BENJAMIN H. LATROBE'S PHILADELPHIA WATERWORKS OF 1801: INSTRUMENT AND EXPRESSION OF AMERICAN EQUILIBRIUM

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This study interprets Benjamin H. Latrobe’s Philadelphia waterworks of 1801 as a uniquely American architecture based on a designed equilibrium between the infrastructural production of public health, the architectural construction of civic landscape, and the republican cultivation of democratic society. This research produces an interdisciplinary reconsideration of Latrobe’s waterworks as a public health intervention which incorporated ancient ideas concerning environment, interwoven with contemporary theories of equilibrium in politics, technology, nature, and art. This study demonstrates that the waterworks was designed to restore balance to the city on three scales of registration:

**System** – The steam engine and reservoir at the heart of the system were placed inside a perfect marble cylinder within the Centre Square, beyond the settled parts of the city. Latrobe’s plan responded more strongly to the urban grid than to hydrological conditions, topography, distribution of settlement, capacity of steam engines, or engineering precedent.

**Environment** – Latrobe, an active member of early republican scientific and political circles, crafted the neoclassical engine house to calm the city’s inflamed climate, to combat recurring yellow fever epidemics. The marble rotunda was designed to supply adequate water so that, in Latrobe’s words, “the whole city may be alternately cleansed and cooled.”

**Image** – Latrobe attempted to invent a beauty appropriate to American democracy and civic utility. He intended to integrate his industrial intrusion within a cultivated balance of
architecture and landscape, so that it might be “an ornament to the city.” It was his belief that a balanced integration of art and nature could directly improve the character of the citizens of a democratic republic.

Latrobe’s design froze in stone the most important elements of early republican thought. These theories of natural law, human sensation, and common equilibrium would so radically alter the nation that the design soon seemed unintelligible, or insensible. An analysis of the writings and drawings surrounding its design reveals that Benjamin Latrobe’s Philadelphia waterworks was an essential pivot in the history of American infrastructure, urbanism, and ideas. This unique steam-powered pavilion marks a transition from ancient theories of cultivation and environment to the modern technical management of the industrial city.
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Introduction

The Philadelphia Waterworks of 1801: Pivot and Hinge

B. Henry Latrobe, Engineer, submitted his View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water in December of 1798. His proposal, to draw clean Schuylkill River water into the body of the city through an engineered system of tunnels and pipes, was radical in both its scope and its implications. Latrobe set out to remedy recurring yellow fever epidemics, the city’s primary public health crisis, by distributing water on a municipal scale. At the heart of his design was the Center Engine House, a marble pavilion within a cultivated urban square. It is my argument that Latrobe’s proposal was an effort to bring the city into equilibrium and to represent that balance through an integration of infrastructure, architecture and landscape. I propose that the design for the Philadelphia waterworks was rooted in the modern medical, scientific, aesthetic, and political theories of balance that underlay early American democracy, but which built their legitimacy upon ancient Greek and Roman ideas of environmental health and civic ornament. Benjamin Latrobe's municipal treatment of urban inflammation through an architecturally ornamented system was based on a long intellectual history, and can be read as a pivotal link between historical ideas concerning the fabric of urban health and the modern, large-scale urban infrastructural interventions of the later nineteenth century, which attempted a different type of equilibrium.

Latrobe grounded the design of his hydrological urban system equally on an imagined republican past and on his ideas concerning the quality of the native soil that would support the development of a balanced American republic. The technical apparatus of the waterworks was part of the larger understood System, that spanned from soil to morals and that linked the days of Classical Athens to the future health of Philadelphia. Latrobe hoped to establish the Centre Engine House as a civic marker at the center of an innovative technical system of hydrological
improvements. This first American urban waterworks attempted the integration between the architectural construction of public space and the infrastructural production of public health, all to serve the democratic evolution of mature republican citizens.

This dissertation sets out to understand Latrobe’s Philadelphia Waterworks within three interrelated registers. The first is as a technical hydraulic system that spanned the width of the city, and incorporated elements for intake, power, storage, and distribution. The second is as an environmental improvement that is only sensible within the scientific discourse of the time concerning health and balance. The third level of understanding is as a civic architecture and landscape designed in response to, and to further cultivate, the manners of the new nation. I propose that each of these fields of inquiry reveals that Latrobe’s infrastructural pavilion was both a hinge and a pivot between ancient and modern ideas of democratic balance, public health and environmental system. Further, I conclude that his attempt to achieve an equilibrium that spanned from urban infrastructure to individual temperament was in some ways sophisticated, not just by the technical standards of Latrobe’s time, but perhaps viewed retroactively from a new century in which modern science is again pointing to the complex interrelationships between environmental systems and individual sensation and well-being.

Systems, Balance, and Equilibrium

The two terms system and balance were crucial to Latrobe’s understanding, and are one framework also of this research into his work. Equilibrium is the third term that intervenes, connecting and complicating the first two. The idea of the perfection of an ordered balance of opposites was an underlying structural and epistemic element of eighteenth-century thought. By 1800, however, the scientific understanding of equilibrium was already promoting a more dynamic asymmetrical paradigm of balance. In Latrobe’s work we see an effort to remedy the city according to an ancient quadrilateral environmental ratio hot and cold, damp and dry. This encompassing Classical System of active and passive elements spanned from sky to earth, and
from art to morals and politics. Latrobe attempted to marry this grand neoclassical cosmological System with a technical hydraulic system, distributed within a grid. In American early republican thought, the regular orthogonal geometry of the grid functioned to mediate nature and culture, unfortunately the steam-engine operated according to a more dynamic and asymmetrical equilibrium.

The ideas of equilibrium, system, and balance are rich elements that assist in the understanding of Latrobe’s work, but the terms are also confused and confusing, because of the epistemological problems, overlaps, and divergences, which were characteristic of the usage at the time. The friction between the various meanings can be seen to underlay the disjunctions within Latrobe’s own understanding. The conflict between the epistemology and the engineering of equilibria eventually undermined his design of the Philadelphia waterworks. In fact, Latrobe did not label his design for Philadelphia a system, because man-made devices could not be so termed. He would use the words plan or work to describe his own and other hydraulic systems. When he chose to use the term system, it was to categorize empirically proven scientific theoretical approximations of the more perfect organizations of nature. As he noted in a journal entry of 1806, “I care very little about any system, for after all we can but give a probable guess, as to the methods by which Nature performs her operations. If our guess is upheld by all the facts, which bear upon the subject, it is as perfect as any system can be, and we may give it the Name of a Theory, or a system.”

While Latrobe used the term system for several types of scientific schema, the most significant one for his theories of environment and evolution was that of thought and sensation.

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2 Latrobe also used the word “system” a paper for the APS published in 1809. In this paper, Latrobe bemoaned the loss of his collection of fossils and also complained that the responsibilities of his “laborious profession” prevented him from finding “the leisure necessary to reduce into something like system, the various notes I have made.”
Latrobe believed that inherited organic habits of perception operated in conjunction with natural systems of sense. The interactions between inherited internal patterns and external sensations shaped the physiognomy of individual thought and character. The organs of sense were stimulated to motion by external “excitement,” and Latrobe stressed that with each practice of stimulus and motion, “with the more ease and perfection will it be performed.” Latrobe further speculated that each idea might be affiliated with a variety of systems of stimulus and motion, and so, the “organs of sense, capable of motions of association,” could produce “innumerable ideas, by the excitement of one of the ideas, belonging to that system.” Latrobe’s belief in systems of sense was to an extent compatible with the Classical notion of a larger fabric or System. By the terms of his sensory theory, thought, character, and morality were physically and internally modified by nature and external perception. This was a mechanistic explanation, which also explained the cosmological connection of season and atmosphere to perception, emotion, and health. Latrobe believed that variations in temperature and humidity might alter the shape of the eyeballs, further adapting habits of perception. Vision and sensation in America were unique to its unusual physical and political environment.

Latrobe’s addititon to this sensory theory, what he called “my dogma,” was the concept that some ideas were innate, rather than determined entirely by sensation. He argued, against Étienne Bonnot de Condillac, that each child inherits their sensory apparatus, “... in such a state as they existed in the parents, though weaker at first because not perfectly evolved.” Each individual is born with organs “habituated” to particular associations and motions which join sense to thought. Latrobe’s theory of habits of motion of sensory organs was constructed upon the biological ideas of Erasmus Darwin.


4 The editors of Latrobe’s journals note that Erasmus Darwin’s “physiological psychology” drew on David Hartley’s ideas of “vibrations of the sense organs.”
elaboration, individual character might be improved through the appreciation of unadulterated nature, or of more cultivated yet simple stimuli, such as neoclassical architecture. A citizen of a civilized city in balance with nature would pass on her improved habits of sense to her progeny. For Latrobe, art and environment were intrinsically linked to the improvement and evolution of democratic society.

Urban System

Benjamin H. Latrobe’s Philadelphia waterworks was the first industrial municipal infrastructural system in America, but it has not yet been studied independently of its role as a primitive precursor to other nineteenth-century hydraulic systems, or as an awkward predecessor to Latrobe’s mature neoclassical style. It is perhaps the Center Engine House’s unique appearance that led the editors of Latrobe’s architectural drawings to judge that the history of the Philadelphia waterworks “belongs principally to the history of technology and public works.”

Ironically, if the waterworks has been judged less relevant to architectural history, it has also been a minor if important character in histories of urban technology and public health. Because the Philadelphia system was constructed decades before other American municipal water-supply systems and was flawed in its design, Latrobe’s waterworks makes a frequent, but narrow appearance in most histories of urban planning and industrial infrastructure in America.

The Philadelphia waterworks has been considered a “proto-system” and “something of an anomaly,” in the words of historian of technology Martin V. Melosi. In both of Melosi’s thorough studies of water and sanitation in America, he describes the Philadelphia waterworks as, “sophisticated even by European standards,” but his focus lies not on the eighteenth-century context, but on the exponential growth of municipal systems during the later nineteenth century.

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Chapter 2 of this study will address questions regarding the waterworks that require placing Latrobe’s technical system within historical context. I will first attempt to outline European standards at the time, in order to determine if and how this system may have been sophisticated in comparison.

Latrobe’s system was revolutionary, as the first steam-driven water-supply system designed and constructed for the public benefit and funded by a democratic municipal authority. It was not at the time generally assumed that the public supply of utilities was within the role of government, at least in Britain and America. France did have a longer history of public supply, though the French systems were not as reliant as the British on external power sources. Paris had only begun to develop its first steam-driven system during the late 1770s, and at first had to rely on imported British engines. Yet it seems likely, though it was never admitted by Latrobe, that the ornamental pavilion that centered the Philadelphia system owed most to the Parisian models, which were in turn connected to the hydraulic architecture of the gardens of the Ancien Régime.

Latrobe’s system was also pioneering in the development of American urban systems of management and maintenance. Latrobe’s allegiance to Thomas Jefferson’s republicanism, and perhaps more importantly, his connection with Philadelphia’s philanthropic class supported the imagination and the funding of this new urban model. Cost and schedule overruns and Latrobe’s arrogance regarding the same soured many of his Philadelphia relationships, but the system he invented was influential. The men in Latrobe’s training were consulted in the design of the next generation of urban water supply systems, carrying forward many of his ideas, and accomplishing them with greater efficiency. The urban system was also influential in that the construction of the waterworks required the creation of the structures of government, financial, and technical management that would contribute to Philadelphia’s industrial growth during the nineteenth century, and provide a model for other American cities.
Environmental Remedy

The Philadelphia waterworks was constructed in response to a public health crisis, the seasonal yellow fever outbreaks that plagued American cities from their founding and through the nineteenth century. As the eighteenth century progressed, cities were forced to find cleaner water sources than their own wells and rivers due to regular outbreaks of yellow fever, as well as cholera and typhoid. Yet medical science did not yet fully encompass the means of disease transmission. Latrobe suggested the possibility of altering the city’s climate and thereby reducing inflammation. This concept of the connection of inflammatory climate to inflammatory disease was derived from ancient Greek medical theory, and was still a generally accepted idea within the eighteenth and nineteenth-century medical establishment. The proposal that climate could be altered on a large scale through technological means was, however, a radical notion without support from medical theory.

Latrobe utilized modern engineering techniques to remedy insalubrity within a Hippocratean framework: health was commonly understood at the time as arising from the particular constitution of airs, waters, and places. At the time the Philadelphia waterworks was constructed, salubrity, whether of body, ground, or republic, was a matter of equilibrium. I maintain that the waterworks operated in the same context as Dr. Benjamin Rush’s purgative medical protocols which balanced the inflammatory diseases unique to America by baths, teas, and bleeding. Latrobe’s system can also be read as a Jeffersonian democratic improvement. The waterworks treated the disease-ridden commercial congestion at the Delaware River by mobilizing the pure pastoral waters of the Schuylkill River via William Penn’s ideal grid. Latrobe’s hydrological design linked the ideas of Jefferson and Rush to a Hippocratean notion of

7 During the 1880s and 90s, Dr. Carlos Finlay proposed, and Dr. Walter Reed confirmed, that the Aedes aegypti mosquito was the disease vector for yellow fever, rather than the fetid water and swamps that often stood near areas of epidemic outbreaks.

8 The authorship of the Hippocratic writings is still debated, but during the late 18th century a variety of writings on the interrelationship between air, water, place, and physical, mental, and political health were understood to originate with Hippocrates.
disease arising from place. American improvements through the next two hundred years would similarly propose to regain equilibrium by changing the nature of place through universally-applied engineered means.\(^9\)

I argue that Latrobe was equally interested in the health of nature and of citizen, and in connecting Philadelphia’s pure water supply to the city’s civic life and image. During the eighteenth century, the means of judging natural and physical health were very different than those of today. It was taken as fact that the well-being of nature, body, and spirit were innately and intimately related. It was commonly assumed as well as medically asserted that the quality of air, water, and place contributed directly to physical, mental, and emotional health as well as to the political well-being of the nation. It was also understood, at least by Latrobe and his peers, that visibility, the artistic framing of the link between nature and city, was a necessary element to create a civic link between the two.\(^10\)

Civic Art and Landscape

Latrobe sited his pump house in a place of priority, at the center of the planned grid of the city, within a commons that had been intended by William Penn, the city’s founder, to be an open field surrounded by public buildings. In his first proposal to the city, Latrobe laid out the problem, the immediate provision of an adequate and reliable water supply, and declared, “I shall proceed to state to you, what appears to me to be the only means of concentrating all these requisites in one work.”\(^11\) This centralizing strategy seems never to have been attempted in any

\(^9\) Architectural representation, due to an increased separation between the professions of architect and engineer and an increasing emphasis on quantifiable utility, would become less critical in the century that followed.

\(^10\) Latrobe’s understanding of both “nature” and “city,” as well as how the connection and the balance between them might be represented, was far from our contemporary urban assumptions, which combine genetic analogy, biological environmentalism, economics, systems theory, demographics, statistics, planning, and identity branding.

European steam waterworks, though it echoed the central position of wells and fountains in some pre-modern squares and piazzas, and related also to the renaissance and baroque garden fountains and statuary that punctuated the terminus of circulation vectors and views. In several ways, Latrobe's infrastructural intervention was designed as a discrete pavilion within an urban garden as well as a functional element of a hydraulic system.

Latrobe aspired to create an American architectural symbol of democratic munificence and technological sophistication. The engine house was a sixty foot high marble rotunda which housed a steam engine and reservoir, to supply the city through a grid network of wooden pipes. Viewed pessimistically, the result was an unsuccessful effort to marry explosive steam technology to the cool repose of neoclassical architecture. Unfortunately, Center Engine House, the “concentring” architectural element of the system, drew criticism as an example of architectural arrogance and government overspending, and proved difficult to modify to provide greater efficiency, utility, or adaptability.

The Center Engine House was set within a cultivated landscape for peaceful recreation, and the engine house became a beacon for civic gatherings. The city square was constructed around the new technological instrument, the steam engine, the power of which forced a cleansing surge of waters into the streets, purging and rebalancing a city ravaged by yellow fever. Yet, the effect of the system surpassed its instrumental power. Because of the unique assumptions that he made regarding the design of the system, Latrobe's architecture became a means by which the new technology could be seen, celebrated, and integrated into the life of the city.

Latrobe's design of the Center Square’s landscape also seems to be founded on the idea of a balance between nature and city, connecting it to the English landscape debates of the 1790s. In the Center Square landscape and other works, Latrobe seems to have agreed with the ideas of Humphry Repton about the appropriateness of certain formal geometries in adjacency to architecture, and a greater wildness in private or removed parts of the landscape. Latrobe had
been well acquainted with Repton and his son during his years in London. In his youth, Latrobe also had exposure to this idea of a balanced landscape. While at the Moravian school in Niesky, Saxony, Latrobe was befriended by the Count von Schachmann of Königshain, who had recently rebuilt his own baroque castle to have both French and English landscapes, calibrated to the overall plan of his estates, with geometric plantings near the castle, and park and forest for the more distant prospects.

I hope to demonstrate the importance of Latrobe’s Philadelphia waterworks as an architectural and urban plan encompassing infrastructure, environment, architecture, and landscape. Latrobe’s Philadelphia waterworks provides an interesting study because it was constructed at the very beginning of the century during which it became necessary to find means by which to supply additional water, both to power industry and to support a growing urban population. This was the final moment before the demands of steam-driven industry would reshape cities around an entirely different order of needs.

Latrobe’s project was unique because its design assumed the city as a place to be arranged and irrigated like a garden. Latrobe considered artistic as well as utilitarian requirements, shortly before riverfront use and urban plans would bend away from aesthetic and geometric concerns and towards the needs of factories and railroads. A distant view of this proto-industrial system provides a reflection on our own time, and reveals the ways in which artistic, technological, and health considerations are still enmeshed, and often assumed with little reflection. The remediations we attempt today will, like Latrobe’s waterworks, solidify evolving scientific definitions of urban health into permanent form, and have a lasting impact on city life.\textsuperscript{12}

\textsuperscript{12} Jumping ahead to the railroad explosion of the 19\textsuperscript{th} century, or to Edmund Bacon’s 20\textsuperscript{th} century ideas about highways and the health of Philadelphia, we can see that a conviction that circulation and motion are the keys to urban health has repeatedly shaped city planning in Philadelphia, and in fact in most major cities. Today’s emphasis on DNA or coding seems to be eclipsing the dominant seventeenth century metaphor based on the motion of the blood, or the prior circulatory metaphor which was based on the motion of waters from the earth to the heavens.
Research Outline

Question and Method

The strangeness of Latrobe’s design in relation to prior examples indicated to me that he considered factors which surpassed the purely technical or utilitarian, and the question of what those factors might have been began my interest in the Philadelphia waterworks and its Center Engine House.\(^\text{13}\) The grandeur of Latrobe’s design against the humble brick background of eighteenth-century Philadelphia, and the strangely short life of the waterworks, made it a mystery worth investigating. The building has been viewed primarily through a lens which prioritizes nineteenth-century urbanism and art, and from this stance has been judged as both incredibly advanced (pre-dating other urban water supply systems in America by decades) and simultaneously as a naïve proto-system encased in a minor work of a major American architect. Latrobe himself has been judged as a landscape painter uninterested in picturesque theory, as an infrastructural engineer too driven by aesthetics. Yet he considered himself a modern architect, working according to the most advanced scientific methods. This dissertation was driven by curiosity, and a hope to better understand this strange project and its author.

My hope was that by sifting through his words, I might gain a better sense of Latrobe’s intellectual position. He wrote prolifically, both in journals and letters, so there is no shortage of information. I chose to focus on Latrobe’s ideas concerning architecture's relationship to science, technology, cities, health, and nature. What I found was that he treated all of these subjects as part of one whole. Latrobe’s theories evolved within a political and philosophical milieu that valued the role of sensation in the formation of human character, and that saw man as embedded in

\(^{13}\) There is some difficulty in interpretation of Latrobe’s ideas regarding the Philadelphia waterworks because his journals XII and XIII which cover the years he resided in Philadelphia have been lost. (see n.9, Journals II, 379) Therefore his Philadelphia Waterworks must be read based on its physical attributes, and within the context of other works with which Latrobe was likely familiar.
nature through the “Chain of Being.” Equilibrium or balance seemed to be the factor most often used to gauge all aspects of society, from environmental state and physical health to political function, aesthetic value, and proper manners. Balance in improvement was also one of the founding ideas of Thomas Jefferson’s democratic republicanism, as well as English landscape theory, as it was explicated during eighteenth-century debates. Latrobe was a passionate believer in republicanism, and claimed to be more interested in the works of nature than in those of man. The idea of an equilibrium designed in accord with nature that guided Latrobe’s design seem to have contributed both to the Philadelphia waterworks’ popularity as a site for civic recreation, as well as to its eventual demolition and replacement.

Context and Theory

This research has only become possible through significant work compiled by others. Latrobe’s son, John H.B. Latrobe, penned articles on his father’s work during the 1870s. Fiske Kimball studied Latrobe, and wrote his entry for the Dictionary of American Biography in 1933. Talbot Hamlin published his landmark biography of Latrobe in 1955. In 1976 the Maryland Historical Society issued an indexed microfiche edition of extant materials. The collected works of Latrobe were published by Yale University Press for the Maryland Historical Society between 1977 and 1994, including ten edited volumes of drawings, paintings, sketches, letters, journals, and papers. The Yale University Press series was edited by distinguished scholars John C. Van Horne, Lee Formwalt, Darwin H. Stapleton, Jeffrey A. Cohen, Tina H. Sheller, and Charles E. Brownell, under editor-in-chief Edward C. Carter II. Series I includes three volumes of journals covering Latrobe’s journey to America through his death in New Orleans, spanning from 1795-1820. Series II is three volumes of Latrobe’s architectural and engineering drawings. Series III is one volume of excerpts from Latrobe’s sketchbooks. Series IV is three volumes of correspondence and miscellaneous papers. In 2006, Michael W. Fazio and Patrick A. Snadon published *The Domestic Architecture of Benjamin Henry Latrobe* with The Johns Hopkins University Press.
University Press, and within their sharp focus managed a comprehensive picture of Latrobe and his ideas concerning this portion of his work.

The Philadelphia waterworks belongs to a history of cities, and of the shaping of cities in relation to technology. The work of Sir Patrick Geddes was instrumental in the beginning of this research, to contextualize the trends in nineteenth and twentieth-century thinking concerning urban growth and topography and the evolution of technologies and cultures. If the origin was in Scotland with Geddes, the branches of this tree took me to his followers in the realm of health and design, nature and cities, all of whom were influential in Philadelphia during the latter half of the twentieth century. This path travels through the University of Pennsylvania and marks a significant contribution to contemporary thinking and design around the balance between technology and geometry, life and nature. This list of these authors includes Lewis Mumford, Ian L. McHarg, and Ivan Illich. Histories concerning Philadelphia are almost too numerous to list, but very few contain more than a few paragraphs concerning the first Philadelphia waterworks.

The technical aspects of the waterworks are a part of a history of hydraulic technology. Writing on water-supply systems has passed through several evolutions. Of course, Latrobe commented on the water-supply systems with which he was familiar, but very few others in the early Republic were qualified to do the same. French works of the eighteenth and early nineteenth century, including Vauban and de Bélidor were construction references for Latrobe, but focused on hydraulic-powered and static civil works rather than on steam-driven systems. Nineteenth-century writings include large encyclopedias placing contemporary industrial systems within the

14 Works of this Scottish/University of Pennsylvania lineage include:
Geddes, Sir Patrick. Cities in evolution, an introduction to the town planning movement and to the study of civics. New York, H. Fertig, 1968. (c 1915)
span of all time,\textsuperscript{15} and short pamphlets written to promote various positions on improvement and sanitation.\textsuperscript{16} Starting at the end of the 19\textsuperscript{th} century and continuing to today, professional engineers of various qualifications have assembled catalogs which have interwoven quantitative and narrative strands, documenting the increasing power and efficiency of modern technology and sanitation, especially following the discovery of bacteria and the advent of electrification.\textsuperscript{17}

All of these histories place engineering at the heart of the study, only incidentally revealing intellectual trends of their own time, and without addressing the ways in which intellectual and social forces have interacted with technological and urban development. In \textit{Water for the cities; a history of the urban water supply problem in the United States} (1956) Nelson Manfred Blake bridges between this period and the next, writing within the realm of what he calls "social studies," and providing a fair and detailed account of Philadelphia's first water supply.

The social construction of technology approach, centering on the work of Thomas Parke Hughes of the University of Pennsylvania, became a popular approach to the history of technology during the 1980s. This theory of the social construction of technology provides one possible lens through which to examine the Philadelphia waterworks. This method describes a 'seamless web' of society and technology, and depends to varying degrees on the interpretation of technological history as a series of interactions between "different but interlocking" systems.\textsuperscript{18} For the purposes of this study, the social construction method is just a starting point. I borrow from this approach by addressing political, medical, art, and landscape theories as systems that are interwoven within the technical and physical aspects of Latrobe's design for the Philadelphia waterworks. Unlike the social constructivists, I choose not to place technology as the central determinant of history. Even later writings by Hughes categorize the "culture" of modern times

\textsuperscript{15} The works of William Matthews and Thomas Ewbank are early examples of this category.
\textsuperscript{16} In this group works focused on Philadelphia include the publications of Charles M. Cresson, William R. Hill, and Emile Geyelin.
\textsuperscript{17} The writings of George E. Waring and Henry Winram Dickinson are early examples of this type.
by the primary qualification that it is “technology-based.” In terms of dominant systems, I believe that medical theory, in particular theories of the health of the body, have historically been of equal or possibly greater importance.

Some of the most important recent work in the field of technology, culture, health, and urbanism has come from the descendants of social construction theory, environmental historians who share territory with contemporary architectural and urban theorists. Joel A. Tarr and Martin V. Melosi began with Hughes’ approach to technological and cultural history, but their work has moved towards greater concern with environment, and they have both written on urban sanitation and water supply. Influenced by Melosi and also by Lewis Mumford, Michal McMahon has also published an article concerning Philadelphia’s nineteenth-century water supply in environmental context, and contributed a chapter to J. Worth Estes and Billy G. Smith’s edited volume concerning the yellow fever. Latrobe both pre-dates and pre-sages modern environmental history, however, and so has not yet been a topic for thorough evaluation.

Environmental urban history is a general area that includes many disciplinary approaches, including art history. Within the field of architecture, Elizabeth Milroy and Dell Upton have recently produced excellent works that relate directly to the story of Latrobe’s waterworks. They, as well as Andrew M. Schocket, who unraveled the innovative funding mechanisms for the waterworks in his *Founding Corporate Power in Early National Philadelphia*, have recognized

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In this particular Hughes’ judges that Louis Sullivan “failed to articulate an embracing concept of a modern technology-based culture.” This book is dedicated to a more sensitive interpretation of technology that describes it as a “tool and source of symbols” for architects and artists. (4)

Latrobe’s Center Square design as important milestone in the shifting politics, economics, and topography of the city. These authors have provided valuable insights, and I consider their work adjacent to my own research.

Closest in technical subject matter to my own study is Carl Smith’s recently published *City Water, City Life: Water and the Infrastructure of Ideas in Urbanizing Philadelphia, Boston, and Chicago*. Smith sets out to decipher later nineteenth-century urbanism, explaining Latrobe’s Philadelphia waterworks in terms of the “visual appeal” of the engine house, but also concludes that “the best thing one could say about the system was that it did seem to improve the health and fire safety of Philadelphians.” In the context of the sanitary theory and technological efficiency quantified by later nineteenth and twentieth-century methods, the embedded meanings that Latrobe believed his work would bear forward have been largely lost.

In spirit and in aspiration towards a synthetic history of ideas and artifacts, my research relies most heavily on the methods of two French historians who have examined the social history of infrastructure and thought, Antoine Picon and André Guillerme. They do not place a primary emphasis either on rationality, or what Hughes refers to as the “human-built world,” or on the

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21 Elizabeth Milroy, “Repairing the Myth and the Reality of Philadelphia’s Public Squares, 1800-1850,” *Change Over Time* 1 (March, 2011): 52-78. Milroy tracks the cultivation of Philadelphia’s urban squares during the early 19th century, in the context of concerns over public health, and in accord with hopes to memorialize Penn’s plan and, at the 50th anniversary of the Declaration of Independence, to celebrate the city’s importance to American revolutionary history.

creative or what Picon calls the «imaginaire» as a separate entity inspired by the technological real. Instead they arrive at more nuanced conclusions through an annaliste’s close reading of a variety of materials related to a stated problem. Their investigations treat the built and unbuilt equally, allowing the inclusion of visual, textual, and material evidence, what Picon and Marc Desports call «d’images et d’expériences, de modèles et de réalisations». This approach allows for the simultaneous understanding of different temporalities and agencies that overlap and interact, «des permanances de longue durée et des inflexions brutales, des processus de sédimentation et des bouleversements assimilables à des révolutions ».23 The benefit of this approach is a serious treatment of technology and of ideas, and an examination of the overlapping and lingering concepts that persist through shifts in technology.

Other strong influences on this study have been several French and American historians of science and society, including Alain Corbin, David S. Barnes, and Conevery Bolton Valencius.24 Their respective works all touch directly on the shaping and cultivation of land and urban space according to theories of disease, miasma, and odor. It has been my great fortune to have studied with David Barnes, who has generously shared his ideas about this period in American history. Barnes’ *The Great Stink of Paris and the Nineteenth-Century Struggle Against Filth and Germs* addresses public health remedies within an evolving synthetic late nineteenth-century understanding of disease. His upcoming book will focus on the Philadelphia Lazaretto, which was an alternate public health response to Philadelphia’s yellow fever outbreaks contemporary with Latrobe’s waterworks. Valencius’ “*The Health of the Country:*” *How American Settlers Understood Themselves and Their Land*, documents the persistence of the idea

that dangerous miasmas arose from land that fell in-between natural and cultivated. This idea of the dangers of partial cultivation is also important to understanding Latrobe’s design for the Philadelphia waterworks. This dissertation attempts a micro-history after the style of Corbin, and a synthetic reading of medical theory and spatial imagination inspired by Barnes and Valencius. I hope that by drawing a close focus on a single artifact, I may simultaneously pursue several avenues of inquiry to derive a more synthetic understanding of Latrobe’s thought and design.

Structure

Chapter 1 provides a background of Latrobe’s character and training, as well as a brief introduction to the design of the Philadelphia waterworks. Chapter 2 contains an analysis of the hydraulic system in relation to prior European urban water supply systems. Chapter 3 assesses the Philadelphia waterworks as a public works project designed to remedy yellow fever by altering the environment of the entire city. Chapter 4 addresses the wider eighteenth-century context of public works, civil, garden, and scientific architectures. Chapter 5 explains the importance of the waterworks in relation to Latrobe’s theories of sense and nature, and in connection to eighteenth century debates regarding landscape, character, and situation.
Chapter 1 - Character and Situation

This chapter attempts to place Latrobe in the context of his time, and provides a brief description of the Philadelphia waterworks to lay the foundation for all that follows.

Latrobe: Man of Taste

*He says he is an American. He may be, by gignition, but is an Englishman by birth.*

... To sum up the whole, it must be acknowledged he is a man of taste,

—Dr. William Thornton, “William Thornton to Samuel Harrison Smith, Editor of the National Intelligencer,” Washington, 20 April 1808

[Taste] is in Art, what Wit is in conversation, the power of combining agreeably and unexpectedly objects essentially different: the power of harmonizing Contrasts.


... true taste in every art, consists more in adapting tried expedients to peculiar circumstances, than in inordinate thirst after novelty...

—Humphry Repton, Sketches and Hints on Landscape Gardening, 1794

A review of available sources gives a sense of the complexity of Latrobe’s biography, and indicates the difficulty of discussing his work within the limits of architectural history. It is helpful to view Latrobe through the lens of “Taste” a term he used often to describe the pinnacle of artistic powers. Latrobe believed that taste was the power of combination, and that while it could be improved through education and exposure to the cultivated arts, its origin lay elsewhere, that “its seeds are in nature.”

Latrobe’s biography demonstrates a wide array of experiences, travels, trainings and interests. His work incorporated a number of rich strains of thought, drawing on a deep knowledge of history, literature, philosophy, technology, science, and art. The sophisticated adaptation and combination of these ideas that Latrobe devised for the Philadelphia waterworks would have a profound influence on American architecture and urbanism.

Existing works on Benjamin H. Latrobe typically portray him as an innovative designer, either as a founding father of American neo-classical architecture or as a capable engineer, but even these impressive credentials cannot entirely circumscribe Latrobe’s abilities or intentions. Talbot Hamlin, Latrobe’s official biographer, has explored Latrobe’s erudition and the breadth of his scientific and intellectual interests, but chiefly describes the Philadelphia waterworks in terms of the strategic machinations behind their creation. The collected works of Latrobe, published by Yale University Press for the Maryland Historical Society between 1977 and 1994, includes ten edited volumes of drawings, paintings, sketches, letters, journals, and papers. The editors paint a picture of a complex man, comfortable in the worlds of science, art, and engineering, and committed to political ideals, but also to his own importance. Due to the huge volume of materials, the editors could not treat the waterworks, or any individual work, within all of these contexts, though all were certainly as much a part of Latrobe’s thinking as the architectural precedents with which he was familiar.

Latrobe is typically portrayed by art historians as, in the title of the recent PBS documentary, “America’s First Architect.” Latrobe’s prolific career and lasting monuments such as the U. S. Capitol and the Baltimore Cathedral, and his role as mentor to William Strickland, Robert Mills, and other qualify him for this epithet, but the title in no way adequately describes his ambitions. Latrobe has also been described as having a profound influence on engineering, as “the nation’s first major steam engineer,” but an evaluation of the failures of his steam

26 The Yale University Press series was edited by distinguished scholars John C. Van Horne, Lee Formwalt, Darwin H. Stapleton, Jeffrey A. Cohen, Tina H. Sheller, and Charles E. Brownell, under editor in chief Edward C. Carter II Series I is 3 volumes of journals covering Latrobe’s journey to America through his death in New Orleans, spanning from 1795-1820. Series II includes 3 volumes of Latrobe’s architectural and engineering drawings. Series III is 1 volume of excerpts from Latrobe’s sketchbooks. Series IV is 3 volumes of correspondence and miscellaneous papers.

ventures would lead one to question whether this is an entirely accurate description. In the Yale volumes, the details of Latrobe’s waterworks are assessed with little treatment of their relationship to the city. Nor is the waterworks evaluated in relation to what was, at the time, one of its primary purposes, healing the yellow fever, one of Latrobe’s primary scientific and personal concerns. Cultural history was not the purpose of the extensively and exquisitely researched Yale volumes, and it is perhaps worth noting that as an architectural work deemed to be of secondary quality within Latrobe’s oeuvre, the waterworks has gained less attention than have his more notable and lasting designs.

If art and architectural historians describe Latrobe as an originator of an American neoclassical lineage, Darwin H. Stapleton and Jane Mork Gibson, historians of technology, describe Latrobe within the bounds of early engineering. Stapleton’s volume of Latrobe’s engineering drawings provides detailed analysis of the technical aspects of Latrobe’s design, but doesn’t discuss the context or setting of the Philadelphia waterworks, or place it within the line of prior European waterworks. Stapleton has also written an excellent article on Latrobe’s broad scientific erudition. Stapleton’s scholarship is meticulous, but the waterworks was not the most successful of Latrobe’s projects, and intellectual and cultural urban history was not the author’s goal. Mork Gibson focuses on Latrobe’s accomplished assistant, Superintendent Frederick Graff, who devised the waterworks still extant on the banks of the Schuylkill River.

Latrobe’s architectural and engineering expertise should not be separated in retrospective analysis, because they were in no way separate in his thinking, or in the definition of the time. The two professions were becoming distinct in Europe, but were not yet segregated in America. Latrobe competed unsuccessfully against English engineer William Weston in 1797 for the

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28 Latrobe, Journals, I: xv
design of a canal for Richmond, Virginia.\textsuperscript{29} Darwin Stapleton notes that Latrobe and William Weston trained a small corps of practitioners of civil engineering. Latrobe’s students William Strickland and Robert Mills were to become not just architects, but also canal and railroad engineers.\textsuperscript{30} In papers surrounding the Philadelphia waterworks Latrobe would be described as “the engineer,” though he generally signed his drawings, B.H. Latrobe, Archt. It was only with his shift to the national capital and his work on the Capitol building that he would win a more emphatic definition as “the architect.”

The problem with discussing the waterworks as nothing more than an awkward architectural shell around a revolutionary technological core is that this project, perhaps more than any other he designed incorporated the broad range of Latrobe’s knowledge and interests at the start of his American career. I choose to position the waterworks within an intellectual and cultural framework that encompasses landscape, urbanism, architecture, and science in part because I believe it can be seen as an antecedent to contemporary models of urban infrastructural planning, but more importantly because this approach seems true to Latrobe’s understanding of his own work. In this sense, I hope to take up the model and the challenge of Paul Ricoeur, to find “the sympathy proper to the historian,” in “the suspended and neutralized adoption of the beliefs of past men.”\textsuperscript{31} I hope to convince the reader that Benjamin H. Latrobe’s system of beliefs in no way gave priority to art over science, architecture over technology, or building over environment, but in fact saw them all as part of the whole. It is out of sympathy for this view that I argue that Latrobe sought a “happy medium” that adapted historical models to the peculiar nature and manners, or situation and character, of the rapidly changing new nation.


\textsuperscript{30} Darwin Stapleton, ed., \textit{The Transfer of Early Industrial Technologies to America} (Philadelphia: American Philosophical Society, 1987), 68.

Latrobe lived during a time in which knowledge was less specialized, but even within this milieu, his education was considerably more cosmopolitan than that of most of his American acquaintances. He would insist that he was an American, but he was born in England, and spent almost half of his youth on the continent. His mother, Anna Margareta Antes (1728-1794) was an American from Bethlehem, Pennsylvania, and his father was born in Dublin and educated in Glasgow.\(^\text{32}\) Latrobe was born in 1764 in Fulneck, Yorkshire where his father, Reverend Benjamin Latrobe (1728-1786), directed the Moravian boys’ school. Benjamin Latrobe was educated within the communal system of the Moravian church, and grew to become a member of a literate intellectual London circle cultivated by his father. In the first year of Latrobe’s life the family moved to London, where their circle of friends would include Dr. Samuel Johnson (1709-84) and Dr. Charles Burney (1726-1814).\(^\text{33}\) Reverend Latrobe was the minister of the Fetter Lane Chapel on King’s Road, about a mile west of the Chelsea Royal Hospital and one and half miles from the famous Chelsea waterworks.\(^\text{34}\)

Latrobe’s Moravian education began at age three when he was sent back to Fulneck in Yorkshire to attend boarding school. It was typical within the Moravian church to send children to be raised away from their family within a community centered on a school called a Pedagogium. At age twelve, Latrobe advanced to the Pedagogium at Niesky.\(^\text{35}\) At the Pedagogium, Latrobe would have studied Greek, Latin, Hebrew, and French. Of course he was also fluent in English and German, and spoke some Italian. The school’s curriculum, as described by the editors of the Yale editions, included writing, drafting, and music, as well as mathematics, trigonometry, geometry, history, geography, natural history, astronomy, botany, and physics.

\(^\text{33}\) Dr. Burney was a member of the Royal Society, a musician and music historian appointed in 1783 as organist to the Royal Chelsea Hospital cathedral through the influence of his friend Edmund Burke. He was also the father of the writers Fanny and Sarah Burney. Latrobe and his wife visited Burney at the hospital, and would have passed by Chelsea waterworks on their way.
\(^\text{34}\) The Chelsea steam engines were on the site now occupied by Victoria Station.
\(^\text{35}\) Niesky is located approximately 60 miles east of Dresden in what was then German Silesia.
Latrobe declared a desire to pursue architecture and engineering, and around 1781 or 1782, left Niesky for Gnadenfrey, Silesia, where studied “river improvements,” under Heinrich August Riedel (1748-1810), a Prussian architect who was working on dikes in Saxony during the time Latrobe would have apprenticed with him, and who was a member of the modern architectural elite that included Friedrich David Gilly.  

