state had the capacity to enact the same kind of social and physical structure that had been accumulating on the ancient European rivers for centuries. Revetment construction, down to the composition of fascine mattresses and brick patterns for the reinforcement of levees subject to extraordinary pressures, was derived directly from the lowcountry deltas of the Rhine and Maas, though “strict accordance to the Dutch method” was relaxed in the face of different labor and botanical environments in Texas and elsewhere.²⁴ The concave, pincer forms of concentrator jetties at Galveston and Charleston can be traced directly to published works on the Liffey in Ireland and the Swinemunde that empties into the Baltic Sea, both built decades before the American Civil War. The focus on tidal fluctuations came from admiration and study of the Stevenson brothers’ works on rivers of Scotland; the Clyde, Dee, and Cromarcy Firth all mentioned in connection with Savannah, Cape Fear, Ashley, Cooper, and Mobile Rivers, and


²⁴ Abbot to Humphreys, December 22, 1869, Official and Personal Letters, June 10, 1867 – April 20, 1870, HLAP; ARCE 1869, 347; ARCE 1875, 541-542; Tower to Wright, October 31, 1880, Box 160, E71-RG77, NA; H. C. Ripley to Mansfield, July 3, 1880, ibid.
Galveston and Corpus Christi Bays.\textsuperscript{25} The anatomy of far-flung cotton ports, already transformed by colonial powers under pressures from capital, such as the Nile and the port of Karachi, were similarly part of the discourse.\textsuperscript{26}

“There are few maritime constructions less susceptible of general rules and more dependent on local influence than jetties,” wrote Gillmore, quoting the French hydraulic engineer Minard, when nonetheless prefacing a page of attempts at calculation. Techniques of empirically-derived description failed to render an accurate depiction of the forces at play and proved of little use for helping predict the best method of using the tides and basins. As the engineers worked on vast and shallow tidal basins on the Gulf and Atlantic Coasts, they found themselves in uncharted mathematical territory. In the antebellum delta survey, Abbot used Pierre-Louis-Georges Du Buat’s formula when determining velocity and volume of discharge of rivers, which had been empirically derived from Bossut’s observations from the previous century, and there is no indication that he made any use of Prony’s modifications.\textsuperscript{27} Finding the data gathered at the St. John’s River in Florida did not match his projections from Abbot’s formula, Gillmore was forced several times in the 1870s to create a bricolage of equations from other sources. Though he sought and tried the methods of Prony, D’Aubisson, Eytelweir, Rankin, and Weisbach, he again found them lacking and unable to encompass the scope of irregular

\textsuperscript{25} Gillmore to Humphreys, July 25, 1878, Box 113, E71-RG77, NA; as the engineers sought to compare rivers from disparately geographical regions, their evaluative criteria evolved to assign attributes to familiar rivers and search for correspondence in foreign rivers, sometimes just represented by a map. This exercise developed specific ways of looking at hydraulics and topography even if, like Gillmore, one couldn’t “detect any great similarity” between, say, the Clyde and the Savannah. \textit{ARCE} 1873, 746; \textit{ARCE} 1876, 456.

\textsuperscript{26} \textit{ARCE} 1881, 1056-1061; \textit{ARCE} 1875, 558; \textit{ARCE} 1881, 1062.

\textsuperscript{27} Abbot to Humphreys, May 25, 1874, Box 52, E71-RG77, NA; James D. Forbes, \textit{A Review of the Progress of Mathematical and Physical Science in More Recent Times, and Particularly Between the Years 1775 and 1850, Being One of the Dissertations Prefixed to the 8th Edition of the Encyclopaedia Britannica} (Edinburgh: Adam and Charles Black, 1858), 88.
discharge. After setting up a network of gauging stations on the Savannah River, Gillmore’s assistant James Post balked at his ability to synthesize the interaction of river and tide:

Much has been written and many formulae have been deduced from elaborate sets of experiments for ascertaining the volume of discharge of non-tidal streams, but very little or nothing can be found in regard to the application of these or any other formulae to tidal streams.

His solution, which was to divide the tidal basin into sectors, construct curves describing the constantly changing velocity of the river over the course of the tide, and then to modify the curve as the rate changed according to monthly fluctuations in rate of discharge, was as laborious as it sounds. Gillmore lamented the situation, in which they were forced to use “the most complicated forms of equations, with no guarantee that the final result of the calculation can be relied on as approximately accurate.” His equations failing him, Gillmore and the other engineers waded into the uncertainty around river manipulation by resorting to analogy, positioning the state engineer as the conductor of an “equilibrium of forces” that maintained landforms, as opposed to someone who produced fine-tuned machines.

Because of the inherent lack of precision in calculation, engineering conceptually shifted from an operation at the scale of a device to that of a landscape. Cognizant of this shift, the

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28 Though it may be tempting to blame Gillmore’s insufficient mathematical ability, it is useful to remember that he was known as a gifted mathematician as a student, and later instructor, at West Point. *ARCE* 1876, 448-50, 459; *ARCE* 1879, 776;

29 James Post to Gillmore, March 5, 1879, Box 181, District Office, Charleston S.C., Reports re: Exam and Survey of River and Harbor Project, Entry 1142, Record Group 77, National Archives, Atlanta, Georgia.

30 Ibid.

31 *ARCE* 1876, 459, 465.

32 Picon employs a similar construction when describing the relationship between fortification construction and infrastructure in France at the end of the eighteenth century. He uses the terms “simples équipements” and “dispositifs structurants de l’aménagement” to distinguish similarly the conception of certain works as additive and others as playing an essential role in the “dessein global de maîtrise du territoire.” Picon, “Naissance du territoire moderne,” 104.
military engineers resented the ability of civilian engineers and capitalist “inventors” to capture the attention of legislatures with their various “appliances.” Though like that of Eads, the various schemes to concentrate the flow of water in the locality of the bar would work to a certain extent, these devices offered no answer to the question of a long-term solution, and their contracts more often designed to extract as much fee as possible. Though historians have seen this resentment as petty territoriality on the part of the army engineers, they were not without antagonists. This is especially so in the case of Eads, who while collecting one million dollars a year in payments for his work on the mouth of the Mississippi, sought to parlay his success into public mistrust of the army’s competence and gain further contracts for his syndicate, all while using the volumetric data officers like Gillmore were diligently collecting at various locations along the coast.  

Regardless of their bruised reputation, the military extended their surveys further upstream and inland all across the South, and began to experiment with the limits of Federal authority in matters of controlling where ships were berthed and the ability of various enterprises to construct salients into the main channel of discharge. That this charge was impressed upon the local institutions is evident in the rhetoric around these projects, such as the Galveston News publishing in 1876:

How shall the laws of nature be controlled so as to preserve for commerce the present facilities of the Galveston channel, and even to increase them? ... Every drop of scouring water must be carefully husbanded, no obstruction to its free flow allowed, and all carefully guided along the channel. Restrain the prolongation of the wharves, conform their heads to the natural curve of the bayou, (or channel) leave the space open beneath them, avoid obstructions in the channel as depth, resist with arms, if need be, the occupation of the flats....

33 H. N. Armstrong to Humphreys, January 1873, Box 30, E71-RG77, NA; Mansfield to Chief of Engineers, March 19, 1884, Box 249, E71-RG77, NA; ARCE 1879, 784.

34 Gillmore to Humphreys, August 13, 1875, Box 76, E71-RG77, NA; A. M. Lea, “Galveston Harbor,” Galveston News, October 2, 1876, Box 87, E71-RG77, NA.
What emerged was a working theory of the landscape, and especially wetland and marsh, acting as temporary, diurnal reservoir component of a pulsing or breathing conduit.

In this systemic conception of rivers, the watersheds gained more measurable components as the engineers developed their reservoir theory. Karachi, the port used as precedent with the simplest form, had no feeding river, and the daily volume available was easily calculated. At all other ports, the conceptual transformation of linear landscape to reservoir became a more difficult problem. As “securing a much greater volume of water” became the key objective of design, the engineers sought saturated and semi-saturated lands yet unclaimed by private landowners to fill with water. In areas where powerful tidal dynamics did not exist, or were relatively gentle, such as at the Brazos River in Texas, the engineers aimed to alter the landscape in order to strengthen the tide’s power. Like at Charleston Harbor, where “[t]here is plenty of water inside,” the engineers looked to large energy-less masses of water and strategized about extracting energy in a favorable vector. The momentum around the idea of systematic leveeing further and further upstream, and the closing off of natural outlets in the “overflowed districts” there, supported the idea of concentration hydraulic force in a productive direction. The engineers realized that productive force would come from some system of reservoirs which could supplement the flow when needed. In their deliberations, they drew on precedent of canals, the design of which usually contained a reservoir of water at its high point to maintain appropriate levels throughout the system. The difference between the volume of water needed for a canal versus a tidal river, however, is vast. Gillmore noted Minard’s research into the use of swamps and marshes as potential reservoirs, including the French engineer’s assertion that they needed to be protected from silting. Swamps, however, were rare in the upper rivers of the South, where planters had driven slave gangs to drain and reclaim much of the land to put under
Figure 5.11. Sketch of dam placement to concentrate tidal force at Brazos Santiago, Texas, 1881. Q432, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.
cultivation of cash crops. This forced the engineers to use coastal wetlands in the unreclaimed bays, or find places upstream to build reservoirs from scratch. The same social pressures calling for higher and higher levees also blocked the engineers from planning a series of riverside reservoirs upstream. In the original report on the reclamation of the Mississippi Basin, published in 1875, Abbot and Warren and the other engineers on the board found the idea of reservoirs “attractive,” but noted that the plantations had already reclaimed the most favorable reservoir land and had put it to cotton, and that no conceivable political will existed to seize it in the name of common good.\(^{35}\)

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\(^{35}\) Joseph Totten to Jefferson Davis, July 10, 1854, Box 12, E25-RG77, NA; Maj. Samuel Mansfield, “Project for the improvement of the mouth of the Brazos River, Texas,” August 16, 1880; Box 153, E71-RG77, NA; Gillmore to Humphreys, January 30, 1871, Box 3, E71-RG77, NA; Daniel J. Murphy to J. C. Proudmore, May 27, 1867, Box 17,
Landslapes that underwent transformation as the engineers searched for and extinguished any impediments to velocity bore little in visual evidence of their capture under federal control. By the mid-1880s, the sluggish estuaries of the St. John’s River and Cumberland Sound could only measure federal presence by the presence of a dredgeboat and some scattered tidal stations. The real impact was the extension of federal control in an apparatus that was suited to evaluate volume and force derived from that volume, a systematic harvest of data that would represent a specific construction of nature to the federal bureaucracy, with ramifications extending well past the lifetime of the significance of the factors that caused the system to be put in place in the first place. By 1927, paddle wheeled cotton boats were gone, but the system of acceleration laced into the landscape was still firmly part of federal engineering policy.

**Engineering in the Popular Imagination**

The army engineers relied on cooperation and concordance with the public to execute their designs. Though publically the engineer corps maintained that it enacted the will of the representative government, the engineers were not above manipulating the perception of their work and warning of the consequences of not heeding their expertise. Generally the military was not popular with the general public of the South, and attempts to manage their public perception were generally anemic, if not an aspect of their work largely ignored. With members of congress, however, they assiduously cultivated relationships, knowing that the power of budgetary allotments flowed through the lower house, especially. The engineer bureau accomplished this

E25-RG77, NA; *ARCE* 1880, 989-991; the C&O canal, a tiny creek compared to a river like the Savannah, was referenced explicitly, see ibid., 990; *ARCE* 1875, 540.

36 John Mecham to William Ludlow, December 25, 1868, Box 12, E25-RG77, NA; *ARCE* 1873, 750; *ARCE* 1876, 448-450; discussion of tide gauge networks can be found in Gillmore to Humphreys, July 15, 1878, Box 112, E71-RG77, NA; “Report of Operations Connected with Resurvey of Savannah River, Ga.,” March 4, 1873, Box 31, E71-RG77, NA; Gillmore to Humphreys, March 14, 1878, Box 107, E71-RG77, NA.
by adopting what could be termed a whiggish valence to their work and purview: that their expertise in everything from regional-scale hydraulics to construction methods would benefit the growth and strength of the nation. This was framed primarily through the language of economics, even if the public works were more of a symbolic landscape of progress than an efficient economic infrastructure. Regardless, the engineers shaped the ability of the congressmen (and to a lesser extent, the different factions of the general public) to imagine infrastructure, and to believe the transformation of the landscape was to some national benefit.

Members of congress from the New South, both Republican and Redeemer, hungered for evidence of potential projects which would transform the South, and were eager and driven to support the processes of modernization. They flooded the engineer bureau with requests for spatial and economic data. The Commerce Committees in both houses of the Federal legislature relied on the War Department to provide regular updates on the status of construction initiatives and commercial activity throughout the occupied South. Members in these committees soon learned that macroeconomic and spatial data beyond the mission of the Freedman’s Bureau could be found in the engineer bureau’s files. Senate subcommittees looking to organize investigations into transportation networks, such as Senator William Windom’s “Committee on Transportation Routes to the Seaboard,” explicitly used the army as agents on the ground and to produce data and analysis used to garner political support. Legislators without the power to compel the army to conduct surveys and studies nevertheless followed the movements of individual officers, divining the trajectories in the grand design with a view to bending existing projects to their advantage if Federal attention strayed close enough to their interests. Some congressmen even
displayed a minute and particular interest in the finer points of hydraulic surveys, and even asked about specific underwater formations.\textsuperscript{37}

The relationship between congress and the engineer bureau changed as members of both organizations fashioned a common language that acknowledged the currency of the other’s rhetorical structure, and how value was determined in the two institutions. Congressmen wrote of the size and capacity of watercourses; the engineers framed their projects in terms of economic benefits and political feasibility. In the decades after the war, however, the scales tipped. Expertise and technical questions came to dominate the discussions over the relative value of engineering projects. Though their relationship was symbiotic and powerful congressmen were still seen as the prime “movers of the work,” legislators came to rely on the engineers to provide the bulk of the justification behind a projects feasibility and appropriateness.\textsuperscript{38}

Humphreys and other leaders in the engineer bureau changed the legislature’s perception of engineering projects from a problem solved with funding to a complex operation that needed to be planned, funded, and managed over a period of time in order to be successful. Projects’ inherent complexity affected the way they were spoken of in political circles, effectively changing Congress’ conception of the work from interventions dispatched within a fiscal year to an ongoing, expensive, and technically-demanding restructuring of the economic landscape. This shift was brought about by the engineers, who worked to explain to congressional contacts the increasing complexity of the activity. A prime example was the question of dredging.

\textsuperscript{37} Humphreys to Secretary of War, January 30, 1871, Box 1, E71-RG77, NA; W. R. Price to Humphreys, January 20, 1871, ibid.; E. J. Holladay to Humphreys, February 28, 1872, Box 17, E71-RG77, NA; House Resolution, March 11, 1872, ibid.; Senator William Windom to Humphreys, August 25, 1873, Box 39, E71-RG77, NA; Robert B. Vance to Humphreys, December 11, 1874, Box 56, E71-RG77, NA; A. J. MacIntyre to Humphreys, December 16, 1871, Box 12, E71-RG77, NA; Robert J. Mills to Belknap, December 31, 1874, Box 62, E71-RG77, NA.

\textsuperscript{38} Joseph E. Brown to Alexander Ramsay, Secretary of War, January 14, 1881, Box 166, E71-RG77, NA; D. M. Du Bose to Belknap, December 24, 1872, Box 30, E71-RG77, NA.
Humphreys faced an uphill battle when convincing the legislature that seasonal dredging of the Cape Fear River was pointless when compared to the vastly more complex and expensive (and less certain) project of converting the estuary into a self-sustaining tidal system.\textsuperscript{39} Once convinced of the engineers’ projects’ abstruse complexity, legislators relied on the bureau to set project parameters and funding requirements.\textsuperscript{40} In several instances, the light of congressional attention only shone on specific projects after the engineers had commenced preliminary work and established the project’s objectives.\textsuperscript{41} Internal memoranda in Humphreys’ correspondence files indicate that though the engineers projected objectivity outwards, a political calculus played a role in any “engineering question.”\textsuperscript{42} Political assessment included placating local interests and ensuring that the projects fit into a national symbolic scheme in words and phrases that were important to Federal-level elected politicians.\textsuperscript{43} An individual’s ability to speak both languages and present themselves as figures of authority in legislative venues gave military officers considerable power.\textsuperscript{44}

\textsuperscript{39} Humphreys to Secretary of War, January 2, 1872, Box 13, E71-RG77, NA.

\textsuperscript{40} Frederick A. Sawyer to Belknap, February 20, 1873, Box 31, E71-RG77, NA, Sawyer to Belknap, February 27, 1873, ibid.

\textsuperscript{41} Senate to Secretary of War, April 25, 1878, Box 109, E71-RG77, NA; Matthew C. Butler to Humphreys, May 20, 1878, ibid.

\textsuperscript{42} Andrew Humphreys, untitled ms. memorandum, n.d. (October, 1875), Box 77, E71-RG77, NA; Gillmore to Humphreys, October 12, 1875, ibid. In this memorandum, Humphreys comments on the selection of dam type to be built in Savannah, stating that if a dam without a sluiceway “is built, without anything of Congress, we will have trouble.” Though supplying Congress with justifications for work, the engineer bureau in turn fell back on the existence of an appropriations law to justify its own legitimacy.

\textsuperscript{43} Peter Dax to King, March 22, 1880, Nashville Dist. Engineering Studies, Historical Reports, Entry NA-1666, Record Group 77, National Archives, Atlanta, Georgia. Dax encouraged King to cite John C. Calhoun’s speeches on internal improvements from the first half of the century when fighting for funding with parsimonious senators.