Niesky, Latrobe’s home prior to his departure to study hydraulic architecture, was arranged around the approved order of most Moravian towns but was also linked to their Bohemian origins. The town itself, like all Moravian planned towns, was divided and designed strictly around gender divisions and social roles, with houses for married brethren and for unmarried brothers and sisters. Niesky had been founded in 1742 by Bohemian immigrants fleeing Catholic religious persecution. There Latrobe came to know Baron Karl von Schachmann (1725-89), scholar and a secretary to Count Zinzendorf (1700-1760), the influential Moravian Bishop. Baron von Schachmann, a painter and naturalist, lived in a castle of his own design near the Moravian settlement, and would become Latrobe’s mentor and friend. At the time the young Latrobe was formulating a desire to study architecture and engineering, he was living within the gridiron of Moravian town planning, and spending happy hours within the Count’s baroque domain at Königshain.

36 Latrobe, Correspondence, I: 6-9.
From 1780-96, Heinrich August Riedel was engaged with the drainage project for Drömling. In 1790, Riedel would tour the hydraulic architecture of Westphalia and Holland with Friedrich David Gilly.

37 Hamlin, Benjamin Henry Latrobe, 12.
Baron von Schachmann lived in a baroque castle of his own design, and may have shared his interest in architecture with his protégé. [Königsheim, built 1764-66] The Baron also published Beobachtungen über das Gebirge bey Königshayn in der Oberlausitz (Observations on the mountains in Königshain in Upper Lusatia) in 1780, accompanied by illustrations of rock formations not dissimilar from those Latrobe painted on his arrival in America. Von Schachmann was also founder of Die Oberlausitzische Gesellschaft der Wissenschaften (Oberlausitzische Society of the Sciences).
Despite his strong connections to the Moravian hierarchy, Latrobe was more devoted to rationality than to religious faith. Latrobe entered the seminary at Barby in 1782, but proved ill-suited to the ministry. He was singled out in a report submitted to the church elders in March of 1783 as one whose open disbelief at the church's teachings might, 'cause a great deal of damage.' A few months later Latrobe was dismissed from the seminary in order to take up study in Vienna, 'to perfect his inclination toward fortification [i.e., military engineering].' Latrobe would later describe the Society of Moravians against the opposite character of his father who he deemed, "distinguished from them, and their rather morose address of the others, by his elegant and winning manners." While he may not have accepted the religious doctrine or morose manners of the Unitas Fratrum, the formative years he spent in a visibly and rigidly ordered communal society cannot be judged irrelevant to the young Latrobe’s intellectual and social development.

Moravian planned towns were carefully ordered, and I believe Latrobe’s siting of the Philadelphia waterworks assumed that similar distribution was possible within a large American city. It is clear from Latrobe’s later statements on the subject that America’s freedom from the weight of church control, and the revolutionary dedication to an egalitarian and common society, were the reasons he pledged his allegiance to the new nation.

Prior to his departure from the Continent, Latrobe made an architectural tour of Europe, passing through Germany and France. On this trip in 1783, or perhaps on a second journey in 1786, he also visited Naples and Rome. Unfortunately, Latrobe’s journals from this time have not been preserved, but in later correspondence he describes several of the buildings which left a strong impression on him. In his 1803 lecture, “Remarks on the best form of a room for hearing

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38 Latrobe’s older brother Christian Ignatius was a successful seminarian, as well as a musical scholar.
40 Latrobe, Correspondence, I: 47.
41 Latrobe, Journals, I: xix.
and speaking,” Latrobe noted the excellent acoustical qualities of certain buildings he has seen, including the Pantheon in Rome. He ranked the Anatomical Theater at the Ecole de Chirurgie in Paris as, “perhaps the best lecture room in the world for speaking, hearing, and seeing.” The Halle au Blé also received mention, as did Sir John Soane’s Bank of England. Latrobe explained in his Remarks that a sphere was the most perfect acoustical form, but that as that shape is, “impracticable,” then “next to it in perfection ... is a Cylinder covered with a half globe or semi-spherical dome.” This form was, in Latrobe’s opinion, not only acoustically superior, but also achieved, “the most space within the least quantity of walling.” Several polygonal centralized forms, including Surry Chapel in Southwark, and the Octagon Chapel at Bath, also merited Latrobe’s approval.43

Upon his return to London in the summer of 1784, Latrobe pursued varied intellectual interests and worked in both architectural and engineering offices. His first employment was in the Stamp Office, but by 1788 he was working under John Smeaton (1724-92), the inventor of the term “civil engineer,” designer of various improvements to the steam engine, builder of Eddystone lighthouse, and founder of the Society of Civil Engineers.44 Under Smeaton and William Jessop, Latrobe worked on the Rye Harbour improvements, the Basingstoke Canal, and later on the Chelmer and Blackwater Navigation in Essex.45 Even early in his American career, Latrobe displayed great facility as a surveyor and civil engineer. Just as the Philadelphia waterworks was being completed with great difficulty and delay, Governor McKean of Pennsylvania appointed Latrobe surveyor and assistant to his uncle, Colonel Frederick Antes, on the Susquehanna River Survey. Despite obstacles to his success, he completed the survey within a

42 The “Remarks” were a guide written for his friend Thomas Parker who had requested Latrobe’s opinion for the Quaker Arch Street Meeting House in 1803.
43 Latrobe, Correspondence, I: 404-406.
44 Latrobe, Journals, I: xix.
45 Latrobe, Correspondence, I: 84.
month, and soon afterward painted a 17' long watercolor of the river. He successfully petitioned
the Pennsylvania legislature to complete the river improvements by 1802. 46

Latrobe’s professional architectural training began when he was around 25. Probably
around 1789 Latrobe entered the office of Samuel Pepys Cockerell (1754-1827) under whom he
worked on the Admiralty House in Whitehall and functioned as surveyor for the London police.
As the editors of Latrobe’s collected works point out, at this time Latrobe would have been aware
of the “most advanced architects,” the modern architects of England, including Cockerell, George
Dance the younger (1741-1825), and Sir John Soane (1753-1837). Michael Fazio and Patrick
Snadon point out that Latrobe likely saw Soane’s work at the Royal Academy when he lived in
London between 1788 and 1795, and would have had access to Soane’s published work.47 The
editors of Latrobe’s journals have also noted that Latrobe, “independently produced brilliant
solutions to sophisticated design problems that were strikingly similar to those Soane arrived at
when faced with similar challenges.”48

Latrobe had been strictly educated and professionally apprenticed, and was also well
traveled and well read. In a volume on early American architects and their books, Jeffrey Cohen
has pursued research into Latrobe’s architectural influences and context.49 He examines Latrobe's
library, positioning him at the beginning of nineteenth-century Neoclassicism and eclecticism.
Cohen is faced with a difficulty that was far more troubling for Latrobe himself, namely that he
lost a library of 1500 volumes which were seized by a French ship during his passage from
England to America, and his reconstructed American library was also dispersed. Cohen, one of
the editors of the Yale series, traces references made in Latrobe’s journals and letters, pinpointing

46 Latrobe, Journals, II: 22.
        Two days after Latrobe left Philadelphia, Colonel Antes was reported ill, and died on 20 September. As
        Latrobe attended his uncle in Lancaster, he kept a dispassionate journal record of his symptoms.
47 Fazio and Snowden, The Domestic Architecture of Benjamin Henry Latrobe, 524.
48 Latrobe, Journals, I: xx.
49 Jeffrey A. Cohen, "The Architectural Libraries of Benjamin Henry Latrobe." In American Architects and
        Their Books to 1848, ed. Kenneth Hafertepe and James F. O’Gorman (Amherst: University of
        Massachusetts Press, 2001), 109-128.
the many books he knew almost by heart, including Le Roy, Stuart and Revett, Gilly, Gilpin, Payne Knight, Durand, de Bélidor, Perronet, and Vauban. On the matter of “hydrodynamic science,” Latrobe also cited Bernoulli and Kaestner (likely Abraham Gotthelf Kästner), and Mariotte in his arguments for the Philadelphia waterworks.50

Latrobe’s endeavors were not solely professional; he also was engaged in various cosmopolitan intellectual and social endeavors during his time in London. In 1788, Latrobe published an English translation and adaptation of the biography of Frederic II of Prussia, and the following year an account of Denmark’s revolution of 1772. He also had some role in James Bruce’s *Travels to Discover the Source of the Nile*, though their partnership ended in a lawsuit.51 Latrobe also often visited Dr. Burney at his home on the grounds of the Chelsea Royal Hospital behind the Chelsea Physik Garden. Both Latrobe and his brother Christian were fluent in German and musically trained, which made them useful assistants to Burney’s studies. Latrobe’s closeness to the family is demonstrated by the fact that he was at one point considered as a marriage prospect for her sister Charlotte Ann (1761-1838) by Fanny Burney (1752-1840), though in fact he would marry Lydia Sellon in 1790.52 It was likely through the Burneys that Latrobe came to know the Repton family. Writing a letter to Charlotte in March of 1789, Latrobe asked her to pass on a “heart shake o’the hand” to his “good honest friend Jack Repton,”53

During this very successful period of Latrobe’s life, it seems that he came to know both John Adey Repton and his father, landscape gardener Humphry Repton, and while it is impossible to trace a direct lineage from one to the other, I hope to demonstrate that Latrobe’s work in Philadelphia gives evidence to similar ideas concerning landscape and the “interference of art.” Latrobe would claim in a letter dated 16 April, 1816 to President Monroe that, “Repton, engaged

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51 Latrobe, *Correspondence*, I: 13, 18-19.
53 Latrobe, *Correspondence*, I: 18.
with beautifying and laying out parks, with whom I was very intimate (1794) stated his income to be 5,000£ sterling.”

In 1794, of course, Repton was compiling *Sketches and Hints on Landscape Gardening*, and engaged in battles with Richard Payne Knight and Uvedale Price regarding the role of the picturesque and painting in the art of landscape gardening. Fazio and Snowden, in their study of Latrobe’s domestic architecture, note that each of the English estates Latrobe designed in Sussex, Hammerwood Lodge (1792) and Ashdown House (1793), were set upon an earthwork terrace, which was they judge “recalls Repton’s landscapes.” They find this similarity in the raised platform that supports the house, as well as in Latrobe’s emphasis on open parks and “the appropriation of distant views.”

It is true that Latrobe, like Repton, valued the prospect, both from and towards a building, but I think that their more important similarities can be found in the ways they challenged painterly notions of the picturesque landscape and associated ideas of irregularity, sublimity, and strong emotion. I would point out that in the plan for Ashdown, Latrobe located a formal garden near the house, giving way to a park beyond. This calibration of a more geometrically controlled landscape, what Repton called “the interference of art,” to architecture is one of the key arguments contained in *Sketches and Hints*. In the final chapter of this dissertation, I will address the theoretical similarities between Repton and Latrobe that mark them as “modern” designers, for whom the immanence of nature was the source of beauty and meaning, and the foundation for rules based on balance, between what Repton calls, “the two opposite characters of native wildness, and artificial comfort, each adapted to the genius and character of the place.”

54 Latrobe, *Correspondence*, I: 761.
55 Fazio and Snowden, *The Domestic Architecture of Benjamin Henry Latrobe*, 94-95, 148. Fazio and Snowden also find evidence that Latrobe was introduced to John Baker Holroyd, Lord Sheffield (1735-1821) between 1792 and 1794 and did work at Sheffield Place following a renovation by James Wyatt (1747-1813), which may have been a second connection to Repton beyond the acquaintance through the Burney family, since Repton had worked on Sheffield’s park since about 1789. (Fazio and Snowden, *The Domestic Architecture of Benjamin Henry Latrobe, 606*
56 Humphry Repton, *Sketches and hints on landscape gardening. ... The Whole Tending to Establish Fixed Principles in the Art of Laying Out Ground*. (London: printed by W. Bulmer and Co. Shakspeare printing
Latrobe’s fortunes declined after the completion of his work in Sussex, prompting his emigration from London to America. In 1793 his wife Lydia died giving birth to their third child. According to his brother, Lydia’s death, ‘quite deranged his affairs and almost his mind.’ Soon afterwards Latrobe’s mother died. By Latrobe’s own account the French war and anti-French sentiment reduced his prospects in London, since his support of the revolutionary cause was well known and made him unpopular in some circles. Latrobe inherited a portion of his mother’s land near Bethlehem outside of Philadelphia, and decided to close his architectural office and leave his children in the care of his sister, sailing for Virginia late in 1795.

\[\text{footnote}{57} \quad \text{Latrobe, Journals, I: xxii.}\]
Perhaps he may have an antipathy to the name of Washington for that great man was asked by a very respectable gentleman now living, why he did not employ Mr. Latrobe? "Because I can place no confidence in him whatever"—was the answer. And yet the modest Mr. Latrobe told a gentleman high in the present administration, before several witnesses, that he (ille ipsit) was the only scientific Architect in America!

—Dr. William Thornton, "William Thornton to Samuel Harrison Smith, Editor of the National Intelligencer," Washington, 20 April 1808

Latrobe arrived in Norfolk, Virginia in early 1796, a sophisticated and educated world-traveler, and an amateur scientist and naturalist, with a professional education in the business of architecture and engineering. In America he would pursue his career as a modern and scientific architect, dispensing with unnecessarily elements of the past and promoting a new clarity and balance. He was a practical man who had left the religious enclave of his youth, but remained an idealist with a strong admiration for the American revolutionary leaders. In his journals Latrobe wrote glowingly of his new country, reveling in its youth and freedom from affectation. His admiration, and his youthful arrogance, was evidenced in his impressions during his visit to George Washington's Virginia estate during July of 1796. Spying a garden parterre planted in the form of a fleur-de-lis on the west lawn of Mount Vernon, Latrobe was appalled. He noted that he had not seen this royalist pattern since leaving Germany, and called it, "the expiring groan, I hope, of our grandfathers' pedantry."  

The early American republic was riven by political debates concerning the role of the Federal government and central banking, as well as by split allegiances to France and England. Jefferson's Democratic Republicans claimed to represent artisans, agriculture and nature, and held closer ties with France, while Alexander Hamilton's Federalists took a position in favor of

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58 Latrobe, Journals, I: 165.
the development of central banking, metropolitan cities and trade with England. Latrobe was enamored of the republican position even prior to arriving on American soil. His initial letter to Jefferson in March of 1798 attempted to curry favor by stating the difficulties he feared that he would have finding work with the American government because he was a friend of "the most independent and virtuous men in Virginia," and had even dined with James Monroe. In this statement he was not so subtly pledging his allegiance to the pro-French Jeffersonian republicans at a time when John Jay was establishing a trade agreement with England, opposed by the Monroe, the ambassador to France. Shortly thereafter the XYZ Affair in which agents attempted to bribe an American diplomatic party on behalf of Talleyrand-Perigord, the French minister of foreign affairs, would be made public, further inciting the public to allegiance with the Federalist and to calls to declare war against France. During the congressional elections of April 1799, just a month after construction began on the waterworks, the pamphlet, *The Cannibal's Progress, Or, The Dreadful Horrors of French Invasion!*, was widely circulated.

Latrobe's sympathy for the French seems to have been political, and also theoretical. In fact, the issue of Latrobe's sympathy for the French cause may have been an obstacle to his progress as an architect and surveyor, even in Virginia, the most Jeffersonian of all states. Latrobe would reinvoke his political stance in another letter to Jefferson in September of 1798, saying that after he had spent weeks designing alterations and barracks for two military forts in Virginia, his design was ordered to be executed, and then his involvement suddenly terminated, in Latrobe's opinion, "because a man of my politics is not to be trusted in so important a case as the defence [sic] of the Country against the French." [italics Latrobe] Latrobe's design for Philadelphia, as will be addressed in later chapters, also indicates his philosophical alignment with French engineering theory, with its focus on symmetry and appropriate ornament. This conflation of

59 Latrobe, *Correspondence*, I: 81.
60 Latrobe, *Correspondence*, I: 86, n.2.
61 Latrobe, *Correspondence*, I: 97, n.3.
62 Latrobe, *Correspondence*, I: 96
utility and art was already in marked opposition to the English engineering approach which tended to place much more emphasis on devices and on mechanical function than on aesthetics or geometry.

Latrobe shared the predominant Jeffersonian-Republican convictions of the time, partly scientific and partly political, that physical health, climate, and the cultivation and visual appearance of the environment were intimately linked. Latrobe understood this connection to be so direct that in 1798 he ordered eyeglasses in 3 different strengths, because he suspected that the, "change of Climate" between England and America might have physically altered the convexity of his eyeballs and was unsure whether it would reduce or increase the needed magnification. Latrobe assumed that the quality of American air and the geometry of his own physical organs were linked, so it is perhaps not surprising that he believed that an alteration of the atmospheric climate of Philadelphia would have significant effects on the health of its citizens.

The belief that a balance of habit, climate, and architectural planning were inextricably linked to health is evidenced in Latrobe's writings on city organization, as well as his theories on domestic architecture. In the planning of American cities, he argued for plots that were longer from east to west, and shallower from north to south, because, in his words, "We have in America only one good Aspect, the South." Latrobe also derived his domestic theories from his scientific ideas concerning climate, as well as from his knowledge of French and English methods.

63 Latrobe, Correspondence, I:73.
64 It is impossible to address the topic within the context of this study, but the influence of philosophy, medicine, and technology originating in Scotland and in Birmingham cannot be underestimated when addressing ideas concerning the interrelationship between environment, urbanism, health, and technology in early republican America. Doctor Benjamin Rush, one of the most influential members of Philadelphia's medical establishment, obtained his medical degree at the University of Edinburgh. Doctor William Thornton, who would become Latrobe's enemy over the design of the United States Capitol, was a doctor trained at Aberdeen. Doctor William Small, a teacher and mentor to Thomas Jefferson who taught at the College of William and Mary, was also trained at Aberdeen. Small was also a member of the scientific Lunar Society in Birmingham along with Erasmus Darwin and Joseph Priestly, and is said to have introduced Matthew Boulton to Scottish engineer James Watt. Both also became members of the Lunar Society.
65 Latrobe, Correspondence, II:42-45.
of design. He concluded that American manners were based on British custom, but would gradually become more similar to those of the French, since the American climate was more closely akin to that of France. Architecture should become, “as well adapted to the climate as to the manners of the people,” which would, according to Latrobe’s theory, require a balance of the two influences, habit and environment. In a letter to William Waln dated 26 March, 1805, Latrobe argued that “In America our manners are English, but our climate is in almost every particular the contrary of the climate of the British Islands.” He found great fault particularly in the typical English central hall and staircase, which he criticized as “a kind of turnpike road through the house over which every one, whether visitor, or member of the family, male or female, sick or well must pass, ...”. He determined that the superior and more salubrious model was the French division of the house into a hierarchy of adjacent parts, planned for a separation of function, while allowing proper communication between parts. Latrobe opined that while America was warmer and dryer, and therefore more akin to France, “that chan[ge] of our manners which the difference of a climate slowly, but certainly will effect, has not yet made any very great progress in the middle and northern states, a house, completely arranged on French principles, would be as illy adapted to the habits of life of an American family, as a house completely on the London model is to its health and comfort.” Latrobe’s architectural theories were based on a science that linked ways of life to the weather through the mediation of geometry and distribution. These theories operated from the scale of the bedchamber to the extents of the metropolis.

Latrobe believed wholeheartedly that nature, health, and art were linked, not just metaphorically, but literally through the process of sensation, which he believed was present in all living things. He was a scientific adherent of the ideas of Erasmus Darwin (1731-1802), whose poem The Botanic Garden (1790) linked together the story of Genesis and the lives and loves of

66 Latrobe, Correspondence, II, 35-36.
the plants with the advances of industrial technology, placing industrial devices including the
steam engine within a lyric natural trajectory of growth and change.67 During his early years in
America freely quoted from Darwin’s recently published *Zoonomia; or the Laws of Organic Life*
(1794-96). In the preface to this scientific tract, Darwin offered that “The great CREATOR of all
things has infinitely diversified the work of his hands, but has at the same time stamped a certain
similitude on the features of nature, that demonstrates to us, *that the whole is one family of one
parent.* On this similitude is founded all rational analogy...”68

In his *Essay on Landscape* (1798-99) written as he was designing and beginning work on the
Philadelphia waterworks, Latrobe drew frequently on examples from Darwin. In this instruction
manual, technically directed at the painting of landscapes, Latrobe studied and drew rocks, trees,
and ground sections, but also included detailed views of wasps, sea anemone, oysters and various
plant life forms. He was particularly interested in symbiotic relationships and in plants such as the
“Flycatcher”, the Mimosa, and the Silene which demonstrated predatory behavior, suggesting a
bridge between plant and animal life that Darwin’s “Great Chain of Being” described. Latrobe
rejected the religion of his youth, and never became an adherent of another, yet he could wonder
at creation, that wasps seemed “to possess a very large portion of reason,” and speculated that
plants might also contain, “not only sensation, but sentiment and affection.” Latrobe described the
entire contents of the living world as showing “a gradual sliding, if I may use the expression, of
the one mode of life into the other.”69 It is no wonder, in this fluid world, that qualities of heat
and cold, dry and damp, might have a profound bearing not just on the growth of plant life, but on
the productions of man.

Nymphs! You erewhile on simmering cauldrons play’d; And call’d delighted Savery to your aid;
Bade round the youth exploding Steam aspire; In gathering clouds, and wing’d the wave with fire; ...
Darwin, M.D. F.R.S. author of The botanic garden. ; [Four lines from Virgil, with six line translation].
of Columbia College, no. 99 Pearl-Street, 1796), 1. Darwin was the grandfather of Charles Darwin.
The tightly linked chain of life meant to Latrobe, as to many of his time, that the soil and trees and air of a particular place were the literal foundation of higher realms of culture. Latrobe was proud to define himself as an inheritor of American blood, as “a patriot, who has devoted himself to his country.” He believed that the particularities of American soil and American freedom would give birth to the highest art, which would serve utilitarian and democratic goals. In his 1811 address to the Society of Artists in Philadelphia, Latrobe stated that, “Art is a hardy plant,” but explained that only free soil could give birth to the finest and purest works of art. Latrobe expected that American examples of these fine works would be neither “hidden” nor, “powerless,” but instead would be the new “public works.”  

Public works sprung from fruitful free soil, and followed rational plan and purpose. The essence of Latrobe’s belief was that American soil was free from the excess and injustice of Europe, and would therefore support and nourish the growth of men, as well as technical and artist works, that were simple, beautiful, useful, and powerful.

As America grew in population and prosperity, Latrobe was as concerned as Thomas Jefferson, Dr. Benjamin Rush, and other Democratic Republicans with the role of cultivation in establishing a healthy balance between nature and city. In March of 1796, about one week after landing in America, Latrobe suggested that with its, “firm and dry,” location, Norfolk Virginia could avoid fevers and become, “sufficiently healthy,” but only if it were properly cultivated and the surrounding woods cleared.  

There are several such statements in his journal entries from around this time. That it was the role of citizens to create health through the modification of landscape was an essential belief of early American thinkers from both ends of the political spectrum. It was Latrobe’s unique European artistic and intellectual training, as well as his

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70 Benjamin H. Latrobe, Anniversary oration, pronounced before the Society of Artists of the United States by appointment of the Society, on the eighth of May, 1811 by B. Henry Latrobe (Philadelphia: Bradford & Inskeep, 1811), 32, 31, 20, 17, 10.

71 Latrobe, Journals, I: 79.
political idealism, I believe, that underlay his translation of this cultivation beyond the open fields of Norfolk to the urban grid of Philadelphia.

Latrobe identified himself as an American, protesting that he did not have “a drop of English blood” in his veins, but his European education and training embodied Enlightenment rationality, as well as the faith of the times in the limitless powers of nature. He brought with him technical knowledge that was a precursor to the powerful new field of engineering, nascent in Europe but almost unknown in America, which would radically alter the landscape of cities during the nineteenth century. European surveyors who shared Latrobe's training used the grid system as a tool for measurement, to design infrastructure across broad terrains. Latrobe was also a respected amateur naturalist, as were many gentlemen who shared a high level of education and a degree of leisure. And finally, Latrobe in his understanding of architectural history, symbol and geometry, emerged from a sophisticated lineage, yet was part of a younger generation willing to abandon an attachment to outmoded emblems and excessive ornament. In addition, then, to the prevailing belief in the interdependence of the health of environment, body and society, Latrobe combined three profoundly modern elements – the rational engineering, environmental calibration, and architectural planning of civic spaces around technological, natural, and aesthetic systems. These three theoretical elements, the technical, the scientific, and the aesthetic, underlay his modern urban design for the Philadelphia waterworks.

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72 Latrobe, *Journals*, II: 304. His mother was an American, and his father born in Ireland.
To sum up the whole, it must be acknowledged he is a man of taste, but the Pennsylvania Bank, considered as his master-piece, was after a very chaste piece of Architecture in Athens, which had been seen by two of the directors and which he was ordered to imitate. The centre-house for the water works in Philadelphia, I doubt not, is his own.³⁷

—Dr. William Thornton, “William Thornton to Samuel Harrison Smith, Editor of the National Intelligencer,” Washington, 20 April, 1808

All that is said on this subject is as absurd as it is false—Even the Porticos vary in every part of their proportions of columns and entablature from every temple in existence.

—B. Henry Latrobe, “To Jonathan Smith Findlay, Editor of The Washington Federalist,”

⁷³ Dr. Thornton meant the clear attribution of the Philadelphia Center Engine House to Latrobe to be read as a resounding insult. However, the point is true, that the waterworks, like the Bank of Pennsylvania, was unusual, and that its originality sprung from the particular “genius” of Latrobe.
Latrobe’s urban and scientific interests underlay his invention of a uniquely American strain of modern architecture. The Philadelphia waterworks was one of Latrobe’s earliest American projects, and, I argue, the design strongly reflected his technical, scientific and aesthetic interests, all of which were based on ideas of combination and adaptation to achieve balance. The Center Engine House reflects these theories of equilibrium, with a brutal clarity and originality that sets it apart from his later designs. Each chapter of this study will address a different aspect of the balance apparent in this work. The technical program of the steam-driven waterworks did not have a long lineage, nor did Latrobe have a history of building in America. Latrobe may have allowed his particular “genius” to seek a greater level of invention in the waterworks than could be exercised in his later domestic and civic works. His unique ideas were most clearly reflected in the form of the Center Engine House. As Doctor Thornton condescendingly noted during his public battles with Latrobe, the design of the engine house was unmistakably original, and unquestionably Latrobe’s.

Latrobe designed the Philadelphia waterworks around ideas of balance, intending that his waterworks would simultaneously connect the city to a purer nature to heal its fevered airs, and also culturally elevate the city, improving its position as a favored metropolis. His knowledge and theory placed him as an intellectual equal and political comrade of the leading Democratic Republicans in America, but his understanding of architecture and planning was grounded also in the geometric complexities and hydraulic systems of the baroque cities and gardens of Europe. This set him apart from most of his republican compatriots by rooting his interests as strongly in landscape gardening and urban display as in agriculture, industry, and utility.

Latrobe’s design for the Center Engine House was a balance of invention and nature, new, yet firmly rooted in the unique physical and cultural environment of America. The site and building became, briefly, a civic center for Philadelphia and an important precedent for urban
planning and infrastructure. Latrobe’s assumptions about the possibility of expressing
government munificence through ornamented public works were not entirely successful in their
ambition, but were correct their direction. In recurring moments of populism and federal
economic control, the American government has offered symbolic public works. That each of
these has been controversial marks the conflicted American attitude towards public spending for
the architectural integration of public art and technological necessity. Significantly, spending on
public parks has always been more popular in America than expenditures for architectural
monuments. While today, this seems an accepted aspect of American “manners,” Latrobe could
not have predicted this aspect of American taste, and so designed his architecture for the early
republic based on European architectural examples, simplified to reflect the new nation’s freedom
from royal constraint and excess.

Latrobe devised his plan for Philadelphia as an American architecture, distinguished by
simplicity as ornament and by a balanced integration of landscape and building, plan and
pavilion. The construction of the Center Engine House was also an opportunity for Latrobe to
demonstrate his knowledge and abilities, in particular to Thomas Jefferson and to the scientific
and intellectual circles of Philadelphia.\textsuperscript{74} Latrobe demonstrated his vision of an architecture that
would be “consistent with the manners of”\textsuperscript{75} American society, and that was therefore, I argue,
based on several types of equilibrium. The Center Engine House was designed as an integration
of Greek and Roman art and infrastructure, municipal and private funding, French and English
architecture and engineering, rural and urban settings, and the square and circle, all situated

\textsuperscript{74} Latrobe’s first meeting with Jefferson occurred in March of 1798 on his first trip to Philadelphia, and in
March of 1803 after his election to President, Jefferson appointed him “Surveyor of the Public
Buildings of the United States at Washington.”

\textsuperscript{75} Latrobe, \textit{Correspondence}, I: 405.

“\textit{What is injurious to the object, or inconsistent with the use of a building can never be}
ornamental. Simplicity is one of the first of Architectural ornaments, and the highest achievement
[sic] of study and of taste; and to the attainment of the object you have in view it is as conducive, as
it is consistent with the manners of your society.” (Letter to Thomas Parker, c. 1803)
within a centralized rotunda in an urban square. In particular, the Center Engine House bears a
relationship to garden pavilions constructed in both France and England, as well as to the
idealized civil architectures of the eighteenth century, which wrapped rustic function in
neoclassical geometries.

Latrobe’s design for Philadelphia will be addressed in the following four chapters, which
roughly correspond to his areas of expertise. At the infrastructural and urban scale, the
Philadelphia water supply system was an engineered intervention that proposed a particular
hydraulic response to urban ailments and topography through the construction of a large system
of tunnels, pipes, an aqueduct, reservoirs and hydrants. Chapter 2 will address this technical and
urban infrastructural system. Chapter 3 will assess the system as Latrobe’s response within
contemporary debates concerning public health and methods of remedying the yellow fever. At
the integrated scale of architecture and site, Latrobe’s design was punctuated by the two public
buildings which housed the steam engines, each calibrated to its site. Chapter 4 will delve into the
architectural design of the Center Engine House, and Chapter 5 will more fully address its
integration within the landscape of Center Square.

As an introduction, it is necessary to provide a brief description of the system to orient
the reader to Latrobe’s overall plan. The system that Latrobe designed for Philadelphia spanned
from the mostly unimproved west side of the city at the banks of the Schuylkill River, and
brought water to the center of the city’s planned grid in order to distribute it to the densely settled
commercial eastern front of the city at the Delaware River. Water was drawn in through a sluice
gate into a marble faced settlement basin 200 feet long and 84 feet wide, through a 300 foot brick
tunnel, then lifted 48 feet vertically to the top of the river.76 [Figure 2] The pump that lifted the
water was powered by a version of the 1787 Boulton & Watt double-acting steam engine, which

was housed in the Schuylkill Engine House. From this first house, which lifted the water up to the height of the city, it flowed through over 3,000 feet of brick tunnels and a short aqueduct to the “Second, or Center Engine House” in Center Square. The Center Engine House housed a slightly smaller steam engine, which elevated the water 51 feet into reservoirs under the dome of the rotunda. From there, the water was distributed to the settled part of the city through wooden pipes and a series of pumps and hydrants.


The Schuylkill Engine House was a modest stone structure set on the site of what Latrobe called “an old redoubt.”[79] [Figure 3] The traces of the defensive fort the house replaced are outlined lightly in the plan for the settlement basin. [Figure 2] The Select and Common Councils Watering Committee Report of 24 November, 1799 described the first engine house as “a plain strong solid building, of 60 by 50 feet in area, nothing will be expended in internal or external ornament.”[80] In fact, its modest appearance was in accord with the existing rural architecture of the countryside beyond Penn’s grid. It bore a marked similarities to William Hamilton’s recently


constructed Woodlands mansion, which lay across the Schuylkill River, or more particularly to that estate's outbuildings. Yet, as the editors of Latrobe's papers have demonstrated, even in this "plain" building, Latrobe went to great lengths to reinforce symmetry. The flues from the two boilers coiled in gentle curves to meet the perfect exterior balance of the north and south chimneys. [Figure 4] The façades, even the lesser fronts facing away from the streets, were marked by an even series of three arches, left blind where no opening was warranted.

Figure 4 - Benjamin H. Latrobe, Section of the Schuylkill engine (view from the east), c. 1799, Latrobe, *Engineering Drawings*, 161.

If the Schuylkill Engine House was simple and balanced, and placed within the unimproved part of the city that remained wild and clean, it had a lasting influence on the city. Inside its solid, battered walls, extra power from the engine was used to power a rolling mill, making it one of the first steam-powered factories in Philadelphia. It might also be said that the
plain, strong stone walls and simple arctuation proved to be in keeping with American taste in
public works, and that the siting of an infrastructural work in a country setting also gained
preference during the nineteenth-century. Latrobe’s first Philadelphia waterworks of 1801 would
be replaced by that of his draftsman, Frederick Graff, and the position of Graff’s works at the Fair
Mount, just north of the Schuylkill Engine House, would in turn justify the creation of
Philadelphia’s Fairmount Park to protect the city’s water source.

This study will focus on the cosmopolitan sister of the rustic Schuylkill Engine House,
the architectural and literal heart of Latrobe’s plan, the “Second, or Center Engine House.” The
second engine house held priority of place, and was designed as the centerpiece of a cultivated
urban square. A white marble shell wrapped the steam-powered machine that lifted water up into
reservoirs located underneath a striking copper-domed rotunda. From this exquisite elevation, the
waters were distributed to the more densely populated eastern side of the Philadelphia along the
markets and docks of the Delaware River. The building at Center Square was from the start
intended to be beautiful as well as practical and rational. [Figure 1] In his first proposal, executed
over a few days in December of 1798, Latrobe proposed that the building “may be rendered an
ornament to the city.”81 The city government agreed, even with rising expenditures, arguing that,
“placed as it is, a fair mark for the critic eye of taste, it is not probable the Corporation would
have been easily pardoned by the present age, or by posterity, had they determined to place a
homely mass of building, in the best situated square belonging to the citizens of Philadelphia; and
as this house is intended to combine ornament with utility, it will necessarily be more expensive
in construction, than if it had been placed in any other site, where ornament might have been
spared … .”82

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81 Latrobe, View of the practicability and means of supplying the city of Philadelphia with wholesome water, 18.
82 Philadelphia, Watering Committee, Report ... on the 24th of November, 1799 ... , 28-29.
Latrobe’s two engine houses were poised against each other as city and country, one a gleaming urban exercise in formal geometries, the other a productive factory of rough stone. Each building had a particular symmetry suited to its situation and character. This dissertation focuses on the “Second, or Center Engine House” as Latrobe’s most ambitious statement of what a metropolitan American architecture of modern technology and civic health should be. Latrobe adapted prior models to a particular situation, as well as to a site fixed within the center of an open square “belonging to the citizens.” This fact, that it was for all citizens and open to all views, would greatly shape the design. Yet even though it was a public building, Latrobe had a large degree of latitude in determining the character of the Center Engine House, as it would be the first urban infrastructural edifice for the new nation. This combination of civic visibility and functional innovation required an exceptional architecture. I hope to demonstrate the complex interplay of multiple ideas of balance that underlay Latrobe’s deceptively simple design.
This chapter addresses the Philadelphia waterworks as a hydraulic system designed within particular technological and topographical constraints and in light of both ancient and recent precedent. By treating the system and the ways in which its adaptation of prior models implied a particular attitude towards the American city, I hope to demonstrate that Latrobe's design embodied ideas that surpassed its utilitarian function. The pertinent background to this chapter concerns the uses toward which water supply technologies were designed prior to 1800, the means by which specific technologies invited or created particular uses, and the distribution of the devices and infrastructures within the cities they served. There is also the question of whether, and in what ways, prior waterworks had been constructed to modify urban climate to improve public health. Following this analysis, it is possible to propose how Latrobe adapted the concept of "climate change" to suit the American situation. Despite his considerable knowledge, in order to achieve his goal of modifying the temperature of Philadelphia, Latrobe built a monument which was difficult to maintain, and not particularly well-sited in relation to topography. Latrobe may have attempted not just to balance the airs and waters of the city, but also to incorporate ancient technical ideas about water supply, civic ornament, and social order to concenter in one work both new and old urban organizational systems.

If Latrobe did aspire to achieve something more than utility in his waterworks, he was drawing on thousands of years of hydraulic history. We know of ancient cenotes and oracles, sacred springs and mythical bridges to the worlds of the dead and of dreams.83 Continuing through the Middle Ages and the early modern period, water supply remained strongly associated

with both functional and ritual needs. Early hydraulic systems served the public good, providing water for cooking, cleaning, and fire protection. Hydraulic sources have also always been connected with public festivals and religious rituals; as well as with fantastic entertainments, magical garden landscapes, and country retreats. Since medical and scientific theories have changed rapidly over the past 500 years, public health methods and treatments have varied significantly in time and in place, while at the same time ancient environmental and social ideas have persisted, accumulating layers of new interpretation. Latrobe had a deeper historical education than most of his peers, and was also a member of the most advanced scientific circle in America, so we perhaps see this layering of persistent and ancient ideas of health and cities, overlaid with the rapid oscillation of more fashionable explanations and treatments, even more vividly in his thoughts.

In order to assess the peculiarities of Latrobe’s system for Philadelphia, several questions must be addressed both for the Philadelphia waterworks, and for its precedents. First, what was the physical and technical system, including collection, engine, and distribution? Second, what were the intended uses, both utilitarian and cultural or social? And third, what was the architectural integration of the mechanical system, and how did it facilitate function? Finally, what was the relationship of these three factors to each other? In other words, if every urban water system collects water from a source in order to diffuse it within the fabric of the city, what is the total effect between machine, system, function, and image? Later chapters will focus on the design of the Philadelphia waterworks within the context of particular dialogs concerning democracy, inflammation, art, and nature.

In this chapter, the focus will be drawn on the position of the physical artifact of Latrobe’s Philadelphia waterworks within the European history of water supply systems. The chapter is divided into three sections. The first section provides a general orientation to urban water supply, and a specific assessment of Latrobe’s knowledge of ancient and contemporary
sources of information regarding hydraulic systems. The second section provides a summary of
the operations and effects of the types of urban water supply systems with which Latrobe was
likely familiar, from Medieval to modern. The third section assesses the Philadelphia system
versus these prior models, to define and to explain Latrobe’s areas of invention.
2.1 Hydraulic Context

Urban Waters: Life, Power and Image

All great cities have been connected to rivers. From the ancient floodplain cities of Ur, Cairo, and Mohenjo-Daro through the modern port cities of Paris, London, and New York, urbanity and hydrology are linked. The shape and intensity of those bonds has evolved over time. As technology has changed, so have the relationships between cities and their water sources. New cities such as Los Angeles, Atlanta, and Las Vegas, or the new desert cities of China rely on modern large scale hydrological management. Yet the irrigation of arid sites is still achieved with the most ancient hydrological devices, dams, reservoirs, and canals. The means of powering these infrastructures have improved exponentially, however, allowing water to travel much greater distances, and cities to grow far from natural sources. But if water management today relies on energy sources unknown during ancient times, urban life, form, and waters still exist as interdependent systems.

Historically, hydrological management has been crucial to the consolidation of power and the maintenance of political stability. Those who control the water generally control the region or city, and centralized systems reinforce centralized control. Ancient Egyptian, Chinese, Mayan, Cambodian, and many other water systems have been ruled by kings and emperors who attained godlike status, demanding the slavery and sacrifice of their subjects. The link of a royal lineage to the control of nature and to the lifeblood of agriculture elevated and concentrated the power of the ruler. Political power and hydrological management cannot be separated.