\textsuperscript{44} Gillmore enjoyed a reputation for competence and was sought after to testify before appropriations committees, see Julian Hartridge to Humphreys, March 19, 1878, Box 107, E71-RG77, NA. For an excellent account of how military officers parlayed their expertise into authority in the 20th century, see Theodore Porter, \textit{Trust in Numbers: The Pursuit of Objectivity in Science and Public Life} (Princeton, N.J.: Princeton University Press, 1995), 148–90.
Outside of the federal government, the progress of projects was an obscure force that, when it appeared in various manifestations in the landscape, set off rounds of speculation and anxiety as Southerners imagined the impact of various designs on their daily lives. Linear transportation projects garnered created excitement along the planned “line.” “The people … in the contiguous territory are greatly interested in this very important work,” wrote Alexander Stephens of Georgia of the Savannah River improvements, “and are very anxious to have it expedited.”*45 Infrastructure brought the promise of prosperity, and anticipation was greatest amongst the classes who stood to benefit the most. Contractors, underemployed civil engineers, and surveyors all expressed interest; however, the land speculators and railroad stockholders paid the most attention to the reports of government surveying parties, and made both subtle and overt attempts to influence the final location of the engineer bureau’s “line.” Opportunities for investment abounded. E. J. Cattell, a Philadelphia merchant who encountered a surveying party looking for an inland route that avoided Cape Hatteras in North Carolina, inquired with the engineer bureau if it was a private or government work. Speculators had no qualms about requesting maps of potential canal routes, some demanding maps that the draughtsmen had not yet even completed. One enterprising New York businessman asked the chief of engineers for information about number of rail lines and furnaces in Sheffield, Alabama, prompting the response that the town had not yet been built. Men connected with railroad enterprises emphasized their prestigious positions and supposed professional objectivity as they weighed in on the choice of infrastructural line. Anson Bangs, an engineer who had worked on the Blue Ridge Rail Road, pushed McFarland to select the “Hiawasee Route” for the Southern Canal project, which he felt superior from an engineering standpoint. In the same breath, however,

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*45 Alexander Stephens to Humphreys, August 24, 1878, Box 114, E71-RG77, NA.
Bangs revealed that he was paid for his work on Blue Ridge in stock for a defunct railroad that would become valuable again should the government invest in the Hiawasee Route. Even dull government dredging projects had the power to animate colorful characters in the postwar building boom. Baron Frederick George de Pardonnet flattered the engineer bureau in an attempt to get copies of their maps and plans of Galveston, saying that he had already secured some four million dollars in funding in Amsterdam, and wanted their data before he returned to Europe to raise more. 46

City elites competed fiercely for status in the eyes of the government engineers and Congress, each hoping to portray their city as the true center of gravity in the region, and most important place for infrastructural investment. Commercial coastal cities were used to advertising the wealth and prosperity by citing the number of rail termini and their enmeshment in commodity transportation networks. Supplementary Federal funding was seen as a means of expanding the city’s demesne. City governments sought influence through both formal and informal channels. Rail and steam allowed sleepy coastal cities, established in colonial times, to project their future onto the far western territories. Agents representing commercial interests sought information about projects germinating far inland, seeking to stake out their city’s commercial territory as far as natural and constructed limits would allow. This territorial struggle pitted cities against each other in a battle over imaginary infrastructure that had, in some cases, not even yet been surveyed. For instance, Savannah and Charleston authorities both petitioned the engineer bureau over where McFarland’s survey on the Tennessee River was supposed to

46 Charles Campbell to Gilmore, January 29, 1869, Box 12, E25-RG77, NA; E. J. Cattell to John Parke, June 20, 1882, Box 202, E71-RG77, NA; John A. Lynch to Humphreys, June 10, 1873, Box 37, E71-RG77, NA; Acting Chief Clerk of the Secretary of War to George S. Fisher, August 29, 1873, E71-RG77, NA; William McKraken to John Newton, May 23, 1884, Box 250, E71-RG77, NA; Anson Bangs to McFarland, August 10, 1874, Box 56, E71-RG77, NA; Baron Frederick George de Pardonnet to Wright, April 21, 1879, Box 122, E71-RG77, NA; de Pardonnet to Wright, March 2, 1880, ibid.
begin—an operation hundreds of miles away that necessarily would affect the flow of commodities through their ports. Though the engineering records omit mention of undue influence coastal cities may have wielded, successfully or not, the process cannot be assumed to have been above all suspicion of corruption or underhandedness. A cryptic note in the Muscle Shoals files from an engineer who had worked on the first generation of internal improvements refers to the savvy of local politicians, who had their “own way of satisfying the projectors.” The establishment of “river conventions,” where capitalists and city and county level politicians
could convene and form coalitions to petition for attention or funding indicates that an eclectic assortment of social arrangements could and did affect the placement of the “line.”

Newspapers, both North and South, played a crucial role in selling projects to the public and fixing the conceptual image of the infrastructure of northern capital. Newspaper editors saw it as a duty to inform their urban readers of the progress of the countryside. “Hundreds of our citizens have no conception of the improvements that have been made in the eastern portion of the city within the last few years,” exclaimed the Savannah Morning News after a railroad corporation had drained swamps just outside of the city. “It’s high time that the truth about this harbor should be known to the people,” read an editorial in Galveston. Though hyperbolic, the newspapers militated against a default isolation and provincialism. Myopia and limited mobility of most civilians meant that they had to rely on landscape description in urban newspapers in order to understand and form a view on the transformation of the landscape often just beyond the city limits. These landscape descriptions made urban residents envision their immediate landscape and the nation beyond as a network animated by commodity flows. “News” was primarily made up of the arrival of material into the city, which reporters dutifully counted and published along with the route by which it arrived. Publishing this data along with fluctuating freight rates created a dynamic vision of connections that spread well beyond the horizon.

Knowing that they were closely read by wealthier urbanites with interest in commodities markets,

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47 Edward C. Anderson to Humphreys, July 24, 1872, Box 22, E71-RG77, NA; Savannah Chamber of Commerce to William Belknap, August 10, 1872, ibid.; Henry Bryan to Belknap, July 9, 1873, Box 38, E71-RG77, NA; S. V. Tupper to Humphreys, August 28, 1874, Box 56, E71-RG77, NA; Charleston Chamber of Commerce to U.S. Senate Committee on Transportation, May 14, 1874, ibid.; W. Rogers Hopkins to Joseph Henry, October 14, 1876, Box 89, E71-RG77, NA; King to G. G. Dibrell, September 24, 1879, E71-RG77, NA.


49 See, for example, the listing of consignments in Savannah Daily News and Herald, January 6, 1868; discussion of transportation routes in Savannah Morning News, September 11, 1873, October 9, 1873, November 11, 1873.
the newspapers reveled in their ability to gather public interest in engineering projects. In one case at least, a newspaper claimed to have moved a congressman from a neighboring state to push for surveys of a route they had long advocated for.\footnote{Savannah \textit{Morning News}, May 12, 1875.}

Military officers, though aware of the power of the trade press, distinguished between popular and scientific publications, preferring the more prestigious technical journals and looking down on the popular press. Abbot in particular held the “popular view” of newspapers in contempt, modeling the exchange of information around engineering projects on the formal and genteel methods of the learned societies. Abbot defended his view as not a matter of mere snobbery, but of frustration with the imprecision he found when gathering data at Willets Point. “The newspapers give such facts as they can obtain but absent any system of observation such statements are often erroneous or so vague as to be of little value,” he wrote to Humphreys, sharing a list of newspapers nationwide that he felt had a sufficient enough reputation for accuracy.\footnote{Abbot to Joseph Lovering, June 11, 1868, Letters and Telegrams Sent, Civil War and Mississippi Duty, 1862-1867, v. 3, HLAP; Abbot to Humphreys, March 2, 1870, ibid.} Abbot, however, was not alone in his mistrust of scriveners—and nor were the misgivings entirely a matter of precision of data. Weitzel found newspapermen as a class entirely unfit for employment with the government or even, it seems, his personal association. McFarland fired a surgeon who he found to be writing anonymous articles for a local paper, chronicling the progress of the work and working conditions of the laborers.\footnote{Weitzel was ashamed that he even temporarily employed a newspaperman, apologizing after firing him: “I do not wish any of my superiors to think that I would employ an editor as a clerk.” Weitzel to Humphreys, March 11, 1870, Box 39, E25-RG77, NA; Florence \textit{Gazette}, August 18, 1875.}

The impulse to control information and omit informing the public of their progress did the engineer bureau no favors in terms of public opinion or support for specific works when
public favor would have been useful. Though engineers generally believed that public opinion should have little bearing on technical decisions, they nonetheless lamented the obscurity of their work in the public eye. “It would be well,” wrote the Chief of Engineers before the Civil War, “if it [the work] were fully appreciated by the public as it is by the engineers.” Yet little salesmanship was displayed (or believed to be needed) and projects commenced construction as if by fiat. The ingrained reticence of their military class caused their perception amongst the locals as distant and arrogant, often a product of competition with municipal engineers or commercial actors who were more savvy as to the importance of public enthusiasm over gruelingly long construction periods, or when setbacks occurred. Some local officers operated strategically. Howell, when at Galveston, knew not to expend his funds when it was ambiguous if the results would be claimed by the municipal engineers’ efforts: “We shall get no credit for anything we may do before,” he wrote. But generally “credit” played little role in the federal engineers political calculations, as military hierarchy showed preference for drawing on authority from higher social strata, and ignoring the wishes of the grassroots. Silence from the engineers allowed misconceptions of their work to take root and become amplified by the press. The “sneering criticism” of the locals at Cape Fear derived considerably from ignorance of what the government was actually doing, and to what end. Ship’s masters and local “authorities” complained about route decisions, often floating their own hydraulic theories and protesting the corps’ construction methods. Protesting the government works as “a peace [sic] of jobbery,” one Savannah resident protested the revetment work as “[t]he river is seriously damaged by being filled up with mattresses and stone” and “large appropriations will be needed to remove the stuff

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53 Joseph Totten to Jefferson Davis, July 10, 1854, Box 12, E25-RG77, NA.

54 Howell to Humphreys, December 5, 1871, E71-RG77, NA
now dumped into the river.” The theme of ongoing damage was widespread. The Wilmington Chamber of Commerce drew attention to the plight of the Cape Fear river by framing it as a restoration project, undoing that which had been “damaged by the work of the public authorities” in the past. In at least two instances, journalists reported on confronting the engineers and contractors with questions of why they were not following the general principles deployed by Eads in Louisiana, only to find that plans along those lines had been in place for years.\footnote{Craighill to Humphreys, April 7, 1875, Box 69, E71-RG77, NA; D. L. Russell to George W. McCrary, Secretary of War, April, 1879, Box 124, E71-RG77, NA; Henry Willink to Joseph Brown, March 31, 1884, Box 251, E71-RG77, NA; \textit{Wilmington, North Carolina, Past, Present, and Future}, “Prefatory”; Savannah \textit{Morning News}, February 17, 1877, October 17, 1879.}

The engineer officers saw little value in the words of the press as they believed that the value of the work was self evident in the physical constructions in the landscape. “I feel that I cannot exaggerate the importance of making the improvement of the Suck an accomplished fact,” wrote Weitzel of efforts to improve a treacherous section of the Tennessee below Chattanooga. The engineers’ knew the success of their work relied on concrete existence and function of their work, with each node in the system supporting the larger assertion of competence in administration of the larger design. “If the obstructions of the Suck are conquered,” Weitzel continued, demonstrating this characteristic logic, “the whole enterprise will gain a prestige…”\footnote{\textit{ARCE} 1869, 285.} Feeling that the “magnitude” of their work, when seen onsite, was enough to convince anyone of the worth, the engineers displayed their prejudice for relating the immediate experience of a project to the benefits of the larger system. That this did not translate well to people with only a casual familiarity with the project, or the aims, never seemed to fully penetrate the bureau’s leadership. There were efforts at convincing the public, such as a large exhibition at the Centennial Exhibition in Philadelphia in which models and drawings of a variety of works were
displayed. Relying on the self-apparent value of visual evidence, however, was never enough to cement the corps as the undisputed arbiter of engineering decisions for the state. The army’s authority continued to be disputed by men like Eads, who commanded competent operations, and others whose “suggestions” bordered on the fantastical. The bureau’s failure to understand how engineering authority underwent a shift to popular construction reflected their ignorance of the rise of a cultural climate where representations of engineering in media were ascendant, and in many cases more important than the actual functional status of the work.

The combination of actual construction and representations of the symbolic transformation of the landscape in the press served to increase generally the discourse around infrastructure at the time. While Americans had long imagined canals and roads, opening the interior of the country to markets, the post-Civil War period was marked by a distinct break from earlier periods in the suppression of agrarian imagery attached to transportation technology. While George Washington may have (apocryphally) imagined a canal around the Great Falls of the Potomac to the agricultural bounty of the Old Northwest, the agents of the republic after the Civil War were animated by a different, urban vision. When McFarland speculated that “a city, the rival of Pittsburgh, would have long since sprung up in the mountains of Eastern Tennessee,” and “the honors and profits of supplying the South and West with coal, iron, and manufactures,”

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57 *Wilmington, North Carolina, Past, Present, and Future*, 59; Howell to Humphreys, March 15, 1876, Box 82, E71-RG77, NA.

58 See Argument of Capt. James B. Eads before the Committee on Commerce of the Senate and the Committee on Rivers and Harbors of the House of Representatives, May 21 and 22, 1884, in support of Senate Bill 1632 and a Like Bill in the House, to Provide for the Improvement of the Channel between Galveston Harbor and the Gulf of Mexico (Washington, D.C.: Rufus H. Darby, 1884), passim, Box 255, E71-RG77, NA; Henry F. Knapp to Robert Lincoln, Secretary of War, May 23, 1884, ibid.; “Galveston,” Clarksville (Texas) Standard, September 19, 1884, ibid.; D. Spangler to Wright, n.d. (January 1885), Box 283, ibid., Spangler to M. C. Endicott, April 14, 1885, Box 291, ibid.; Captain Charles Powell to Chief of Engineers, November 18, 1885, Box 300, ibid.

he articulated a vision of a productive countryside that revolved around the urban and held pastoral pleasures in low esteem.\textsuperscript{60} The infrastructural vision amongst the engineers was one of a hard progress that ignored the set of images around a type of agrarian increase. The efficient landscape, streamlined for commodities, was one stripped of the engineer’s concern for adjacent and complex agrarian functions beyond minimizing the damage to the plantation landscape status quo.

Suppression or indifference to ecological consequences emerged at Savannah as a case where the engineers elevated the “common good” of wealth from industrial production and international commodities markets over local devastation wrought on the rice planters. The engineer bureau had no working theory of “ecology,” in a contemporary sense, but did take into account the interconnected nature of agricultural processes, the rhythms of seasons and rivers, and the reliance on related processes that kept a landscape functioning. Under the engineers, the notion of function narrowed, and a singular function valorized at the expense of others, often supplemented by mechanical aid.\textsuperscript{61} At Savannah, they knew that the Cross Tides dam would have an impact on plant communities and the landforms that supported life in areas downstream. They simply prioritized the infrastructure over the ecosystem. The social and ecological ramifications were immediate and can be seen in the legal dispute over the Cross Tides project. The majority of the complaints from the planters contested that the hydraulic change would alter the carefully calibrated “system of irrigation in the tide-swamp lands.” The dam amounted to a molestation of their ecosystem, which the value of their plantations was dependent on. The

\textsuperscript{60} ARCE 1872, 480.

\textsuperscript{61} A prime example of this is Gillmore’s 1880 schematic for the Suwannee River at a marshy portion, which he proposed to dam and use the low country as a reservoir to feed the Southern Route canal. He proposed to supplement the reduction of the river to a certain type of volumetric system, supplemented by stations that housed centrifugal pumps and coal-burning engines to regulate the water levels across the system. ARCE 1880, 993-994.
ecosystem in this case had been protected by the murky legal situation at the border between two states, where neither state could claim supremacy. Federal assertion of regulatory powers, abetted by Reconstruction acts, changed this. Gillmore too seems to have sought ways around the eventual injunction, even instructing his agents in Savannah to hire different contractors whose names did not appear on the document enjoining against construction in the marsh. Work proceeded with only minor stoppage immediately after the injunction, and public assurances were made, even from the level of the War Department, that the needs of the planters had been considered. Gillmore’s internal reports indicate that the engineers had indeed tried to make changes that would not affect the typical tidal fluctuations, and that the construction process would change the dynamics of the place gradually, “in order that there may be no sudden changes in the stream.” Yet Gillmore himself, when forced to defend against lawsuit, argued that the river and tidal system, which the rice landscape had been tuned to, was anathema to the river’s construction as a commercial artery. Intervention in the ecosystem, as Gillmore argued, fell under the law allowing the army to “abate a public nuisance, or construct works of improvement.” That he cites both powers indicates the army was developing an outlook that considered the entangling nature of agricultural (essentially floral) dependence on specific landscape configurations a hindrance to the commonwealth. Nearly a decade after the construction of Cross Tides Dam, the corps received complaints about damages suffered by its existence. Junior officers sent to conduct investigations into these claims received specific instructions not to put in writing “any assessment or confession of damages” to the downstream ecosystem they might find.62

The projects and the discourse around the projects participated in the transformation of the governing metaphors about how commodities and the national landscape worked, shifting from an agrarian vision to an arterial model of abstract commodities in volumes and rates. Notions of military importance of certain harbors fell away in even the military engineers’ rhetoric, replaced by imputations of “potential commercial capacity.” The image of specific commodities filled out the mental models of volumetric capacity. Tables of statistics outlining the volume and global trajectory of cotton shipments through a part were a standard inclusion of topographic and hydraulic surveys. Abstracted, cotton stood as a variable volume that could inform the dimensions of a canal prism or the draft of a ship; its role in the mental schema of the engineering process held power to affect the form of entire landscapes. The proliferation of railroads played a significant role in shaping the terms in which commodities and transport were described; overlapping metaphors, such as a railroad branch being described as “well located to drain the southern and southwestern counties of Georgia,” served to indicate a system unified in abstraction. It can’t be underestimated how abstract notions like the “cotton harvest” had power to change the priorities or orders of procedures of the entire engineering operation, such as it was conceived in service to the processes of that plant. Yet as the 1870s decade progressed, other commodities found their way into the rhetorical structure as all goods underwent commodification and became abstract, generic volumes. Gillmore’s calculations on Florida and Georgia projects took into account the timber production of the region and the dimensions of

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General, “Brief for the Defendants,” May 4, 1876, ibid.; Gillmore to Humphreys, April 17, 1876, ibid.; Alphonso Taft to S. L. Hoge, April 11, 1876, ibid.; Gillmore to Humphreys, March 30, 1876, ibid.; George Mills to Chief of Engineers, December 23, 1885, Box 301, E71-RG77, NA.