If water and power are always linked, not all water management systems have reinforced dictatorial regimes. In ancient Mesopotamia, where urban civilization arose at the Tigris and

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84 Karl August Wittfogel (1896–1988) coined the term “hydraulic civilizations” in Oriental Despotism: A Comparative Study of Total Power (Yale University Press, 1957). The suggested of eastern difference has been problematized since the book’s publication as have many specific points made by Wittfogel. If western imagination of a generalized “orient” has been eradicated in modern scholarship, however, some of Wittfogel’s points regarding centralized control and water management still stand.
Euphrates Delta, violent and irregular flooding and unpredictable agricultural cycles were managed by a semi-democratic process of decision making and a communal system of agricultural distribution. The system was architecturally focused in the great ziggurats that combined agricultural distribution with worship. In the Netherlands, another location with too much rather than too little water, and in which land building was in the interest of the entire society, infrastructures and regulations have been in place since the thirteenth century which have typically been managed democratically and in the public interest. 85 These systems of democratic hydraulics have been characterized by shared burden and gain, legislated by common agreement. It is beyond the scope of this dissertation to speculate, but it is clear that royal, private, public, and hybrid systems seem to be linked to particular hydrological conditions and water management strategies, and that those systems may be mutually reinforcing.

Just as water management and political systems are entangled, hydrology and urban morphology have always been linked. Cities have been sited with a particular orientation to the ocean and to rivers in the interest of water supply, and to support agriculture, trade, industry, and defense. The priority of each of these interests has shifted over time, and has been managed variously according to available technologies. Port cities have risen and fell as they have managed or failed to accommodate shipping changes such as steam turbines, containerization, and deeper draught vessels. 86 Each type of water use—bathing, shipping, drinking, transportation, defense, power—is connected to a different technological lineage, all of which change at separate but interrelated rates.

Water supply technology has developed rapidly since 1700, and these changes have had a definitive and visible impact on the evolution of urban life and development. Changes have

86 Ann L. Buttenweiser provides an excellent analysis of these technological jumps and accommodations in Manhattan, water-bound: planning and developing Manhattan’s waterfront from the seventeenth century to the present (New York University Press, 1987).
occurred in the power sources that drive water supply, in the sources used to provide clean water, and in the storage, treatment, and distribution of water. When the first Europeans arrived in America, settlements were built around wells, springs and rivers. Water quality was more readily determined by sight and smell, as well as by disease outbreaks localized to the vicinity of particular springs. With the rise of population and contamination, water was pumped and channeled in aqueducts and canals from sources increasingly further from human settlement. If wells and ponds were once central gathering places, a final shift from centralized distribution points to domestic piping entirely removed those visible, social centers of settlement.

Medical and scientific changes outside of hydraulic engineering have also influenced the relationship of cities to water. After the discovery of bacteria’s link to disease during the late nineteenth century, the shift to chemical sterilization at the turn of the twentieth century further distanced water use from water source. Water pumping stations moved even further from the center of cities, and the process of supply became more opaque as many cities continued to draw water from rivers contaminated by sewer outflows, but blanketed the filthy source by filtering processes involving charcoal, and later chlorine. In some cities, including New York and Boston, instead of using local water, fresh water was brought via aqueduct from distant “natural” locations. In these cases, urban reservoirs were often encircled with protective parks such as New York’s Central Park, which provided new places for urban recreation and a sylvan respite from the pressures and motion of the industrializing city. It seems fair to imagine that the park itself bloomed within the increasingly fast and dirty city, springing forth from the crystal waters of the rural Croton River.

Modern water treatment and post-industrial urban configurations have shifted the sources of city water far from view, but prior to the nineteenth century urban water supply was almost always linked to ritual, celebration, communication, and recreation. There is evidence of the links between water supply and religious and civic rites around the world, and it is too extensive a topic
to be adequately treated here. Through myth if not memory, we are familiar with the sacred springs, oracles, fountains, and cenotes of the ancient world, and of rivers and lakes as places of memory and bridges to the afterlife, underworld, or heavens. In ancient Rome, water management reached an apex, as did the volume of water used by the urban population. In Medieval cities, water fountains for public use were at crossroads and squares, and were places for speeches and plays. Fountains might even flow red with wine on feast or victory days. In Continental cities, fountains were often linked to pilgrimage routes, and might places for washing as well as drinking, which required the design of unique fountains to serve both functions or to prevent a mingling of uses. In Baroque gardens, water-powered jeux d’artifice such as hydraulic organs and automata allowed nobles and royalty to demonstrate their mastery of natural magic and technology, and were centers for royal celebration, ceremony, and symbolism.

Neoclassical Waters: Beauty and Well-Being

The historical font to which Latrobe’s thoughts were most often oriented was Pericles’ Athens, and his knowledge of hydraulics also referenced Classical systems in alignment with particular political situations. He was aware of the historical importance of hydraulic infrastructures to powerful empires, both for utilitarian purposes and as monuments to the munificence of governments. In his “Anniversary Oration Pronounced before the Society of Artists,” of 1811, Latrobe mused that Roman architecture was inferior to that of Greece because it “dwindle[d] into absurdity in the style of their decorations, and the imperfection of their execution.” Yet he allowed that in the realm of civil architecture, Rome built what might be considered, “monuments erected to the memory of the departed liberty of the people.” In this class he put the “fifteen or sixteen aqueducts, which once supplied Rome, ... all of which were erected and decorated by the best skill of the age, the strict connexion of the interests and enjoyments of the people, and of the cultivation of the arts of design is still more illustrated.”

87 Latrobe, Anniversary Oration Pronounced Before the Society of Artists, 15, 16.
Latrobe’s knowledge of Classical waterworks and urban distributions was drawn to some extent from his own observations during his travels from Germany across Europe and to Italy, but he was also aware of the hydraulically advanced systems of the Middle East and Asia. Latrobe was well versed in the documentary encyclopedias produced by the itinerant gentlemen archaeologists of the late sixteenth and early seventeenth centuries. Latrobe knew Le Roy’s *Les Ruines des Plus Beaux Monuments de la Grèce* of 1758, which contained sketches of the Ionic arch that marked what was identified by Le Roy as the ruins of L’Acqueduc d’Adrien. He was also familiar with François Bernier’s *Histoire de la dernière révolution es etats du grand mogul* (1670-71) with its tales of the canals and fountains of Delhi and Agra; and Patrick Brydone’s *A tour through Sicily and Malta* (1773) with its description of the reservoirs and ruins of the Naumachia in Tauromina. Other works which he knew included Tobias George Smollett’s *Travels through France and Italy* (1766) which was laced through with tales of ruined aqueducts and baths, and Jean Baptiste Tavernier’s *Les six voyages ... qu’il a fait en Turquie, en Perse et aux Indes ...* (1676) which documents the power and grandeur of the hydrological empires in Egypt, Persia, Turkey, and India. Latrobe himself had a role in the production and illustration of James Bruce’s *Travels to Discover the Source of the Nile* (1790), though their partnership ended in a lawsuit.

Latrobe’s understanding of the link of civil architecture to civic representation and to the “enjoyments of the people” echoed LeRoy, who divided architectural principles into three classes. The first axiom – of the solidity and parallel and perpendicular structure of a building—was universal. The second and third class of rules were dedicated to general and specific conventions.

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adopted according to country, climate, material, custom, and caprice. These, Le Roy insisted, made up « ce que nous appelons le beau dans cet Art » and have the aim of « la conservation & le bien de notre être » These secondary principles are pleasurable, meeting « notre vue, le plus précieux de nos organes. » I argue that Latrobe designed the Philadelphia waterworks to address the gaze, enjoyment, and improvement of all citizens, while remedying the warm climate of the city, and representing the power and munificence of the new nation.

Engineering: Steam and System

Latrobe’s desire to craft a civic hydraulic well-being upon a balance between art and technology placed him in a precarious position. We witness in Latrobe’s difficulties not just the problems of any ambitious and complex design, but also a schism between French and English engineering, a split, to put it perhaps too simply, between system-making and machine-making. By the late eighteenth century the French engineering approach still associated regular geometry with efficiency, and assumed architectural ornamentation as a necessary element of public works. This association of visible form with physical function suffused French practice, which also stressed the mapping and control of large territories through these perfect geometries. English engineers were not part of an organized royal corps, and tended to practice the competitive invention of devices divorced from aesthetic considerations, and often removed from systemic analysis or graphic expression. In essence, Latrobe had a French understanding of cities as places to be rationalized and improved by large-scale planning centered on public works with civic faces. He attempted to carry out an ambitious public works plan, unfortunately, in a

91 The disjunction between French and English engineering practice is described in Antoine Picon’s French Architects and Engineers in the Age of Enlightenment (Architectes et ingénieurs au siècle des lumières), trans. Martin Thom (Great Britain: Cambridge University Press, 1992).
new nation without an organized system of funding and management or the sustained will to support such magnificent works.

Latrobe was familiar with the water-supply systems of London, unfortunately it seems that he had little detailed technical knowledge of the engines themselves, and was forced to rely on American mechanic-entrepreneurs. This handful of craftsmen were attempting to build modern engines in a country without adequate metal fabrication shops to craft engine parts, in particular cylinders, to the English standard. As H.W. Dickinson succinctly describes the situation, "we should mention that in 1803 not more than six engines could be mustered in the whole of the States; mechanical construction and skill were at least fifty years behind those of England."\(^{92}\)

Latrobe is rightly credited with advancing the state of American engineering, but his technical hydraulic knowledge was of a particular kind suited to survey, drainage, excavation, and embankment projects. As has been stated previously, there are indications that he was employed by August Riedel conducting river improvement projects in Saxony when he was seventeen. In London after 1788 he worked for John Smeaton, who was very engaged in the documentation, testing, and design of steam engines, and at the time was publishing his account of the Eddystone Lighthouse, which he built between 1756 and 1759 using hydraulic lime, a predecessor to modern concrete.\(^{93}\) Latrobe, however, did not work on Smeaton’s steam projects. The few years of apprenticeship Latrobe undertook for Smeaton at Basingstoke Canal and Blackwater Navigation, combined with his work for Riedel, probably gave him the material knowledge and technical skill typical to a junior military engineer, rather than the particular mechanical abilities of London’s expert instrument-makers. Yet even in this specialized capacity, Latrobe would have been exposed to the breadth of the field of engineering in England at the time, from machine-maker to surveyor to material scientist.


Latrobe’s primary mode of thought seems to have been systematic and symmetrical rather than mechanic and irregular, and his primary technical references were French manuals. He considered all of the works of Jean-Rodolphe Perronet’s as among a handful of materials which by 1804 had, “become almost indispensibly necessary,” to assist in his own work. Bernard Forest de Bélidor’s *L’architecture hydraulique, ou l’art de conduire, d’élever et de ménager les eaux pour les différents besoins de la vie* (1737-53) and Jean-Nicolas-Louis Durand’s *Recueil et parallèle des édifices de tout genre, anciens et modernes* (1799-1800) were other books he described as essential when he requested them through a friend traveling to France. Sadly, none of these works would assist in the construction of a steam engine, though de Bélidor did include an image of an early atmospheric engine built in 1739 at Fresnes, France by English engineers. All of these works were, however, characterized by the regular geometry and ornamental expression of public works.

The organized French Corps of Engineers undertook major works with an eye to aesthetic expression and balance. Though an emphasis on utility and function would gain greater strength in the decades following the revolution, French engineering works would still maintain an elegance and ornament which surpassed English efforts. French engineers were professionally trained and focused on large scale royal and national works, surveying, and systematic mathematical analysis and testing. In *French Architects and Engineers in the Age of Enlightenment*, Antoine Picon traces the evolution of French engineers from a subset of architects who maintained and built roadways, fortifications, and other utilitarian works to the delineators and managers of a new “territorial reality,” in which space was understood as a series of flows of “men, ideas, and commodities.”

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94 Latrobe, *Correspondence*, I: 569-570.
96 Antoine Picon, *French Architects and Engineers in the Age of Enlightenment*, Translated by Martin Thom (Great Britain: Cambridge University Press, 1992), 101.
professional standards which positioned engineers to become the rational masters of buildings, infrastructure, landscapes, cities, and nations during the nineteenth century. By 1794, when the Ecole Polytechnique was founded, architecture had less dominance in the sphere of building, and engineers were firmly linked to what Antoine Picon calls, “a perspective involving the conquest of nature and social progress.” The engineer’s perspectival management of infrastructures and flows also included the planning and oversight of airs, waters, and places, the standard Hippocratean elements known to underlie urban health, all managed within an ordered geometrical expression.

Latrobe’s work in Philadelphia paralleled the French engineering approach to territorial reconfiguration in service of urban improvement and public health, and spanned between the practical and the visionary. What united the two within French practice was a precision of calculation, graphic comprehension, and centralized management. By the time Latrobe’s waterworks was completed in 1801, French engineers had, in Picon’s opinion, established, “the mathematisation of the science of engineering and the passage from the classical world to the universe of the machine and of precision.” The French universe of the machines was exquisitely drafted and geometrically elaborated. As early as 1769, we see in the drawings of Pierre Patte the futuristic vision of the modern city as a network of subterranean engineered tubes. It is not certain that Latrobe would have known of Patte’s drawings, but the fantasy of rationalizing the city’s growth through an underground infrastructural network was the essence of his plan for Philadelphia. Not only did Latrobe aspire to regulate an urban environment through perfect orthogonal geometry, he designed the visible aspects of the waterworks based on an imagined level of development, cultivation, and management that did not yet exist anywhere in America.

97 Picon, French Architects and Engineers in the Age of Enlightenment, 4.
98 Picon, French Architects and Engineers in the Age of Enlightenment, 198-99.
While the French dominated the analytic and theoretical sphere of engineering during the eighteenth century, in the field of steam-driven waterworks France lagged behind England until well into the nineteenth century.\textsuperscript{99} To construct the first steam-driven Paris water works between 1778 and 1881, the Périer brothers were forced to purchase the primary components of a Bolton & Watt engine and import them from Britain.\textsuperscript{100} They would build a foundry at Chaillot, which allowed them to complete the engine, and which would in fact produce hundreds of engines after 1815, when English engineer Arthur Woolf joined the operation.\textsuperscript{101} During the 1790s, Antoine Picon explains that for the French, the steam engine was, "more an object of curiosity than an instrument of economic development." He cites J. --P. Rioux, whose statistics indicate that by 1830 England had 15,000 steam engines, whereas France had approximately 3,000. At the same time, however, Picon observes that most books concerning steam engines were produced in France. French engineers such as Riche de Prony were concerned not just with illustrations and descriptions of engines, but also provided tables and charts as in the second volume of his \textit{Nouvelle architecture hydraulique} published in 1796.\textsuperscript{102} If the British were more advanced mechanics, the French theoretical and organizational bent would eventually result in more rigorous efforts to precisely analyze the function of the engines and to develop theories accordingly.

Latrobe attempted to construct a hydraulic system that is intelligible within the French model of large-scale surveying and the systemic and imaginative control of the city, but he

\textsuperscript{99} See H. W. Dickinson, \textit{A Short History of the Steam Engine} (New York: The MacMillan Company, 1939). Experiments with steam pumps had at first been conducted within England by members of the Royal Society, including the Hon. Robert Boyle, Robert Hooke and others, during the 1650s and 1660s. In 1675, the doctor of medicine Denis Papin fled the laboratory of Christian Huygens at the Academy at Paris, fearful regarding his position there as a Huguenot, and joining with the Boyle was able to test and improve the basic operation of his double-acting air pump, a vacuum pump which was largely ignored for the next century in favor of the steam-driven engine. (Dickinson, \textit{A Short History of the Steam Engine}, 7-12)


\textsuperscript{101} Dickinson, \textit{A Short History of the Steam Engine}, 100.

\textsuperscript{102} Picon, \textit{French Architects and Engineers in the Age of Enlightenment}, 318-321.
centered his design on the disordered but productive English improvements to steam-driven hydraulic systems. Steam engines fell largely into the domain of the tinkerers, more akin to watch-making than dam-building. Boulton and Watt, the most successful steam-engine builders of the eighteenth century, were trained respectively as a silver stamper and an "instrument maker."

By this time, the English engineering corps, despite Smeaton's formation of the Society of Civil Engineers, was a disorganized and internally competitive array of practitioners; some at the level of noble experimenter, some at the level of mine or brewery mechanic, and many spanning between the two. They often participated in parallel scientific and mechanical endeavors, affiliated with the Royal Society or with private clubs such as the Lunar Men of Birmingham. The members of these groups might dabble equally in what we would today define as industrial fabrication, mechanical and civil engineering, medicine, astronomy, biology, and chemistry.

Also complicating the systematization of hydraulic engineering in eighteenth-century England, London had no centralized municipal water supply, instead individuals subscribed to one of a variety of companies. Within this atmosphere of heated competition, each tinkerer and entrepreneur sought to supply a greater volume at a lower cost to serve the expanding residential neighborhoods. This environment of aggressive improvement probably resulted in a more rapid testing of diverse hydraulic mechanisms, but it also prompted secrecy, espionage, patent claims, and confusion regarding the actual construction of the engines. With each man attempting to surpass his peers, there was tremendous innovation, but spectacular financial and technical failures also occurred with regularity. This hodge-podge of technical systems, each offering a different quality and volume of water at a different cost, was exactly what Latrobe hoped to avoid in Philadelphia. He designed an integration of architecture and technology that drew on

contemporary French engineering models, to mobilize a technically advanced system that simultaneously referenced an earlier time of grand hydraulic ambitions.
2.2 Urban Waterworks: Domestic, Environmental, Symbolic, and Social Function

A complete history of urban water supply is beyond the scope of this dissertation, but a schematic survey is necessary to demonstrate the various models layered within Latrobe’s understanding, and to determine the ways he chose to deviate from those examples.

Medieval Waters: Hydrokinetic Ecologies and Urban Rituals

In his own life and travels, Latrobe would have gained direct knowledge of Medieval European water supply systems, many of which were still operational in European cities, though reclothed by Latrobe’s time. During the early Middle Ages in Europe, water for drinking, washing, and daily use was still primarily obtained from the rivers, wells, and streams that flowed through cities. As cities grew in population after the year 1000, and especially with the growth of urban industry during the twelfth century, larger management systems were needed. These pre-industrial gravity-driven systems were integrated into the network of streets and squares, with simple fountains and conduit houses marking their entry into the life of the city. It has been demonstrated by André Guillerme that this growth of hydrokinetic networks was part of a sophisticated ecological urban system, in which the beauty and clarity of the water was as essential as its use. Latrobe would have been aware of the lingering artifacts and traditions from this time, and his own system for Philadelphia expressed similar ambitions for an urban totality composed of natural purity and civic utility.
The most populous European cities began to have difficulty meeting their need for water 500 years before American cities would reach the same problems of urban density and resource depletion. During the twelfth and thirteen centuries, the growing populations of European cities placed high demands on their hydrological systems. Well water and streams were increasingly polluted. In response to this contamination, Paris and Siena built complex public hydraulic systems during the 1190s, London followed in 1237, and Dublin in 1244. These systems depended on gravity, redirecting natural streams and springs through canals, pipes, aqueducts, cisterns, and fountains. Simple wooden machines translated the motion of water to power the work of artisans and manufacturers. Domestic water use was primarily confined to cooking, cleaning, and drinking. Medieval bathhouses existed, but were certainly not as elaborate or as commonly frequented as the baths of ancient Rome. During the thirteenth century Paris had twenty-six commercial bath houses offering tubs and steams, and London also had bathhouses supplied by water-carriers. Siena and Viterbo had spas associated with springs. The washing of hands, face, and feet was practiced somewhat more regularly in monasteries, as well as by pilgrims prior to entering churches. Baths only became common, and then for royalty, during the late thirteenth and fourteenth century in Europe.

The shape and expanse of medieval hydrological improvements were part of the larger project of canalizing cities to serve industry. André Guillerme describes a shift during the twelfth century feudal period, in which water took on a new intensive use: “Water was the economic nerve center of preindustrial urbanization; without water, there would have been neither millers nor weavers, neither dyers nor tanners, nor would communities have existed.” Interestingly, Guillerme demonstrates that medieval industry was part of a careful ecology, which attempted to preserve the water's clarity, so that it could be appreciated by the ruling class, who viewed it

105 Roberta J. Magnusson, Water Technology in the Middle Ages (Baltimore: The Johns Hopkins University Press, 2001), 148-149.
equally as a useful and aesthetic pleasure. “Hydrokinetics” is the word Guillerme uses as an emblem of feudal times, during which he observes that the prosperity of a city and a noble was associated with the number of canals.106 This idea of the visibility of prosperity, aligned within a wider environmental system, resonates with Latrobe’s ideas of a balanced system regulating and symbolizing an improved urban condition.

In the feudal system described by Guillerme, the cleanliness of the waters themselves was given aesthetic value, which marks a more immediate ecology than could be provided by Latrobe. Yet both show an understanding of the city as a “hydrokinetic” ecology. This was by no means an automatic assumption in the years between 1300 and 1700. Guillerme demonstrates that this ecological knowledge was in many cities lost, or overwhelmed, by the time of the Renaissance. Ironically, during the “Dark Ages” cities functioned, by Guillerme’s description, as complex networks that bound industry within the moving clarity of urban waters, whereas between the fourteenth and seventeenth centuries cities became stagnant sites dependent on industrial textile processes that shifted to rely on fermentation rather than on plant and mineral substances.107 By Latrobe’s time, engineering and chemistry had a strong influence on industry and water management, leading to the enclosure of many urban streams and canals. In post-revolutionary America, cities moved rapidly from a pre-industrial state directly to the enclosure and engineered management of waters.

By the twelfth century, the population explosion in Europe challenged the balance of early medieval hydraulic ecologies, and threatened the health of common citizens. In this situation, new technical systems were devised to provide more and cleaner water collected outside the centers of settlement and conveyed into the burgeoning cities. In Water Technology in the Middle Ages, Roberta Magnusson demonstrates that all of the most advanced early European waterworks were built to serve monasteries and palaces: for instance Magdeburg (1125-60),

106 André Guillerme, The Age of Water (College Station: Texas A&M University, 1988), 52, 72, 75.
Chartres (c. 1090), Cluny (by 1063), Canterbury (1153-67), and Westminster Palace (1169-70). The first to benefit from new water supply systems were the clergy and royalty, who would in turn dispense clean water to their subjects and parishioners. This dynamic, of the provision of water by those in power, was in a sense replicated by Latrobe, but also radically altered. The provision of fresh water became not just a gift, but a right of Philadelphia’s citizens.

Those who first granted water to the poor were often the religious orders. In Paris, monastics devised several large aqueducts to bring water into the city from the Belleville plateau north of Paris. As Laure Beaumont-Maillet explains, these works were gradually constructed by religious orders between the twelfth and fourteenth centuries, and then reconstructed with some grandeur by earthly authorities during the fifteenth and sixteenth centuries. The Pré-Saint-Gervais Aqueduct was originally established by the religious order of Saint-Lazare during the late twelfth century. Phillippe Auguste purchased the forest of Saint-Laurent in 1182, and reserved some of the Saint-Gervais waters for the first public fountain in Paris, located in his new markets, Les Halles. This water was also the source for the Fontaine des Innocents, which existed in simple form by the thirteenth century. Belleville aqueduct was also constructed during the twelfth century by the abbey of Saint-Martin-des-Champs de Cluny, which would also build the Savies aqueduct drawing from the same plateau north of Paris. Sadly, these ambitious systems would always provide somewhat unsatisfactory waters. The waters of Belleville were so full of sulfates and magnesium that by the eighteenth century they would be used only to purge and cleanse the Grand Egout.108

Urban hydraulic systems were funded by the political and spiritual powers on earth, and designed and distributed within the intellectual sphere of the monasteries, drawing on ancient knowledge. During the High Middle Ages, monastic orders and universities became the primary disseminators of water technology, which spread through reports of pilgrims, students, and

traders. It is unclear what the exact sources of this technological revival may have been. Some monasteries may have possessed copies of Vitruvius' *De Architectura*, but Frontinus's *De Aquis Urbis Romae* seems to have been unknown. It is also possible that intensified urban construction during the High Middle Ages lead to the unearthing of Roman systems, which may have provided models for the new systems.\textsuperscript{109}

The contemporary religious revival also greatly influenced the widespread investigation and diffusion of hydraulic technologies. David Knowles and R. Neville Haddock have compiled data that suggests that if the Cistercians were the earliest and most dedicated experimenters with hydraulic constructions, statistically, at least in England, the Benedictines had the largest number of water systems, and the Carthusian order had the highest percentage of monasteries with water supply systems. The expansion of these technical systems within the religious sphere has been attributed to the optimistic, yet rational, turn in theology that occurred at this time.\textsuperscript{110} After the Apocalypse failed to manifest in the year 1000, in an atmosphere more forgiving towards human weakness and less tolerant of financial excess, religious orders came to embrace hydraulic modifications as the natural manifestations of God's creation. This idea of rational natural rules within nature, and their celebration through the manipulation of hydraulic flows, was an important underlying idea of Latrobe's system also, as will be discussed in Chapter 5.

\textsuperscript{109} Magnusson, *Water Technology in the Middle Ages*, 19.  
\textsuperscript{110} Magnusson, *Water Technology in the Middle Ages*, 6-14.
Architecturally, medieval water systems set a template for later structures of hydraulic diffusion. The most sophisticated systems entered the monastery in a water tower, which drew the water to its head height in a second story fountain. In pressure systems water would fall by gravity, but if conduit pipes were sealed without intermittent open tanks, the water would regain its head pressure on release. From the second story of the monastery, the water would then descend, as shown in this twelfth-century detail of Canterbury, through pipes that branched to serve various fountains and lavers for the cloister, the infirmary, and other areas of the priory. [Figure 5] These lavatoria were common in France and on the continent prior to their appearance in England in the late twelfth century. Perhaps importantly for our analysis, the exterior of these water towers were very often octagonal, an echo of the baptistery form. The lavabo, the wash
basin for monks, was often housed in a small octagonal fountain house, placed within the cloister and outside the refectory, as the well-known Cistercian model at Citeaux, illustrated in Viollet le-Duc’s Dictionnaire Raisonné. [Figure 6]

Figure 6 - Viollet le-Duc, Dictionnaire raisonné de l'architecture française du Xle au XVle siècle, 1854-1868, tome 6, 171.

111 Magnusson, Water Technology in the Middle Ages, 101-102.
If these elaborate monastic systems were constructed to serve the monasteries and their hospitals and parishioners, this technology was soon distributed to become an essential part of the more exuberant aspects of urban civic life. Monastery supply systems were extended or replicated during the thirteenth century in London and elsewhere to serve the public. Points where waters entered the city were often the sites of rituals, pageants, and ceremonies. These locations were determined by the topography of each city, as well as by the street networks under which pipes could be laid, and of course by the wealthy patrons or religious orders who funded construction. In most situations urban fountains or cisterns would be located in relation to existing squares, with usually made them adjacent to markets, churches, and major street crossings. In both the monastic and urban examples, the sources of water were visibly celebrated.

These civic pivot points took different forms in different cities. Fountain morphologies and technologies circumscribed their means of use. On the Continent fountains with open basins were common, so civic authorities had to resort to policing and fines to prevent bathing, watering of animals, washing of clothes, or other activities which would contaminate basins designated for drinking and cooking. In parts of Italy fountain basins were built to overflow into lower troughs, designed either for the watering of animals, or with a sloped stone edge in the lavatoio which were used for clothes washing. In England, closed cisterns were most commonly used, so citizens could only fill vessels to take away for domestic use. It seems that in London clothing was still primarily washed on the banks of the Thames. During the Middle Ages, different types of waters came from different sources for different purposes.

In London, public water sources were typically small stone enclosures that enclosed lead-lined centralized cisterns, with a few taps available for public use. These modest buildings could be rectilinear, but were also commonly cylindrical or octagonal, and somewhat confusingly called

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112 Magnusson, Water Technology in the Middle Ages, 148, 145, 147.
“conduits.” In plan they bear some resemblance to the original baptistery type. Conduits in London could be either these small terminus houses from which water was distributed within the city, or could be “head houses,” which marked the final gathering point for canals or tunnels that collected the country streams or springs at the edge of the city, from which a series of pipes would split the waters to branch out to serve different neighborhoods. The equivalent term in France for these enclosed terminus houses was the “regard,” a point for inspection of the waters either at the start or the end of a collecting aqueduct.

The system of conduits in London were generally instituted by the city and by the King in order to provide public water at a time when wells were increasingly contaminated, and this gift of water became also an opportunity to mark royal celebrations. In 1236, with the increasing contamination of wells in the city, Henry III allowed the City of London to draw water from the Tyburne to feed city conduits via lead pipes, ‘for the poore to drinke, and the rich to dresse their meate.’ “The Great Conduit at Chepe,” a lead cistern on an octagonal foundation, enclosed in a stone tower, became a landmark for processions and a site for performances, set within London’s principal street. It ran with wine to celebrate the birth of Edward III in 1312, and was the site of a pageant to welcome Henry V’s return from Agincourt in 1415. This dialectic between the municipal generosity of the ruling class and popular public celebrations centered on the artifacts of that munificence is threaded through the history of urban waters, and was certainly also a part of Latrobe’s design for Philadelphia.

113 Magnusson, Water Technology in the Middle Ages, 60.
116 Magnusson, Water Technology in the Middle Ages, 138-139.
Conduits set within London’s markets and squares were popular landmarks for special occasions and parades, and they were also daily gathering places for socializing and sharing news. The broadside, “Tittle-Tattle,” which was published during the mid-eighteenth century, based on an original likely dating from circa 1600, shows the key features of the English distribution model and their effects. [Figure 7] The closed conduit with several taps required that users had to queue up to wait their turn. The centrality of the conduit, and the absolute necessity of waiting for its use, likely provided a moment of welcome rest, as well as an opportunity to pass news from the surrounding quarters. (The tone of the broadsheet poem is less sympathetic.)
In continental Europe, water was more typically distributed by fountains that spilled into open basins into which vessels could be dipped to draw water, but these nodes in the water system similarly acted as symbolic and civic anchoring points for citizens of all classes. Fountains were often associated with particular saints, as Siena’s Fonte Gaia dedicated to the Virgin Mary. Roberta Magnusson relates that in 1343, when water first flowed from the fountain, it was an occasion for high and low to celebrate together. According to Agnolo di Tura del Grasso, people of all types ate and drank together within the Piazza del Campo, ‘without a hint of scandal.’ It seems an inherently romantic idea, this levelling of society, as men and women, young and old, noble and commoner came together to celebrate the miraculous and life-giving appearance of water brought from over 15 miles away. Yet it is certain that communal gathering and visible celebration were and have always been associated with water distribution points.

As the populations of cities reached their high point in the fourteenth century, there are records that this element which so wonderfully drew people together also became a source of conflict between royal, domestic, and industrial consumers. There was simply not enough water provided by these gravity systems to serve all the needs of urban life. As has been mentioned, London’s Great Conduit had originally been established as an act of royal charity, to provide drinking water for the public. By 1345 a legal conflict arose between domestic users and brewers and manufacturers who were siphoning off large volumes for industrial use. The verdict reiterated that the purpose of the system was ‘so that the rich and middling persons therein might have water for preparing their food, and the poor for their drink.’ In response to these challenges, London’s city government built new conduits and placed bans and restrictions on commercial users. In Paris, when private taps were draining the public fountains in 1392, Charles VI began the process of revoking private rights and destroying private lines, also banning professional water carriers from taking water from the public fountains to supply to tradesmen. These conflicts

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117 Magnusson, *Water Technology in the Middle Ages*, 1.
were negotiations between the uses of nobility, commercial interests, and common city-dwellers. Rulers and municipal authorities understood the importance of managing public health to maintain power and peace. Both London and Paris employed conduit marshals or wardens during the thirteenth and fourteenth centuries to oversee their urban systems, and to secure them against illicit use. The elaboration of these systems would be greatly expanded during the centuries that followed. One of the contributions of Latrobe’s system to Philadelphia would be its instigation of new systems of control, since America in 1799 was just beginning to define and defend municipal authority and public rights.

Renaissance and Baroque Systems: From Renovation to Regimes and Recreations

Latrobe hoped to draw together city-dwellers of all classes, but his plan must be firmly fixed to the template of baroque waters, rather than to the more chaotic medieval hydraulic configurations. During the early modern period, technological innovations, a high concentration of political power and wealth, and new methods of graphing and controlling territories underlay coherent plans to improve the quality of urban life and health through the deployment of elaborately conceived hydraulic public works. The idea of a comprehensive urban system anchored by visible monuments to water and civic munificence was also the essence of Latrobe’s plan for Philadelphia.

Several major shifts occurred during the early modern period which contributed to the development of the first proto-modern urban hydraulic supply systems. These changes were demographic, political, and, beginning in the late sixteenth-century, technical. Generally, throughout Europe there were greater consolidations of power and authority, accompanied by hierarchical systems of order, control, and representation. The first wave of hydraulic innovations were reconstructions or reproductions of ancient Roman gravity-fed aqueduct systems. Often a medieval water distribution conduits and fountains were replaced with ornate markers that more

118 Magnusson, *Water Technology in the Middle Ages*, 139-149, 165-166, 119.
powerfully signified the generosity of the patrons of renewal. The second wave of change began during the final decades of the sixteenth century, with the rediscovery of ancient hydraulic machines that would power even grander and more extensive displays of water, and that would also draw city water to higher reservoirs.

*Renovatio*

Most of the hydraulic urban experiments of the baroque period arose first from practical concerns. In England and on the continent, the first major change was a demographic recovery following the 14th century’s population losses due to the plague, and an increasing search for cheap and plentiful water. Roberta Magnusson points out the large scale shift in Europe towards this time, which is that water quantity began to be valued over quality, so rather than using conduits and gravity systems to draw clean water from far away, cities began to use waterwheels, pumps, and engines to draw water off of their rivers.¹¹⁹ This shift to making greater use of urban river waters seems also to have taken place in Paris. By the end of the fifteenth century, despite the presence of three aqueducts and at least twenty-seven public fountains in Paris, the Seine was still used for water provision, and, more problematically, for waste disposal. Parisian aqueducts are estimated to have supplied 350 cubic meters to a population just over 270,000 at the time. By that calculation each person used about a liter per day, which indicates that the river was a likely supplement.¹²⁰ Those wealthy enough to avoid drinking the Seine water straight would only drink water mixed with their ale or wine.¹²¹

During this period many urban plans were redesigned on a large scale in conjunction with a concentration of royal power. In both France and England, as well as in most of the rest of Europe, a consolidation of central control came with the waning of the feudal period and challenges posed to the church. Waters were increasingly conceived not as separate holdings, but

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¹¹⁹ Magnusson, *Water Technology in the Middle Ages*, 167.
¹²¹ Magnusson, *Water Technology in the Middle Ages*, 134.
as territorial waters, owned by right by kings. Monarchs continued to expand monastic water systems in coordination with public health efforts. In England monastic water sources were taken over and transferred to cities during the dissolution of the monasteries by Henry VIII following the Acts of Supremacy of 1534.\textsuperscript{122} In Paris, after 1453, following the neglect of the Hundred Years War, the aqueducts of Belleville were reconstructed and thereafter managed by the corps de ville. In the face of the city's repeated devastation by the plague, a fourth aqueduct system to capture and distribute the waters of the north was established by Henri IV in 1607 to serve the new hôpital Saint Louis.\textsuperscript{123}

The most important hydraulic renovation of the fifteenth and sixteenth centuries, and one that likely lay underneath Latrobe's hopes for Philadelphia, was that of Rome. The model of ancient Rome was one Latrobe returned to, and having traveled in Italy, and he must have considered baroque Rome, though he did not reference it directly. The restructuring of Rome in concert with the restoration of its aqueducts between Popes Pius IV (1560-65) and Urban VIII (1623-44), and particularly under the administration of Sixtus V between 1585 and 1590, was then the most elaborate expression to date of the infrastructural and aesthetic integration of a hydraulic urban ecology, though it relied primarily on technologies dating to the twelfth century. Katherine Rinne argues that the role of Sixtus V has been exaggerated, since he was building on the work of Pius IV and Pius V to restore the ancient aqueducts, but she also states that his influence was distinguished by its elaboration within, "a clear agenda of urban renewal."\textsuperscript{124} The renovations of Sixtus V improved public health, but also clarified the urban order. To compare Latrobe's design to the renovatio seems excessive, yet it must be stated that he too viewed the entire city as a whole that could be restructured and rebalanced by water. Latrobe's design for a

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\textsuperscript{122} Magnusson, \textit{Water Technology in the Middle Ages}, 165.
\textsuperscript{123} Beaumont-Maillet, \textit{L'eau à Paris}, -59.
\end{flushright}
marble engine house as a central ornament to a civic square, like the interventions of Sixtus V, provided an optical focus from all of the cardinal points of the city.

Baroque administrative regimes expanded with the hydraulic restructuring of Rome. Regulatory systems to control the distribution and to legislate disputes around water became extensive galaxies of quantification and management. For Rome’s public fountains, a hierarchy of purity was established, and aligned with a regulatory list of approved uses. Rinne has done an exquisite job of describing the variety of fountain types in baroque Rome, from the beveratori for animals and workers to the fontane pubbliche and semi-pubbliche for drinking, the lavatoi for laundry, and purgatoi for wool manufacturing. She tracks the trickling down from the acqua pura to the acqua caduto (fallen) and the acqua di ritorno. She also demonstrates that after the purest waters filtered through the estates of cardinals and nobles, as well as the organizations and people they designated as subscribers, only about 15 percent of waters arrived at the public fountains.\textsuperscript{125} This statistic was likely similar in other major cities, and resulted in the most munificent monarchs hiring experts in new, or renewed, technologies to design innovative machine-driven river waterworks to serve the urban poor.

The fifteenth and sixteenth centuries saw the replacement of simple medieval cisterns and conduit houses with ornamental fountains and castelli designed to reflect the glory of kings, nations, cities, and God. Medieval water systems had been technically sophisticated, but the markers of these systems had usually been modest designs, often of wood, lead, and rough stone. In the example of Rome, as well as in hundreds of less ambitious baroque urban plans across Europe, public water termini became destinations for views and processions plotted in conjunction with the reconfiguration of the streets. The city-state of Bern built 100 ornamental public fountains during the sixteenth century. The Fontaine des Innocents was reconstructed

\textsuperscript{125} Katherine Rinne, \textit{The Waters of Rome}, 157-58, 181.
between 1548 and 1549 in a grander manner in honor of King Henri II’s reign. The Great Conduit in London was also encased in a more elaborate shell at some point prior to 1638. [Figure 8]

Figure 8 • A North East View of Cheapside with the Cross and Conduit and part of the procession of Marie de Medici, to Visit her Son-in-law and Daughter, King Charles I and Queen Henrietta Maria, dated 1638. Courtesy of the Museum of London Collections Online. (the conduit is the smaller structure, right of center) http://collections.museumoflondon.org.uk/Online/object.aspx?objectID=object-99839&start=123&rows=1 [accessed 14 June, 2015]

One interesting case of the renovation of a medieval system is La Regard de la Lanterne in Belleville, Paris, a conduit house that marked the head of the aqueduct. [Figure 9] This house was reconstructed between 1583 and 1613 in a style that Laure Beaumont-Maillet argues was “hors de proportion avec les services qu’ils devaient rendre,” though she also explains the serious ceremony involved in the annual inspection by the city’s aldermen.126 This small neoclassical rotunda, measuring just over 15’5” feet in diameter (4.70 meters) and 28’10” high (8.8 meters including the submerged portion), is a similar diminutive version of the central cylinder and rotunda of Latrobe’s Central Square Engine House. Its oculus is covered by a lantern, similar also

to Latrobe’s first design for Philadelphia. The Paris rotunda, like the Center Square Engine House, was a storage chamber within a larger system, to be accessed only by administrators and engineers, and admired from the outside by others.