63 ARCE 1876, 481-2; Ludlow to Gillmore, April 20, 1871, Box 6, E71-RG77, NA; ARCE 1881, 1076; Gillmore to Humphreys, August 28, 1876, Box 87, E71-RG77, NA; Gillmore to Humphreys, September 10, 1872, Box 25, E71-RG77, NA; Gillmore to Humphreys, October 17, 1872, Box 26, E71-RG77, NA; Gillmore to Humphreys, December 4, 1872, Box 28, E71-RG77, NA.
vessels used in the lumber industry. Beyond turpentine and board feet of lumber, by the 1880s, Gillmore even began to factor the growing citrus industry in Florida, speaking of engineering in terms of oranges and quoting underwriters of shipping insurance in New York.64

The state engineers’ practice fixed the assignation of the forces of capitalism as a part of Federal policy. By drawing, calculating, and justifying the existence of state works as a matter of commodity flows, they placed the system of signifiers used by capitalists as the dominant symbolic system of nation building. Because they were not interested in narrow profit in one industry, but the general increase across industrial and agricultural production, the projects they built and the discourse around them allowed a comprehensive view of a national, capitalist infrastructure to form. As such, their network of constructions rendered visible the moments where friction of capital met the landscape and denoted areas where the invisible hand needed assistance from engineers. Their drawing boards and jobsites participated in what Bruno Latour has called the “flattening” of the abstract notion of capital into social structures that then allowed for a shared conceptual structure to be referred to. Symbolic structures, such as the “colonizer companies” and notions of “foreign capital” making inroads to the South, embodied by the “N.Y. steamships” nosing into Southern harbors, were all connected by the underlying assumption that they were enabled by engineering.65 “Commercial cities grow by the aggregation of capital,” explained the Savannah Morning News in 1879, implying that the pathways on which the parts move to accumulate should present as little resistance as possible. In the prevailing rhetoric, the capriciousness of capital when it met an obstacle was well-known, even amongst the engineers. “[T]he capital that originated the work,” wrote Howell in 1880, “has turned away and sought

64 Gillmore to Humphreys, February 8, 1869, Box 12, E25-RG77, NA; ARCE 1869, 271-271; ARCE 1881, 1130-1.

another route,” as delays in channel construction caused an entire railroad to come into being.\textsuperscript{66} Public works that fixed the flow of capital in a pathway most civically beneficial revealed the larger system at work.

\textbf{A Proliferation of Lines}

Public acceptance of linear, commodity driven infrastructure that stretched into the interior became apparent in the boom of enthusiasm for speculative, linear projects—comprised of all modes of transportation—that connected distant landscapes to the seaports. The engineer bureau’s methods and data gave shape to these speculative projects, as military engineers were relied on to translate civilian ideas for “systems of work” and “speculative objects” into working infrastructure.\textsuperscript{67} The first, most politically contentious and economically portentous, step was plotting the “line.”

The officers of the corps saw themselves as the intellectual inheritors of the men who built the first transit routes through the country and claimed the national transit system as their domain to both improve or maintain. During Reconstruction, this mythology was repeated with the notion that the grand design was theirs to protect. Humphreys wrote in 1876:

\begin{quote}
Almost all the great routes of internal communication in the interests of commerce and speedy transit, now in existence in the country, were first explored, located, and projected by officers of this Corps.\textsuperscript{68}
\end{quote}

The claim had more truth than just a verbal assurance of bureaucratic territory. The military did indeed take a holistic view of political economy and infrastructure building—often more so than

\textsuperscript{66} Howell to Wright, January 5, 1880, Box 136, E71-RG77, NA.

\textsuperscript{67} S. B. Maxey to Humphreys, October 23, 1877, Box 71-RG77, NA; “Galveston,” Clarksville (Texas) Standard, September 19, 1884.

\textsuperscript{68} Quoted in Henry L. Abbot, “The Corps of Engineers,” December 8, 1893, Letter Press Book B 1893-95, Box 10, HLAP. It is noted that the original quote appeared in the Army Register in 1876.
the congressional “movers.” Their comprehensive scope came from a unique perspective of continental administration, which emerged naturally from their diagrammatic, graphic practice.

Training in military geometry, and its pervasive practice, formed the basis of the conceptual layout of a national commercial network in the second half of the nineteenth century. Systems of transit were not wholly organic but were rather shaped by the logistical technologies contained in the way military engineers practiced in landscapes. Though capital pushed at its boundaries, a relatively small handful of military engineers played the crucial role of determining which would be the dominant seacoast nodes from which real and imagined infrastructure could be constructed, and insuring that projects not commercially viable had the support of the state. Because they were not confined to one route, the army’s engineer bureau took a view that connected the interior lines, allowing the Southern interior to be seen as a network. This is not to discount the private capital that drove the vast majority of railroad construction that penetrated the interior. Instead, it should be seen that the state’s engineer bureau built a baseline of coastal structure and ensured that a national network was both physically and conceptually present and maintained. From this baseline both private and public lines could spring.

The first major postwar system began as the simultaneous survey of projects connecting various interior locations to the coastline in 1874. The precise placement of the baseline was left to officers in the field, who each worked independently, conceiving of the national network from multiple starting points, with each route designed to maximize its own efficiency in construction and operation. The engineer officers in Rock Island, Illinois, Cincinnati, Baltimore (Craighill), Cairo, Chattanooga (McFarland), Chicago, St. Louis, and Minnesota were sent orders under funding from the Senate to submit suggestions for the construction of new lines, or the “radical
improvement” of existing. As all were federally-administered, the proliferation of lines formed a concerted, interlocking system to support further routes. As these projects were surveyed and there relative merits and specifics began to circulate in military, governmental, and public circles, they set off an explosion in speculative lines across the American landscape proposed from sources both in and outside of the army.

“Running a line” was an intellectual and physical process brought the high-minded continental imagination into contact with the more mundane contingencies on the ground (or underwater). The high rhetoric of someone like Gillmore, writing in Florida but rhapsodizing about moving “wheat and corn…from Minnesota, Iowa, Wisconsin, Illinois, Indiana, Missouri, etc…” through Southern ports by water routes was always tempered in kind by the field engineers, like Howell, whose main business was choosing where to strike the line given local conditions that constrained any real choice to variations within a few hundred feet of one another. The process was always a mixture of the two, and projects reflected the idealistic and pragmatic polarity of the enterprise. Plans submitted by amateurs and outside engineers ranged from diverting the entire Missouri River into the Assiniboine, entailing cutting a river-sized canal through at six-hundred foot tall plateau, to smaller projects born from local thought that had been brewing for a long time. Multiple voices from North Carolina called for Federal attention for an

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69 “Estimates for Surveys of routes proposed by Senate Committee on Transportation Routes to the Seaboards,” n.d.; Box 53, E71-RG77, NA; John N. Macomb to Humphreys, June 13, 1874; ibid.; Craighill to Humphreys, telegram, June 11, 1874, ibid.; William E. Merrill to Humphreys, June 15, 1874, ibid.; Charles R. Souter to Humphreys, June 11, 1874, ibid.; McFarland to Parke, June 16, 1874, ibid.; D. C. Houston to Humphreys, June 11, 1874, ibid.; James H. Simpson to Humphreys, June 11, 1874, ibid.; F. W. Farquhar, June 11, 1874, ibid.

70 ARCE 1880, 401-403; for an indication of how the channel line was laid out in the field (or in this case, in the bay) see Howell to Humphreys, May 21, 1877, Box 97, E71-RG77, NA; Tower et al to Humphreys, September 10, 1877, Box 101, E71-RG77, NA;

71 Abbot to Humphreys, December 22, 1869, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.
inland waterway behind the barrier islands of the North Carolina and Virginia coasts, connecting the ports and Norfolk and Wilmington and avoiding the treacherous Outer Banks. North Carolinians justified these projects the grounds that they were “of high importance in both a national and conventional sense.” “Conventional” lines took on a national dimension, which became clearer as federal dollars approached, even when promoted by Redeemers.

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Figure 5.14. General Map Illustrating the Survey of Water Routes from Norfolk Harbor, Virginia to the Cape Fear River, 1878-9. Canals 161 - No.1, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.

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72 A. S. Merrimon to Humphreys, March 23, 1875, Box 68, E71-RG77, NA; Henry Nutt to Humphreys, April 13, 1875, Box 70, E71-RG77, NA; Humphreys to George McCrary, June 10, 1878, Box 110, ibid.
Though many of these lines were well known conceptually, their existence on maps concealed that the landscapes they ran through were largely unknown or had changed significantly since the first internal improvement push generations before. This was true even of landscapes that had been occupied by European Americans since the colonial era, and even moreso of the marshy ragged coast on both the Gulf and Atlantic coastlines. On receiving orders to survey “all the water lines and routes leading or that may lead from the Harbor of Norfolk,” Phillips detailed the expense involved in gaining an accurate picture of the ground and water needed to make a decision. Even the existence of structures built a generation before, such as the Great Dismal Swamp and Albemarle and Chesapeake Canals did not preclude the need to reassess the configuration of the landscape.\textsuperscript{73} Obscured by growth, decay, and a changing social atmosphere, the landscape presented a problem that needed to be approached anew. The old systems could not be relied upon to have the capacity, even with modification, to accommodate new technology. This forced carte blanche effect strained the engineers’ resources, causing McFarland to grumble to the head of the Senate committee, “we need all the topographical knowledge of this region that we can get:—but the funds available are barely sufficient to run one good line…”\textsuperscript{74}

The force driving these imaginative and speculative infrastructures, however, was sufficient enough to project lines into the unknown and unfeasible. The heroic stature Ferdinand de Lesseps attained through his work at Suez and the beginnings of his involvement at Panama hung large over the mid nineteenth-century international engineering community.\textsuperscript{75} Caution was

\textsuperscript{73} Phillips to Humphreys, August 10, 1878, Box 113, E71-RG77, NA.

\textsuperscript{74} McFarland to William Windom, July 22, 1874, E71-RG77, NA.

\textsuperscript{75} See Zachary Karabell, \textit{Parting the Desert: The Creation of the Suez Canal} (New York: Knopf, 2003); McCullough, \textit{The Path between the Seas}.
rarely invoked in plotting works that would affect the economics of entire hemispheres. Gillmore used promotional materials from de Lesseps’ Panama company to promote the idea of large, interior ship canals, even if the canal’s receipts never exceeded ten percent of the government’s capital expenditure.  

Both McFarland and Abbot played significant roles in the “Isthmus Canal” expedition in the 1870s—McFarland was ordered away from his duties at Muscle Shoals to a survey in the Central American jungle in 1874—as the government drew on the army engineers to support its first forays into global economic reconfiguration by engineering. Suez’s success reverberated decades after its completion, making even provincial urban elites look at their hinterlands and potential place in global shipping networks in new light.

In the southeastern states, a flurry of activity and speculation emerged around the idea of a “Southern Route,” linking the Tennessee River to one of the coastal seaports, such as Savannah or Charleston. The idea had existed for decades with various routes proposed, including an 1835 proposal by the architect Robert Mills for a link between the Savannah River and the Tennessee by way of the Hiwassee. McFarland, however, was saddled with the enormous geographical project of surveying all conceivable routes; his commission encompassed the Tennessee, Hiwassee, Tombigbee, French Broad, and Cumberland Rivers. As the mapping progressed, McFarland’s search expanded from his departure point near Guntersville, Alabama to the

76 There is also a growing sense of envy in Gillmore’s reports at other massive “water lines” that were in the process of being projected by the era’s imperial powers beyond Suez and Panama. Gillmore cites the Welland Canal in British Canada as another development that lent his own projections some urgency. ARCE 1880, 985.

77 McFarland to Humphreys, July 21, 1874, Box 55, E71-RG77, NA. Abbot was involved in the various isthmus projects, both in Nicaragua and Panama, for over thirty years and well into the twentieth century.

78 American newspapers reported on the progress of the army’s isthmus surveys in great detail, keeping the public abreast of when expeditions returned from the jungle, and connecting excitement at the prospect of a western hemisphere canal with De Lesseps’ achievement at Suez, Savannah Morning News, February 18, 1869, November 29, 1869. It was in this context that the “old idea” Southern Route canal, between the Tennessee River and the coast, “has been revived.” Savannah Morning News, February 26, 1869.

79 Savannah Morning News, November 8, 1878.
headwaters of the Coosa and Warrior Rivers—an expanding terrain that forced him to delegate the survey of other streams, such as the Oostenaula, to his assistants Long and McCalla. What became clear immediately, and was communicated back to Congress through the War Department, was that the Southern Route as envisioned “is one of no ordinary magnitude.” McFarland’s preliminary report included no less than nine different routes for what was alternately termed the “Great Western Canal,” some of which reached all the way to the Great Lakes. Through no fault of his own, McFarland could find no way around the geological formation in northeastern Alabama known as Sand Mountain; even conservative estimates for the amount of locks needed to gain the five hundred feet of elevation were “enormous,” and the dreaded specter of tunneling through a significant portion of the Alabama countryside rose. The route the senators pushed, going directly over sand mountain, required 78 locks at a cost of $12,000,000 to overcome some 864 feet of elevation. But this was just one section—McFarland later included the four or five millions of dollars needed to complete the Muscle Shoals Canal to Guntersville, and the hundred more or so various locks throughout the rest of Georgia, bringing the grand total cost of the project to $30,523,184.80

An equally implausible project to construct a canal across the base of the Florida peninsula received similar promotion and enthusiasm despite confronting similar practical limitations. A Judge Stickney toured the still-reeling Reconstruction South, promoting his Florida Canal and Transportation Company’s scheme to build a 400-mile-long inland canal from Savannah to Jupiter Inlet on the Gulf of Mexico. Southern newspapers were quickly joined in

80 McFarland to Humphreys, August 29, 1874, Box 56, E71-RG77, NA; ARCE 1872, 480-481; William Belknap to House of Representatives, May 20, 1872, Box 20, E71-RG77, NA; Windom to Humphries, August 25, 1873, Box 39, E71-RG77, NA; McFarland to Humphreys, December 29, 1873, Box 46, E71-RG77, NA; McFarland to Humphreys, March 28, 1872, Box 71-RG77, NA; McFarland to Windom, July 22, 1874, Box 56, E71-RG77, NA; McFarland to Humphreys, September 10, 1873, Box 39, E71-RG77, NA.
consensus that this was a worthy undertaking. Gillmore’s report on the Okefenokee Swamp Expedition, which the government undertook to appease these interests, was published ten years later in 1877. In it, Gillmore describes a straightforward process of pushing a line through the unknown territory with the notion that the hydraulic landscape the line touches will be reworked to the requirements of the line. Gillmore simply drew a straight line with a ruler between St. Mary’s River on the east coast, and St. Mark’s on the West, and adjusted the line to take advantage of watercourses that it crossed or came near to on his map. The problem came from the accuracy of Gillmore’s underlay. Three previous military survey expeditions into the Okefenokee Swamp in the 75 years before had produced similar results: the Swamp, which drained 925 square miles of Florida, was roughly 625 square miles itself, composed of “soft muck…cypress, bay, gum, and pine…and frequently an almost impenetrable undergrowth.” The swamp was subject to fluctuations in water level, and Gillmore worried that adequate water for a ship canal “will require a certain amount—probably a very considerable amount—of engineering work to make its hydraulic resources available.” Gillmore looked to the damming the Suwannee River and alternately flooding and draining portions of the natural wetlands of Okefenokee, explicitly referencing the draining of the East Anglia fens. A civilian engineer named Freemont who worked on a detailed proposal for the canal in 1880 proposed an even more radical solution. Freemont’s report called for complete drainage of the Gum and Bay swamps south of Okefenokee, and the construction of two “great storage reservoirs,” one north and one south of the canal, 15 miles wide each and stretching almost 100 miles continuously alongside. His

81 Savannah Daily News and Herald, January 7, 1867, November 5, 1867.

82 ARCE 1877, 382-404. Previous surveys had been conducted by Lieutenant R. L. Hunter in 1857, a C. A. Locke in 1875, and a Major Perrault in 1829.
estimate for the cost of construction, at $61,812,814.68, was justified by being only $1 million more than the total cost of Suez.\textsuperscript{83}

The continent-scale line of the era that did eventually come into existence ran along the Gulf and Atlantic coasts, behind the barrier beach and through the swamps, today known as the Intercoastal Waterway. It began as a series of smaller lines between coastal destinations that eventually were aggregated into one larger project. Perception of the landscape itself played into the engineers’ vision; Gillmore saw the physical geography of the Gulf Coast as forming a “nearly continuous land-locked water route” that would require minimal dredging and hard cutting. This inviting topographical configuration stretched from the coast near Tallahassee to Lake Pontchartrain north of New Orleans, and to Gillmore’s vision, could act as a collector of grain, cotton, and timber from the interior, shunting the goods toward Atlantic markets. Other routes were planned off this collector branch, stretching through the Sabine Pass and Galveston, pushing even to the Mexican border on the Rio Grande on the Texas Coast, and up to the smaller projects in the Sea Island and wide bays behind Cape Hatteras. The army built on the efforts of smaller-scale system builders, such as Col. Charles F. Dilkes, an agent of a shipping firm in Philadelphia, who had plotted private networks along the coast. It was almost as if conglomeration at the hands of the federals were an organic process that emerged from the abundant smaller efforts. Private channels had been dug by various companies at various times along the route, and the government moved to purchase the rights-of-way in the pursuit of a continuous line. The water line’s status as a public work rankled corporate interests who stood to lose revenue from Federal subsidy of its operation, but became politically viable because of public enthusiasm, largely brought about by favorable newspaper coverage. Public water routes

\textsuperscript{83} ARCE 1880, 996-1003.
were portrayed as an alternative to railroads and their oppressive freight rates; both the
intercoastal line and the Southern Route were promoted as America’s “efforts to emancipate her
people from the thralldom of the eastern monopolists and protectionists.” The project, however,
endured a decades long gestation before its full instantiation as a continuous federal route.84

The combination of aggressive geometrical practice and the diligent conjuring of
commodities networks in print media combined to make a continental diagram: a way of
conceiving of economy, nation, and landscape that enabled a shared vision of capitalist
infrastructure. This is not to say that the engineers’ conception of transportation networks aligned
perfectly with that of the capitalists, or that this diagram was necessarily legible to members of
the general public, especially those who held property or livelihood in the pathway of the great
diagram’s lines. But it did provide an intellectual engine for the reconfiguration of the landscape,
one that clarified acceptable justification for landscape intervention and produced a hierarchy of
commodity over ecology that sustained its production. A complex and dynamic system, the
diagram persisted in national operation only through sponsorship of the national military.