Figure 9 - Regarde la Lanterne, Belleville, Paris

**Bridge Works and Water Towers**

The later sixteenth century also saw the rapid expansion of water supply systems that used new machines based on rediscovered ancient technologies such as screws, wheels, and pumps to draw water from urban rivers or from more distant springs. Even prior to the rediscovery of ancient hydraulic texts, several cities in northern Germany were using water-lifting wheels, a practice that spread through Germany and Switzerland by the fifteenth century.\(^{127}\) The

\(^{127}\) Magnusson, *Water Technology in the Middle Ages*, 169.
most important innovation for the supply of water were wheel works constructed within the arches of existing bridges, to operate pumps that forced river water above the height of the city. The privately operated London Bridge Waterworks was operational in 1582, over a decade after what was probably the first such large municipal system was constructed in Danzig (now Gdansk), and twenty years before the public pump in Paris, La Samaritaine. Because these water wheels and pumps were located at river level, the lowest point in the city, to gain an adequate head of water to feed pipes, cisterns, and fountains, the water tower usually sat directly on top of the machinery, with a reservoir housed in the tower attic.

The public supply of water for Paris was expanded by the construction of a bridge works under the aegis of Henri IV. In 1602 the first pompe de la Samaritaine was constructed at the Pont Neuf according to a royal order. This water supply was designated as a public health response, an act of the King in service of his people, and it was designed as an architectural presence to make visible his generosity. The Registres des délibérations de Bureau de la Ville from 3 February, 1600, noted that it was his Majesty’s will to restore the city’s fountains because, «beaucoup de

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personnes travaillez de collicques, pierreuses at aultres incommoditez qui procède de ce que les eaues ne sont bien bonnes». Henri instructed Sully to argue his part against the city's aldermen who wanted to preserve their right to determine the uses for the arches under the bridge, pointing out that the bridge itself was paid for out of the royal pocket. The works were intended to relieve the burden placed on the city’s aqueducts by the royal palaces and gardens, which were using approximately fifty percent of the city’s water at the time. The new bridge works would also feed the Louvre and Tuileries from the Seine. The pump house building was rebuilt between 1712 and 1719 and later renovated by Soufflot and Gabriel. Once completed, La Samaritaine was a magnificent edifice with cupola and clock tower. [Figure 11] A series of ordonnances were issued in 1667, 1706, and 1764 to protect the structure from the damage caused to it by riverboats. In 1797 the engine stopped, and the edifice was destroyed in 1813.129

Later in the seventeenth century, the city government would develop its own wheel-driven bridge works to increase supply to Paris. Beginning in 1669, the Bureau de Ville constructed their own pump at Notre Dame, designed by Denis Jolly, the royal engineer then in charge of La Samaritaine. The Petit Moulin was constructed in the arch of the Pont Notre-Dame which crossed to the Quai de Gesvres. The Moulin was a series of waterwheels carried by rafts that floated on the tide. A second works, the Grand Moulin, was constructed in the adjoining arch by Guillaume Fondrinier (Jacques de Mance) and both were functioning by 1673. The buildings were utilitarian but formidable, with a reservoir housed in a central tower sixty feet high. [Figure 10] The tower was necessary to distribute the water to three central points at Hôtel-Dieu, the fountains of Saint Gervais, and in the Grande Boucherie. Interestingly, the sole ornamental features were Ionic columns at the entrance to the tower. The works was still operational when it was demolished in 1858 during the Second Empire.130

It would be a wonder if Latrobe did not pass by the Grand Moulin at Notre Dame [Figure 10] as well as La Samaritaine [Figure 11] during his visit to the city in 1783. The Pompes de Notre Dame fed a central tower above, and was a symbol of public waters, simple and admired, a dramatic marker of the elevation of water to serve all citizens. Like Latrobe’s central tower, these symbols of collection and diffusion were austere and powerful volumes that did not express externally their hidden contents. Latrobe’s tower was not set at the level of the river, so in fact it had no need to sit directly astride the machine that moved the water, but, like Notre Dame and la Samaritaine, the Center Engine House lifted waters to be stored under its eaves. La Samaritaine was of a similar grandeur, raising its water 20 meters above the pumps, and hiding them behind.
an elegant façade. Of course, La Samaritaine could broadcast the flow of water with its hydraulic chiming clock. Latrobe designed his tower for Philadelphia so that only the smoke and steam escaping from the oculus revealed the pressures within the device.

Figure 11 - Garnier d'Isle, « Coupe et profil par le milieu de château de la Samaritaine et de la pompe qui fait monter l'eau » 19th-century watercolor. B.N.E., in Beaumont-Maillet, L'eau à Paris, 79.

Suburban Recreation and Royal Celebration

New machines powered urban towers on the bridges in the heart of Paris and London, but also drove systems that spanned broader territories, reaching into the countryside for clean water. If the bridge and tower systems were devices, this second type of system owed as much to
systems of measurement and survey. In London, private water companies were established during the seventeenth century, drawing water to the city by canal, and pushing it to suburban reservoirs which came to be associated with pastoral and more active recreations. In Paris, the most extensive and notable hydraulic work, the Machine de Marly, was built to serve the gardens at Versailles, to provide water to outline and punctuate the geometric, symbolic, and social cosmology that surrounded the Sun King.
The power and wealth of the nation under Louis XIV’s long reign allowed France to develop vast hydraulic systems and impressive watery displays during the seventeenth century. Latrobe didn’t speak of La Samaritaine or Le Grand Moulin, but he did, of course, refer directly to the works at Marly in his initial proposal for the Philadelphia waterworks in December of 1798. The great waterwheel-driven works at Marly was built to activate the magical fountains and canals of Versailles beginning in 1682, and was known and admired around the world. Latrobe mentioned Marly, however, as a negative example. He explained that water-driven systems such as that at London Bridge, Versailles, and Bremen were “subject to ice and freshes,” which meant that the wheels might be frozen at times of fire, or would at the very least require constant work to repair them. He offered that the cranks that go with waterwheels are “the very worst things in mechanism.”  

Of course, in the democratic climate of Philadelphia, posing the modern steam-engine in opposition to the corrupt royal system at Versailles was also a savvy political maneuver. The Machine de Marly elevated royal celebration to an unsurpassed height, but is well known and requires little explanation. The expansion of London’s waterworks to include suburban entertainments at this time was likely far more familiar and relevant to Latrobe. During the seventeenth century, London’s waterworks were entirely private, for-profit ventures. With new technologies they better served residential development, but also came to be associated with various types of entertainment. The New River Company was created by Hugh Myddleton in 1613 to bring water 40 miles from Hertfordshire via canal, just a mile short of the Croton aqueduct that would be constructed to serve New York City approximately 230 years later. King James I became a 50% partner in the private venture. He instructed his Privy Council to plea to London’s Lord Mayor that the work was for the “public good,” to provide “wholesome water” and to prevent fires in the city.  

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131 Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 15.
Perhaps because London’s water engineers were profit-driven tinkerers at this point, during the early seventeenth century in London, the salubrity of the city’s atmosphere does not seem to have been a primary concern to be treated. Since these companies were entirely dependent on subscriptions of individual estates and eventually households, the supply of new neighborhoods seems to have been the main motivation for water supply companies in London. Sir Walter Roberts proposed a venture similar to the New River in 1641 to bring water from Hertfordshire in a closed aqueduct. He proposed it to supply, “The Cities of London and Westminster being growne very populous; and there being of late many faire houses and other large and spacious buildings erected in them ....” Of course Latrobe’s Philadelphia design was poised as a prospective service to new development as well, and was also based on an optimistic hope for residential subscriptions to cover the costs of construction.

It is surprising that the proposals to establish waterworks within London during the seventeenth century addressed the provision of domestic water, and supply to keep the city clean and free of fire, but none of the proposals seems to suggest that the air might be cleaned by the water. The first such suggestion takes place at about the same time that steam power came into use during the 1720s. In Paris, by comparison, by the 1620s we already find in the writings of Salomon de Caus that water supply to public fountains was associated with cleanliness and with an improved air quality, and that the urban fountains were supplied by royal edict and graced by art. If London lagged behind Paris connecting the provision of clean water to a purification of the air, this was certainly not because their air was cleaner. In his work of 1661 titled *Fumifugium: The Inconveniency of the Smoak of London dissipated*, &c. John Evelyn (1620-1706) praised London as a city, “that is plentifully and richly irrigated, and visited with Waters which Christalize her Fountains in every Street, and may be conducted to them in such farther plenty, as Rome her self might not more abound in this liquid ornament, for the pleasure and

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divertissement, as well as for the use and refreshment of her Inhabitants.” Yet this beautiful “ornament” was not described by Evelyn as a cure for the city’s ailment, namely the industries that burned coal in quantity beyond the boundaries of the city, creating an atmosphere of “infernal Smoake.” He instead proposed the planting of fragrant hedges to purify the environment. Yet in other ways, Evelyn’s thoughts about the threat an imbalanced environment might pose to political stability predicted the theories of Latrobe and his republican cohort. As Evelyn explained, “Aer it selfe is many times a potent and great disposer to Rebellion.”

Private waterworks in England were at first dedicated primarily to providing water for domestic use and for fire protection, but by the late seventeenth century the waterworks themselves had become places for democratic public spectacles. These recreations differed significantly from the civic and royal rituals associated with the medieval conduits and fountains because they functioned more exclusively as diversions and retreats from civic duty (if in fact political dramas remained a popular subject). In 1685, just a year after the machine de Marly was completed, the Sadler’s Wells “spa and music house,” was established near the New River reservoir in north London by one of the company’s surveyors and was a well-known place for democratic entertainment when Latrobe lived in London. [Figure 12]

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134 John Evelyn, Fumifugium: The Inconvenience of the Smoak of London dissipated, &c. (London: W. Godbid for Gabriel Bedel, and Thomas Collins, and to be sold at their Shop at the Middle Temple Gate neer Temple Bar, 1661), 5, np, 1.
Probably around 1802, Sadler’s Wells expanded to become, “The Aquatic Theatre,” no longer only serving wine and plays to all ticketholders at the site of a rumored healing spring, but now also featuring a 90 foot tank in which battles at sea could be staged.\footnote{Ward, London’s New River, 205.} [Figure 13]
Science, Magic, and Sanitation

If the naumachia of London’s New River and the extravagances of le Roi Soleil seem far removed from the logic of urban water supply and sanitation, it must be acknowledged that from the start of the scientific exploration and technological revival of the late fifteenth century, hydraulic machines have been associated with magic and entertainment. The distribution of hydraulic technology during the early modern period was inseparable from a fascination throughout the increasingly powerful centralized royal courts of Europe with perspectival tricks and mechanical automata. These conjoined technologies of motion and vision expanded across Europe during the late sixteenth and early seventeenth century through a class of itinerant artists and proto-engineers and were studied within monasteries and universities. In the letter to the
reader, Salomon De Caus, one of the most prolific of these itinerant artist engineers, explained that after the great water systems and hydraulic machines of Rome were destroyed, their art was lost until “trois grands Princes ... tous curieux,” Emperor Charles V, Francois I, and Henry VII, followed shortly by Pope Sixtus V, desired to reestablish these grand machines.\textsuperscript{136} The sixteenth century’s powerful rulers supported the experimentation and expansion that would transform magical machines to become the power behind industry and cities.

Another event contributing to the development of new technologies during the late sixteenth century was the renewal by natural philosophers of the Greek concern with “natural magic.” Along with a revived interest in Archimedes, particularly important for the history of hydraulic machines was the Latin publication in 1575 and in 1583 of Hero of Alexandria’s \textit{Pneumatica}. It was also republished or imitated in many vernacular editions. The \textit{Pneumatica} dates from the first century A.D., and is a catalog of magical machines powered by air, water, and steam. According to historian of technology Marie Boas, Hero was widely enough known by the seventeenth century that early scientists and theorists, including Galileo, Mersenne, Boyle, Pascal, Burton, Bacon, Fludd, and Kircher, could make “casual reference” to Hero and expect to be universally understood.\textsuperscript{137}

The movement of hydraulic technologies around Europe during the sixteenth and seventeenth centuries is beyond the scope of this study, but it is clear that religious wars and religious persecution contributed to the movement of hydraulic knowledge within Europe. Thomas Parke Hughes traces a history of European Technology in which the Thirty Years War had the general effect of displacing technological advancement from the German principalities to France between 1618 and 1648. Under the reign of Louis XIV from 1643 to 1715 the Languedoc Canal, the great works of Versailles, and many other ambitious projects were undertaken.

\textsuperscript{136} Salomon de Caus, \textit{Les Raisons des forces mouvantes avec diverses machines tant utiles que plaisantes ausquelles sont adjoints plusieurs desseins de grotes et fontaines} (Paris : Jérôme Drouart, 1624), np.

However, the royal revocation of the Edict of Nantes in 1685 drove Huguenot engineers to seek refuge in England, Ireland, the Dutch Provinces, Germany, and Switzerland, again shifting the balance and leading to the re-diffusion of technologies.\textsuperscript{138}

Wars and alliances forced the movement of engineers across Europe, and royal courts also protected and patronized the work of this nascent class of artist technicians. The work and writing of Salomon de Caus demonstrate the ways in which water technology spread in direct conjunction with perspective techniques and magical gardens that displayed royal power. Like other engineers at this time, including Girard Desargues, de Caus had a wide array of interests which were unified around mathematical, optical, and technological systems. De Caus was also a garden designer, musical theorist and teacher of perspective drawing. He reworked Hero’s encyclopedia, and published it in 1615 as \textit{Les Raisons des Forces Mouvantes avec Diverses Machines tant Utiles que Plaisantes}. Some historians grant this volume importance equal to Hero’s original.\textsuperscript{139} De Caus worked for a time in England, where he contributed to the design of the waterworks and fountains at Richmond Palace, Hatfield House, Somerset House, and Greenwich Palace while teaching perspective drawing to Prince Henry, son of King James I.\textsuperscript{140} De Caus left the Stuarts in 1614 to travel to the Court of the Electoral Palatinate at Heidelberg.

He followed Princess Elizabeth Stuart who had married Frederick V the year before in London.\textsuperscript{141}

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\textsuperscript{138} Thomas Parke Hughes, ed. \textit{The Development of Western Technology Since 1500} (New York: The MacMillan Company, 1964), 4-5.


\textsuperscript{141} Interestingly, the biography of Descartes intersects with that of De Caus in at least two areas. First, the daughter of Frederick and Elizabeth would become Descartes’ friend and pupil. The catalog of their letters to each other provides a glimpse of a nuanced rationalist. [\textit{Princess Elisabeth of Bohemia & René Descartes, The Correspondence between Princess Elisabeth of Bohemia and René Descartes}, Ed., transl. Lisa Shapiro (Chicago: University of Chicago Press, 2007)] Also, Descartes’ biographer Desmond Clarke speculates that Descartes may have read \textit{Les Raisons des Forces Mouvantes}, which was reissued in Paris in 1624, and that it may have been formative for Descartes, helping him to end his youthful meanderings. Descartes drawings of the pineal gland being struck with animal spirits in the brain’s center bears a striking resemblance to de Caus’ etching of a ball in a grotto being balanced on columns of water. [\textit{Descartes: A Biography} (New York: Cambridge University Press, 2006)]
There is a parallel to be drawn to the itinerant career of Benjamin Latrobe, also a member of an oppressed northern European religious sect, who was an heir to this tradition, trained in drawing, architecture, engineering, science and music.

During the late sixteenth and early seventeenth centuries, water driven machines were associated with both science and magic, as well as with royal claims to divine and natural power. De Caus, a Calvinist, believed that he must spread the word of God through the study of “nature, man, and the divine,” by “the text, the drawing, the machine, and the magical events devised for the gardens.” He understood the mathematic harmony of music to be a representation of divine order. A miracle gardens, like an astronomical clock, was a grand geometrical artifice, designed to incorporate the motions and meaning of the entire universe. In England, de Caus worked as a hydraulic engineer, and was brought to Heidelberg by Frederick V to take on an expanded role as the master of artifice, designing a grand garden to celebrate the union of the royal couple as well as Frederick’s dominion over his empire. De Caus designed hydraulic devices borrowed directly from Hero’s Pneumática: a singing mechanical bird, a moving nymph, a water-driven pipe organ. His musical expertise as well as his skills as architect and engineer allowed him to create an oeuvre complete.

The Heidelberg Garden, constructed between 1614 and 1619, was a reflection of the new scientific idea of the rational mathematical laws underlying the natural world. It was simultaneously a religious and royal symbol of cosmic unity and power. It included fountains and grottos of all sizes that included Classical and rustic subjects. A double semicircular scale included fountains on each step that poured into the next. One of the largest fountains was a craggy mountain scene, complete with alpine flora. The Emperor was represented as Neptune,


lord of waters.\textsuperscript{144} In his excellent work on Salomon de Caus, Luke Morgan aptly argues that the garden was not, as has been argued by Frances Yates, a work crafted within the hermetic language of what she calls the Rosicrucian Enlightenment.\textsuperscript{145} Morgan cleverly names the garden a ‘hortus inconclusus,’ since its destruction when it became a staging ground for attacks on Heidelberg Castle during the Thirty Years War has somewhat obscured retrospective examination. Morgan explains the garden as a collection of nonnarrative topoi, “thematic emphases” conventions borrowed from “an international style of landscape design” drawn across Europe from late sixteenth-century Italian designs.\textsuperscript{146} Despite their devastation, the gardens were widely known through a published work, de Caus’ \textit{Hortus Palatinus} of 1620. For a time the gardens were known across Europe as the “eighth wonder of the world.”\textsuperscript{147} [Figure 14]

In a sense these types of expression, of magic, deception, and private meaning, are the opposite of what Latrobe intended for Philadelphia, or perhaps he was testing an invisible industrial magic. His garden and engine house were designed to make sensible to all the power of nature and technology, yet gave no glimpse of the movement of water or machine. He cloaked the mechanism in smooth marble, allowing only its smoke to escape, hinting at its atmospheric powers. He hermetically sealed the engine and reservoir within a geometric interplay between opposing geometries. Latrobe repeated the popular baroque pattern, the circle in the square split by the cross, and punctured at the center by water. This was by no means the only choice for Philadelphia. The small engine house need not have been placed symmetrically within a formal distribution of walks and ring roads, yet the design for Center Square was an echo of these

\textsuperscript{144} Salomon de Caus, \textit{Hortus Palatinus a Friderico Rege Boemiae Electore Palatino Heidelbergae Exstructus} (Heidelberg, 1620).
\textsuperscript{145} Frances A. Yates, \textit{The Rosicrucian Enlightenment} (London: Routledge Classics, 1972)
\textsuperscript{146} Morgan, \textit{Nature as Model}, 21, 27.
baroque plans, in which drama, recreation, and play were intermingled with the ceremonies that enacted and solidified the legitimacy of the governing class within the patterns of the cosmos.

Baroque magical machines flourished with explorations of automata and other diversions, and these games were also at the root of modern steam technology and urban sanitation. The same engineers who devised jeu d'artifice were also enlisted to construct city fountains and hydrants to clean ever denser cities during the seventeenth century. After the publication of *Hortus Palatinus*, de Caus was invited back to Paris by Louis XIII. He was commissioned to map the city, and to manage its sanitation for the next 40 years, establishing a system which raised water via machine to supply 20 public fountains to clean the mud from the city. Fountains were designed by masons Jacques Huguenin, Jean Gobelin, and Pierre Bernard. The project was well under way when de Caus died in 1626. Luke Morgan theorizes that the garden device of the
hovering sphere floating on water jets designed by de Caus may have influenced Descartes’
diagram of the brain and vital spirits, since the two overlapped in Paris by a few years.\textsuperscript{148} It is
necessary to locate the basis of modern rational technology and thought in the hydraulic magical
automata of the early modern period than to see the two as entirely opposed.

Latrobe’s design for Philadelphia can be seen as a direct inheritor of the intermingled
currents of the seventeenth century, when waterworks were seen both as magical celebratory
machines and as devices that, by cleaning filth, would clean the air and thereby improve the
physical and spiritual health of city-dwellers. We can be certain that de Caus, like Latrobe, was
concerned with the effect of filth on the air quality of Paris based on a conversation he inserted
within his translation and reworking of Vitruvius. De Caus scripted a debate on the merits of
Paris between Architecte and Ingénieur, in which the engineer asks if Paris can be considered a
great city although it is far from any good port and it is “filled with mud and infections.” To the
architect’s reply that the grandeur of the royal court makes the city great, the engineer points out
that silver tarnishes in the air of Paris. As the architect withdraws from the debate, a
mathematician appears to explain that not all bad smells are pestilent.\textsuperscript{149} It is significant that in
Paris during the early seventeenth century, the engineer and mathematician were sometimes
judged more capable than the architect in managing urban health. In the early days of the
American republic, the hierarchy of professions and expertise was perhaps not yet so well
established.

Ideas of health did change between the time of De Caus and the start of the nineteenth
century, but ancient ideas proved very durable. De Caus’ belief in the pestilential airs of Paris
signals an understanding of the transmission of disease that was quite similar to that of Latrobe as
will be addressed in Chapter 3. It is powerful evidence of the medical concepts of miasma and
pestilence which would continue to influence medical and engineering theory through the

\textsuperscript{148} Morgan, \textit{Nature as Model}, 67.
\textsuperscript{149} Morgan, \textit{Nature as Model}, 69.
nineteenth century. De Caus's role in mapping, rationalizing, and cleansing the city in the interest of public health also has a distinctly modern ring. It seems that, at least in Paris, the cleansing of the airs was already a concern of the engineers of royal magic. Latrobe need not have been familiar with de Caus to carry forward seventeenth-century ideas of urban health and captivating urban displays. By the eighteenth century, the overlap between fountains, symbols of power, clean airs, and salubrious cities was generally assumed knowledge.

**Moravian and German Waterworks: Creating Happiness and Dispensing Benefits**

There is no record regarding which baroque gardens and palaces Latrobe may have seen in Paris, Rome, Naples, Dresden, and elsewhere on his journeys between, but he relates that during his youth his "young unbroken mind" often gained its happiest exercise at a baroque manor near the Moravian settlement at Niesky. Looking back from America, he wrote fondly of his frequent visits as a youth to Schloß Königshain, the home of his mentor the Baron Carl Adolph von Schachmann. The Baron designed and constructed this new palace between 1764 and 1766, after his return from travels to France, England, and Sweden. Latrobe described the manor as "in the first style of elegance in all its arrangements. His library, his Gallery of pictures, his magnificent collection of prints, his Gardens and his park, proved the refinement and cultivation of his mind which was devoted to literature and the arts. He himself was an admirable draughtsman."

The Baron's draftsmanship and his taste for simplicity and symmetry are evident in the plan he created for Schloß Königshain. [Figure 15] In this drawing, as well as a perspectival rendering by another artist at a later date, it appears to have been a simple castle with a landscape split between an irregular, perhaps "English," area of plantations, and a baroque terrace and regular symmetrical walled garden and lawn adjacent to the house. [Figure 16] The area framing the view from the entry courtyard featured simple fountains pouring from two stone columns into two rectangular basins, and it appears from there descending into a large, sloping pool, possibly
for watering animals. Unfortunately I have not located a key for this drawing, but I believe the
two buildings framing the pool are likely barns or stables and carriage houses. The Moravians
believed in constant industry, and in their settlements integrated workshops, foundries, and other
utilitarian buildings around the residential squares reserved for male brethren rather than at a
distant remove. The images of Schloß Königshain also show the lightning rods with which the
Baron was notorious for experimenting.
With insufficient evidence, it would be speculation to give further explanation of the baroque inventions of von Schachmann. It seems possible, however, that the most important lessons learned at Königshain were not concerning draftsmanship, landscape, or hydraulics. Recording his fond memories in 1797, Latrobe mused that it was “dangerous to a mind glowing with warm ideas of liberty to loiter on such enchanted ground,” for the he observed that the Count ruled only by “creating happiness and dispensing benefits” to his “inherited bondsmen.” A few years prior to his own attempt to dispense benefits to the citizens of Philadelphia, Latrobe wondered regarding this antiquated, yet beloved, feudal model, “Can liberty do more?”

150 Latrobe, Journals, II: 315.
Latrobe would not only have known the baroque gardens of Germany, but would also have been exposed to the public water supply systems that were common in the largest German cities. At age 18 or 19 when Latrobe departed Niesky, he traveled in Saxony while working on river improvement projects with August Riedel. It is unquestionable that he would have seen some of the most advanced river-powered pumps in the world during this time, many of which were associated with civic sculpture or other ornament. In his drainage work with Riedel he also must have utilized tide or current driven forcing pumps.

The earliest public machine-driven water systems were constructed in German cities. Thomas Ewbank quotes a European visitor to Augsburg during the sixteenth century who described the “curious” tower, “handsomely ceiling’d” with a hexagonal reservoir, into which the water flowed into an open reservoir through a pipe sculpted in the shape of a dolphin. From this tower, the water descended to public fountains, and was also piped by subscription into private homes as early as 1705. In his proposal for the Philadelphia waterworks, Latrobe would reference the same type of system in Bremen, which is described by Ewbank as having an automaton of a soldier at the entrance, triggered by a mechanism under the steps.\(^{151}\) It is known that this river-powered water-wheel technology made its way from northern Europe to be installed at London Bridge in 1582 by German engineer Peter Morris.\(^ {152}\)

A more spare version of this northern technology was the foundation of the first small American machine-driven water supply system, constructed at Bethlehem, Pennsylvania. This Moravian settlement hired Hans Christian Christiensen, a millwright who had arrived from Jutland in New York in 1751, to build a mill-driven water system for their town. The system, constructed between 1754 and 1755, was a water wheel and pump which elevated the water

\(^{151}\) Thomas Ewbank, *A descriptive and historical account of hydraulic and other machines for raising water, ancient and modern : with observations on various subjects connected with the mechanic arts, including the progressive development of the steam engine ...*. (New York: Bangs, Platt, & Co., 1850), 293-294.

through hemlock and lead pipes to a reservoir. Then, in 1761 a 32 foot high water tower was added, elevating the water a full 94 vertical feet from the river, and over 300 feet distant. By 1790, the water was distributed from the tower to seven reservoirs: in the town square, apothecary, Market Street, the farm house, the Sun Inn, the Brothers’ House, and the school area. Pipes also connected the Bell House Square to three other locations within the settlement.\textsuperscript{153} The tower that housed the water was described by John Adams, writing to Abigail on 7 February, 1777, as “a little Building, in the shape of a Pyramid, or Obelisk, which stands upon the Top of the Hill and is Twenty or thirty feet high. From this Fountain Water is conveyed in Pipes to every Part of the Town.”\textsuperscript{154}

Latrobe, in the words of Jeffrey Cohen, considered himself “the Prince of the Moravians.”\textsuperscript{155} Bethlehem had an admired water-supply system, and Latrobe’s grandfather, Henry Antes, had been influential in the founding of the town. Antes was one of three American landholders who kept the settlement land in trust for the church, since Pennsylvania law did not allow aliens to hold property. In addition, Antes was the millwright who constructed the town’s first mill, and is considered to have been Bethlehem’s town planner.\textsuperscript{156} It seems likely, even unavoidable, that Latrobe would have visited and studied the system, since he had inherited land holdings from his mother, which he gradually sold. Yet Bethlehem doesn’t receive any mention in Latrobe’s writings, and neither does its water system.\textsuperscript{157} Of course, the system was not

\begin{thebibliography}{99}
\bibitem{155} Jeffrey Cohen, conversation, 9 July, 2013.
\bibitem{157} Visits with the Antes family would almost bookend Latrobe’s stay in Philadelphia. Returning to Virginia after his first trip to Philadelphia in April of 1798, he wrote a letter to his uncle, revolutionary war hero Colonel Henry Antes, apologizing for failing to visit with him while in the city. After completing the waterworks, Latrobe departed Philadelphia on the 5th of September 1801, traveling with another maternal uncle, Frederick Antes. Governor McKeans of Pennsylvania had appointed him as assistant to Antes on the Susquehanna River Survey. Two days after Latrobe left Philadelphia, his uncle fell ill, and
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revolutionary by European standards, and Latrobe had utterly rejected the Moravian religion. In 1808, Latrobe wrote in a letter to the Washington Federalist, “independently of having been when a boy, for some years at a Moravian school, I have never had any connexion with that society.”

In addition, the Unitas Fratrum held controversial beliefs regarding sexuality, both inside marriage and with the divine. Fear of being associated with the group should those beliefs have become publicly known may have contributed to Latrobe’s avoidance of Bethlehem.

died on 20 September. As Latrobe attended his uncle to his death in Lancaster, he kept a dispassionate journal record of his symptoms.

158 Latrobe, Correspondence, II: 608.
159 See Aaron Spencer Fogleman, Jesus is Female: Moravians and Radical Religion in Early America. Philadelphia: University of Pennsylvania Press, 2007. The Moravians during the time of Count Zinzendorf worshipped Christ as the Creator, and viewed his side wounds on the cross as a purifying uterus, washing believers in blood and water. Sex was seen as a sacrament, to be practiced conservatively in order to maintain passion for Christ the father, who was the husband to each man’s soul. The soul was judged to be female, and the genitals were seen as sacred and celebrated in hymn.
Steam-Powered Water Supply Systems: Mechanics and Economics

I have attempted to demonstrate that in Europe prior to the eighteenth century, urban waterworks functioned in three ways: as utilitarian interventions, built particularly for the domestic use of the poor and middle class; as municipal agents of health, constructed to clean the streets and air; and as royal symbols, linked to magic and power. These elements combined to encourage particular social interactions around water. With the consolidation of power during the sixteenth and seventeenth centuries, large urban projects united all of these modes, the domestic, environmental, symbolic, and social.

London’s first experiments with steam-driven waters had not been devoted to municipal supply, rather, as in the baroque royal gardens, the machine was deployed to mobilize a dramatic spectacle of dancing waters. Unlike the moving waters of Versailles, this display was available to any member of the public who could afford a ticket. The first works established specifically to serve public entertainment purposes was at Chelsea, constructed in 1696 by Henry Winstanley, the engineer of the first Eddystone Lighthouse, to feed a fountain exhibition at Hyde Park which cost a shilling for admission. The next steam engines in England used to power water supply were built for private and royal gardens. Savery and Newcomen atmospheric engines were installed at Campden House, Kensington, Dudley Castle, and York between 1712 and 1714. I believe that the association made in Baroque gardens between hydraulic power and natural magic continued into modern times, and became even more compelling with the “fire engine.”

I would argue that there was a shift in the symbolic function and visibility of waterworks between the seventeenth and eighteenth centuries in England, during the same period that steam-

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driven works were developed, and simultaneous to the definition of modern engineering. Many
seventeenth-century waterworks powered fountains, automatons, and gardens which had visible
symbolic functions. As John Evelyn had written in 1661, London’s many fountains were her
"liquid ornament."\textsuperscript{162} An expansion of steam-powered works took place during the mid-
eighteenth century in London, primarily in order to provide service to newly constructed
residential neighborhoods. This expansion of volume and range of service was assisted by the
improvement of the steam-powered engine, accelerated between 1768 and 1798 with the
experiments of John Smeaton and Boulton and Watt. During the eighteenth century, when
waterworks were expanded to power hidden domestic uses, their visible function continued, in
the reservoirs of Hyde Park for instance, but the waterworks themselves took on a less central
symbolic function within pastoral settings, and were often surrounded by country pleasure
grounds for healthy recreations such as picnicking, cricket, and promenades. The celebration and
visibility of the water itself was reduced and relocated with the introduction of the explosive fire
ingines.

It would be impossible and unnecessary to describe the entire history of the steam-driven
waterworks of the eighteenth century. It is important, however, to demonstrate that despite
numerous modifications to the engine, there were, at the time Latrobe conceived his design for
Philadelphia, only a few methods of distributing and enclosing these systems. I will describe the
largest and most successful models of London and Paris, which Latrobe also referred to in his
letters and proposals. What will become evident, I hope, is that Latrobe proposed a model for
Philadelphia that, though driven by the same machine as contemporary systems across the
Atlantic, was entirely innovative in its design.

\textsuperscript{162} Evelyn, \textit{Fumifugium}, 5.
The London model of steam-driven city water supply seems by any logic to be the primary model that Latrobe would have followed. Steam engines were in use for the supply of water in London for over fifty years before they were introduced in Paris, and it would be almost another fifty before they were used for this purpose, on a limited scale, in Prussia. Also, Latrobe lived in proximity to London’s great water supply company, the Chelsea Waterworks. Between the ages of 24 and 29, when he was already a trained engineer, Latrobe lived first, after 1788, with his brother Christian at Great Titchfield Street, and then in 1790 with his wife Lydia at Grafton Street. Both of these homes were within a few miles of the Chelsea works. The engine house could be clearly viewed from the famed Willow Walk, a path he likely traveled to visit family friend Dr. Charles Burney, who was the organist and resided at Chelsea Hospital after 1783. Latrobe would have been well aware that the English fashion of the time was the association of suburban waterworks with cultivated country retreats which served tea and buns alongside wholesome recreations.

The period Latrobe lived in London between 1784 and 1795 was a very active time for the modernization of waterworks by the addition of steam power. The three largest waterworks in London at the time were Chelsea, London Bridge, and the New River Company, by the early eighteenth century serving 9.5, 10, and 59 thousand houses respectively. These three London waterworks represented three different models of hydraulic system. New River was a constructed river drawing water by gravity from 40 miles inland. Chelsea and London Bridge both drew from the Thames, but until the nineteenth century, Chelsea’s tidal inlet waters were considered to be of a better quality than river water. All three were modernized during the eighteenth century by the addition of steam engines layered on top of older technologies. New River added a Newcomen engine designed by John Smeaton in 1767, and Chelsea installed two atmospheric engines in

163 Hamlin, Benjamin Henry Latrobe, 28, 30.
164 Gwilym Morris Roberts, Chelsea to Cairo, 115.
1741-42, which were replaced after 1778 with a more powerful Boulton and Watt engine. After 1761, the initial intake engines were supplemented by a smaller auxiliary engine located within Hyde Park. London Bridge did not add a steam engine until 1786. The same year, New River would replace Smeaton’s engine with a far more efficient Boulton and Watt engine, and then pair it with a second engine in 1794. Chelsea would move to paired engines in 1803 when they added a Boulton in Watt double-acting engine to work in tandem with the engine of 1778.

Latrobe was familiar with the London steam-driven water supply from direct experience, and his Answer to the Joint Committee of March 2, 1799 directly referred to the English models. He specifically described the Chelsea works as well as New River, and mentioned also Hungerford, Stratford, Shadwell, and Lambeth Marsh. In response to Philadelphia’s Joint Committee of the Select and Common Councils’ request that he, ‘state in as concise and clear a manner as possible, the detail of the plan proposed to be executed for supplying the city of Philadelphia with pure and wholesome water,’ Latrobe included an appended “Account of Steam Engines, &c.” This appendix began with Chelsea, the closest in distribution and function to his own plan. Latrobe explained it as two engines, a first that elevated the water from a tidal inlet to Hyde Park’s reservoirs and to lower Westminster, and a second, smaller engine which forced the water higher than the park reservoir to serve the northwest. Regarding New River, he also reported accurately, that the head of the system was high enough to serve most of the city, but for parts of Islington and Mary-le-Bone a steam engine pushed the water to a reservoir slightly further north and at a higher elevation. What both of these systems had that Latrobe’s design lacked was ground reservoirs to serve even when the engines were under repair. Also, both London systems built their steam-engines inside large utilitarian sheds, which allowed sufficient space, light, and ventilation to perform routine maintenance and to operate the machines.

165 Latrobe, An Answer to the Joint Committee. . . . March 2d, 1799, 5-6.
The first steam-powered city water supply was constructed by the York Building Company. It was briefly powered by a Savery engine starting around 1714, and then by an engine likely constructed by Newcomen himself in 1725 after Savery’s death. The works had a practical purpose, but still held magical as well as physical connotations. The engine-driven works were compared in *Ladies Diary* of 1725 to a heart, with ventricles, valves, and arteries, born of both Neptune and Vulcan. The *Daily Courant* of 14 December 1725 referred to the engine as a “Dragon,” to be fed by a “Lancashire wizzard” [sic] with “live coals.” The works included a high, tapered, octagonal wooden watertower to which the water was elevated by the

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steam engine, from which water traveled through iron mains and wood pipes to a reservoir in Marylebone Fields, and from there to pipes which fed the new homes in Hanover Square.\textsuperscript{168} The tower was built directly adjacent to Inigo Jones York Watergate of 1626. [Figure 17]

The York works was a variation on the London Bridge works, in that it was a reservoir tower set at river level, but if the bridge’s waterwheel was successful, Newcomen’s Dragon was not. Though it fed the popular imagination, the waterworks was soon taken offline due to mechanical difficulties and to the high cost of coal. In 1727 Richard Bradley reported that when Savery, “undertook so great a Work as furnishing the Publick with Water, but doubled every Part in the York-buildings Engine, and by that made it impracticable for one Man to work it; and it was liable to so many Disorders, if a single mistake happn’d in the working of it, that at length it was look’d upon as a useless Piece of Work and rejected.” A similar critique would be leveled against Latrobe’s Philadelphia machine over seventy years later. Jean Théophile Désaguliers identified the specific ailments of the York machine. After a visit in 1734 he wrote that, “Its heat was so great that it would melt common soft solder; and its strength so great as to blow open

several of the joints of his machine.” The York Dragon was taken offline around 1730, but the site remained a popular curiosity until 1752 when a new atmospheric engine was installed. 169

New River

The waterworks of London were not distributed according to orthogonal or radial geometries, and they were rarely built all at once. Inlets, pump stations, pipes, offices, keeper’s house, and reservoirs were generally distributed according to the city’s topography to require the least effort to attain a head of water. Again it is necessary perhaps to mention that as profit-driven operations, they made little effort towards the ornamentation of the mechanical elements or of the engine houses, but improved their machinery as often as necessary to keep up with demand and with their competition. Most of the large London water companies accumulated technologies through the seventeenth and eighteenth centuries, layering one type of machine on top of the last with each new innovation. By the end of the eighteenth century, some of the oldest water companies were simultaneously using a combination of two or more of the available power sources, gravity, animal, wind, tide, water, and steam. The pumping stations were generally a collection of utilitarian sheds shaped to house each function.

The New River Company, already mentioned as an early gravity-fed system, was one of the largest providers in London by the eighteenth century, and an example of a company that grew organically over several centuries, experimenting with new machines to generate more power, volume, and elevation. Three engravings make clear the evolution of the site. When the company first brought water into the city by gravity in 1613, it was collected in the “round pond” with the keeper’s house adjacent. It is likely that Latrobe knew the site, but I have found no reliable architectural renderings of it from the time. Yet it is undeniable that the perfect relationship of circular reservoir within circular settlement basin, and the apparently Doric colonnades framing the keeper’s house makes a tempting comparison to the Center Engine House. [Figure 18]

Figure 18 - New River Head House, early 18th c, in Robert Ward, London's New River, 87.
The second image, a 1794 reproduction from Canaletto’s 1753 *Views of London*, shows the Islington site as it lay above and outside the center of the city 140 years after its founding. [Figure 19] There was by then on the site a new tower, first a windmill, then converted to a horse-mill. A third image from around 1775 shows a closer view from the same (north) side of the site. [Figure 20] The round tower of the old mill is inexplicably crenellated, and sits quietly alongside the percolating steam-engine house built by John Smeaton in 1768.  

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The technological and topographical expansion of the New River Company made it the largest provider in the city by 1809, serving approximately 472,000 people. The central pond was eventually surrounded by the various later engines. The technology did not share the

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domestic space of the overseer, and did not correspond to the recreational space of the aquatic Sadler’s Wells theater, independently operated, but bordering the original reservoir. Each shelter was constructed according to the shape and requirements of its engine, and bore no particular geometrical arrangement with the exception of the earliest elements. It is also notable that the irregularity of the site allowed the construction of new and higher reservoirs as demand for water grew. [Figure 21] Pulling away from the perfect circle of the center, an upper reservoir was added in 1708 and fed by the windmill, and later by the steam-engine.