The Reinvention of Texas

The general conception of Texas changed in the postwar era as a result of the state’s imposition
of a commercial diagram along the broad arc of its coast. Because much of the Civil War in the
“West” (that is, not in Virginia) involved inroads into Confederate territory by way of rivers, an
accompanying visual culture emerged in newspapers and other print media that showed southern

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84 ARCE 1877, 383; “Project and Estimate for a Survey for a Ship-Canal between the Waters of Galveston Bay and Sabine Lake, Texas,” n.d. (June, 1872), Box 21, E71-RG77, NA; “Project and Estimate for an Examination of the West End of the Pass at and Near Blue Buck Point,” n.d. (June, 1872), ibid.; Howell to Humphreys, telegraph, April 30, 1873, Box 34, E71-RG77, NA; Howell to Humphreys, December 17, 1874, Box 60, E71-RG77, NA; Savannah Daily News and Herald. July 24, 1867; Savannah Morning News, September 19, 1879; William Belknap (private citizen) to Chief of Engineers, July 24, 1879, Box 128, E71-RG77, NA; Savannah Morning News, October 15, 1873, January 4, 1873, April 3, 1873, May 17, 1873; ARCE 1885, 1215, 1237.
Figure 5.15. Panorama of the Seat of War: Birds Eye View of Texas and Part of Mexico, ca. 1861-1865. 325A, Special Collections, Rosenberg Library, Galveston, Texas.

territory as vulnerable to its penetrating waterways. A war-era print showing Texas as a fertile green territory extending infinitely westward, inviting because of the array of waterways leading into unknown bounty illustrates exactly the kind of territorial orientation the engineers and government were trying to achieve. The engineering projects at Galveston, Sabine River, and Port Aransas show the diagram in operation as it produces a new way of thinking of inland territory: along the Gulf Coast arc, the natural configuration of riverways aligns generally with lines plotted perpendicularly to a given tangent, almost as if drawn by a geometer.

The Texas coast had historically presented the engineer bureau with a problem of immensity. Site conditions, such as the quality of the sand that made up the majority of the
formations along the coast, as well as the strong littoral current, were seen as problems that only possessed prohibitively expensive solutions. Efforts began soon after the Civil War to come up with a workable, systematic scheme of improvements for the bar at Galveston Harbor, as locals had impressed upon the War Department that the coast “has developed changes in that harbor of a character so serious as to threaten its existence even, if allowed to continue….” Chronically underfunded, by 1868 the engineers had made little progress on the detailed surveys needed for hydraulic manipulation. The main problem cited was the impossibility of completing the survey of an area of six hundred square miles with only one rowboat, and that their plea for assistance from the Coast Survey vessels operating in the area denied. The survey of the harbor entrance and problematic sandbar was complete only in 1870, and surveys into Buffalo Bayou and the Neches River continued well into that next decade. The eventual design, settled on after years of experimentation and gradual enlargement of the scope, were two jetties extending from Galveston and Bolivar points into the Gulf of Mexico, each about three miles in length.85

Following similar principles as Gillmore on the east coast, the engineers had conceived of the bay as a large tidal engine.86 Similarly, Charles Howell, the project engineer, sought expenditure of most of the early appropriations in survey of the “entire harbor” to get a grasp of the water power available. The problems they confronted in this transformation were material: there simply was no easily-accessible source of stone on the Texas coast. In a series of costly and

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85 George B. McClellan to Joseph Totten, January 13, 1853, Box 129, E71-RG77, NA; W. H. Stevens to Joseph Totten, December 26, 1853, ibid; McAlester to Humphreys, March 26, 1867, Box 16, E25-RG77, NA; McAlester to Humphreys, May 9, 1867, Box 16, ibid.; ARCE 1868, 497; McAlester to Humphreys, February 6, 1868, Box 18, E25-RG77, NA; Benjamin Peirce to R. E. Halter, January 20, 1868, ibid.; Howell to Humphreys, January 4, 1871, Box 1, E71-RG77, NA; “Project and Estimate for a Survey of Harbor at Galveston, Texas,” n.d. (June, 1872), Box 21, E71-RG77, NA; “Report of Operations, Harbor of Galveston, Texas,” November 1872, Box 27, E71-RG77, NA; H. C. Ripley to Mansfield, July 3, 1880, Box 160, E71-RG77, NA.

86 The ground may have been prepared for Gillmore, as Hugh Rice, the city engineer at Galveston, had written the city fathers at Savannah for statistics and advice about how to improve their harbor. Savannah Daily News and Herald, July 30, 1867.
Figure 5.16. Examination and Survey of Galveston Harbor with a View to its Preservation and Improvement, Maj. Miles McAlester, 1867-8. Q139, Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.

Figure 5.17. Detail of Howell’s Drawings for Cordgrass and Concrete Gabions. Civil Works Map File, Record Group 77, Cartographic Division, National Archives, College Park, Maryland.
ill-fated experiments, Howell tried his hand at manufacturing drums woven of pliable wood, coated in concrete and then filled with sand and sunk to the harbor’s bottom to act as the kind of seed structure around which sand could accumulate and form the base of the jetty. The “Bolivar Gabionnade” however, was met by catastrophe after catastrophe. The hurricane of September 1877 wiped swept away the a six-hundred-foot length of Howell’s jetty, destroyed all of their tidal instruments, and drowned one of their officers. Presaging the devastating hurricane of 1900, which nearly wiped out the entire city (and destroyed almost all of the visual records of the corps’ work), both the Federal engineers and city officials began to rethink the protection of the harbor as more than just jetties to achieve a deeper channel. A rhetorical shift occurred, where harbor improvements were talked about at least in the same breath as the simultaneous construction of substantial leveeing or a seawall to protect the city. Amidst the setback and lack of clear Federal direction, James Eads was almost able to extract a $7,000,000 contract to rebuild the jetties destroyed by the hurricane. Narrowly defeated by northern congressmen who balked at paying a seven hundred percent increase in construction costs to Eads, the proposal nonetheless highlights the environmental difficulties indiscriminate application of one particular paradigm across all conditions.  

Despite environmental friction against the engineers’ preferred techniques, development of the coast in areas that promised easy water access to the interior proceeded apace. Seeming to pay no heed to shortages of heavy equipment in the region, a number of heavy industries thrived along the bayous of the Texas coast. 1871 became the year of the Texas coast, when surveys were approved for a ship canal at Ft. Saint Philip, Cypress Bayou, Bayou St. John, Brazos

87 “Project for the Improvement of the Harbor at Galveston, Texas,” n.d. (June 1872), Box 18, E71-RG77, NA; Howell to Humphreys, January 27, 1875, Box 65, E71-RG77, NA; ARCE 1885, 1449-1451; C. E. L. B. Davis to Howell, September 20, 1877, Box 101, E71-RG77, NA; Argument of Capt. James B. Eads, “Galveston,” Clarksville Standard, September 19, 1884, Box 274, E71-RG77, NA.
Santiago, the Sabine and Trinity Rivers, Aransas Pass and Pass Cavallo, and edging into Louisiana’s Atchafalaya Bay. The existence of the established port at Galveston seemed to matter little, as the ability to achieve the depth necessary for the Clyde steamer hulls governed where the most benefit could be derived, and where the funds should be invested. Cities and
ports were thought to simply arise later, once the all-important harbor of sufficient capacity was established.\textsuperscript{88} Galveston fought the notion of capricious capital and that it was expendable. Contesting harbingers of fleeing capital, such as the insurance underwriters who in 1880 stated plainly that “[t]he site of the city is unsafe. It is liable to be overwhelmed and obliterated…” Galveston city officials attempted to exert influence over the engineering work that would prevent this fate and continue its attractiveness to capital and secure its place in the diagram. In 1883 the Texas legislature voted to allow coastal cities to issue bonds for the improvement of their harbors, and Galveston quickly established a “sinking fund” which was available to be drawn on by Federal engineers to increase the capacity of their work. By 1884, the city had covered one-tenth of the total cost of its Federally-designed harbor improvements.\textsuperscript{89}

Construction efforts on the Texas coast had immediate effect on the interior. Agents of the various powerful cotton exchanges, representing enormous wealth in land and crop and vast inland territory, portrayed themselves as tribunes of vast inland populations and paid minute attention to engineering decisions that would affect the fortunes of “the people of the North Western States as to our own.” Established planter communities struggled with carpetbaggers over the proper allocation of resources and effectively control over interior domains. Squabbling around the engineering projects centered around which cities stood to benefit, similar to eastern ports. Even in the early 1870s, Houston began to exert influence, and Galveston’s rivalry with its smaller but fast-growing neighbor up Buffalo Bayou grew rapidly over the decade. In 1876, two-

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\textsuperscript{88} Howell to Humphreys, April 1, 1871, E71-RG77, NA; S. B. Maxey to Robert Lincoln, January 28, 1882, Box 193, E71-RG77, NA; Howell to Humphreys, July 31, 1871, Box 9, E71-RG77, NA; Howell to Humphreys, March 26, 1872, Box 17, E71-RG77, NA; Howell to Humphreys, June 24, 1872, Box 21, E71-RG77, NA; “Project and Estimate for a Survey for a Ship-Canal between the Waters of Galveston Bay and Sabine Lake, Texas,” n.d. (June 1872), ibid.; Edwin Hawes to Wright, December 5, 1879, Box 134, E71-RG77, NA.