Chelsea

Latrobe ignored the model of New River, but in physical distribution if not technical arrangement, Philadelphia had some similarities with the example of Chelsea. The Chelsea Company established a tidemill in 1722 in the marshy tidal inlet where Victoria Railway station now lies.\textsuperscript{172} The commercial operation was given patent by Parliament to supply new residential neighborhoods of “the City and Liberties of Westminster” at around the same time the York Dragon was built.\textsuperscript{173} According to the \textit{Daily Post} of 10 March 1726, the works was built so that, “in a little time great plenty of Water will be thrown into Grosvenor Square, Hanover Square and all Places adjacent,” offering water to the houses in greater quality and at lesser cost than other companies. The Chelsea works added two atmospheric engines in 1741 and 1742. Installed after a severe frost in 1739-40, the two steam engines pushed the water uphill almost 2000 yards and 70’ above the level of the Thames to reservoirs at St. James and Hyde parks, and then fell by gravity to serve the residential squares to the east.\textsuperscript{174}

\textsuperscript{172} Chelsea’s tidemill, also called the “small engine,” worked in a sluice, returning the waters through the Tyburn. It supplemented the early atmospheric engines but was decommissioned in 1776 when the tandem Boulton and Watt engines were installed. (Gwilym Morris Roberts, \textit{Chelsea to Cairo}, 58- 59, 106)

\textsuperscript{173} Gwilym Morris Roberts, \textit{Chelsea to Cairo}, 56.

The uses of the Chelsea and Hyde Park system were primarily domestic, but also included allowances for health and for the service of the general public, even those who could not afford a subscription. Chelsea’s proposal was to supply water for “the ordinary Occasions of the Inhabitants,” of the City and Suburbs of Westminster, and also for “Fire, the Pestilence, or any Exigency whatsoever.” While the waterworks was built chiefly to supply new residential construction and the royal palaces and grounds, it also allowed water for washing to “the Relief of the Labouring Poor,” who required such water for their work.  

The mention of pestilence in the Chelsea proposal of 1722 echoes de Caus’ plan for Paris of a century earlier, though in London’s profit-driven hydraulic economy public health still seems to have fallen subordinate to the concerns of supplying private homes. Ironically, as soon as steam engines came into use, the waterworks also polluted the air. In 1766, John Gwynn complained that the Chelsea waterworks, by then improved with a third steam engine, spilled smoke towards the Queen’s Palace.

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175 Gwilym Morris Roberts, *Chelsea to Cairo*, 54.
176 John Gwynn, *London and Westminster improved*, illustrated by plans: to which is prefixed, a discourse on publick magnificence; with observations on the state of arts... (London: Printed for the author; sold by Dodsley, 1766), 11.
Chelsea’s general distribution was similar to Latrobe’s plan for Philadelphia in that water was taken from an inlet to a first engine house that then pushed the water higher again to a second engine house, then to be distributed to the city. However, Chelsea’s engines actually fed reservoirs at several levels to serve the growing neighborhoods. By 1778 a Boulton and Watt engine had replaced the earlier tandem atmospheric engines at the inlet channel, and the second engine located in Hyde Park simply described as a smaller engine, was added in 1761. The author of *London in Miniature* described the lower engine as also housing a reservoir above its works, and praised the upper engine as a “curious Engine,” which stood “adjoining” the “fine Bason, or Reservoir,” near the Queen’s house and the new gate. It seems likely that the upper engine may have been near the oblong reservoir nearest to St. James Square. The two engines worked in sequence to elevate the water to the upper park. In plan the engines, the house, the recreational area and the reservoirs are distantly distributed and organized in relation to the tides and topography rather than to a particular geometry. [Figure 22]

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177 London in miniature: being a concise and comprehensive description of the Cities of London and Westminster, and Parts adjacent, for forty Miles round. In which The many publick Buildings, Statues, Ornaments, Royal Palaces, Houses of the Nobility and Gentry (London: printed for C. Corbett, in Fleet-Street, 1755), 196.
Chelsea Waterworks
Overlay diagram. Base drawing: Horwood’s Map of London, 1792

Figure 22 – Overlay diagram, Chelsea Waterworks. Base map: Horwood’s Map of London, 1792.
Chelsea waterworks provided a technical and topographical model that would have been ideal for Philadelphia. Chelsea was the third largest provider of water by the early nineteenth century, and was a place Latrobe knew well. Just as in London, Latrobe needed to draw water from a river to feed residential neighborhoods that were both inland and uphill. The area to the northwest of Center Square was still largely undeveloped, and filled with low lying watery areas. A cut in the Schuylkill banks in the area of the second waterworks by Frederick Graff and the excavation of an inlet would have provided a simpler system, also drawing on Latrobe’s knowledge of River improvements. A pair of steam engines in sequence, sending water perhaps to a tower, or to ground reservoirs, just as at Chelsea, would have been less prone to failure. Latrobe’s engines could easily have pushed water to a sufficient height, either to a tower at the city center, or to a reservoir to the north of the city. These solutions would all be the ones arrived at later by Latrobe’s superintendent, Frederick Graff, but not until he had spent a decade repairing Latrobe’s original design.

The most pleasant aspect of Chelsea, noted by Londoners at the time, was its recreational Willow Walk. [Figure 23] The walk passed between the 200 acre Neat House market gardens and the canals, and was a favorite subject of drawings and fondly remembered by many authors. In physical design, it was quite simple, by 1762 it was described as, ‘handsome gravel walks, lighted with lamps and shaded with trees and hedges.’ Looking back nostalgically in 1874, Charles Dickens noted that a century earlier, the stroll across the opens fields between Westminster and the Chelsea waterworks was a “pleasant walk, especially for ladies and children bent on a visit to the famous Old Chelsea bun house.” He also fondly remembered the music hall area of Islington.

178 According to Roberts, by 1809 three water supply companies “dominated” the market. New River provided 11 million gallons a day, London Bridge 4 million, and Chelsea 1.25 Million. (Gwilym Morris Roberts, Chelsea to Cairo, 115)
179 Gwilym Morris Roberts, Chelsea to Cairo, 59.
at New River waterworks as, “quite out of town then, with greenery to render them attractive as suburban tea-gardens.” 180

White Conduit

As urban density increased during the eighteenth century, not only the newer works, but also remnants of medieval London waterworks came to be associated with pastoral suburban retreat and recreation. The London of Latrobe’s youth was a city of rapid residential growth, with waterworks often sited at the still green edges of the city. The “white conduit house,” was a famous tea house built around 1730 beside a medieval Carthusian conduit. The tea house was located three blocks directly north of the upper reservoir of the New River works in Islington. [Figure 24] A nineteenth century author noted that, “… until this century, during the latter half of

which, the modern Babylon has become one huge mass of bricks and mortar, it served as a pleasant place of recreation for the city. There was an uninterrupted prospect … which was purely pastoral, with the exception of sparsely-dotted farmhouses.”181 It was not an accident that reservoirs in London were often associated with their excellent “prospects.” Since older reservoirs drew fresh spring waters from outside the city, using only gravity distribution, they were sited above and outside the areas of the city which they served. Eighteenth century London waterworks offered more than just a view, they were also connected to healthy food and sport. During the 1750s, the White Conduit advertised its tea room, which served fresh milk, butter, and rolls, as well as its circular fish pond and gardens with their, ‘copious prospects, and airy situation.”182 The White Conduit was also the site of the first metropolitan cricket field, established during the late eighteenth century.183

Figure 24 – The White Conduit House, c.1840, C. H. Matthews

Latrobe’s Philadelphia works followed the model of siting the engine and reservoir within a placid green retreat from the city. Yet his design was “visionary” in the truest sense, constructed according to an elegant Continental standard. No doubt he imagined that the city grid of Philadelphia would soon fill with homes and industry, and that his articulated intervention would both fit the needs of a cosmopolitan city, and allow respite from its demands. If Latrobe rejected the suburban charms of London’s waterworks, and wished for a more sophisticated urban environment, he was not alone. Unfortunately, Center Square as a site lacked the primary topographical logic that made London suburban waterworks places that were protected (at least for a time) from the interference of the city. The healthy recreations, shaded walks, and greenery that rendered New River, Chelsea, and the White Conduit favorite retreats from the city were incorporated in the idea of Latrobe’s design for Center Square, but his rigid orthogonal planning constricted improvement, and in the end proved less popular than these pastoral sites.

**18th Century Parisian Engineering and Steam-Driven Waterworks**

Latrobe visited Paris in 1783 on his return from Germany to London, two years after the steam-powered Chaillot waterworks had begun operation, but his knowledge of the French system seems vague. It is unclear whether he visited Chaillot, but it was difficult to avoid, and he did refer to the works in his *Answer to the Joint Committee* of 1799. Latrobe called the Paris engine “a very extra-ordinary steam engine,” and mentioned that he could say on “good authority,” that company shares “sold at an advance of 600 percent.” This was the year the city took control of the system due to its mismanagement and financial insolvency. The stock offering was controversial at the time. Latrobe knew of Chaillot, but either he was not aware of its difficulties, or, having chosen to model his own system on the doomed Parisian venture, he chose not to dwell on its shortcomings. He informed the city that Chaillot began operation in about

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184 Over a hundred years earlier, John Evelyn had unfavorably compared seventeenth century London to the ornamented squares and grottos of Italy and France. Evelyn’s Diary would not be published until 1818.

1784 or 85, which was late by three years, and would have dated it after his visit. (though there are indications he may have traveled Europe again in 1786) Latrobe may have been confused regarding the dates, of course, but he seemed otherwise loose on his idea of the machine. He described it as a single engine built in England, but in fact, it was powered by twin engines.

News did not always travel rapidly from Europe, so others in the early American scientific milieu were likely also unaware of the difficulties with the Parisian works, and did not know of their similarity in certain respects to the system Latrobe proposed. Thomas Jefferson visited the Chaillot works in 1785 while he was Minister to France, but at the time he was not yet familiar with Boulton & Watt’s improvements, and so believed the works were powered by a Newcomen atmospheric engine. In reply to an inquiry mailed to him by James Madison about “a new method of raising water by steam,” which Madison believed would soon, “come into general use,” Jefferson wrote back that Paris had “nothing more than the fire engine you have seen described in the books of Hydraulics … the idea of which was first taken from Papin’s digester.” Jefferson met Boulton six months later in England, however, and was enlightened as to the working of the new engines.\textsuperscript{186} Since the American Philosophical Society called on Latrobe as late as 1809 for his expert opinion on steam engines, despite the fact that he had never built or designed engines but had merely been employed by the expert Smeaton to work on other civil

\textsuperscript{186} Carroll W. Pursell, \textit{Early stationary steam engines in America; a study in the migration of a technology} (Washington, D.C.: Smithsonian Institution Press, 1969), 15.
engineering projects, it is clear that this tinkerers science was not a central concern of Philadelphia’s elite.

The Chaillot works in Paris was in some ways similar to the Philadelphia waterworks, and its failures seem to stem from similarly super-rational goals. In short, Chaillot, like the Philadelphia waterworks, seems to have been a pavilion for display that bore an uneasy relationship to topography and technology. The Périer brothers were “ingénieurs-mécaniciens” in the entourage of Phillipe Duc d’Orleans, and mainly built clever garden follies, notably at the Château de Bagatelle. Although they had business acumen, the brothers lacked the technical expertise to complete a public water system. When they obtained a royal patent in 1777, they were forced to import two Boulton and Watt engines from London. The American Revolution prevented rapid progress on the engines, and the waterworks were not operational until 1781.\(^{187}\)

For the shell of their pumphouse at Chaillot, the brothers hired the architect François-Joseph Bélanger. Bélanger was a student of Julien David Le Roy, and had designed the Château de Bagatelle for the Comte d’Artois. An engraved view of the Chaillot engine house from the south, adjacent to the Cours de la Reine, shows a cubic central volume with a centrally peaked roof and separate chimneys, fenced from the street, but visible to passersby. Severe and heavily rusticated masonry walls are set above a triple arched foundation. The wall is marked by three masonry actuations, pierced by three small, deep-set hemispherical openings above, from which water appears to be pouring forth. [Figures 25 and 25a] This engraving suggests that the water was elevated, only to fall into a pool and to pass into tunnels under the building. This would have provided a dramatic view, but would have been entirely efficient. I have not yet found confirmation of the peculiarity.

\(^{187}\) Beaumont-Maillet, L’eau à Paris, 100.
Figure 25 - Le Campion, d’après un dessin de Testard, Vue de la façade du bâtiment de la pompe à feu, vers 1789. B.N.E., in Beaumont-Maillet, L’eau à Paris, 96. Figure 25a - Inset detail of hydraulic apertures.

Figure 26 - Le Campion, d’après un dessin de Testard, Vue de la pompe à feu prise de la cour, vers 1789. B.N.E., in Beaumont-Maillet, L’eau à Paris, 95.

Viewed from the courtyard to the north, the Chaillot engine house appears less forbidding, and in fact seems to welcome views to the interior. [Figure 26] Entrance doors are central, with
inset glass panels. A variety of windows ring the building, eyebrow windows puncture the roof, square windows ring the upper story, oval windows act as transoms, and narrow rectangular windows at least 12 feet high surround the ground level. Two squat domed beehive-shaped volumes that house the boilers frame the building, and from each a chimney rises to the height of the roof peak, upon which rests a decorative sphere. The building’s façade is a truly active face, and the separate expression of the boilers demonstrates the fiery work conducted inside.

This almost whimsical neoclassical masonry container surrounding the utilitarian mechanical core appeared more as a smoke-wreathed garden pavilion than as an infrastructural edifice, at least in comparison to the humble example of Chelsea. Bélanger’s insistence on enclosing the engines and pumps within a perfect cube was in keeping with French neoclassical imaginations of public works projects, as will be discussed in Chapter 4. But Chaillot was not a royal project, and its fortunes could not recuperate the expense of its ornamental shell. Chaillot was a private for-profit business similar to the London water systems, though the brothers Périer framed it, for the purposes of advertisement and sales, as an act for the benefit of the public. Similarly to Latrobe’s plan for Philadelphia, Chaillot was intended to supply both individual subscribers and to serve civic fountains in particular locations. Unlike Latrobe’s republican plan, however, their fountains would also charge «un prix modique». On the day the works opened the Périers framed their success as a national strike against England, declaring it «un grand acte de courage et de patriotisme», to take such a speculative risk. They mention the «œil jaloux» of Parisians travelling to London, seeing water in «une profusion aussi abondante». They declared water to be, «l’élément le plus nécessaire à la salubrité de l’air, à la propreté de la ville, à la santé, 

188 The French architectural academy was generating visionary neoclassical designs to symbolize public works projects. Claude-Nicolas Ledoux envisioned symbolic communicative volumes for imagined programs in his plans for the ideal town of Chaux (1775-80). He also constructed the Royal Saltworks at Arc-et-Senans (1775-1778) and a series of barrières that formed entries in the Farmers-General Wall (1785-88) constructed to control the commerce of Paris and to collect taxes. A few of these barrières were volumetrically similar to Latrobe’s water house.
au bien-être des citoyens». 189 (Water is the element most necessary to the salubrity of the air, the cleanliness of the town, and the health and the well-being of the citizens.)

Figure 27 – Overlay diagram, Chaillot and Gros Caillou Waterworks. Base map: Armand Renaud, Plan de la Ville de Paris en 1789, 1887.

Chaillot did not fail, like Latrobe’s design, because of a technological obstacles. The Chaillot works was not an identical system to that of Latrobe, because it did not house interior reservoirs, rather it pumped its waters to four reservoirs at a height of 36 meters above the level of the Seine. [Figure 27] This allowed distribution to most of the right bank. The water could settle prior to distribution, and there was storage in the event the engines failed. Unfortunately, the decision to establish fountains serviced by water porters meant that few people chose to subscribe and to connect water to their homes, and it was difficult for the company to make a profit. 190 This situation was repeated in Philadelphia.

The Paris systems were challenged not just financially, but by the fact that the quality of the water was very poor and the public perception of the company was fairly negative. In 1785 Mirabeau pointed out that cleaning the streets with expensive Chaillot water was like cleaning

them with a chamber pot since all sewers led to the Seine.\textsuperscript{191} The Chaillot waterworks was sited for marketing purposes, more than according to the needs of distribution. [Figure 26] According to Beaumont-Maillet, the brothers Périer chose a site west of Paris and just south of the Place de l’Etoile for the works out of a desire to advertise. They intentionally chose a location on the carriage path from the Tuileries to Versailles. Apparently the skilled showmen hoped that that the first estate would pass by in carriages and, seeing the new technology, would themselves take a subscription.

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{10. TANDEM STEAM ENGINES/tower_Gros Caillou 1788}
\end{figure}

In 1788, the Périers built a second pump house across the river, in an attempt to address consistent public criticisms of the cost, quantity, and quality of the water supply. The system was intended to serve Saint-Germain and the southern part of the city. This second water house, Gros Caillou, is the only steam-driven model I have located that, like Latrobe’s Center Engine House, attempted to house all functions, including the reservoir, inside an architectural shell. Like Chaillot, this system was powered by twin engines, but the low-lying location on the Ile des Cygnes, which had only been connected to the riverbank since 1780, also required that it house an internal reservoir to achieve static pressure for distribution.

\footnote{\textsuperscript{191} Beaumont-Maillet, \textit{L’\'eau \`a Paris}, 103.}
Belanger's design was for an austere volume with a slim central reservoir tower which somewhat resembled a light house. The rectangular base was faced with three arched recesses that supported the square tower seventy feet high, all composed of stone blocks, and lined with heavy horizontal masonry joints. [Figure 28] Sadly, the location of Gros Caillou, just downstream of the Grand Egout des Invalides, proved to be unfortunate, as soldiers took ill and rumors of fatalities spread. The brothers continued to have financial problems, and the company was briefly taken over by the Bureau de Ville in 1788, and ceased operation until 1805. It would reopen and regain popularity, even adding public baths, during the nineteenth century.\footnote{Beaumont-Maillet, \textit{L'eau à Paris}, 105.}

\textit{Steam across Europe before 1800}

Germany, Italy, the Netherlands and Spain lagged behind England and France in the development of steam-powered industry and water supply. During the seventeenth century...
following the distribution of Hero’s *Pneumatica*, though many inventors and natural philosophers across the Continent experimented with fire engines, they were not able to develop engines that generated consistent power. In 1722, the first Newcomen engine was brought to Europe by Fischer von Erlach’s son, returning to Vienna after a visit to London. It was used for mining in Königsberg (today Kaliningrad).193 Lissa Roberts has investigated the uses of the steam engine in Holland, and proposes their connection to imported ideas of English landscape gardens. While the Dutch had been experimenting with versions of the Savery engine since 1716, they did not develop the advanced technologies seen in London. As late as 1779, Rinze Lieuwe Brouwer, constructing an engine for John Hope’s Groenendaal landscape park, would opt to construct an old Newcomen type engine rather than import a Boulton and Watt model.194 Most of the steam engines developed in northern Europe were simple models dedicated to mining. This also remained the most typical use in England and America during the eighteenth century, though experiments were made to use the engines to power travel by boat.

The example of Peacock Island demonstrates that Prussia would have had no examples of active steam waterworks for Latrobe to follow, but also embodies similar struggles. By 1823, when landscape architect Peter Joseph Lenné wanted to include a steam pump to provide enough water to support a lush landscape for the royal retreat of Prussia’s King Friedrich Wilhelm III on Peacock Island, there was only one steam engine in the city of Berlin, within a china factory. Peter C.W. Beuth was called on to design the engine, and Karl Freidrich Schinkel to design the engine house, with its solemn neoclassical chimney rising above the trees. The house was open to the public, and the engine kept clean for visitors.

Schinkel’s design for Peacock Island showed some similarity to Latrobe’s project over twenty years earlier, in that there was a struggle to sheathe the engine in a shell which would

allow it to reside within the space of a public garden. Norton and Elaine Wise note that the device raised philosophical debate at the time, inspiring Friedrich Schleiermacher (another ex-Moravian seminarian from Barby) to lecture on the struggle between, “the interrelated freedoms of man to control nature and of nature to remain natural on the engine-powered Peacock Island.”195 This debate regarding freedom and nature was of essence also to Latrobe’s design for Philadelphia. If public arguments in the local press arose primarily over its cost and function, the waterworks was intended to be a means of providing the health and purity of clean air and water to the citizens of a free republic based on natural law and democratic balance.

2.3 The Philadelphia Waterworks: Technology and Topography

Types of Waterworks in use before 1700

1. GRAVITY FEED/ point-to-point
   Belleville 12c/ Regarde la Lanterne
   Tyburn 1236/ Great Conduit
   Aqua Felice 1587/ Moses Fountain

2. WATER WHEEL/ tower
   Danzig 1570
   London Bridge 1582
   La Samaritaine 1602
   Pont Notre Dame 1672

3. GRAVITY FEED/ suburban reservoir + entertainment hall
   New River 1613/ Sadler's Wells 1685

4. GRAVITY FEED + WATER WHEEL/ palace gardens and Jeu d'Artifice
   Hortus Palatinus 1614-1619
   Marly 1685/ Louix XIV Versailles 1661-1689

Note: all hydraulic diagrams by the author.
Types of Waterworks in use between 1700 and 1775
(all types in use before 1700 were also still in use at this time)

5. SINGLE STEAM ENGINE/ tower
   York 1714 Savery; Newcomen Dragon 1725

6. GRAVITY FEED + STEAM ENGINES/ suburban reservoir + higher ground reservoir
   New River 1767

7. TANDEM STEAM ENGINES/ urban park reservoir
   Chelsea 1741-42
Types of Waterworks in use between 1775 and 1800
(all types in use before 1775 were also still in use at this time)

8. SEQUENTIAL STEAM ENGINES/ park tower + urban park reservoirs
   Chelsea amall engine1761; B+W 1778 (tandem in 1803)

9. TANDEM STEAM ENGINES/ urban park reservoir
   Chaillot B+W 1781

10. TANDEM STEAM ENGINES/ tower
    Gros Caillou 1788

11. SEQUENTIAL STEAM ENGINES/ park tower
    Philadelphia Waterworks 1801
Architectural Modulations to accommodate Steam Engines

TANDEM STEAM ENGINES/ urban park reservoir

Chelsea

Chaillot
Architectural Modulations to accommodate Steam Engines

DOUBLE STEAM ENGINES/ tower
Gros Caillou

SEQUENTIAL STEAM ENGINES/ tower
Philadelphia Waterworks
Philadelphia's System in Relation to Prior Works

Benjamin Latrobe’s Philadelphia waterworks was completed in 1801, and was unusual within several urban engineering contexts. The first context in which Latrobe’s waterworks must be considered is the contemporary American efforts to supply water to cities. At the time most domestic water for use in cities was still taken from neighborhood wells or cisterns, though these were increasingly polluted by privies and other organic and industrial waste. Most urban water supplies at the end of the eighteenth century in England and Europe, were by private individuals or private companies operating for profit. Latrobe’s design was the first urban municipal water supply in the United States, and I believe that it was the first public steam-driven system in modern times.

The second, but far wider field, of comparison is the advanced steam-driven systems of London and Paris, on which Latrobe’s design was technically based. While he was aware of contemporary and historical water supply systems, Latrobe altered some of the key features that were crucial to the success of these systems. Many steam-driven water supply systems included two engines working in tandem, which increased their power and protected against failure. Latrobe’s urban distribution separated the engines, placing one at the river bank, and one in the city’s Center Square. This meant that whenever one engine stopped, the supply was interrupted. British steam-driven systems and all but one French steam-driven system also had external reservoirs, retention ponds located at a higher elevation than the areas to be served. Reservoirs had three purposes – first, to keep a head of water for mains during supply hours; second, to allow impurities to drop; and third, to balance fluctuation in supply and demand. Once steam engines were in use, mechanical failures or coal shortages made reservoirs even more essential to protect against imbalances in supply.¹⁹⁶ The containment of a reservoir, engine, and boilers within a constrained and limited architectural volume was unheard of up to this point. The closest similar

¹⁹⁶ Gwilym Morris Roberts, *Chelsea to Cairo*, 150.
models were the towers that sat astride traditional hydraulic wheel-driven bridgeworks, and necessarily enclosed the water they drew from the rivers. The only close model was the Gros Caillou works in Paris, which seems to have been unknown to Latrobe at the time of his design. Latrobe entirely enclosed Philadelphia’s reservoir under the marble dome of his pump house, “concentring” the works within a singular cylinder, and forever limiting its capacity.  

Latrobe’s design was peculiar. The Centre Square engine house ignored the example of London’s functional sheds, but showed kinship with a recent French neoclassical design. English steam-powered water-supply systems were generally housed in wood or stone sheds that followed the shape of the engine, with the beam arm of the device often protruding through a slot in the body of the building. The two Paris engine houses by François-Joseph Bélanger seem to have originated as an expansion of the language of baroque garden follies, and his second design for Gros Caillou contained an internal reservoir. These, or the elegant shell of La Samaritaine, renovated by Soufflot and Gabriel, bear a more marked similarity to Latrobe’s aesthetic aspirations for his American infrastructure, though Latrobe avoided any ornamental excess which might bear the stain of royalism.

It is not a matter of coincidence that the closest infrastructural antecedent to the Center Engine House was, I argue, François-Joseph Bélanger’s building for the steam engines at Gros Caillou. [Figure 27] Bélanger had also designed the Château de Bagatelle for the Comte d’Artois, brother of Louis XVI. If Latrobe was familiar with the appearance of Gros Caillou, or the earlier Chaillot engine house, he would not publicly have aligned his American project with the work of an architect so intimately connected with the worst decadence of French royalty. Bagatelle was a notorious bachelor’s pavilion, and the rotunda’s central chamber, under the oculus, belonged to d’Artois’ bedroom. [Figure 29] The chateau was not only morally suspect, it was also shoddily

197 Latrobe’s use of the term is a lovely description both of the beauty and the difficulty of his design: “I shall proceed to state to you, what appears to me to be the only means of concentring all these requisites in one work.” (Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 4.)
built. It was constructed in just 64 days following a challenge by Marie-Antoinette to Artois, her young brother-in-law, that he could not construct a pavilion suitable to entertain her within two months. It was built at great expense and using military labor, which was entirely in keeping with the Comte d'Artois' reputation as the 'most reactionary member of the royal family.' Whether Latrobe knew of the pavilion and its architectural connection to the Paris waterworks, it is certain he would have denied any connection with its architect.

Figure 29 - Chateau de Bagatelle, Paris

Latrobe’s initial argument for the Philadelphia waterworks, which he laid out in his “View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water,” of 29 December, 1798, belied his baroque imagination of the city not, as he so frequently stated, as the Athens of the new world, but as a new Rome. While I have stressed his firm resolution to elevate the height of the reservoirs to supply fountains to cool the air and calm the climate of Philadelphia, his desire for fountains was more than scientific. In the postscript to his first proposal to the city, he chose to address four issues that he seems to have viewed as

controversial. The first postscript argued for the superiority of river water over spring water, and related as a matter of authority that the American “Indians” prefer streams to springs, thus certifying the natural truth of the matter. The final postscript assured the committee that though there was “some uncertainty in the estimates, in which the Steam Engines are concerned, [this] must be expected.”

The two central postscript arguments, titled “Fountains” and “Public Baths,” reveal the baroque imagination behind Latrobe’s proposal. It was here that he defended the more spectacular recreational components of his system on the basis of elevating Philadelphia’s standing as a city, while bringing down its temperature. He described the need for public baths in the city, in order to “counterbalance the fashionable inducements which point to the Potowmac.” He hoped that the cultural and literal elevation of water within the bounds of the city would allow Philadelphia to remain what he called a “primary Metropolis,” at a time when Washington D.C. was supplanting it as the nation’s capital. Latrobe here also painstakingly explained baths as a medical necessity to adapt “the habits of our Northern ancestors” to a more southern climate. In keeping with this metropolitan imagining, Latrobe described fountains that would spring up on every street corner, purifying and cooling the air.

The strength of Latrobe’s attachment to his fountains not just as hydrants for dispensing water but as sprays of water became evident in the conflict that followed. The author of the Canal Company’s report arguing against Latrobe’s plan offered that the canal would, “send Floods of water down all the Streets, and raise Fountains in most of them, without those aerial castles, and elevated reservoirs, of different stories, which have been proposed.” To this, Latrobe responded that based on the canal’s level, it would be “insufficient, under these circumstances, to raise a fountain of five feet in any part of the city above Front-street.” He further replied that the

author's "gaiety" might require consultation with Monsieur Mariote's "excellent work in French upon fountains." It is clear from this exchange that, at least prior to complaints about costs, Latrobe intended his Engine House as the center piece in a city perforated by sparkling fountains and public baths, further justifying my interpretation of this work as an urban pavilion at the center of a radically unified urban system. Sadly, Latrobe would not become Philadelphia's City Engineer and in the face of budget overages and in the hands of others, the entirety of this metropolitan scheme would not be carried out.

The Machine in the Grid

Soon after the invention, steam engines were justly considered as dangerous, man had not yet learned to control the immense power of steam, and now and then they did a little mischief. A steam engine is, at present, as tame and innocent as a clock.

—Benjamin H. Latrobe, "An Answer to the Joint Committee of the Select and Common Councils of Philadelphia, on the Subject of a Plan for Supplying the City with Water, &c., 1799

... this delay has not been without its use; for it has been discovered that some of our innovations, the theory of which appeared to be very perfect, have proved extremely deficient in practical utility.


Latrobe convinced the scientific community of Philadelphia that he was an expert on public works, civil engineering, and steam engines and capable of designing a modern steam-

200 Benjamin H. Latrobe, Remarks on the Address of the Committee of the Delaware and Schuylkill Canal Company to the Committee of the Senate and House of Representatives, As Far As it Notices the "View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water" (Philadelphia: Zachariah Poulson, Junior, 21 January 1799), 17.

201 In fact, the devices to supply water would be wooden storage chests below the sidewalk connected to upright pumps for water supply and cast iron fireplugs with stopcocks to allow repairs. (Latrobe, Engineering Drawings, 199.)
driven water system. He completed his reassurance to Philadelphia’s Select and Common Councils with the statement, “Soon after the invention, steam engines were justly considered as dangerous, man had not yet learned to control the immense power of steam, and now and then they did a little mischief. A steam engine is, at present, as tame and innocent as a clock.”\textsuperscript{202} It is certain Latrobe knew something of engines from Vitruvius, who was of course interested in water and hydraulic machines.\textsuperscript{203} It is unlikely however, that he had much practical knowledge of the engines prior to his work in Philadelphia.

Steam engines would undermine Latrobe’s success for his entire career. His New Orleans water supply system was delayed in part by the War of 1812, but also because Latrobe had decided to establish his own engine foundry to save money. After hiring mechanics who successfully cast or forged the small parts for a standard Boulton and Watt low-pressure engine, Latrobe was unable to find anyone to fabricate the larger iron components, the pipes, pumps, and steam cylinders. This situation eventually lead him to join with Robert Fulton’s Ohio Steamboat Company in Pittsburgh, where he set up a machine shop but was still unable to complete the engine.\textsuperscript{204} The Steamboat Company failed in the fall of 1814, as did Latrobe’s relationship with Fulton, leaving what Talbot Hamlin calls “a tangle of debts left dangling.” Latrobe passed into a period of depression and suffered from “hemicrania.”\textsuperscript{205}

Steam engines were notorious slow and difficult to build even for Boulton and Watt, so Latrobe should be faulted more for his optimism than for ignorance.\textsuperscript{206} It is unfortunate that he did not choose Oliver Evans to fabricate the Philadelphia engines. By 1803, Evans, a mechanic in

\begin{thebibliography}{9}

\bibitem{202} Latrobe, \textit{An Answer to the Joint Committee. . . March 2d, 1799}, 1-7.
\bibitem{203} All of Book VIII is devoted to water, to its different qualities and types and management. Book X includes water powered machines, wheels, screws, organs, and pumps.
\bibitem{204} Latrobe, \textit{Engineering Drawings}, 39.
\bibitem{205} Hamlin, \textit{Benjamin Henry Latrobe}, 429.
\bibitem{206} Boulton and Watt contracted cylinders and other parts from fabricators, and engines were built in situ from parts that were often shipped. [Dickinson, \textit{A Short History of the Steam Engine}, 78.]
\end{thebibliography}
Philadelphia, had independently arrived at the first American high-pressure steam engine. Latrobe was sufficiently informed to select the most advanced British engine type to power Philadelphia’s works. The engines he enlisted Nicholas Roosevelt to construct were in the family of double-acting beam engines developed by Watt after 1783 and standardized by 1787. These were rotative engines, with a “sun” gear fixed to the piston attached to the driven shaft from the beam, and a “planet” gear attached to the drive shaft and fastened by a connecting parallel motion rod or crank to the center of its orbit. This arrangement required a large a flywheel to carry and center the planet gear. The double-acting, or rotative engine could power mills, but also increased the power of the pump, since for each stroke of the engine, the planet wheel would revolve twice. These engines had been installed by several London water companies before Latrobe left for America, but only very recently. One was installed in 1786 at New River, replacing the existing Smeaton engine. In the same year, London Bridge would add a Boulton and Watt double-acting engine, and New River would add a second one in 1796. Chelsea would only add a second supplementary engine of this type to work in tandem with its existing engine in 1803. It seems likely that, since all of these replacements and experiments were under way while Latrobe was in London, he would have known of them, though perhaps would not have been intimately familiar with the mechanics.

Latrobe hired one of the only steam engineers in America with the knowledge necessary to build a rotative engine. The Philadelphia engines were designed by James Smallman at Nicholas Roosevelt’s New Jersey Soho Works Company. Smallman had worked for Boulton and Watt prior to coming to Roosevelt’s shop and copied the double-acting crank engine used at New

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207 In a vivid act of advertising, Evans drove his engine powered “Orukter Amphibolos, or Amphibious Digger,” around the Center Engine House in 1805 before taking it into the Schuylkill River. [Eugene S. Ferguson, Oliver Evans: Inventive Genius of the American Industrial Revolution (Greenville, DE: The Hagley Museum, 1980), 37-41.] As Dickinson has noted, Evans would be rewarded for his invention of an American version of the Cornish, or Trevithick, engine with “no encouragement; indeed, he was derided and criticized for his attempts.” [Dickinson, A Short History of the Steam Engine, 95.] He did however supply one engine to the Fairmount Works in 1817. (Latrobe, Engineering Drawings, 35)

208 Dickinson, A Short History of the Steam Engine, 80-82.

Unfortunately the boilers and flywheels in Philadelphia were of wood, whereas in England boilers were already being made in copper by 1725, and in rolled or cast iron by the late eighteenth century. Iron-rolling would be far more widespread in Philadelphia and elsewhere after Latrobe’s introduction of steam engines helped set the groundwork for steam-driven factories. In fact, Latrobe’s Schuylkill pump house would power a rolling works. This was a technical success, but a failed financial scheme, and a sore point in Latrobe’s contentious relationship with Nicholas Roosevelt, who would become his son-in-law. While the first Philadelphia waterworks was only in use for about a decade, it seems likely that the engine’s ill-health, which demanded the importation or training of numerous mechanics, helped to put Philadelphia ahead of other American cities in steam engine manufacturing at the start of the nineteenth century.

Latrobe’s design for the Philadelphia put a heavy tax on its engines from the start, because of its geometrically rigid distribution scheme and the centering of its reservoir within a fixed building set in the center square of the city. Latrobe’s rendered section dramatically illustrates the problem with his system. [Figure 30] The water enters the system at low tide through lock gates, the reverse of Chelsea and other river systems, because Philadelphia’s water was more brackish at high tide. The water settles in the marble basin and passes through an intermediate sluice gate, before passing into a tunnel excavated in the bank. It is drawn to the clifftop by one steam engine, and then runs horizontally, both through tunnels and a raised aqueduct to hit the civic center of the city. This riverside embankment, unlike Chelsea’s use of an existing tidal channel, was a massive and expensive works built of granite, brick, and marble,

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211 Latrobe, Engineering Drawings of Benjamin Henry Latrobe, 34.
213 Latrobe, Engineering Drawings of Benjamin Henry Latrobe, 35.

‘there is no part of the world in proportion to its population, where a greater number of ingenious mechanics may be found than Philadelphia. Steam engines with all their various improvements are built and applied, beneficially, to the most useful purposes.’ Pittsburgh and NYC would soon surpass Philadelphia, however. (Pursell, Early stationary steam engines in America, 40, 42)
cutting a straight line through whatever hit its path. While the constraints of the architecture of the pumphouse caused considerable difficulty to the water engineers, the most critical failing of the system was the splitting of the two engines. In order to bring the water up the cliff at the Schuylkill, Latrobe had to locate one pump at that site, and another at the reservoir at the Center Square Engine House. This meant that if either engine failed the entire system ceased operation, and without exterior reservoirs, there was no buffer when the machines stopped. Since many engine parts were made of wood, the machines failed frequently as these were gradually replaced.

Figure 30 - Benjamin H. Latrobe, "Section of the Works from the Schuylkill to the lower, or Schuylkill Engine house," from Designs of Buildings erected in the Year 1799 in PHILADELPHIA, by Benj. Henry Latrobe, Archt & Engineer, 1799. Courtesy of the Historical Society of Pennsylvania.
Figure 31 - Benjamin H. Latrobe, Plan drafted over Hills' map of Philadelphia (1796), in *Designs of Buildings erected in the Year 1799 in Philadelphia*, by Benjamin Henry Latrobe Archt. & Engineer, Presented as a token of Sincere affection to his Brother C. I. Latrobe. Courtesy of the Historical Society of Pennsylvania.
The topography of Philadelphia was suited to the type of intake system and sequential engine power that drove the Chelsea works during the time Latrobe lived in London. Latrobe was aware of the geological features of Philadelphia, and also knew the system at Chelsea. The section of the system makes exquisite note of the various layers of granite, gravel, and clay at the Schuylkill Banks. Latrobe drew his Philadelphia supply plan on top of Hills’ map of 1796 [Figures 31 and 31a] which marked the topography of the city in hachure. In this map, it is apparent that the area roughly along Mulberry Street, north of center square, was low and marshy land with a streambed that reached all the way to Broad Street. The watery quality of the city is even more apparent in a tinted version of the same map in Chapter 3. [Figure 36] I would argue that this topography was quite similar to the inlet at Chelsea, a deepened low lying area linked to
the river by a sluice gate. At the inner end of the Chelsea channel was the first steam engine that
 Elevated the water 2000 yards laterally, and 70 feet horizontally to a distribution reservoirs in
 Hyde and St. James Parks. A second steam engine pushed water into a cistern located above the
 engine, to serve higher parts of the city. This system accomplished a greater volume of supply
 than was needed in Philadelphia, using two low-pressure steam engines.

 Latrobe’s urban distribution was a hybrid of the French and British models, though to call
 it a balance of the two would be an exaggeration. Most prior British waterworks became places
 from which to view the city and backdrops for healthy entertainments, rather than focal points.
 French waterworks, in contrast, at least as crafted by Périer brothers and François-Joseph
 Bélanger, seem to have been located to be seen rather than for clear reasons of topography or
distribution. In their favor, however, they housed tandem engines and located the boilers adjacent
to the central architectural volumes, which allowed some safeguard during engine maintenance.
Latrobe seems to have drawn on the baroque model, or that of the medieval cistern, placing his
 infrastructural edifice within the focal center point of the urban fabric. But his structure, unlike
 those attractions, did not provide water for use or allow access to its hydraulic devices. The
 neoclassical shell of the Center Engine House was both an obstacle to use and to observation.

 If Latrobe knew of the Chelsea system, and understood the terrain of Philadelphia, why
did he design a costly, time-consuming system that ran axially underneath the city? He seems to
have been only loosely familiar with the Chaillot works, and was a geologist and professional
surveyor. The area that Latrobe chose for the river intake of the Philadelphia system was only
three blocks south of the small stream that would have provided an easy inlet. Instead, in order to
deliver water along the axis of Chestnut Street, the city had to blast tunnels through rock and run
an aqueduct for two blocks. In contrast, the existing stream along Mulberry Street wound its way
around a few small farms, and otherwise touched no developed properties.