\textsuperscript{89} U. S. Walker to Captain Carlile Patterson, April 19, 1880, Box 144, E71-RG77, NA; Mansfield to Chief of Engineers, April 24, 1883, Box 234, E71-RG77, NA; “Galveston Ordinance of April 16, 1883), ibid; Mansfield to Chief of Engineers, March 19, 1884, Box 249, E71-RG77, NA.
fifths of the 460,000 bales of cotton that shipped out of Galveston were first unloaded from rail in Houston then floated down Buffalo Bayou to Galveston. This extra step became the focus of decades of struggle, which Houston sought to eliminate, and bypass the older Galveston altogether. Houston’s location of the terminus of nine different trunk railroads gave it a considerable advantage over Galveston, vulnerable on a spit of land at the far end of a branch line. As internal transit lines evolved, their lines conceptually altered the hierarchy of cities in the landscape. As soon as hydraulic surveys were completed, a new railroad causeway built through the marshland would so alter the tidal dynamics and form of the bay floor that the survey would have to be repeated or significantly modified. De Pardonnet’s promotional literature on the
expanding rail networks cited the reach that extended to North Texas, Indian Territory, Kansas, “Nebrasca” [sic], Missouri, the “minerals of Colorado, New Mexico, and Arizona … Already many of the counties through which it passes are thickly populated with industrious and thrifty people.” Perhaps most important of the bounty fought over was a throwaway line toward the end of his pamphlet which talked about a “valuable oil” called “PETROLEUM,” in some places so abundant that “[e]ven the mud in these lakes and springs is so impregnated with this oil that it burns freely and is used by the people in the neighborhood for illuminating purposes.”

The reorganization that of the engineer bureau reflected the reorganization of the landscapes in which they operated by capital—institutional division directly acknowledged the existence of this force. Gillmore’s 1881 report on the status of Charleston, South Carolina, was bullish. Cotton production had doubled since 1870, mostly due to the use of phosphate fertilizers—themselves the product of an expanding and polluting industry that recorded twenty two mines on the rivers leading to Charleston alone. Hundreds of coastwise and foreign vessels arrived and departed daily. The population of the South had increased by 33.4% overall, and the state of South Carolina, 41%—a higher growth rate than the United States in general. Gillmore completed his report with a detailed description of the branching network of rail and river transportation that reached up to the Appalachian Mountains.

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90 W. L. Moody to George McCreary, November 15, 1879, Box 133, E71-RG77, NA; Philetus Sawyer to Humphreys, March 15, 1872, Box 17, E71-RG77, NA; F. H. Scanlon to U.S. Congress, December 8, 1873, Box 42, E71-RG77, NA; A. H. Willie to Humphreys, June 18, 1874, Box 53, E71-RG77, NA; D. C. Stone, J. S. Sellers, A. M. Hobby, et al to Humphreys, September 7, 1876, Box 88, E71-RG77, NA; Cooper to Chief of Engineers, telegram, September 12, 1876, ibid.; Texas and the Country Traversed by the Houston, Sabine Pass and Denison R’y Company and its Important Terminus at Sabine Pass (Houston: W. H. Coyle, 1879), 1 and passim.; Charles A. Whitney to Humphreys, September 18, 1878, Box 116, E71-RG77, NA; Texas and the Country Traversed, 7-9.

91 ARCE 1881, 1049-1051.
Federal officers and agents worked to insure the unimpeded comingling of capital and landscape, using engineering principles as a means of purifying the governance structure to one central authority. In order to preserve this hard-won configuration of prosperity, Gillmore argued that Federal authority in this landscape was “paramount and conclusive.”92 This was a marked change from the institutionalized disinterest of just a decade beforehand. An advantageous position in the legal structure that governed the ability to concentrate the flow of water was simply too valuable—to too essential to the system’s operation—to countenance leaving it to squabbling states or impoverished and selfish planters. In their operations and their willingness

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92 ARCE 1876, 437.
to outwardly describe their work as pragmatic, measured, and meant to support the common

good, the engineers portrayed this legal positioning as a great beneficence. Much of the work of
getting the public to acknowledge that capitalist development was truly beneficial, and that the
legal and material needs of the engineers’ projections were but a small price to pay for prosperity,
had suffused the petit bourgeois and garnered either support or indifference amongst the working
classes. Unreconstructed planters, who both begged for federal dollars to repair their wasted
levees and, at the same time, vigorously protested ill effects to their estates that rippled outwards
from the Federal structures, were the only ones who vocally took issue with the reorganization of
bureaucracy and landscape.

The field engineer, embedded and practicing in his assigned watershed, played an
important role in the reorganization that mediated between federal bureaucracy and local
landscape. Design engineers, like Walter McFarland, exercised immense autonomy and power as
they marked maps and determined scope and “practicability” in the field.93 Seen as technical
gatekeepers, their individual design decisions modulated the voices of senators and pilots alike;
their sense of fairness, practicality, and the things they needed to control in order to accomplish
their tasks necessarily affected the course of projects and the ability for capital to penetrate and
reorganize their sphere of influence.

The transition to a district system, which placed a bureaucratic foothold within its own
demesne, coterminous with the watershed, describes the adaptation of the bureaucracy to the
natural world. Establishing districts of governance, and eschewing loosely assembling

93 McFarland to Humphreys, September 7, 1874, Box 56, E71-RG77, NA; McFarland to Humphreys, August 29,
1874, ibid. McFarland solicited wishes from representatives of areas affected by the route or potential routes, asking
for ideas and regional objectives that state officials might have. His report, which essentially records his attempt to
balance national, local, topographical, and economic forces into one line, shows the immense power of the field
engineer in determining the possibilities of large areas of the country.
engineering projects under one charismatic or heroic engineer, indicates that the bureaucracy “learned” its most effective configuration in the natural environment. This process happened slowly, and is described in the engineering files as a product of exigencies of distance and a desire for more efficient administration. The engineer office in New Orleans ceded administration of Galveston (and the rest of Texas) only in 1880, when Samuel Mansfield rented an office in Galveston to house his data, papers, and drafting equipment. James Mercur similarly left Baltimore and established an office in Wilmington to oversee the Cape Fear River, and other adjacent projects, in 1882. King began to spend time in 1884 insuring that bridge owners complied with Federal regulations governing navigation in the Tennessee River, extending the issues that his office in Chattanooga would address. Active regulation and assertion of control became part of the engineer’s pragmatic practice. King wrote, “[i]t is evident that the policy of the Government to remain passive in such matters and abandon the interests of navigation to the State authorities, produces bad results…”

The army acknowledged the landscape view as the best means of understanding the “growing regimen” of dynamic interaction between political economy and the natural flux of hydraulic systems. Even with the embarrassment at the hands of Eads at the South Pass of the Mississippi, Henry Abbot remained the relentless advocate for a “permanent system” of surveillance and informed adjustment that spread across the entire American landscape. Drawing on his observations of the ruined levees and landscape after the war, Abbot had consistently articulated a vision that nothing short of massive Federal intervention could provide

94 Mansfield to Wright, April 2, 1880, Box 143, E71-RG77, NA; James Mercur to Chief of Engineers, December 5, 1882, Box 221, E71-RG77, NA; Mercur to Wright, April 10, 1883, Box 232, E71-RG77, NA; King to Chief of Engineers, Box 250, E71-RG77, NA.

95 Abbot to Humphreys, March 2, 1870, Box 1, E25-RG77, NA.

96 Abbot to Parke, April 20, 1870, ibid.
anything more than a “temporary security.” Concentration on the device scale, and not acknowledging the importance of the interaction of devices working in concert throughout the landscape, would prove fatal either by commercial starvation or a catastrophic act of god that would overwhelm all systems but an integrated federal one. The irony—that the avoidance of economic irrelevance by building levees that would eventually produce the disastrous floods would be left to be observed by later generations.

The legacy of military infrastructure building, and military reorganization of the landscape, is really a product of the intermingling of global capitalism and local ecologies at a specific time in the history of the United States. Capital worked throughout much of the nineteenth century to reconfigure the hinterlands of vast swaths of the planet. In the American South, the army mediated between “national” ambitions, the political and physical exigencies left by a devastating war, and the tragedy of the failure to bring true freedom to U.S. society, while shaping the landscape to promote capitalist development in the guise of national reconciliation and unity. Because so much of this effort was driven by agriculture, this process was by definition ecological. Because so much of this was driven by the acquisition of knowledge of the environment of the U.S. South, and the limits of the humans who inhabited it, and the ability of an institution to grow, adapt, and reconfigure its own environment, Reconstruction was a key moment in the United States’ technical history. Neither approach can perfectly describe the physical processes of the era. The legacy of infrastructure building in the United States remains inextricably tied to the great modernizing event of the Civil War, born out of the negotiation between race, class, and the landscape itself. Above all, it was described by the rhythmic

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97 Abbot to M. Jeff. Thomson, July 15, 1869, Official and Personal Letters, June 10, 1867 – April 20, 1870, Box 9, HLAP.
processes of the rivers and tides themselves, who play a continuous and noted role in the continual construction and reconstruction of American infrastructural territory.
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