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I speculate three possible reasons for Latrobe's unfortunate choice: a certain amount of haste, a respect for the development of Philadelphia along Penn's grid plan, and a desire to avoid conflict with the competing canal project at the north edge of the city. Latrobe provided his Philadelphia water supply plan within the course of a few days, and refined it within the course of two months. He arrived in Philadelphia in early December 1798, traveled to survey the proposed water source north of the city on 27 December, and submitted his proposal on 29 December. He provided drawings and details on 3 March of 1799. Carelessness is, however, an unlikely excuse for such a deliberate design. A more likely reason is a respect, both abstract and practical, for Penn's ideal grid. The practical reason for taking the water supply tunnels under Chestnut Street rather than expanding the streambeds northwest of Center Square to provide a supply and settlement channel, would have been that this intrusion would have prevented the development of the land parcels in that sector of the grid. In 1811 James Mease noted that, "a few streams of water originally crossed part of the city plot; but these in the course of improvement have entirely disappeared." Throughout the eighteenth and nineteenth century, filling and covering streams to perfect the gridiron plan had been a part of land improvement as well as public health.

Philadelphia's grid was never entirely regular, but it was persistent. Even in the original Holme plan, the squares were of uneven sizes due to the ground topography and to the water passing north of the city, and street widths were calibrated to their proposed functions. The power of this template was unusual. That it held even though it took more than 120 years to begin to develop the western half is a sign that Penn was correct when he made a part of his original charter that "there may be convenient roads and streets preserved, not to be encroached upon by

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any planter or builder, that none may build irregularly, to the damage of another.”

This legislation of common respect and regularity preserved a framework for balanced improvement.

A practical reason for Latrobe’s geometrical clarity and topographical difficulty may have been an effort to avoid the delay of legal conflict. A water inlet to the northwest, even if it were calibrated to the grid, might have led to a conflict with the competing Delaware & Schuylkill Canal Company. This private company had failed to provide water to the city after numerous expenditures. The Hills’ map of 1796 shows the partially complete canal running west to east, north of Callowhill Street. Latrobe was initially invited to assess the Mill Springs north of the city. In his proposal he evaluated the possibility of a canal from the north and judged that even a new attempt would be failure as it would not be possible to prevent evaporation or to control its temperature, and it might have insufficient volume. But he also admitted, with what was either modesty or disingenuousness, “I confess myself very imperfectly informed.”

There is no record of communication on the topic, but it is possible that the members of the Watering Committee instructed Latrobe to ignore the favorable topography and stream inlets to the northwest of the city. Many years later, in 1820, Thomas Pym Cope related in his diary that they had been considering Mill Springs or the Wissahickon as water sources, but tested the waters and confirmed that the Schuylkill had less lime content. He claimed that at that point, “the most approved” watering plan was “to raise it by machinery on to Morris Hill, now Fairmount & thence to distribute it over the City.” This of course would be the solution found by Frederick Graff after Latrobe’s system failed, a solution that was in use for almost a century. But the “most approved” plan may have retroactively imagined by Cope, and at any rate was not the one suggested by Latrobe, who had been hired by the committee. Cope explained in 1820 that when

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217 Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 9, 15.
he informed Benjamin Morgan, the director of the Canal Company, of the Morris Hill plan, Morgan produced the Company charter which appeared to give them rights to the waters, “from that quarter.” If the waters of the entire northwest quadrant of the city were owned by the Canal Company, that would have forced Latrobe only to consider waters south of High (Market) Street, which required the construction of an expensive infrastructural system. Still, none of these circumstances required the arrangement of boiler, engine, and reservoir within a perfect punctuation mark in the center of the city.

The Grid as Egalitarian Measure and Guide

Philadelphia is situated on a plain at the foot of the high land of the great Granite Ridge which extends from the N.E. to the S.W. boundaries of the United States of America. This plain is bounded on the East by the Delaware, on the West by the Schuylkill, and on the South by a lower plain of rich meadow land. The elevated Philadelphian plain is two miles nearly in length and as much in width. It has a gentle slope each way from the Center to the rivers that bound it.

-Benjamin H. Latrobe, the first sentences of the hand-written introduction to “Designs of Buildings erected in the Year 1799 in Philadelphia, by Benjamin Henry Latrobe Archt. & Engineer, Presented as a token of Sincere affection to his Brother C. I. Latrobe”

I argue that Latrobe designed his system to fit within the grid, an ideal cellular pattern, just as the industrious and orderly wasps and ants he studied, sketched, and admired for what he perceived as their industriousness and capability for reason. The perfect grid of his intake system for Philadelphia had no relationship to any precedent works, or to the topography of the


This publication is a version of Latrobe’s journal entry of 29 June, 1797, in which he observes two different species of spider-catching wasps (Sphex caerulea and a second species). Latrobe notes that what he describes as an “industrious Workman,” responds to the disruption of his cells by retrieving lumps of dirt to patch up the missing wall. Latrobe is also impressed that the two species constructed their cells behind the same picture frame, and seem capable of harmonious coexistence.
city. Latrobe was a professional surveyor and amateur geologist, and generally correct in his assertions about Philadelphia’s terrain, so this makes the incongruity of the design even more startling.\(^{220}\) It is not sensible in any realm except that of an idealism based on geometric abstraction and civic representation. It also corresponded to Hippocratean theories of climate, balance, and health, at least as understood by Latrobe and the natural scientists of Philadelphia. This will be addressed in Chapter 3.

One of the crucial aspects of Latrobe’s plan for Philadelphia is that by creating a central water distribution point, he reinforced the legitimacy of William Penn’s ideal plan for Philadelphia. The city’s growth followed the land parcels and roads established according to the Holme map, but the realities of trade and topography meant that construction had in no way proceeded as evenly as desired. Latrobe constructed stubs at the cardinal points so that (had the reservoir and engines been of sufficient capacity) his engine house at Center Square could supply new developments that would re-establish an equilibrium of settlement in the city. Even the London models based on residential development had never presumed the water engines as the centerpiece of urban development.

From the start, the municipal area of Philadelphia was a union of, and balance between, country manors and brick townhouses, green and grid. William Penn and Thomas Holme’s original plan for the settlement of Philadelphia was based on a double-identity, a connection between the commercial city and the productive countryside, linked by the intermediate “liberty lands.” Anthony Garvan describes the decision made by Penn to offer a 10-acre city lot to every buyer who purchased a plantation of at least 500 acres. Garvan argues that Penn hoped to attract, “the class of men like himself who, though they enjoyed country life, were no stranger to the

\(^{220}\) During his second journey to Philadelphia with William Maclure in December of 1798, Latrobe investigated the terrain and fossils along their path and published “Paper on the Cape Henry Sand Hills.” In this scholarly paper, he supported the “Neptunian theory,” of Abraham Gottlieb Werner, that the earth had once been covered by ocean. Latrobe, *Correspondence*, I: 103-109.
city’s trade.” As parcels of land in the country were sold, Surveyor Thomas Holme decided to divide the city into much smaller urban lots than those Penn had promised. Since plantation owners would only receive an acre, or a half acre, for a purchase of 5,000 acres, each buyer also received a portion of the 10,000 acres of “liberty lands” at the edges of the planned grid of the city, which fell within its legal jurisdiction. While this model had been followed in Ireland, and the liberties became an extension of the agricultural plantations, Philadelphia developed differently. The growth in population resulted in “a kind of speculative suburb” of a city ringed by second homes for merchants set on country estates too small to be used as farmland. 221

Latrobe’s proposal to site his works in Centre Square was in part successful because the city government feared that its ownership of the as yet undeveloped green spaces within the city might be challenged if they were not occupied by municipal functions. Ironically, the waterworks secured the city’s claim to public ownership of Centre Square by ignoring Penn’s founding intention that the commons remain open, surrounded by public buildings. By fixing the technical motor for the city’s environmental improvement in the heart of the city, Latrobe validated and anchored Penn’s planned grid. He also continued the practice of establishing a balance between country and city.

Latrobe’s and his scientific peers including Dr. Benjamin Rush and Thomas Jefferson, viewed the grid as a necessary component of salubrious urban planning. Speculating on the cause and treatment of yellow fever in a letter to the Count de Volney, Jefferson wrote, “I have supposed it practicable to prevent its generation by building our cities on a more open plan.” He suggested a “chequer board,” in which the black squares are built, and the white squares open. “The atmosphere of such a town would be like that of the country, insusceptible of the miasmata

which produce yellow fever.” In Jefferson’s scheme, the dialogue between “improved” and unimproved land provided the balance of health.

Latrobe was a member of the American Philosophical Society and in close contact with de Volney, Rush, and Jefferson. Although he did not comment on Jefferson’s checkerboard plan, he had his own theories of the deployment of a grid in America. The grid, he argued, must be elongated from East to West because, “We have in America only one good Aspect, the South.” Yet, he emphatically added that, “something more is necessary after a good situation is chosen, than merely to lay down streets after the pattern of a multiplication Table.” The grid’s geometry alone was not sufficient. For a city to thrive, he explained, it was also necessary to have public walks and public buildings, “commodious” streets, and to give, “houses a good aspect.” Improvements, in Latrobe’s scheme, began with a grid, but were completed by the civic and aesthetic face of the buildings and landscapes within it.

The republican citizen could craft improvements from nature, whether agriculture in the country or arts in the city. Jefferson, Rush, and Volney believed that “higher” cultivation might overcome the native dangers of the fever and of cities. Nature was the agent of improvement, the source of balance, but only when properly managed. In a presentation to the American Philosophical Society in 1785, Rush stated, “I beg a distinction be made here between clearing and cultivating a country. … The first settlers received these countries from the hands of nature pure and healthy. Fevers soon followed their improvements, nor were they finally banished, until the higher degrees of cultivation that have been named took place.” Cultivation, to be successful, must follow a particularly even and democratic pattern.

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223 Latrobe, Correspondence, II: 42-45
America's First Moravian Architect

Latrobe is celebrated as, “The First American Architect,” and noted for his egalitarian and republican ideas. That he was raised a Moravian is a subtext of his life which has not been seriously addressed as having significance in the development of his design intuition, natural philosophy, or urban theories. Latrobe did utterly reject the Moravian belief system, but it does not require a heavy-handed psychoanalytical interpretation of his work to propose that the church which stood in the place of parents, and the planned towns that surrounded him for all of his young life may have had some significance. That he considered issues of town planning is also not in question. In fact, Latrobe was asked to proofread and “extend” an article for the Edinburgh Encyclopedia called “Civil Architecture” by Scottish engineer Thomas Telford. His extension to the essay was divided into sections which included “City architecture,” “Rural architecture,” and “Arrangement of towns and cities, as to general plan and detail.”

Both grids and central squares were significant to the Moravians, who designed their towns in rigid patterns which allowed circumscribed interactions between people of different ages, genders, and marital status. Each member of the Unitas Fratrum was a member of a “choir” passing from one to the next, from infancy to old age, each with a particular role in the hierarchy. Moravian settlements were distributed within a grid to house each choir separately, and to facilitate industry. Craig Atwood explains, drawing on Clifford Geertz, that within towns such as Bethlehem, PA, the lived and the imagined worlds were fused. The community was ordered as a body, functioning analogously to the individual body and also to the body of Christ.

Latrobe lived until age 19 within the settled patterns of the Moravian brethren, and his first architectural designs were for these settlements. He lived until age twelve in Fulneck, a Moravian settlement in Yorkshire; and spent the next five years in the famous Moravian

225 Latrobe, Correspondence, ill: 221, n.9. Unfortunately, the manuscript was stolen during Latrobe’s Pittsburg travails of September of 1814.
paedagogium in Niesky; reluctantly entering the seminary at Barby for a very brief period after September of 1782. He also designed a Moravian town plan for the Fairfield settlement in Droylesdon and a boys’ paedagogium, or oeconomy house, for Fulneck. It is worth noting the importance of distributing functions within a grid for the Moravian town system, which organized social function and productive labor within a fixed geometry. It is also worth observing, even more briefly, that the Moravians were very invested in the cleansing powers of diffusion. At the time Latrobe attended seminary, the Moravians preached that Christ was the creator, and the wash of blood and waters from Christ’s side wound was depicted as a womb. Since Latrobe rejected Moravian spiritual belief at a young age, it is difficult to attribute any significance to Moravian liturgy, but the physical organization of Moravian towns in which spatial arrangement, gender, and marital status replaced family order seems likely to have made a more permanent impression.

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Figure 32 - "1784. B.H. la Trobe f., "Plan of the new Congn. Place at Droitsden," from Latrobe, Drawings, I: 60.
The Moravian settlement plan devised by Latrobe shows a complete universe housed within ordered blocks. [Figure 32] Latrobe’s 1784 design for Droylesden falls within Moravian convention, and provides a good indication of the planning ideas upon which their settlements were typically established. The plan sets an axis and a hierarchy from the central chapel, The Congregation Hall, which is flanked by the choir houses. Across the East and West Streets, the Hall is flanked by the Single Brethren’s and the Single Sisters’ Houses. Each of these oeconomy houses includes workshops at the ground level and housing above, with plots of land laid out for the brothers, sisters, and families across the South Terrace. The gardens are divided in even quadrants aligned with the facing buildings, split by an axial road that leads south to the Burying Ground aligned with the worship hall. The Congregation Inn is adjacent to the road to Droylesden, across North Street from the weaving factory and shop. The remainder of the land is parcelled into centralized blocks, and would be developed within the next decade to include an “Infant Street” and a girls’ boarding school behind the Sisters’ House.

Latrobe’s design for the boys’ school at Fulneck, the “Oeconomy House” shows a similarly strict orthogonality and division of spaces. [Figure 33] Like the single congregants’ houses for the older brothers at Fairfield, it appears that it functioned as a workshop below and dormitory above, though the key has been lost. In both of these examples we see an astonishing arrangement of human activity into geometric communality. From work to sleep to worship, and from birth to death, all is set within an orthogonal geometry of startling clarity. Ordered grids provided a framework through which all aspects of life could be ordered, and all relations could be harmoniously managed.
The Moravian communitarian hierarchy operated within a fixed geometry and expected order, and Latrobe was surely shaped by this order, and by the environment in which he lived until age 19. A plan of Niesky from 1823 shows a the settlement framing a large urban square divided into quadrants by tended walks bordered by trees, and centered on an open circle. [Figure 34] This community, in which Latrobe spent his teenage years and eventually fomented his own "indifferentist" rebellion, was, according to Jeffrey Cohen and Charles Brownell, "the most clearly ordered of the chief Moravian communities in Germany."²²⁸

²²⁸ Latrobe, Drawings, I: 61.
Niesky, with its central urban square and many smaller repetitions of quadrangular gardens fixed on circles, spiraling out towards the woods beyond, might be seen as a template for Latrobe’s design for Central Square in Philadelphia. I do not suggest that Latrobe attempted to divide Philadelphia into discreet parcels, splitting citizens into their various orders. Rather, he utilized the substructure of the grid and focal point to structure and concentre a larger urban and environmental order, attempting a balance with nature. This composite of even and equalizing squares and a concentrating element pinned to the grid by fixed axes is an interesting transitional figure, a symbol that embodies the problems and frictions of a centralized democratic community.
Chapter 3 – Inflammatory America: Derangement and Disease

*When Hippocrates lamented that to attain perfection in the medical art, life is too short, he uttered a truth peculiarly applicable to the fine arts.*

- Benjamin H. Latrobe, "Anniversary Oration Pronounced before the Society of Artists," 1811

In this chapter I outline the eighteenth century theories of health and politics that must be understood in order to place Latrobe’s design for the Philadelphia waterworks in the context of the American history of public health. When it was proposed in December of 1798, the Philadelphia waterworks was unique, and its design captures a strange moment during which ancient ideas of disease, sensation, and location underlay the first successful American urban experiment with steam power and with the municipal provision of a public utility. Philadelphia, though small by European standards, was advanced in comparison to other American cities, and was the first to establish a city-funded water supply free to its citizens.

By the end of the eighteenth century, ideas had not solidified that we might recognize as the basis of modern sanitation and public health. Later nineteenth-century theories would be driven by increasing faith in management, technology, industry, and quantification, and accompanied by a dismissal of ideas that could not be empirically demonstrated. When Latrobe put forward his proposal for the Philadelphia waterworks, however, ideas of health were still largely drawn from ancient sources. This was true even in the advanced intellectual circles, of which he was a part. Within these milieus, the study of natural science was inseparable from a commitment to American democracy and a desire to demonstrate the promise and clarity of the New World against the senescence and excesses of old Europe.

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229 Christopher Colles had attempted to establish a water supply system for lower Manhattan but was halted by the Revolutionary War. In 1799, Aaron Burr’s Manhattan Company was nominally established to supply water, but was more successful in its primary goal of establishing a bank.
The chapter is divided into three sections, the first of which provides an introduction to the scientific milieu of Philadelphia and describes Latrobe’s position within that community. The second section begins by describing the longstanding ideas of the relationship of water, health, cities, and balance that were still commonly held in 1798, when Latrobe made his first proposal for the water-supply system. It then explains the city’s imbalance, in particular the yellow fever epidemics which led to a demand for a better water supply, and examines the competing medical theories that gave a political charge to debates around the treatment of the fever. The third section identifies the theories which were beginning to change in the new national and technological context and places Latrobe’s waterworks within the spectrum of those novel republican medical and urban theories.

3.1 Scientific Discourse and Republican Philadelphia

Latrobe’s Science in the Jeffersonian Milieu

During the late eighteenth century, Philadelphia was the most important city in America for the development of medical and scientific theory, and Benjamin H. Latrobe was an integral member of the intellectual elite shaping political and scientific opinion. Philadelphia was the capital of the republic, and the site of the most advanced professional medical care and research in the new nation. The natural sciences were among the dominant concerns of the city’s educated and landed class of men, many of whom were amateur geologists, botanists, zoologists, physicists, and astronomers, while also influential in trade, medicine, politics, and civic affairs. Philadelphia was the site of several private fraternal organizations dedicated to the advancement of knowledge by this predisciplinary intellectual class, who were also engaged in defining the shape of the new nation.

Philadelphia’s prominence in the field of medicine, often practiced in the public interest, was recognized during the eighteenth century. The first American hospital, the Philadelphia
Hospital and Almshouse was founded in 1731. The first lazaretto, or quarantine station, was built on Fisher’s Island in 1743. The famous Pennsylvania Hospital was opened in 1751, and America’s first medical school, which became the University of Pennsylvania, School of Medicine, was founded in 1765. The Chemical Society was founded in 1792. Dr. Benjamin Rush helped found the College of Physicians in 1787. In 1786 The Philadelphia Dispensary was established to serve the working poor. As William Pencak points out in his article on the subject, the dispensary for the poor was funded by Philadelphia’s prominent citizens, during what Dr. Benjamin Rush called, “an era of public spirit.”

Philadelphia’s numerous intellectual and civic organizations were fueled by this public spirit, as well as by the participation and donations of the city’s educated elite. Benjamin Franklin founded the Library Company in 1731. Franklin and John Bartram founded the Philosophical Society in 1743. In 1769 this organization was combined with another, taking the name of, “American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge,” or APS. It was incorporated in 1780. The link between science and the application of that science for society’s improvement was crucial to the members of this class of scientific intellectuals.

Latrobe was a member of the APS as well as the Chemical Society. “Ben. Henry Latrobe, Engineer,” was elected to the APS in 1799. At the time, Thomas Jefferson was President of the society, and Dr. Rush one of the vice-presidents. Records show that the group usually met twice monthly on Friday nights, with meetings typically attended by 8 to 14 men. 1799’s class of seven inductees also included Dr. John Redman Coxe, one of Rush’s medical students, and William

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Maclure, a Scottish geologist who was Latrobe’s companion during his Sand Hill surveys in Virginia, and also his host in Philadelphia when he first arrived. Latrobe’s dear friend Dr. Giambattista Scandella had been inducted the prior year. Scientific inquiry was inseparable from the civic and social life of the Philadelphia.

Latrobe was inducted into the APS with the title, “Engineer,” and the bulk of his participation was scientific rather than artistic, in keeping with the aims of the society. Latrobe was often the sole reviewer of Dr. Benjamin Smith Barton’s botanical and zoological findings, and Barton in return was often the sole reviewer of Latrobe’s geological and zoological observations. Latrobe also reviewed papers and reports submitted on other scientific and engineering matters including windmills, fixing a meridian, American “Indians,” geometric theorems, and canal building.\(^\text{234}\)

The APS formed committees to review each newly submitted proposal or paper, and would publish their opinions, usually within the month. From 1799 to 1806, the time of his active participation, all but one of Latrobe’s APS opinions were scientific. He did not write about architecture for the APS until a decade after he was inducted into the society. He was only involved in one artistic endeavor for the APS, when he was asked in 1803 to give his judgment of Stewart’s portrait of Washington. In 1807 he reviewed Varlé’s work on canals. In 1809, the APS published his geological account of the Freestone found in the Virginia quarries that were the source for the masonry of the U.S. Capitol building in Washington. In 1809, he also published a review of Captain Jones’ report on the building practices of East India.\(^\text{235}\) A notable point of this


paper is Latrobe’s observation that, “In crowded cities, where the court yards are generally small and buried from the light and air by tall houses, terraces on the roofs are almost necessary.” But he concluded that in America, “we have no rational use for flat roofs,” because the cities are “roomy,” and roof decks are very “precarious,” in areas that get frost in winter. At a time when scientists were speculating about the interrelationship between natural, cultural, and political development and comparing the New World to the old, Latrobe was also noting particular architectural devices more or less suited to America’s unique conditions.

Latrobe published five papers in the Transactions of the American Philosophical Society. Two of Latrobe’s papers investigated the subject of geological morphology and the three others concerned the Oniscus, a parasite that lives in the mouth of the Clupeid fish; the Sphex, a wasp that seals stunned spiders in with its eggs; and a final paper on steam engines. Darwin Stapleton and Edward Carter have argued that Latrobe’s approach to science was Baconian, focusing on the collection of data rather than on the development of theory. But it might equally be pointed out that, also like Bacon, Latrobe found empirical data which supported his own intuitions, which turned out in many cases to be accurate. For instance on his first visit to the city, Latrobe supposed that the water supply of Philadelphia was contaminated because of its sand stratum. Since privies were often cut to the depth of the sand layer they, “… must certainly contaminate the water of every pump in the neighbourhood of a sink loaded with the filth of the family, and as the number of these sinks is very superior to that of the pumps each of them is in a manner


surrounded by noxious matter." In this case, it is important to explain that if Latrobe correctly assessed the geological layers of the city as well as a means of toxin infiltration, he did not predict the danger of ingesting contaminated water. He cast his theory in the terms of the day, in which illness was caused by the bad airs emitted from the contamination.

Latrobe’s scientific interests, like his architectural style, presage later nineteenth-century trends. Darwin Stapleton and Edward Carter have suggested that Latrobe’s interest in predator prey relationships may be interpreted as Romantic science. Even in his early studies of plant life, he showed interest in the predatory Venus Flycatcher, which he notes having seen first in the Paris botanical gardens. Latrobe showed none of the morbid emotion associated with romanticism, however. He was not interested in the flower as a flesh-eater. Actually he seemed more concerned with life forms of this type, which showed some plant qualities and some animal qualities, as demonstrations of the interrelationship of all life forms in a proper and orderly Chain of Being. In his scientific theory as well as his architectural styles which ranged from neoclassical to gothic, we might say that Latrobe bridged between Enlightenment and what would later be called Romantic thought, at the same time as he lay the groundwork for what we recognize as modern science, engineering, and architecture.

Latrobe was not only interested in geology, botany, and zoology, but also in meteorology. Even prior to his first visit to Philadelphia, Latrobe was in contact with Constantin François de Chassebœuf, the Comte de Volney, who was compiling an encyclopedia on the American climate and culture. Volney had lived in Syria and Egypt, and derived his theories of historical change

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237 Latrobe, Journals, II: 80. In their editorial note on Latrobe’s geological theories, Carter and his associates point out that Latrobe seems to have been familiar the theories of James Hutton (1726-1797) of Edinburgh and perhaps with Abraham Gottlob Werner and William Smith, but that since “almost nothing” had yet been written on America, Latrobe’s observations on the Piedmont and other topics were quite insightful. [see Latrobe, Series I, Journals, 384-390]


239 Latrobe, Journals, II: 505.
from differences in regional climates, religions, and political organizations. In 1791 Volney
published these as *les Ruines, ou Méditations sur les révolutions des empires, ouvrage bien
propre à intéresser la curiosité*, which Jefferson would partially translate for American
audiences. Volney was inducted to the APS at Jefferson’s urging during 1796. While living in
Philadelphia, Volney engaged in a pamphlet battle with Joseph Priestley, which began with
Priestley’s accusation that Volney, Hume, Voltaire, and Gibbons were guilty of “gross mistakes,”
and Volney of “gross ignorance,” demonstrated in his doubt of the historical existence of Jesus
Christ. In accord with the contemporary hierarchical understanding of national intellectual ability,
Priestley declared that there was as little point in arguing with Volney as, “with a Chinese or even
a Hottentot.”

Volney’s witty retort, published in Philadelphia in 1797, and shared with
Latrobe by a friend in Virginia, was Latrobe’s first contact with the philosopher’s ideas. He
would soon receive a personal introduction via Dr. Scandella. Latrobe fell on the side of the
natural scientists who were challenging religious doctrine, and simultaneously connecting climate
and what we would today call “environment” to national character and manners.

Volney addressed the unique conditions of America, conducting empirical research
during his stay from 1795-98, at which time he collected material for his *Tableau du climat et du
sol des États-Unis d’Amérique*. Latrobe apparently contributed some data to this effort, which


241 An example of Volney’s wit, and of his refusal to answer the actual charge Priestley raises against him: “Nevertheless, as the first impression of an attack always confers an advantage, you have some ground for expecting that you may obtain the apostolic crown; unfortunately for your purpose I entertain no disposition to that of martyrdom: and however glorious to me it might be to fall under the arm of him who has overcome Hume, Gibbon, Voltaire and even Frederick II, I find myself under the necessity of declining your theological challenge for a number of substantial reasons.” From: Volney’s answer to Doctor Priestley, on his pamphlet entitled, ‘Observations upon the increase of infidelity, with animadversions upon the writings of several modern unbelievers, and especially The ruins of Mr. Volney, with this motto; Minds of little pen’ (Eighteenth Century Collections Online. Gale. University of Pennsylvania Library. Philadelphia: Printed for the Author - and sold at the office of the Aurora, 1797), 7.

cataloged the American condition, including geology, winds, weather, and “prevailing diseases.” Volney argued that the temperature of America was rising markedly as trees were being cleared, and connected America’s seasonal yellow fever epidemics to particular conditions of heat and dampness which in combination had a “pestilential influence.” Rush and Jefferson also held to this theory in which tree loss was leading to a warmer climate and a reduction in rainfall. Latrobe noted the interdependence of trees and man, “breathing two distinct airs, mutually, and inversely noxious, render the atmosphere wholesome to each other. This shows the folly of cutting down trees round a dwelling house, a folly for which we pay our physicians in the bills for curing us of agues and fevers.” The link between cultivation and inflammation was a disturbing one for natural philosophers of the time, and also concerned Latrobe.

Latrobe’s relationship with Volney was also connected to his budding American architectural career. Latrobe designed a home for Volney. Unfortunately for Latrobe’s aspirations, after the French Revolution Volney was recalled to Paris, and the house was never built. In the letter accompanying the drawings sent in advance of his own move to Philadelphia, Latrobe called his design, “a neat little convenient cottage around a philosopher, whose mind differs as much in size from the small habitation he proposes to himself, as he himself does from many other eminent men, by deserving the celebrity he has acquired.” Latrobe was an architect seeking a client, but he was also clearly enamored of Volney’s scientific philosophies.


Unfortunately, Latrobe’s drawings for Volney’s “hermitage” have never been found.
During the time Latrobe was a member of its fraternity, the APS had an illustrious scientific membership that engaged in contemporary scientific debates. Their opinions were by no means unanimous. Joseph Priestley, Volney’s sometime enemy, also participated in the APS. Priestley was targeted by rioters on July 14th, 1791 due to his open support of the French Revolution, an opinion at least initially shared by most Jeffersonian Republicans, including Latrobe. Latrobe also claimed that his decision to leave London was due in part to the hostility he experienced as a result of his support of the revolution in France. Priestley had no choice. His church, home, and laboratory were set ablaze before the riot spread, and he was forced to flee Birmingham for London and then for America.

After moving to Northumberland, Pennsylvania in 1794 Priestley became involved with the APS and even attended several meetings in 1801 and 1803 (after Volney had returned to France). In 1799 the APS published Priestley’s essay, “Experiments and Observations relating to the Analysis of Atmospherical Air,” side by side with his essay, “Further Experiments relating to the Generation of Air from Water.” The first essay centered on Priestley’s theory of the phlogiston, which Priestley argued was a part of the air that embodies, “the principle of inflammability (being common to all bodies capable of combustion, and transferable from any one of them to any other).” Although Priestley was one of the figures who may have discovered oxygen, he believed that the fuel for combustion rested in this phlogiston. In the 1799 essay, Priestley also stated that water absorbs air, whether it is “phlogisticated,” or “dephlogisticated.” In the following essay he traced experiments in which it seems that water has the, “power of producing air,” which is exuded at first, “purer” than the atmosphere, but gradually as the water is depleted becomes, “phlogisticated.” 247 Priestley’s developing theory, that water could create both coolness and purity in air, was important to Latrobe’s design for Philadelphia.

Latrobe’s Atmospheric Solution

Latrobe’s design for the waterworks and Priestley’s theory of the potential of water to transform the atmosphere, and to create air, were developed adjacently within Philadelphia’s intellectual sphere. Latrobe’s first essay in the APS Transactions was published within the same volume as Priestley’s essay, no. 4 of 1799, and it is likely that he read both of Priestley’s essays since they open the volume.248 Latrobe proposed his solution for Philadelphia’s water supply on December 29th of 1798, the year before, but both Priestley’s and Latrobe’s essays were given to the APS prior to December 29th. Latrobe’s essay on the Sand Hills of Virginia first appeared in the minutes of the APS on December 21st of 1798, and was approved the following week. The APS reported that a, “Letter on Phlogiston,” by Priestley was left with the printer during the first week of December. It isn’t possible to state with certainty that Latrobe knew that particular essay, but Priestley had published parts I and II of his “Observations on the Doctrine of Phlogiston, and the Decomposition of Water,” in 1796 and 1797. It is pressing a pun to say that the power of water to condition the atmosphere was “in the air,” but the statement is nonetheless true.

I have noted Latrobe’s respect for Volney, and despite the quarrel between Volney and Priestly Latrobe expressed admiration for Priestley as well. At the 28 February meeting of 1803, the sixteen members present, including Latrobe, resolved to stage a private dinner for Priestley to show, “high respect for his Philos. Labors & discoveries, & to enjoy the more particular pleasure of a Social Meeting.”249 In his journals of 1798, Latrobe cited theories of Lavoisier and Priestley as support to his own theory regarding electrical charges in thunder storms.250 Latrobe’s ideas regarding yellow fever, at least in October of 1798, also relied on Priestley’s theory of oxygen (dephlogisticated air) and azot (phlogisticated air). Latrobe speculated that while the lungs might

248 It is a sign of their relative importance that Priestley’s essays were the first in the 531 page tome, pages one to twenty, while Latrobe’s essay was positioned at page 439.
250 Latrobe, Journals, II: 435.
naturally have an affinity to absorb oxygen rather than azot, in “the vitiated state of the atmospheres of a town,” the two types of air, healthy and inflamed, might bond together and both be absorbed into the blood, causing internal “inflammation,” [sic] which was, “synonymous with a fermentation of that fluid.”

Latrobe argued that his design for the Philadelphia waterworks would ameliorate the inflammatory climate of the city, placing the scheme squarely within the framework of public health. Latrobe said from the start that there was an “amply adequate” solution to the city’s increasingly contaminated well water, which was to complete the canal project already begun. Instead of this simple, proven solution, he proposed an entirely enclosed reservoir at a forty-five foot elevation above ground level, to provide higher water pressure to supply a network of fountains so that, “the whole city may be alternately cleansed and cooled.” In fact, he argued, fountains “are the only means of cooling the air.” Not only that, but “the air produced by the agitation of water is of the purest kind.”

It may seem to be belaboring the point, but Latrobe’s waterworks has been interpreted almost entirely within an architectural or engineering framework. His importance to the history of American architecture does not, however, diminish the fact that during his first years in Philadelphia his intellectual efforts were largely directed to the natural sciences, and he posed his design for the waterworks explicitly within the context of American public health. His waterworks must therefore be addressed within the context of the natural sciences, and in particular in regard to epidemic medicine in relation to environmental conditions.

252 Latrobe, *View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water*, 15, 1, 18.
253 Of course, another typical way of increasing water pressure, known since ancient times, was to gradually decrease the size of mains as they traveled downhill from a reservoir.
3.2 The American Fabric of Health

The plan of a town, like that of a house must be perfect or imperfect as it is more or less adapted to the climate and manners of the country in which it is built.

The first consideration however is, of the climate, because upon that depend in a great degree the manners and almost entirely the health of the people.

--Benjamin H. Latrobe, Letter to Samuel Mifflin Esqr., 30 March, 1805

Latrobe was a member of a small yet prolific social and intellectual milieu. He and other prominent thinkers of the time investigated the ailments of the city and the nation, and were particularly interested in the inflammatory quality of its airs, waters, and ground. They were at the forefront of study, yet medical and scientific theory at the time was still derived from ancient ideas of health as a moral, mental, and physical balance embedded within a particular environment. One might term their medical theory neoclassical, due to their reliance on Greek and Roman models, modified by new discoveries and techniques of intervention.

Airs, Waters, and Places

In the 1790s and continuing well into the 19th century, physical, social, moral, environmental, and even political health were understood to be deeply interconnected. Health was defined as a state of equilibrium and moderation. Dr. James Johnson defined a tripartite system within the body. The first “organic” system was ungovernable and natural, the second “animal system,” willfully controlled and physical, and the third, the “sentient system” intellectual and civilized. In Johnson’s description of health, the three systems together composed one “whole fabric,” woven together, “in the strictest bonds of sympathy and harmony.” Johnson defined health as, “a just equilibrium,” and illness as a “derangement” of the fabric. Derangement of the fabric of health would allow the body to become susceptible to disease. A sudden alteration to

any part was perceived as a threat to the whole, while a measured or moderate pace was considered far less dangerous.

The fabric of health was the outcome of an interaction between environmental conditions and each person’s elemental constitution and behavior. Most doctors at the time believed in the connectedness of place to the human body, not just by analogy. The prevailing European and American ideas of health, nature, and cities were built on ancient sources interpreted through the lens of early modern science. Medical theory included some modern elements, for instance the post-mortem examination of bodily organs to ascertain the cause of death. Yet many physicians still traced elements of their theories of disease etiology to writings attributed to Hippocrates (c.460 – c.370 BCE), a physician of classical Athens.

Hippocrates was not just an assumed historical knowledge, but was still an active part of American medical theory at the time. While his methods of treatment violated most Hippocratean protocols, there is no question that the theories of Hippocrates were one framework beneath Dr. Benjamin Rush’s modern medical treatments. Rush studied the classics at the College of New Jersey (later Princeton) and it was said by his eulogist, Dr. David Ramsay that at age 17 Rush had translated Hippocrates’ aphorisms from the Greek. Dr. Rush was described in one of his obituaries as, “unlocking the rich treasures of antiquity, and scattering the luxuriance of modern improvement.” Fittingly, in his final decade of life, his introductory lecture to medical students was still, “on the Opinion and Modes of Practice of Hippocrates.” Rush’s copy of the 1790 edition of, *The Catalogue of the Books Belonging to the Medical Library in the Pennsylvania Hospital; to which are prefixed the rules to be observed in the use of them* includes a 1708 edition of, “The aphorisms of Hippocrates, and the sentences of Celsus . . .,” as well as, “Hippocrates upon air, water, and situation; upon epidemical diseases . . .” Second edition. London, 1752,” and a

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255 C. "A Tribute to the Memory of Dr. Rush." *The Port Folio*, October 1813, 6.
1665 edition of “Hippocratis opera Omnia.” Demonstrating that one could never actually acquire “all” the works of Hippocrates, Rush in his own hand added a new acquisition to the back of the library’s catalog, John Moffat’s, “The Prognostics and Prorrhetics of Hippocrates,” of 1788.\(^{257}\)

Hippocrates assigned particular constitutions to bodies, and particular qualities to places, if these were out of balance, then disorder, and therefore disease, would arise. In the 1752 translation of *Air, Water, and Situation*, which was held by the Society of Physicians, Hippocrates lists those things which must be considered by “whoever would apply himself right to Physick:” seasons, winds, waters, land, and “way of Living.” By judging conditions of weather, environment, and behavior, the doctor will be able to “foretell ... the epidemic diseases of every approaching Season, ... and what particular diseases private Men are in danger of from an alteration in their way of living.” Astronomy, Hippocrates explains, is a necessary subject for a physician because, “with the Seasons the Constitutions of Men likewise change.”\(^{258}\) In this ancient theory of medicine the macrocosm of the stars is linked to the microcosm of the human body, through the medium of the environment, which is variously damp or dry, cold or hot. Intellect and controlled behavior could also be moderate or intemperate, contributing to the body’s stability or imbalance.

In the Hippocratic writings and in the pre-Socratic writings of Empedocles (c.490 – c.430 BCE), as in the literature of the 1790s, water, temperature, and balance were of great importance.\(^{259}\) The 1752 edition of *Air, Water, and Situation*, informs us regarding the various

\(^{257}\) *Catalogue of the Books Belonging to the Medical Library in the Pennsylvania Hospital; to which are prefixed the rules to be observed in the use of them* [printed by Zachariah Poulson, Junior, 1790], unnumbered. [signed and with additional entries by Dr. Benjamin Rush. Society Collection, Historical Society of Pennsylvania, Philadelphia]

\(^{258}\) Hippocrates, *Hippocrates upon air, water, and situation; upon epidemical diseases; and upon prognosticks, in acute cases especially. To which is added the life of Hippocrates from Soranus, and Thucydides’s account of the plague of Athens. The whole translated, and ill.* (London: printed for John Whiston and Benj. White, at Mr Boyle’s Head; and Lockyer Davis, at Lord Bacon’s Head, both in Fleet-Street, 1752), 1-2.

\(^{259}\) During the eighteenth century many ideas were attributed to “Hypocrates” which were in fact drawn from numerous sources, and traveled to America via Europe through a series of indirect translations.
types of water, that “the share they have in the affair of Health is very great.” The most unhealthy water is marshy water in the summer, which is “hot, thick, and stinking, ...bad, and bilious.” The direction of the winds and position of the water source in relation to the sun are also to be considered. Choosing which waters to drink depends on the body’s condition. Those with a hard belly should drink light clear water such as rainwater, whereas those with a soft belly should drink hard water such as mineral water, in order to absorb their bodily humidity.\footnote{260} Hydrological and thermal balance was the essence of Hippocratean health as it was interpreted at the time.

Hippocrates’ theories of epidemic fevers were popularly accepted during the eighteenth century and were relied on by many for explanation of America’s seasonal fever epidemics. In a letter penned by “B.” to Dr. Crawford, first published in the \textit{Baltimore Federal Gazette} and reprinted in Philadelphia’s \textit{Poulson’s American Daily Advertiser} on October 20, 1801, a physician argued that for the diagnosis and treatment of the fever, “Hypocrates ought to be our guide. This celebrated observer had studied and knew perfectly well, the action of the celestial upon our terrestrial bodies. The effect we experience from the seasons, and the different species of air blended with that we inhale, which acquires by this mixture qualities more or less destructive to health....” B. continues:

\begin{quote}
\textit{America, like Greece, affords the same principles capable of altering and corrupting the atmosphere; in effect, when we consider attentively the unbounded extent of this new world, the immensity of its forces, its vast uncultivated regions, [crossed] by numerous lakes, by rivers, by marshes, which after all their repeated overflows, occasioned by the rains and snows of winter, are regularly diminished or exhausted by the enceasing impetuosity of the winds, or by the perennial heat of the burning summer sun; when we examine the exhalations of all kinds spreading themselves throughout the atmosphere, and issuing from these depths, abandoned by the waters, where perish innumerable quantity of reptiles, insects and animals, as well as aquatic plants of all kinds, produced by the collected powers of the wind and sun, it is easy to perceive the risks which}
\end{quote}

and commentaries. Empedocles’ theory of the four elements – air, earth, fire and water – and concerning the balance between these, was an underlying aspect of this large field of ideas about health in relation to weather, site, emotion, constitution, and situation.\footnote{260} Hippocrates, \textit{Hippocrates upon air, water, and situation} (1752), 8-14.
every populated country incurs, that has the misfortune to lie in the neighbourhood of such reservoirs or be exposed to the current of [illegible] deleterious emanations drawn forth by the sun, and then driven by the winds.

Since the epidemic fevers were, "classed under the head of inflammatory, putrid & malignant fevers," to use mercury (a treatment often used by Benjamin Rush) was in B.'s opinion, "but to call oil on the fire in order to extinguish the blaze." It was the same expanses of "uncultivated regions," that were America's bounty, that also allowed dangerous heated swamps to emit their deadly exhalations.261

The medical theories of the eighteenth-century were derived from a long lineage of ideas of constitution, environment, and balance, and it is worth noting that ancient (and Renaissance) architectural theorists were also very concerned with urban health in relation to site. Benjamin Latrobe knew Vitruvius' *The Ten Books of Architecture* well, though since he valued the Greek style above the Roman he considered The Ten Books, "of very inferior rank both in its literature, its taste, and its science."262 Vitruvius was very concerned with environmental theory, especially in relation to urban health. In the first book, as soon as he has outlined the education and the principles and departments of architecture, Vitruvius describes the founding of cities; "first comes the choice of a very healthy site." What then follows is an analysis of the salubrity of various altitudes, humidities, and temperatures. Vitruvius identifies a belief still strongly held in the 1790s; the greatest dangers to health came from heat and from swamps. Vitruvius judges heat to be the most dangerous element because when it, "becomes predominant in any body whatsoever, it destroys and dissolves all the others with its violence."

In Vitruvius, as in Hippocrates it is imbalance, the dominance of one quality over the others, which unravels the fabric of the whole, and heat is the most destructive force. Vitruvius

261 B. "Observations On the Epidemic Disease of America, Commonly called the Yellow Fever," *Poulson's American Daily Advertiser* (October 20, 1801), 2.
also judged marshes as unhealthy, an opinion which would be maintained through the early twentieth century. Vitruvius did not explain the danger of swamps as arising from miasma, the term which would be most commonly used during the eighteenth century to explain the diseased airs that were exuded by swamps and rotting matter, but explained that the unhealthy effect of swamps comes from the “poisonous breath of the creatures of the marshes.” The conclusion in the Ten Books is that a “temperate,” site is best for the foundation of a city. 263

Environment was understood to be a necessary factor in the inflammation that led to fever, but the mind was understood to be equally a part of physical illness. B., in his letter published in the Philadelphia press the year the waterworks began operation, explained that to treat the fever it was crucial to, “soothe the agitated spirits of the public,” because “of the incalculable power of the moral on the physical world.” He concluded that hope must be instilled to affect any cure for the fever. 264 The idea that the balanced interaction between environmental,


Oddly, the Vitruvian theory of the dangerous exhalations of swamp animals had more truth to it in Philadelphia than most of the other transmission theories suggested at the time, since the mosquitos that bred along the swampy edge of the Delaware River were to blame for the fevers that plagued the city.

The term “miasma,” according to the O.E.D., comes from the ancient Greek for stain or defilement (µiaaµa) and while the term appeared in its Greek form in William Harvey’s *Exercitationes de Generatione Animalium* xlix of 1651, the Latinized version appears to have been coined in a 1665 medical pamphlet by Marchamont Nedham, better known for his numerous political pamphlets against Charles I and in favor of a British parliament. The word next appears in 1672, again as the post-classical Latin miasma and miasmata (pl.), and is translated into English as the same by J. Quincy in the 1720 edition of the physician Nathaniel Hodges’ *Loimologia*. It appeared in French as miasme in 1695.

An typical example demonstrates that miasmata were linked to disorder from the earliest usages of the term:

“After the pestilential Miasmata have thus seized a Person, and the Spirits are overcome, the whole Mass of Blood, and other animal Juices, partake of the Disorder...”.


264 B. "Observations On the Epidemic Disease of America, Commonly called the Yellow Fever," 2.
constitutional, and "moral" factors created physical health also meant that politics could have a
direct effect on physical health, and pollution could unravel political stability.

If the idea of balanced elements and constitutions can be traced to ancient Greece, the
idea of public works as treatments for dangerous imbalance had been elaborated in Europe for
centuries. The idea of elaborate urban planning to rebalance the environment and health of a city,
thus solidifying political stability, found strong expression in John Evelyn’s *Fumifugium: The
Inconveniency of the Smoak of London dissipated, &c.*, written in 1661, in which Evelyn argued
that “Aer itselfe is many times a potent and great disposer to Rebellion,” and prescribed public
works such as regular wide streets and the improvement of Plantations in areas “circumadjacent”
to the city, whose “gentle emission through the Aer, should so perfume the adjacent places with
their breath.”265 Evelyn had previously noted in *A Character of England* (1659) the entanglement
between the deformity of London’s architecture and “deformity of mind.”266

This notion of the interimbrecation of environment, mind, and politics persisted in early
national America. Though the notion of extensive public works and town planning was still
nascent when Latrobe proposed his idea, it was clearly understood that something needed to be
done to bring the city to equilibrium, to avoid political instability. As Jacquelyn C. Miller
succinctly puts it in her essay, “Passion and Politics: The Multiple Meanings of Benjamin Rush’s
Treatment for Yellow Fever,” both Thomas Jefferson and Benjamin Rush, “assumed that the
organization of social and political systems and the health of the people who populated those

265 Evelyn, *Fumifugium*, the Epistle, 2, 14, np.
266 It seems that Latrobe’s choice of French over English example has long precedent in English thought.
Evelyn’s dismay with the deformed buildings of London posed their mean form against the ornament and
magnificence of Parisian public works, and similarly against the regularity and visibility of baroque Italy.


“... but you would be amaz’d at the genius of this age, that should suffer this goodly and venerable
fabrick to be built about, and converted into raskally ware-houses, and so sordidly obscur’d and
defac’d, that an argument of greater avarice, malice, meanness, and deformity of mind, cannot
possibly be expressed : nothing here of ornament, nothing of magnificence, no publique and
honourable works, such as render our Paris, and other cities of France, renowned and visited by all the
world; emulating even Italy her self for her palaces, uniform and conspicuous structures ...”.

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systems were so mutually related that any widespread modifications in social relationships would produce accompanying changes in the health of the people involved.”

While it may seem natural to suggest balance and temperance as the foundations of health and urban stability, it is important to point out that these theories were fundamentally drawn from ancient Greek and Roman philosophy. This neoclassical theory of remediation through equilibrium would flare briefly in America, in the short window between its existence as an agricultural colony and its rapid expansion as an industrial power. Ideas of an interwoven and even fabric of health lost much of their traction by the end of the nineteenth century, particularly with the discovery of bacteria and the expansion of chemical and technological remedies for disease. One might suggest that post-war ecological thinking revived attention to ideas of balance and wholeness in the medical debates of the twentieth century, although that balance is now quantified via body mass index, dopamine levels, atmospheric carbon content, etc.

Urban Imbalance: Political Conflict and Medical Crisis

It is clear that balance was understood as the essence of health at the time Benjamin Latrobe proposed his waterworks for Philadelphia. If imbalance could lead to derangements in the fabric of health which compromised equilibrium, then the conditions of Philadelphia during the 1790s were certainly deranged on several fronts, and the harmony of America’s capital city threatened. This imbalance could be understood within the Hippocratean framework, as previously described, as a condition of the atmosphere that was both too hot and too damp. Imbalance was also the political condition at the time, as the first political parties arose, and plunged America into its first “heated” debates, aligning sides with the warring nations France and Britain, and also very broadly splitting allegiances to country and city, agriculture and

industry, south and north. The nature of these debates and the relationship between medical
theory and political position one of the primary topics of a series collected by J. Worth Estes and
Response to the 1793 Philadelphia Yellow Fever Epidemic*. Much of the data I cite in this chapter,
is cited from this volume, as well as several of the key ideas about politics and medicine. This
helps shed a clearer light on the meaning of Latrobe’s own position within the environmental
debates. Through primary investigation, I have elaborated the ways in which the urban geography
and demographic distribution of Philadelphia were simultaneously recognized to be moving
rapidly towards a less balanced condition, which might prevent the constituent parts from
cohering into a stable whole.

This imbalance was perceived to be a condition that accompanied the new nation’s
growth. From 1790 to 1800, Philadelphia was the temporary home of the new federal government
of the United States. It was a cosmopolitan city and a center of trade with Europe and the Indies.
As commerce and immigration increased over the course the eighteenth century, settlement
became increasingly dense near the docks on the Delaware River, rather than developing along
William Penn's largely unbuilt ideal grid of 1683. Within this dense waterfront area,
Philadelphians were beginning to experience endemic urban problems of a severity that had
rarely appeared on American soil: poverty, poor sanitation, contaminated water, crime, and
epidemic disease. The increasing intensity of these dangers, while the country was still testing its
viability as an independent and united nation, was experienced as a severe crisis composed of
inseparable topographical, demographic, political, and medical components.
Philadelphia’s topography, its actual ground, was uneven, as was its pattern of settlement. Chief Engineer John Montrésor’s topographical survey for the British military paints an evocative picture of the difference between the physical qualities of the urban core and the thinly settled territory towards the city’s west edge. [Figure 35] The terrain fell from the rocky northwest near the “Fair Mount” to the plain of the city, with several high points on the plan between 7 and 8
blocks from the Schuylkill River, including Center Square. Philadelphia's geological position at the joint of two physiographic regions, though not yet named the Piedmont and the Atlantic Coastal Plain, was understood by Jefferson, and studied by Latrobe, who was an amateur geologist as well as a professional surveyor. This map also documents the outlying farms and manors to which the center of the city was more remotely linked. This map precedes John Hill's 1796 map of Philadelphia, in this version tinted to show the low-lying watery areas, dramatically demonstrates the solidity of the eastern portion of the city against the many inlets, swamps, and streams to the west. [Figure 36] Latrobe would use an un-tinted version of this map as the underlay for his city plan for the design of his waterworks. (see Chapter 2, Figure 31)

Figure 36 - THIS PLAN OF THE CITY OF PHILADELPHIA AND ITS ENVIRONS, (shewing the improved parts) is dedicated the mayor, aldermen and citizens thereof, by their most obedient servant, John Hills, surveyor and draughtsman. May 30th 1796. Engraved by John Cooke, of Hendon, Middlesex. Philadelphia. Courtesy of the Historical Society of Pennsylvania.

268 Mease, Picture of Philadelphia, 15.
269 Latrobe, Journals, II: 389.
While the geography was uneven, the settlement of the city was also imbalanced. Davies' 1794 map of the developed portion of Philadelphia illustrates that between 1777 and 1794 the area of the densest settlement remained fixed within an 8 block radius of the docks at the Delaware, spilling north of Vine Street along the waterfront to create the suburb of Northern Liberties, and south of Cedar Street to create Southwark. [Figure 37] According to Joseph Scott's *Gazetteer* of 1799 the number of residences in the area increased by at least 50% during this time.270 The city contained only 2,076 dwellings in 1749, 6,704 in 1790, and 9,000 in 1794. According to the first official U.S. census data, the city population was 28,522 in 1790, and 41,220 by 1800.271

![Figure 37 - Benjamin Davies, TO THOMAS MIFFLIN, GOVERNOR... THIS PLAN OF THE CITY AND SUBURBS OF PHILADELPHIA is respectfully inscribed by the editor, 1794. A. P. Folie del. R. Scot & S. Allardice sculpst. This is a](image)

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If growth between 1750 and 1790 was steady, with the temporary establishment of the national capital in Philadelphia density in the settled parts of the city increased exponentially, and residents described the city's imbalanced settlement as a problem. The physical pattern of development could be identified as skewed, and was therefore, by the logic of the times, deemed unhealthy. As early as 1750, Benjamin Franklin had worried about the problems of overcrowding, particularly along the Delaware. Scott specifically complained in his *Geographical Dictionary* of 1799 (which he sent as a gift to Thomas Jefferson) that the unhealthy city had not grown in keeping with Penn's plan, according to which development would occur along both the Schuylkill River and the Delaware, growing to meet in the center. The image of close and heated blocks near the Delaware and open fields towards the Schuylkill was repeated not just in professional surveys, but in popular images. Birch and son’s handsome collection of engravings, *The City of Philadelphia in the State of Pennsylvania, North America, as it appeared in the Year 1800, consisting of TWENTY EIGHT Plates*, would include a rendering of Latrobe’s Center Engine House, as well as a map of the imbalanced city punctuated by the new pavilion. [Figure 38]

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273 Joseph Scott, *The new and universal gazetteer; or, Modern geographical dictionary.* [...]

Settlement was becoming not only geographically but economically skewed. Within the densest areas close to the river, tiny neighborhoods began to divide according to income and class. Wealthy merchants usually maintained second homes within the pastoral liberty lands outside the city. The makeup of the population was in flux, and these changes were reflected in the physiognomy of the city. During the 1790s, Philadelphia was the chief point of immigration to the United States, and was racially and ethnically diverse.\textsuperscript{274} David Paul Nord notes that, despite its prominence as a port, and its position as the seat of state and federal government, one third of Philadelphia's citizens lived at the “subsistence level,” and half “owned no real property.”

\textsuperscript{274} Billy G. Smith, “Comment: Disease and Community,” in Estes and Smith, \textit{A Melancholy Scene of Devastation}, 152.
Philadelphia's relatively even mix of residences, merchants, and small manufacturing was now becoming polarized, even within its small area of development, into areas that were distinguished by income and social status.\textsuperscript{275} William Penn's surveyor Thomas Holme's \textit{A Portraiture of the city of Philadelphia} of 1683, which offered city lots exclusively to large country landholders, must be seen as one of the establishing factors of this high percentage of lower income urban tenants.

Fears over the imbalance of the new nation were exacerbated by factional divides between the heroes of the revolution, including Thomas Jefferson, James Madison, George Washington, Alexander Hamilton, and John Adams. Internal schisms arose largely over disagreements about how much political and economic power should be granted to the federal government, the validity of central banking and national debt, and what position to take in the ongoing wars between England and France. This split led to the creation of the first American political parties, Alexander Hamilton's Federalists (or Hamiltonians) and the Democratic-Republican party of Thomas Jefferson and James Madison (also called the Republican or Jeffersonian party). These parties took radically different positions regarding health and climate, and regarding the importance of public works.

Latrobe heartily inserted himself into his new nation as a Democratic Republican. In January of 1798, reveling in Richmond society, Latrobe penned a "comedy," on the subject of Alexander Hamilton’s affair with Maria Reynolds, called \textit{The Apology}, whose text has not been found. Latrobe admitted in a letter to his friend Dr. Scandella that the comedy became a farce when none of the actors remembered their lines, but noted favorably that no fighting broke out,

\textsuperscript{275} David Paul Nord, "'Readership as Citizenship in Late-Eighteenth-Century Philadelphia,'" in Estes and Smith, \textit{A Melancholy Scene of Devastation}, 21.
"between friends of Hamilton and those of liberty and morality." Latrobe saw the Jeffersonian Republicans as the true friends of liberty, and hoped that they would accept him into their milieu.

It is not possible to provide a complete explanation of the positions of the Federalists and the Republicans, but a brief summary will be necessary to understand the connections between political beliefs and public health responses. (Chapter 5 will explain Jeffersonian Republican ideas in greater depth to elaborate Latrobe's natural and aesthetic theories.) The Federalists gained much of their support from the merchant and early industrialist class and favored a strong central government and increased trade with England. The Jeffersonians clung to revolutionary ideals, and feared that with the rise of a strong federal government and a powerful merchant elite, America would replicate the injustice of royal England. The Jeffersonian Republicans, despite their often elevated positions and landed status, claimed to represent workers, manufacturers, farmers, and artisans. The Republicans emphasized the importance of nature and the cultivation of the land, viewing the city as a corrupting and unhealthy influence. The Federalists feared that the new nation would fall into violent disarray if the controls of government were not held firmly by an urban, educated elite. The Republicans castigated their opponents for their mimicry of English 'monarchism.' Federalists warned against 'anarchy,' and slandered their rivals as supporters of the 'Jacobins' in France. There was also a split between north and south. The Republicans were more closely connected with the southern landholders centered on Jefferson's territory in Virginia, though they also gained fervent supporters within some intellectual and scientific circles, and among the artisan class of northern cities.

The 1790s were also a time of more radical politics. If the Jeffersonians and Hamilton's Federalists took different positions regarding the structure of the new national government, others wished to continue the fervor, or fever, of the revolution, and establish a new egalitarian society,

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276 Latrobe, Correspondence, I: 73
277 Sally F. Griffith, "'A Total Dissolution of the Bonds of Society': Community Death and Regeneration in Mathew Carey's Short Account of the Malignant Fever," in Estes and Smith, A Melancholy Scene of Devastation, 55.
levelling the social classes through redistribution of land and income, and granting equal suffrage
to all male citizens. This idea of popular sovereignty was viewed as a threat by both of the new
political parties. Seth Cotlar describes these movements as drawing their fuel from “an agrarian
strain of Protestant millennialism that invoked visions of a more economically just future.” Cotlar
defines 1796 and 1797 as the pinnacle of debates about inequality, with the publication of three
influential revolutionary tracts in America. Comte de Volney’s *The Ruins: Or A Survey of the
Revolutions of Empires* was issued in three American editions between 1796 and 1799. Volney’s
geographic and historical theories warned the new nation that once men became distant from the
“state of nature,” elite groups would form, wanting more than ‘the blessings which the earth
afforded them, or which their own industry produced.’ Volney was to become an acquaintance
and philosophical colleague of Latrobe’s. The other two radical tracts published in the years
immediately preceding Latrobe’s design for the waterworks were William Godwin’s *Political
Justice*, and Tom Paine’s *Agrarian Justice*.

Paine’s *Common Sense* of 1776, originally edited and possibly given its title by another
of Latrobe’s circle, Dr. Benjamin Rush, was of course one of the modest widely read tracts in
America by the late eighteenth century, and made it violently clear that rights to clean air and
water were not for the state to offer out of charity, but were rather the God-given rights of every
man. In this pamphlet that helped inspire the revolution, Paine’s rant against Lord Dartmouth,
Secretary of State for America, enumerated these rights:

278 Seth Cotlar, *Tom Paine’s America: The Rise and Fall of Transatlantic Radicalism in the Early Republic*
(Charlottesville: University of Virginia Press, 2011), 149-150.
279 Thomas Paine, *Agrarian justice, opposed to agrarian law: and to agrarian monopoly; being a plan for
meliorating the condition of man, by creating in every nation a national fund, To pay to every person,
when arrived at the age of Twenty One years, the sum of Fifteen Pounds Sterling, to enable him, or her
to begin the world: And Also. Ten Pounds Sterling per annum during life to every person now living of
the age of Fifty Years, and to all others when they shall arrive at that Age, to enable them to live in old
age without Wretchedness, and go decently out of the World. By Thomas Paine, Author Of Common
Sense, Rights Of Man, Age Of Reason, &c. &c.* (Philadelphia: Printed by R. Folwell, for Benjamin
Franklin Bache, 1797).
Do you believe that God made America as well as Great Britain? If you do, ponder, consider well, what answer you will give if you escape punishment in this world, when you come to be questioned before the Throne of God, for the destruction you have made of his creatures; the work of his hands, to whom he granted life and liberty, earth, air and water equally as to yourself: and yet presumptuous man, you have dared to counteract his providence!

The idea of “common sense” can be read doubly, as the call for rationality available to all, but this rationality rested on the link of human sensation to the natural world and the regular laws underlying it. Yet this call for commonality was a grave threat to the landed and merchant class of America. The terrors following the French Revolution had generally dampened revolutionary spirit, but radical “Jacobins” continued to agitate throughout the 1790s, particularly in Philadelphia. Even Dr. Rush was opposed to radical democracy, exclaiming in 1787, ‘It is often said that the sovereign and all other power is seated in the people! This idea is unhappily expressed. It should be--all power is derived from the people. They possess it only on the days of their elections. After this, it is the property of their rulers.’

These conflicts over power, class, and natural rights were at the political heart of the new nation. During the 1790s Philadelphia was home to the national government under President Washington, and also home to most of the Republican leaders. The Republicans mocked Washington's government as being imitative of the royal court in London, though the President

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280 Thomas Paine, Common sense: addressed to the inhabitants of America, on the following interesting subjects. I. Of the origin and design of government in general, with concise remarks on the English Constitution. II. Of monarchy and hereditary succession. III. Thoughts on the present state of American affairs. IV. Of the present ability of America, with some miscellaneous reflections. Written by an Englishman. (Philadelphia: Printed. And sold by R. Bell, in Third-Street, 1776), 61.

281 The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthetics by David Summers (London: Cambridge University Press, 1987) examines fifteenth and sixteenth-century philosophies of perception which conceived the work of art as something that by virtue of its internal idea could appeal directly to the soul, naturally and democratically moving the viewer’s morality via his senses. The Earl of Shaftesbury (1671-1713) in Sensus Communis, An Essay on the Freedom of Wit and Humor (1709) argued for the existence of an inner harmony and beauty of the soul based on symmetry and order. This system unites all men, so “common sense” is equated with actions that favor the system as a whole, rejecting selfish interests.

himself was occasionally forgiven as a hostage to the situation. Richard G. Miller, in Weigley's history of Philadelphia, writes of the 'federal court,' with its state dinners and receptions for visiting British dignitaries.\footnote{Russell F. Weigley, \textit{ed. Philadelphia: a 300 Year History.} (New York: W.W. Norton, 1982), 177-179.} Latrobe, in a journal entry of April 1798, describes his first impressions of the situation: "British influence may be denied by one party, and French influence asserted. But a very short residence in Philadelphia will leave no doubt upon that subject. To be civilly received by the fashionable people, and to be invited to the President's it is necessary to visit the British Ambassador."\footnote{Latrobe, \textit{Journals, II:} 374.}

The conflicts between the two parties were thrown into high relief after January of 1793 (the year of the most lethal yellow fever outbreak) with the beheading of Louis XVI.\footnote{Martin S. Pernick, "Contagion and Culture," in Estes and Smith, \textit{A Melancholy Scene of Devastation}, 120.} For the remainder of the 1790s, Philadelphia would be torn between French and English allegiances. This rift was exacerbated by the XYZ Affair, and the Quasi-War with France. The Federalists in congress and President John Adams enacted the Alien and Sedition Acts in February of 1798, which allowed the deportation of immigrants, many of whom were sympathetic to the Jeffersonian Republican cause.

These subjects, and the topic of the yellow fever, dominated the personal correspondence of the time, and made a strong impression on Latrobe. In April of 1798, he wrote with great dismay and some humor to his dearest friend in America, Dr. Giambattista Scandella, making light of the outcry both for and against war with France, which he called "\textit{storms in a teapot de chambre}," and forwarded a copy of a petition against war, signed by Virginia Republicans.\footnote{Latrobe, \textit{Journals, II:} 369.} Later that year, Scandella, forced to leave the country under the Alien and Sedition acts, would die of yellow fever in New York City while waiting for a ship home.\footnote{Latrobe, \textit{Journals, II:} 436.} The fever, and the political inflammation of the country, struck Latrobe personally just months before he was granted the opportunity to devise a cooling monument to civilized balance.

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\footnotetext[284]{Latrobe, \textit{Journals, II:} 374.}
\footnotetext[285]{Martin S. Pernick, "Contagion and Culture," in Estes and Smith, \textit{A Melancholy Scene of Devastation}, 120.}
\footnotetext[286]{Latrobe, \textit{Journals, II:} 369.}
\footnotetext[287]{Latrobe, \textit{Journals, II:} 436.}
American Inflammation

If the world was wracked by political battles and international alignments, the chief concern of Philadelphia’s citizens was the yellow fever. The derangement of the fabric of health was particularly distressing because the survival of the new nation was not yet certain, and the city was, during the 1790s, the capital of the conflicted republic. The fever hovered over Philadelphia during the early national period, with recurring outbreaks generally falling between August and November, and returning to the city in 1793, 1797, 1798, and 1799. In 1793, the year of the most virulent attack, between the 19th of August and the 15th of November, approximately ten to fifteen percent of the population of 45,000 died of yellow fever, and 20,000 fled the city, among them most members of the national and city governments.288 This Committee on the Malignant Fever, organized with the advice of Dr. Rush and including Samuel M. Fox and Samuel Wetherill, expanded to draw on the assistance of prominent citizens and merchants who remained behind in the city, including Stephen Girard, Thomas Wistar, Israel Israel, Mathew Carey, and others. These citizens volunteered to undertake the care of the sick and the poor, and the sanitation and security of the city. The group would be renamed the Committee of Health the following spring.289 According to Martin Pernick, most of the committee work was carried out by Republicans, with the assistance of their French compatriots. The fever hospital at Bush Hill was mostly staffed by Frenchmen, and the largest donation to Philadelphia’s relief came from Citizen Genêt.290 It has been suggested that support for Jeffersonians increased at this time, because citizens were aware that most of the Federalist government of Philadelphia, with the exception of Mayor Clarkson, had abandoned the city, leaving the management of affairs in the hands of local committee of civic leaders.291

291 Griffith, “A Total Dissolution of the Bonds of Society: Community Death and Regeneration in Mathew Carey's Short Account of the Malignant Fever,” 55
If civic-minded citizens drew together to care for the health of the city, political and theoretical disagreements in the medical community about the cause and means of transmission of the disease led to contradictory and ineffective instruction to citizens, often with disastrous results. The fever was often fatal, and the symptoms vivid and gruesome, "yellow eyes and skin, purple hemorrhages into the skin, red blood pouring from the nose and mouth, and black vomit." 292 The Aedes aegypti mosquito was the vector for the disease, but this connection would not be discovered until the end of the nineteenth century. Since the insect could not travel very far, the disease appeared along the swampy riverfront on the Delaware, near the docks, an area that already had a reputation for poverty, filth, and vice. Those who fled the city in 1793 were at almost no risk of contracting the disease, so it was natural for the people of Philadelphia to directly associate the sickness with the density, poverty, and dirtiness of the urban environment. 293

The most famous, and grimly entertaining, account of the yellow fever was publisher Mathew Carey's A short account of the malignant fever, lately prevalent in Philadelphia. Carey's Account described the outbreak of 1793, relating a tale of a city abandoned, businesses closed, people afraid of contact with each other, and an accumulation of victims. The civic malaise described in Carey's narrative has been generally corroborated by letters and other news stories, though it is clearly a dramatic recounting of the crisis. Carey, a member of the committee that shepherded the city through the epidemic, was also a newspaperman and wanted to sell copy. Popular public protections against the disease included firing guns in the air and burning tar in barrels. Citizens who went out in the streets used camphor and vinegar soaked cloths to shield

292 J. Worth Estes, "Introduction: The Yellow Fever Syndrome and Its Treatment in Philadelphia, 1793," in Estes and Smith, A Melancholy Scene of Devastation, 1, 7. Estes notes that even today there is no cure, though modern palliative treatments lead to mortality rates of only 5-10%.

293 Billy G. Smith, "Comment: Disease and Community," in Estes and Smith, A Melancholy Scene of Devastation, 148, 149. As Smith notes, this was not, historically, the most deadly attack of the disease. In 1699, Philadelphia lost one third of its white population and uncounted slaves to yellow fever.
their noses. It was still believed by most people that odor was equivalent with disease, and that strong odors might combat other strong odors. Carey related that people would walk in the center of the streets to avoid passing by a house that might carry the infection. Rumors spread of families leaving dying members at the curb for collection by death carts to avoid contagion. Carey exclaimed: “While affairs were in this deplorable state, and people at the lowest ebb of despair, we cannot be astonished at the frightful scenes that were acted, which seemed to indicate a total dissolution of the bonds of society in the nearest and dearest connexions.”

This idea of a feverish dissolution almost directly echoes the Vitruvian assertion that heat as a predominant element, “destroys and dissolves all the other with its violence.”

This crisis was not just medical or social, but also economic. Beyond his graphic depiction of the terrifying atmosphere of the city streets, Carey also provided detailed information regarding the destructive influence of the fever on commerce. He listed all of the cities that blockaded any passage of goods, people, and ships coming from Philadelphia – including Trenton, Baltimore, Newburyport, Boston, Charleston, Reading, and Havre de Grace. This blockade had a deadening effect on the city's economy, and of course spawned political responses. For Federalists, the position that the disease was not native to Philadelphia but imported oddly enough allowed them to argue that trade should be continued, while Republicans generally supported public works and improvements to shift the assumed quality of the water, ground, and especially the airs of the city.

At a time when issues of physical, social, and moral health were so closely intertwined, and so filled with peril, Philadelphians understood precisely which areas of the city were most

294 Mathew Carey, A short account of the malignant fever, lately prevalent in Philadelphia: with a statement of the proceedings that took place on the subject in different parts of the United States. 3rd edition (Philadelphia: Printed by the author, November 14, 1793), 29.
295 Carey, A short account of the malignant fever, 33
297 Carey, A short account of the malignant fever, 65-72
affected by disease. The reputations of each street and neighborhood were well known, and in light of the city’s booming printing industry, those who could read were aware of the daily tragedies, and word spread rapidly.\textsuperscript{298} The city’s centers of disease were also the centers of poverty and overcrowding, and the spatial connection was explicitly described by residents. One of the nuisances noted by almost every commentator on the ailments of the city was Dock Creek, a small swampy inlet that meandered between Walnut and Spruce, and Front and Third streets. This swamp is clearly visible in the Davies’ map of 1794. Scott said that it was “a common reservoir for the filth of a large part of the city.” To address the problem, portions of it were paved in 1784 at the insistence of Dr. Rush to create Dock Street, but complaints of odor and bad airs continued, and the location persisted in popular understanding as one of ill-health. It was not only, as Mease pointed out in his 1811 \textit{Picture of Philadelphia}, “highly offensive,” it was also, “the only street in the city, not crossed by another at right angles.”\textsuperscript{299} Its filthiness and its non-orthogonality violated Penn’s perfect plan. The street that ran along the Delaware River was also a place of illness. In 1799, Joseph Scott noted that Water Street, which ran along the docks, was “confined and low,” and “the most disagreeable street in town.”\textsuperscript{300}

News of the disease’s spread demonstrates the firm association of the outbreak with specific locations, and also shows that the connection between the fever and political inflammation was made by common citizens.\textsuperscript{301} The letters of one Philadelphia family, George Nord, “‘Readership as Citizenship in Late-Eighteenth-Century Philadelphia,” in Estes and Smith, \textit{A Melancholy Scene of Devastation}, 19-44.
\textsuperscript{299} Mease, \textit{Picture of Philadelphia}, 39, 22.
\textsuperscript{300} Scott, \textit{The new and universal gazetteer}, no page numbers.
\textsuperscript{301} There are no medical maps of Philadelphia’s yellow fever outbreaks of the 1790s, though the physicians, public officials, and residents of Philadelphia noted the frequency of disease near Water and Dock Street, areas associated with poverty, sailors, “filles de joie,” and immigrants. The technique of medical cartography would only be developed during the 19\textsuperscript{th} century, a marriage of the graphic methods of surveyors with the ambitious data collection of world traveling soldiers, surveyors, zoologists, linguists, botanists, and physicians. This cartographic project would be linked, in cities, to the sanitary reform movements, most famously that of Edwin Chadwick in England during the 1840s. David Barnes, in \textit{The Great Stink of Paris and the Nineteenth-Century Struggle against Filth and Germs}, documents the development of ‘hygienism’ beginning in the 1820s in Paris, characterized by “the tendency to see all health problems in spatial terms.” [David S. Barnes, \textit{The Great Stink of Paris and}
Vaux and his descendants, reveals how intently the news of the fever was followed, and the ways in which it was perceived. Writing to her cousin, George Vaux VII, in August of 1797, Mary Ann Warder gave the location of the disease, and also offered the opinion that the unhealthy state [politically] of the nation added to the state of distress:

There has been much alarm of the Yellow Fever it is not yet proved to be contagious & is hoped to be no worse than a bilious complaint several persons have died in the neighbourhood of Pine & Penn Sts very suddenly, & the inhabitants are so soon alarmed that a few families who reside near have gone out of town, the country at present being so very unhealthy makes this dreaded disease [sic] much more distressing [. . .] 302

Four days later, George's father James passed on his own news, again locating the disease, and noting that flight from the city robbed the disease of "feuel." The fever was seen as an inflammatory disease, and often equated with a fire that sparked due to the effect of bad airs in the human body:

I do not expect to write thee again from this place as we are providing to move the day after tomorrow to Ellis Clevers on account of the Yellow Fever spreading in this City, but as yet it has not reached above Penn Street, and it seems the Houses are generally shut up therabouts, [illegible] the business is now sealed, as the Physicians have published that a contagious fever prevales in that part of the City which has carried off about twelve persons . . . . Thy Uncle John & Family I expect will move to Potts Town if the fever increases & I hope a great part of the Citizens will go off as the less the feuel the less will be the Fire . . . . 303

Letters like these fill Philadelphia's archives, always locating the disease and counting the dead, and often complaining of the disease as another symptom within a nation wracked by political

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302 George Vaux papers, 1738-1985; Letter of Mary Ann Warder to George Vaux VII, 12 August 1797.
303 George Vaux papers, 1738-1985; Letter of James Vaux to George Vaux VII, 16 August 1797.
and economic turmoil. This ritual of sharing information while waiting to see if the fever was merely “sporadic,” or becoming epidemic and “malignant,” was repeated almost every year.

The furor over yellow fever eventually became a battle drawn along party lines between opposing theories regarding the transmission of yellow fever. Democratic Republicans, like Dr. Rush, believed in the local, or miasmatic origin of disease. This position corresponded with their strongly held beliefs in an immanent connection between manner, morals, and nature. Federalists tended to believe that the disease was transmitted by contagion, and that the yellow fever had arrived with a wave of 2,000 immigrants who arrived in August of 1793, fleeing the revolution in Haiti (or Sainte-Domingue, as it was then called). The Federalists had interest in banning these Republican sympathizers from the city, and also wished to resume trade, and so deny the fever’s origin within the grounds and airs of the city. It is now recognized that there was also an intermediate position, which blamed a foreign 'seed' that came with the immigrants, and was planted on native soil.\footnote{Pernick, “Contagion and Culture,” 138.} This perhaps comes closest to the truth, as the mosquitoes which arrived from the Indies needed the swampy lowlands and close quarters of the city to spread the disease.

The theoretical disagreement between Democratic-Republicans and Federalists was a part of, and exacerbated political debates. The Jeffersonians were French sympathizers, and more apt to have relationships with the French doctors arriving from Haiti, who believed that location, climate, and sanitation were the sources of the fever. They were also less apt to want to quarantine their friends and associates. The Federalists, on the other hand, feared the refugees as a destabilizing force, and worried that calling the city unhealthy was anti-urban and unpatriotic, and might result in the capital being relocated to a more pastoral (and possibly southern) setting.\footnote{See Pernick, “Contagion and Culture,” in Estes and Smith, A Melancholy Scene of Devastation, 119-146; and Smith, in Estes and Smith, 159.} Dr. Rush believed that bleeding was something that anyone could do, what David Paul Nord calls
a "republican medicine," and so published instructions in the newspaper. While Rush was one of the most prolific and influential voices at the time, most doctors on both sides of the political and medical divide stressed mildness and balance.

If most agreed that the city's fabric was deranged and imbalanced, the diversity of medical, political, and social ideas led to an array of suggested cures. These ranged from mild teas to heroic blood-letting, and from street-washing to large symbolic public works. Although the contagionists were generally Federalists, and the anti-contagionist generally Democratic-Republicans, there was no distinct alignment of treatment methods with those two camps. Rush and his Republican followers used emetics, mercury, and bleeding, and their opponents, including James Currie, generally used the milder cures common to the Indies - stimulants, quinine bark, wine, and cold baths. Though both groups applied some similar cures, and the more vigorous treatments were not applied in every case, the battle of medical ideas was nonetheless polarized in political attacks, with each side accusing the other of murder. Blood-letting was eventually falsely associated with Jeffersonianism, after Alexander Hamilton compared Rush's heroic treatments to the bloody massacres following the French revolution.

The Federalist/contagionist and the Republican/anti-contagionist positions differed tremendously in their economic implications for Philadelphia and in their suggestions for appropriate architectural responses. Dr. James Currie, supporting the Federalist/contagionist viewpoint, blamed the French ship the Sans Culottes for importing the disease. The Federalist government constructed a new quarantine station at Tinacum in 1799, the Philadelphia Lazaretto (still standing) to inspect all ships prior to entry to Philadelphia, and to hold those with any sign of disease. The Federalists believed that any admission that the disease arose from Philadelphia's odorous and dirty "miasmatic" condition would further damage trade.

Republicans believed that the fever arose from Philadelphia's soil. Therefore they promoted a vigorous public campaign to repair the situation by cleaning the city. They believed that the effort itself would reassure citizens and promote commerce. Dr. Rush, in his *Observations upon the Origin of the Malignant Bilious, or Yellow Fever in Philadelphia of 1799*, gives the most dramatic statement of this view:

> Philadelphia was once preeminent over all the cities in North America, in plans of public utility and happiness—she must admit the unwelcome truth sooner, or later, that the yellow fever is engendered in her own bowels, or she must renounce her character for knowledge and policy, and perhaps with it, her existence as a commercial city. May heaven forbid this catastrophe to the present capital of the United States!  

Federalists and Jeffersonians generally agreed about the importance of temperature, dampness, and circulation, as well as on the efficacy of tea, baths, and other mild treatments. Rush, however, developed a more intrusive medical protocol of powerful emetics, laxatives, and blood-letting, which in some cases involved draining up to 80% of the body's blood. At the time, unfortunately, the entire volume of blood in the body was greatly overestimated.

The Jeffersonian position on disease maintained the importance of civic engagement and public works as interventions that would allow a cure to be distributed equally to all citizens. This position also assessed the morphology of urban development in connection to the health of the city. Jefferson, like most others, believed in the importance of fresh air to the prevention of fevers. Jefferson, however, also imagined wholesale urban planning to maximize air flow. This was the underlying motive of his famous checkerboard grid town plan, in which settled areas

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309 Benjamin Rush, *Observations upon the origin of the malignant bilious, or yellow fever in Philadelphia, and upon the means of preventing it: addressed to the citizens of Philadelphia by Benjamin Rush* (Philadelphia: Printed by Budd and Bartram, for Thomas Dobson, at the stone house, no 41, South Second Street, 1799), 28.

310 Miller, “Passion and Politics: The Multiple Meanings of Benjamin Rush’s Treatment for Yellow Fever,” 79.

As Estes notes in his Introduction, Rush based this cure on a copy of letter written by Dr. John Mitchel of Virginia written in 1744, and given to him by Benjamin Franklin. (See Estes, in Estes and Smith, *A Melancholy Scene of Devastation*, 10.)
were interspersed with open blocks. Jefferson sent a drawing of this plan to Governor William H. Harrison in 1803, claiming that ventilation was, "the best means of preserving the cities of America from the scourge of the yellow fever, which being peculiar to our country, must be derived from some peculiarity in it."311 Speaking more personally, however, in a letter of September 1800 written to his good friend Dr. Rush, Jefferson wrote: "Providence has in fact so established the order of things, as that most evils are the means of producing some good. The yellow fever will discourage the growth of great cities in our nation, & I view great cities as pestilential to the morals, the health and the liberties of man."312 This simultaneous agenda of preserving the rights of all men, and the conviction that country life and morals were superior to urban and should naturally prevail, was an inherent and lasting contradiction within the Republican Party, which stemmed from the conflicted convictions of its founder.

311 Jefferson, *Writings*, 1117
312 Jefferson, *Writings*, 1081
3.3 American Treatment

American Soil

If we accept the logical conclusions of Hippocrates' environmental medical theory, and the idea of transitionally perilous miasmas, then the site of Philadelphia was exceedingly perilous in the 1790s due to rapid socioeconomic changes, and the site of the docks was particularly dangerous as a site of winds, damp swampy land, and the arrival and departure of ships and immigrants. In a sense, the nation was in a dangerous state of transition, from a collection of affiliated colonies, to an independent and united nation. America was also understood to have unique soil, which was the grounds for its unique freedoms, but also gave rise to particular dangers. Thomas Jefferson’s debate with the Comte de Buffon, which will be addressed at greater length in Chapter 5, hinged on this issue of a particular American fertility. Jefferson believed that America’s bounty came in part from the active and heated environmental forces that could also cause fever, if not properly cultivated and tempered. He stated that the unusual frequency and deadliness of yellow fever in America must be related to “some peculiarity,” which he suggested was “our cloudless skies.” Jefferson’s notorious contribution to cultivation was to suggest that large and small scale impositions of a grid, to regulate land distribution, and to regulate air flow, were the best means of regulating America’s potency.

If Jefferson seems to have emphasized the role of the heated natural environment in American health and temperament, Dr. Benjamin Rush explained the difference as arising also from American industry, activity, and morality. Dr. Rush understood the virulence of the fever to be unique to America. He believed that the coolness of sedentary and senescent Europe gave rise to milder intermittent fevers. Americans, Rush explained to a colleague in England, required,

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313 Jefferson, Writings, 1117
“depleting remedies,” such as purging and bleeding, whereas Europeans could take gentle tonics and teas.314

Even in 1811, Dr. James Mease, who had studied with Dr. Rush, could argue that “The character of our diseases is for the most part inflammatory. This circumstance is owing to the very variable nature of our climate,” as well as to excessive consumption of meat and liquor. Americans, he believed, did not suffer from the “low fevers” that afflicted the poor in cramped European “confined courts and alleys.” Americans were also free of the “long list of nervous diseases, (strictly so called) which abridge the lives of the higher class of society. Hence the lancet is oftener required than the stimulating draught.”315 From uniquely American excesses arose particular types of inflammatory disorders specific to youth, activity, openness and fertility, which required, according to influential medical opinion, an equally energetic response.

Descriptions of physical health and political behavior as “inflammatory” or “intemperate” arose precisely from medical theories in which mind, body, soil, sun, and air were intermingled and codetermined. Thomas Pym Cope, Latrobe’s adversary on the Watering Committee, argued vehemently against the spread of French revolutionary ideas, calling them a “disease,” “frenzy,” and “commotion,” which had infected even, “those who ought to be physicians.” Cope, a Federalist, also judged that the federal government was established on, “rational” terms and so was “mild & virtuous.” He related that many doubted that a republican government would be maintained in America, because it would require “temperate” conduct or else “rottenness will seize upon the system and decay must ensue.” He worried that those politicians who opposed the federal government would incite the common men and, “inflame their minds.” Cope didn’t prescribe a tea or bath to calm the inflammation, rather he suggested that, “the diffusion of useful knowledge is the only just corrective.”

315 Mease, Picture of Philadelphia, 45-46.
Not everyone believed that the inflammation of the republic required bleeding as a cure. Diffusion, both literal and metaphorical, was seen as a means of soothing physical and political ailments. Cope suggested that against inflammatory politicians, “the diffusion of useful knowledge is the only just corrective.” This idea that flows or diffusions could create health seems nearly universal at the time, and also underlay urban plans in which “large, airy & straight streets are preferable to narrow, crooked & confined ones.” In fact, salubrious streets were to be large and straight, but also exclusively orthogonal. Cope questioned the diagonal streets Washington, as lacking “propriety.”

Cope, as an eminent Quaker, no doubt preferred the gridiron plan established by William Penn and Thomas Holme more correct for a free and egalitarian society. The even and equal movement of air, water, or knowledge was seen as a tonic that supported temperate, moderate, and healthy bodies and cities. This balancing effect was especially necessary in the unstable new republic.

American Impressions

Many late eighteenth century doctors still held a belief in a vital principal of Classical medical theory, called by Dr. William Cullen, Rush’s doctoral mentor in Edinburgh, “vis medicatrix naturae, ὑπερτοι.” According to this theory based on Hippocratean and Aristotelian writings, illness was a struggle by the body to restore natural balance, and treatment’s role was simply to assist in this task, often through gentle remedies such as teas, herbs, and baths. Dr. Rush argued against the Vis Medicatrix, in favor of a more active approach and became infamous for his bloodletting and purging, on a scale undreamt of by Hippocrates. In his lectures at the University of Pennsylvania, the influential Dr. Rush argued against the theory of his mentor that stimuli were of primary importance and the vital principal a myth. Rush explained that health was a, “quality and not a principle,” which, “consists in the unity or equable diffusion of this motion and sensation, over every part of the body, and in the free and easy exercise of all the

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Cope, Philadelphia Merchant, 89, 52, 65.
faculties of the mind. It is as much an effect of impressions upon a peculiar species of matter, as sound is the stroke of a hammer upon a sonorous body." 317 This dual theory of health, that it consisted in even distribution and that it was shaped by impressions, also underlay Latrobe’s urban water supply system, which attempted a universal distribution and a sensory salve. Latrobe, predicting later nineteenth-century urban planners, designed a physiognomic alteration to the body of the city. Later active interventions, conducted universally and predicting even results, echoed Rush’s modern stance against the passive Vis Medicatrix.

American Circulation


Medical theory of the late eighteenth century relied on ideas of sensation and circulation. Rush’s invention, the tranquillizing chair, was based on the connection of sensory stimulation to mental and physical inflammation. [Figure 39] The chair wrapped its occupant, and shielded and limited his view to contain agitation. Rush’s more aggressive treatments were based on several modern notions relating to circulation and active surgical intervention. Rush was a ‘solidist,’ a theory he had learned during his studies in Edinburgh. He believed that all of the blood vessels and nerves in the body were tubes that must stay strong, toned, and elastic for the body’s fluids to circulate freely, and for systemic balance to be maintained. Rush believed in a health regimen that included the use of baths to purify the skin and to soak water into the body, an action that “braces the animal fibres, and thereby increases their tone and strength,” allowing “the more easy action of the vital, animal and natural functions of the body.” Another component of Rush’s notions of tubes, motion and circulation was the belief that the spread of miasmatic infection could be deterred by channels or basins of fresh water. It is interesting to note in retrospect that tubes and circulation would be a prime consideration of the medical community as a prelude to the idea of the modern city as a network of hidden pipes, though this analogy between body and city was not made by Rush or by Latrobe. One might note that at this time no analogy was required to understand the connection between the two, as all were part of the same fabric.

Rush’s ideas about health were deeply related to his republican ideas about the stages of society, which also formed the foundation of his republican political ideology. In *Experiments and Observations on the Mineral Waters* he wrote:

> The different stages of society, like the different ages of the human body, have their peculiar diseases. In the infancy of all societies, diseases are simple and few in number, but in proportion as they advance in arts and opulence, which always bring along with them the refinements of luxury,

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diseases multiply, and are complicated in such a manner, as to require more powerful aids than simple preparations of plants and metals. 321 Rush further explained that medical treatments were only “substitutes for temperance and exercise,” and that while medical treatments might come and go with fashion, the effects of temperance and exercise, “like the obligations of morality, endure for ever [sic].” James Johnson, in a similar vein, observed that:

[...]

on the population of crowded cities, where sedentary habits and confined air prevail, these excesses exert an infinitely more powerful influence than in towns, villages, or the open country. The citizen then, and particularly the civic valetudinarian ought to be especially on guard against this source of ill health.322

This belief in the association of opulent and immobile urban living, or even excessive civic duty, with disease was commonplace, and would gain even more popularity as the excesses of the city grew during the 19th century. The tension between civic engagement and the risk of disease is a thread that perhaps continues even today. In 1799, it probably reflected a common Jeffersonian fear that the young republic was rapidly aging, in connection with its growing economic and political maturity, and so was at risk of succumbing to the decadent ailments of the old world. Latrobe’s urban square, which will be discussed in Chapter 5, provided an open park with shaded walkways to fight the “sedentary habits and confined air” that were the blight of the town.

Rush explained yellow fever as the result of environmental conditions and personal diet, activity, and mental state, but believed that a technological intervention via the lancet might heal the condition. Rush in his Observations upon the origin of the malignant bilious, or yellow fever in Philadelphia noted that while the fever required “putrid exhalations,” in other words filth and fermentation, it also needed, “an inflammatory constitution of the atmosphere,” which “may be compared with sparks of fire.” The third required ingredient for the illness to blossom within an

individual was, “an exciting cause,” such as being too hot or cold or tired, or any “intemperance in eating, or drinking, . . . or a violent emotion of the mind.” He further noted without explanation that, “The pestilential constitution of the air in the United States began in 1791,” and that the disease, as any inflammation, was dampened by frost and heavy rain. Water was a known and reliable cure, not just for the body, but for environmental inflammation.

The physicians of Philadelphia were divided in their beliefs about the origin and transmission of yellow fever, but most agreed on the efficacy of water as a treatment. In an abridged version of James Currie’s encyclopedia of water treatments, which related at great length how to use a thermometer to measure and manage the body’s hotness and dampness, the author stated that “an American physician, whose name is known in every part of the civilized world,” agreed with Dr. Currie, who documented in 1787 that of seven cases of yellow fever, all were cured when cold water was thrown on them, while the one untreated died. While this may have been an overstatement of the treatment’s efficacy, Rush’s belief in bathing and purging with water was well documented. Otherwise, he and Currie were at odds over the treatment of the fever.

In addition to the use of water, the balance of temperature and the circulation of air could be marshaled to treat disease. The Humane Society’s 1789 broadsheet advising on the treatment of various illnesses pointed to the importance of balance in temperature, especially around water. The Society advised that when drinking very cold water, one should first warm the vessel with one’s hands “and thereby lessen the danger which arises from the excessive heat of the body, on the one hand, and the coldness of the liquor, on the other.” Further, “the dangerous Effects of noxious Vapours, from Wells, Cellars, fermenting Liquors,” could be prevented by, “procuring a free circulation of air.” The treatment for someone ill from bad air was the same as that for

323 Rush, Observations upon the origin of the malignant bilious, or yellow fever in Philadelphia, 6, 10, 1.
324 James Currie, An abridgement of the second edition of a work, written by Dr. Currie, of Liverpool in England, on the use of water, in diseases of the human frame; and fever, opium, strong drink, abstinence from food, and the passages through the human skin; with occasional remarks (Printed by Peter Edes of Augusta, in the District of Maine. Sold by Mr. Edes of Augusta, and Mr. Bass of Hallowell, in Maine; and by the booksellers of Boston, New-York, and Philadelphia, 1799), VI: 2.
drowned persons, namely they should be moved to a place with “wholesome air; then let the body be stripped, and let cold water be thrown from buckets over it for some time.” Then the head should be raised, and air blown into the nostril for several hours from a bellows. These instructions were signed by the managers of the Humane Society, including Benjamin Rush, Caspar Wistar, Tench Coxe, and Johns Hopkins.325

Despite his stated political allegiance, Latrobe’s solution responded to both the Federalist and the Republican medical and political opinions. Doctors and civic leaders of all persuasions at the time valued the efficacy of cleaning the streets to improve the city’s health. But the waterworks was also designed to encourage the circulation of air and of water. In Latrobe’s own words, the role of the waterworks was to change, “the whole city,” through fountains that would allow it to be, “alternately cleansed and cooled.”326 This solution fell solidly into the Hippocratean category, as it promised to balance inflammation and to provide a more tempered and temperate climate. It must also be interpreted, however, as a truly modern intervention, in the vein of Dr. Rush’s treatments, because it assumed that the condition of the natural environment could be wholly altered by the administration of an active technological intervention.

Latrobe’s second ambitious goal, beyond the alteration of the climate of the city, was to provide adequate water so that Philadelphians might embrace the Roman tradition of baths, an idea perhaps not coincidentally in alignment with his neoclassical aspirations for American society, and for Philadelphia in particular, which he named, “the Athens of the Western World.” In the same passage, Latrobe argued that while Greece was the paragon of liberty which is the basis of art, it was Rome that proved, “that the cultivation of the fine arts is by no means incompatible with republican institutions.” Latrobe cited Roman public baths and aqueducts as proof of, “the importance attached to the semblance of popular rights, and the indulgence of

326 Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 1, 18.
popular pleasures, even by the most tyrannical emperors,” as well as evidence of the important connection between public works and “the arts of design.”

In his waterworks proposal of 1798, Latrobe focused his argument on the unique urban condition of Philadelphia in section titled “Public Baths.” He opened with a query which is worth quoting at some length:

I have often wondered, that while in many despotic countries, all ranks of men have been provided with the convenience, and the wholesome pleasantness of public baths, fountains, and porticoes, the American people do not indulge themselves, in the smallest gratification, as salubrious, as it is innocent of this kind. Our abstinence is commendable, as it arises from industry, and our attention to more serious pursuits, but highly blameable as it injures our health. ... In the city of Philadelphia, I think baths almost an absolutely necessary means of health. When the engine in center square is at work it will with great ease supply a requisite number of baths. ... Such baths would be a source of a large revenue and perhaps it might not be bad policy in the citizens of this primary metropolis of North America, to counterbalance the fashionable inducements which point to the Powtowmac, by conveniences and advantages which cannot for many years be thought of in a city, which is at present almost destitute of dwellings.

Several things are interesting in this passage. First, Latrobe believed that the provision of water, not just for drinking but also for baths and fountains, was a public work to be provided by the government. This was by no means an automatic assumption, as this had not yet in fact been the case in any American city, nor in recent memory in any major European city. Secondly, he associated baths not just with leisure but with health, a view held by some but not all doctors at the time. And finally, he argued that American seriousness and industry might run counter to public health. His closing plea that the water he supplied might allow for baths which would attract people away from the new capital at Washington, D.C. was certainly a savvy way to gain

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327 Latrobe, Anniversary Oration Pronounced Before the Society of Artists, 16-17.
328 Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 19.
the support of civic leaders sensitive to the reduced status of the city. It also shows that he was aware that the waterworks would be a spectacle and lure to visitors.

Latrobe’s aspirations were original and ambitious, though in some cases based on ancient Greek and Roman or nearer European precedents. Yet his desire for a cooling tower was specifically connected to American republican medical theory which stressed the role of inflamed airs and imbalance as the underlying causes of disease. Latrobe was clearly aware of these theories, and developed his own ideas about the cause of fever, though these shifted during the course of his time in America. A few months before he devised the water supply plan for Philadelphia, in a melancholy journal entry after the death by yellow fever of his dearest friend in America, Dr. Scandella, Latrobe stated that, “in the vitiated state of the atmospheres of a town a chemical combination of airs may take place, ... which therefore combine, with the blood, or are mixed with it by an animal process, and produce inflammation. ... Accurate experiments might settle this point and throw light on the treatment of the fever.”

Latrobe’s waterworks was an urban experiment in applied science, and a political salve for a heated city. The remedy for fermentation and inflammation was understood to be motion and coolness, and this circulatory improvement is what I believe Latrobe was attempting to supply with the construction of the Philadelphia waterworks. The execution of this radical cure embodied a certain balance. Latrobe’s fulfilled the Republican idea that all citizens should have water for free, while meeting Federalist desires to combine public and private initiatives and to erect stately civic monuments on a par with those of Europe. This ameliorative balance was a palliative to a third option, the radical democratic movements that were flaring up in America and threatening to unseat the functional hierarchy. While Latrobe and other Republicans spoke as populists, they clearly offered a more limited notion of democracy, in which the elites were

329 Latrobe, Journals, II: 439.

The efficacy of the waterworks as a cure for the fever is questionable. Since the disease is spread by mosquitos, street cleaning was a helpful measure but the device also created more standing water in some places.
elected to manage on behalf of the less fortunate. Latrobe’s aesthetic intervention was a gesture towards a Classical Athenian notion of patrician democracy that was not entirely comfortable within the American atmosphere of utility and constant improvement. The following chapter will address the Center Square Engine House as a figure designed to symbolize the municipal gift of water, anchoring the system in the public imagination and way of life.
From having observed the gradual evolution of the young animal or plant from its egg or seed; and afterwards its successive advances to its more perfect state, or maturity; philosophers of all ages seem to have imagined, that the great world itself had likewise its infancy and its gradual progress to maturity...

—Erasmus Darwin, The Botanic Garden, 1791

... And on this account, we find ornaments increase in proportion as art declines, or as ignorance abounds.


This chapter addresses the discrete architectural object of the Center Engine House within a family of related modern designs, all of which assumed the existence of a direct link between untamed nature, clarity of geometrical form, and the improvement of human sensation, thought, manners, and morals. The Center Engine House and the ground on which it sat were designed as an integrated whole that operated within this context. [Figure 40] This early American pavilion in a park achieved Latrobe’s definition of “Taste” as a beneficial combination of opposites. Latrobe’s ambitious design unified pure opposing geometries, the circle and square, and was calculated to represent the integration of highest technological works of man with the power of nature it harnessed. Embedded in its austere geometries were assumptions concerning the possibility of achieving equilibrium through the interventions of art and science. Latrobe was guided by his knowledge of the past, but also by the realities of, and his hopes for, the unique American situation. This idea marks Latrobe’s work as an example of modern architecture guided by the idea of evolution, even prior to the later nineteenth-century calcification of the term.  

Latrobe composed the pavilion and plan of the Center Engine House within rigorously calculated rules of intersecting orthogonal and circular geometries, while the engine, hidden at the center, was integrated within the wider urban framework of airs, waters, and temperatures. Latrobe could not have thought of these as separate efforts. His design was for a work of art that united two dimensions, the architectural and the technical, in an effort to simultaneously achieve different types of urban and environmental equilibrium. This equilibrium can also be understood

In fact, Erasmus Darwin used the term in various ways to describe organic growth and change a half a century before his grandson would popularize the modern scientific idea of “evolution.” From The Botanic Garden (1791):

“The gradual evolution of the young animal or plant from its egg or seed.”


Discussing David Hume, in Zoonomia (1801 ed.)

“...he concludes that the world itself might have been generated, rather than created; that is, it might have been gradually produced from very small beginnings, increasing by the activity of its inherent principles, rather than by a sudden evolution of the whole by Almighty fiat. —What a magnificent idea of the infinite power of THE GREAT ARCHITECT!”

within the context of the modern architecture of the time, which was a progressive movement based on a simplification of past models and adaptations of form to more clearly demonstrate natural laws and to accommodate new situations and individual improvement.

The first section of this chapter elaborates Latrobe's aesthetic ideas according to his theories of ornament and evolution, and evaluates the problems he faced in wedding the simplified neoclassical form of the Center Engine House with its complicated technical contents. The second section casts the engine house within the context of adjacent and similar rotunda projects of which Latrobe may have been aware. The third section describes the broader field in which Latrobe's design is sensible, that of the remediating architectures of public works, civil architectures, and scientific designs. In each of these categories aspects of sensation, including light, vision, and airs, were managed through compositional equilibria.
4.1 Simplicity and manners

What is injurious to the object, or inconsistent with the use of a building can never be ornamental. Simplicity is one of the first of Architectural ornaments, and the highest achievement [sic] of study and of taste; and to the attainment of the object you have in view it is as conducive, as it is consistent with the manners of your society.

—Benjamin H. Latrobe, Letters, I: 405, Letter to Thomas Parker, 1803

America had never seen a monument to municipal environmental management and so had no existing custom or habit. It could be seen as both a problem and an opportunity that the engine house was not yet established as a civic architecture in America, and a structure and ornament appropriate to the setting and purpose had not yet been determined. Latrobe had a large degree of latitude in his design, and it is impossible to doubt that he hoped to invent an architecture that would ensure the improvement of the character of Philadelphia and its citizens, and also regulate the quality of the city’s airs and waters.

While peculiar in its resolution, I argue that Latrobe attempted to create a new aesthetic of utility that would represent American democracy, understood as a balance between art, technology, and nature. Its spare volumes mark the engine house as a new type of civic center, built to house a machine that improved the environment and supplied basic human needs, rather than to shelter a government that guided human behavior. Latrobe’s wish seems to have been that the building’s simplicity would supply an ornament in keeping with evolving American manners. That the site was soon appropriated for raucous celebrations, and became a location known for a murder and robberies, indicates that his optimism regarding both the potential for American cultivation and the powers of geometry and nature were not entirely warranted.

The Center Engine House was composed first of all as an integration of opposites, nature and technology, water and fire, circle and square. Latrobe referred to the two parts of his Center Engine House as the “quadrangular part,” and the “circular wall,” when the building was under
construction. The base and the cylinder each had an exposed height of 24’6”, with the dome height bringing the overall vertical dimension to 60’, identical to the width of the building in plan. The engine house was constructed as a cylinder atop a pedestal, with the appearance of having been carved from a perfect cube of 60’ by 60’. This symmetrical, orthogonal base geometry allowed almost limitless reimpositions of these modules within the building and across the site.

Latrobe was insistent on maintaining this ideal geometry. Thomas Pym Cope, the unfortunate member of the Water Committee who so often engaged with the man he called “the Engineer,” noted in his diaries that on November 24th of 1800, he was visited by the steam-engine builder Nicolas Roosevelt, who informed him that their engine would produce enough power to raise water 10’ higher than the contract amount, and so Latrobe “has run the building that much higher.” Yet all later measured drawings of the building, including the design around 1817 by his student William Strickland for a renovation which would have converted the building into an observatory, reflected minor changes to the height of windows and depth of dome, but did not reflect any extension of the overall height of the cylinder or change to the façade heights of cylinder and base. [Figure 41]
Figure 41 - William Strickland, "Elevation of the Philadelphia Observatory, Plan of the Parapet Story," c1817. Courtesy of the American Philosophical Society.
Latrobe’s plan for the waterworks had been arrived at quickly and from the start evidenced a very clear architectural idea. Latrobe’s first sketches, likely presented at a meeting of the city councils on March 3, 1799,\(^3\) show a drum pilaster adorning the central cylinder. These drawings also include the pencil-drawn note, “Nb. No pilasters.” [Figure 42] The applied ornamental pilasters were absent from all future drawings, leaving an unobscured austere combination of two central volumes. The argument has been made by the editors of the Latrobe manuscript collection that the pilasters would have made the engine house a “cultural form,” by tempering the “severe geometry,” and that their removal acknowledged the truth of the house’s contents.\(^4\) In a sense this is true, but even a brief consideration of this building in light of prior European water houses indicates that by utilizing a perfectly symmetrical rotunda form, Latrobe’s

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\(^3\) Latrobe, *Engineering Drawings of Benjamin Henry Latrobe*, 173.

\(^4\) Latrobe, *Drawings*, I: 239
neoclassical shell concealed more of its internal workings than it revealed. As I hope to demonstrate, Latrobe was making an effort to wipe clean the slate of “culture” to suit America’s young temperament, and also hiding the technological devices that were not yet seen as part of the broad and perfect System that united nature, art, and sensation.

Latrobe’s engine house was never entirely successful on a technical level for the reliable provision of water to the city, but it did promote Latrobe’s early theory of an American art and society based on simplicity. Latrobe explained that simplicity is, “the highest achievement of taste and of art; not only in architecture, but in poetry, in rhetoric, in dress, and in manners.” The second part of this theory concluded that a world united by universal principles dictating motion and change could be manipulated towards improvement. The union of these theoretical and technical concerns perhaps explains Latrobe’s removal of pilasters from his Philadelphia waterworks. If an increase in ornament tends to accompany the decline of art, his gentle pencil-drawn note, “n.b. no pilasters,” signals an evolutionary step towards a nakedness unashamed of strength or utility. Unfortunately, the image of strength bore little relation to the financial or mechanical utility of the building.

Latrobe was a founding father of American neoclassicism, but showed little interest in some of the more expressive or emotional elements of eighteenth-century theory. The editors of Latrobe’s collected architectural drawings argue that his works combine “three different but mingled currents ... the neoclassical, the picturesque, and the sublime,” but also point out that, “neoclassicism was far and away the broadest, deepest current in Latrobe’s art.” This is a dead reckoning of Latrobe’s thinking. In his letter to Congress of 28 November, 1806, they find Latrobe’s clearest statement of his vision of neoclassical art. Latrobe, protesting against Dr. William Thornton’s design for the exterior of the north wing of the U.S. Capitol, argued that:

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335 Latrobe, Correspondence, II: 306.
336 Latrobe, Drawings, I: 3.
The chaste and simple buildings of the best days of Athens have been considered as the work of the Gods, even by the barbarians who have despoiled them to erect their own complicated structures. Nothing is so easy as to ornament walls with foliage, with wreaths, festoons and drapery, with pilasters and rustic piers; especially if it be not required that these things should have the remotest relation to the purpose of the building upon which they are carved or that they should contribute to the real or apparent strength or convenience of the structure. And on this account, we find ornaments increase in proportion as art declines, or as ignorance abounds.  

Several things are important about this statement, all of which relate eventually to the art-historical definition of neoclassicism, but perhaps more importantly, Latrobe's protest against Dr. Thornton's festoons provides a clue to his own concept of the role of ornament and of change in architecture.

Latrobe's basic argument, that the fault of inferior designs is that their ornament has no relationship to "the real or apparent strength or convenience of the structure," was not a radical idea. That structural and natural truths were the foundations of architecture was the argument popularized by Abbé Marc-Antoine Laugier during the latter half of the eighteenth century in service of what was understood as Greek architecture. The concept of "convenience" was of course an ancient theory appearing in Vitruvius, but obtaining a more radical meaning with Claude Perrault. Perrault's approach to architectural history, like that of Latrobe, demonstrated his inclination to the empirical study of physiology. In Perrault's *Ordonnance for the Five Kinds of Columns after the Method of the Ancients* of 1683, he treated the architectural orders as specimens which could be measured and compared, with dimensions listed, graphically represented, and averaged – treated as custom rather than as eternal truths. Latrobe was not as radical as Perrault, but similarly, he found it possible to believe both in rational natural laws, and in changing standards of beauty.  

And, like Perrault, he believed that the mind or soul was

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337 Latrobe, *Correspondence*, II: 306.
338 Latrobe could not have speculated, as did Perrault, that "Hence, neither imitation of nature, nor reason, nor good sense in any way constitutes the basis for the beauty people claim to see in proportion and in the orderly disposition of the parts of a column; indeed, it is impossible to find any
acted upon by this beauty, though Latrobe would certainly have maintained proportion, shape, and form amongst his list of the “positive beauties.”

Latrobe’s theory of ornament was a derivative of seventeenth and eighteenth-century natural science and global exploration and archaeology, and drew on the idea that as societies advance, so do their manners, taste, and art. In Latrobe’s proto-evolutionary theory, a reduction of ornament could be equated with an advance in culture, both through choice and causation. Perhaps one might judge Latrobe as a modern hybrid of the positions of Perrault and Laugier. Latrobe argued for the purity and truth of Greek architecture, while assuming that the fundamental laws of geometry and sensation that underlay this architecture existed in nature and history. Simultaneously, he attempted architectural adjustments within the limits of these laws, in order to predicate an improvement of taste, situation, and manners. In other words, the rules of nature might be invoked and mobilized through the arrangement of historical models of architecture to improve what Perrault would refer to as “custom,” thus improving the mind and the larger society. There was certainly no room in Latrobe’s theory for any “arbitrary beauty.”

Unfortunately, the underlying rules of nature that drove the steam-engine were in conflict from the start with the rules of Latrobe’s ambitious civic aesthetic. Latrobe’s effort to turn a technological artifact into a centralized civic ornament unfortunately forced its function into disequilibrium. The Engine house drew all functions under one roof, almost entirely unique in comparison to precedent, even squeezing the boilers and reservoir underneath a marble shell. The simple geometry of the cylinder within a prism was also forced to enclose a coal cellar, offices,

source other than custom for the pleasure they impart.” (Perrault, 51-52) Reason and nature were the basis of beauty for Latrobe. In fact, custom was open to advancement by adhering more clearly to the rules of nature.

Interestingly, Thornton was an English Quaker, who, like Dr. Rush, had been a medical student in Scotland. The incidence of medical doctors as architects would soon wane, but it is important at this point that medical theories of equilibrium are met with architectural theories of neoclassicism, and the building as a body that manages to contain and connect separate functional political organs. Religious beliefs also may have played a part in this idea of division and distribution. The Quakers, like the Moravians, emphasized the architectural reinforcement of social divisions.
and a room for a superintendent. In plan the engine house was pressed and skewed, attempting to align the ideal grid with the centripetal core, unfortunately filled with a large and non-cylindrical steam engine. The closeness inside meant that there was very little light or room in which to carry out repairs. In 1807 the Watering Committee reported that they would not install the largest of three planned replacement reservoirs. They were willing to sacrifice the volume of stored water because, “the contracted space of the building will not admit a greater number, without intercepting the light, which is necessary in so complicated a machinery.” In the same report they complained that the flywheel had never been “sufficiently weighty to steady the engine,” because “the contracted space of the engine room, could not admit of a larger one,” but note their intention to cut into the south wall to allow the installation of a 20’ wheel.340

Figure 43 – Elevation Comparison, based on Benjamin H. Latrobe, detail from "Sketch for a design of an Engine house & Wateroffice in the City of Philadelphia March 1799," in Latrobe, Drawings, I:pl. 6b, versus Latrobe, "Second, or Center Engine House No. Ill, East and West Elevations facing Market Street," from Latrobe, Designs of Buildings erected in the Year 1799. Courtesy of the Historical Society of Pennsylvania.

Figure 44 — Section Comparison, based on Benjamin H. Latrobe, detail from "Sketch for a design of an Engine house & Wateroffice in the City of Philadelphia March 1799," in Latrobe, Drawings, I:pl. 6b, versus Latrobe, "Section from West to East, looking Northward," from Latrobe, Designs of Buildings erected in the Year 1799. Courtesy of the Historical Society of Pennsylvania.

Figure 45 — Plan Comparison, based on Benjamin H. Latrobe, detail from "Sketch for a design of an Engine house & Wateroffice in the City of Philadelphia March 1799," in Latrobe, Drawings, I:pl. 6b, versus Latrobe, "Second, or Center Engine house, Plan of the Ground Story," from Latrobe, Designs of Buildings erected in the Year 1799. Courtesy of the Historical Society of Pennsylvania.
A comparison of Latrobe’s proposal drawings from around March 3rd of 1799 to his presentation drawings from sometime between 24 November 1799 and early 1800 is instructive regarding the struggles Latrobe faced resolving technical requirements with architectural intentions, despite his understanding of the two as aspects that might be unified within the same effort. [Figure 43] It was a difficult process to rectify the two after construction began, since the foundations had to be placed and the walls partly raised before the engine had been built. Latrobe gave his written description of the system on 29 December of 1798 and crafted drawings during the next two months. The initial plan of March 1799 was organized with the lobby to the north, and the coal cellar to the south, the two rooms aligned with Broad Street. [Figures 44 and 45] This plan called for four Doric columns screening each portico at the east and west fronts facing on Market Street, with columns spaced two widths apart. An upper ring of blank panels expressed on the exterior the band between the edges of the upper roof dome and the lower interior dome. Even in the first proposal, the technological contents were barely contained. The reservoirs, whose height and purpose theoretically justified the height and prominence of the Engine House, barely fit within the dome. Wooden bracing struts projected through the wall into the northern “lobby.” On the south, a notch was made in the wall to receive the flywheel. The upper beams appeared to directly intersect the band of the windows that ringed the cylinder.

The resolution of the interior distribution of rooms indicates that as construction continued, Latrobe came to a more sophisticated understanding of the technical demands associated with the operation of a steam engine. A section completed later in 1799 indicates that the wall of the cylinder was carried up 4’8” higher than in the original plan, allowing the crossbeam to be landed securely within the wall, with a stabilizing weight above it. This also shifted the windows and the base of the inner dome. The final plan drawing, after two intermediate iterations, showed alterations that demonstrate an accommodation of the intense demands that the maintenance of the engine would require. In the initial plan, the three rooms to
the north were reserved for the city engineer, an adjoining lobby, and his clerk’s office. At that moment, Latrobe still hoped that he would be occupying the city engineer’s office, which was on the northeastern corner, facing the city. Steps down from the lobby allowed direct access to the central chamber. In the revised final plan, these rooms were listed simply as “Water Offices of the City.” The southern rooms had been entirely separated in the initial design. Each office was externally accessible from the portico. The eastern room, which was closest to the settled part of the city, was for the steam engineer’s offices. The southwestern room was the engineer’s chambers. Both southern rooms had door openings to access the steam engine. In between was the coal cellar, accessible only from within the cylinder. In the final plan, these two corner rooms no longer connected directly to the cylinder chamber, and were marked “Engine Keeper’s Apartments.” This seems a recognition that a full-time attendant would need to be resident at the engine, and that the “keeper,” who might want some separation from the noise, heat, and smoke from the engine, would not be a steam engineer. This may also reflect the fact that by late 1799 Latrobe was at odds with Nicholas Roosevelt, the steam engineer, and while Latrobe still imagined that he might be appointed City Engineer, he did not care to share the Engine House with Roosevelt.

The modifications between the initial and final plan were minor, which is perhaps unsurprising, since the strict geometries of a square and circle allowed very little room for alteration without sliding into irregularity. Some of the changes that were made acknowledged the need for the engine house to be habitable by humans, but unfortunately resulted in a plan even more cramped and contorted. Each corner room received a fireplace in the final iteration, again an indication that the job of maintaining the engine would require that the house was actually a house, a place in which men could comfortably live through night and day, and in every season. A tiny closet was also added to each room, adjacent to the fireplace. In a note of what turned out to be appropriate optimism, a foundation plan dated 1799 marks the future location of the water
main that would in future supply the western side of the city, "Situation of a descending Main for the West part of the City when built." Of course, the Center Engine House would be decommissioned in 1815 and demolished in 1827, so while the western city did become settled and "improved," the architecturally encased engine would not be there to serve it.

The shell of the Center Engine House became more solidly rooted and even more tightly wrapped around its contents in the final iteration, and clarity of the design suffered. The north and south elevations gained thickened piers to support arched vaults, and the basement level was deepened in the final version to represent the reverse-arch foundation construction and the true depth of the intake pipe. The foundation was brick, probably similar to Latrobe's design for the Baltimore Cathedral. [Figure 46] Obviously the foundations preceded what I propose was Latrobe’s evolving understanding of the engine and its requirements, and the perfect prism could not expand. The facing porch walls no longer traced the curvature of the cylinder, instead they were flattened to provide intramural space for the angular interior closets. The centralized niches on each porch were replaced with three recesses, unfortunately pinched inwards by the tiny closets so that they fell out of alignment with the colonnade, which had shifted from tetrastyle to distyle-in-antis. Each column widened in the final plan version from approximately 2' wide to 2’8” in diameter, and 16’6” in height. Though the plan changes were minimal and internal, the grace of the façades suffered as they registered the internal alterations.
Figure 46 - original brick reverse arch foundations, Baltimore Cathedral, with more recent additions and renovations.
[photo C. Bonier, 7 July 2013]
4.2 Neoclassical Balance

The Center Engine House was based on a strict interplay of opposing geometries, and on a simplicity Latrobe deemed appropriate to American manners. For Latrobe, as well as Jefferson, and many of their philosophical compatriots, simplicity in manners was equated with what was understood at the time to be Greek, or "modern" architecture, despite a generalized grouping of arcuated walls and domed vaults into this realm. In 1811, Latrobe made a plea that "indeed, the days of Greece may be revived in the woods of America, and Philadelphia become the Athens of the Western world." What both he and Jefferson identified as a "Greek" architectural style, was a neo-classical recombination derived from multiple sources. It is certain that Stuart and Revett, who also favored the Greek over the Roman style, were a favorite reference for Latrobe. He also admitted borrowing architectural details from William Chambers *A Treatise on Civil Architecture* (1759), but made efforts to distinguish his own opinion, "I have followed the Greek rather than the Roman Style, in spite of Sir William Chambers."

Latrobe's analysis of Greek and Roman art is only intelligible within the context of his political theories. He believed that republican freedom allowed a flourishing of Greek art, and that Roman art foundered with the loss of that freedom. In a public address given in 1811 in Philadelphia, Latrobe repeatedly described "republican simplicity" as the pinnacle of art, and of politics. He praised "the most splendid era, which the arts have ever witnessed," as Pericles' Athens, the highest example of culture, where "perfection in the fine arts, freedom in government, and virtue in private life, were coetemparaneous." He was highly critical of Rome, a position

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341 This view was also shared by Humphry Repton. "The two characters of architecture might, perhaps, be distinguished by merely calling the one GOTHIC, or of old date, and the other GRECIAN, or modern...." (Repton, *Sketches and Hints*, 15)
343 Latrobe, *Correspondence*, I: 553
held by most republican thinkers. Latrobe found “imperfection” and “absurdity” in the excesses of Roman architecture.346

The combination of the circle and square is an ancient and important problem of integration and balance in architecture, as well as a recurring theme of eighteenth-century neoclassicism, so there may be no need to trace the Center Engine House to any specific near precedent, yet it seems relevant to describe Latrobe’s architectural setting. The most advanced architecture of the time was a simplified neoclassicism based on an adaptation of ancient forms. Neopalladian experiments had a strong place in the taste of the time and coincided with the political and scientific emphasis on balance. As Michael Fazio and Patrick Snowden explain, during the early eighteenth century in France and England architects such as Colen Campbell, Lord Burlington, Jean Courtonne explored neopalladian rotunda plans for domestic designs.347 Latrobe was also, of course, familiar with the work of Robert Adams. During the later century, the grand rotunda of Soufflot’s Ste. Genevieve was known to most of the educated elite, and certainly to European architects. Its structural innovations, quality of light, urban influence and symbolic centrality inspired both Thomas Jefferson and Latrobe. Both men had an even stronger affection for Nicolas Le Camus de Mezières’ Halle au Blé and were knowledgeable regarding the construction of the wood-framed dome by Jacques Guillaume Legrand and Jacques Molinos during 1782-83. Jefferson owned a copy of Philibert Delorme’s Nouvelle inventions pour bien batir and visited the “Corn Hall” when he was ambassador to France between 1785 and 1789.348

It is perhaps unsurprising that Jefferson’s submission for the President’s House competition of 1792 was a four-faced execution based directly on Palladio’s Villa Rotunda.349 [Figure 47]

346 Latrobe, Anniversary Oration Pronounced Before the Society of Artists, 15, 16.
347 Fazio and Snowden, The Domestic Architecture of Benjamin Henry Latrobe, 231.
Jefferson’s influence on Latrobe cannot be overestimated, and was especially strong during Latrobe’s first days in Philadelphia, when Latrobe was attempting to win Jefferson’s friendship and admiration. This connection points us to one of Jefferson’s favorite references, *Select Architecture* (1757) by Robert Morris. This work, the second edition of *Rural Architecture* (1750), includes several rotunda designs, though in all cases the central bearing walls are octagonal in plan. Morris’ plan for “a Building for a Garden or Summer House,” [Figure 48, Plates 42 and 43] as well as “the Ionick Order, of an octangular Temple or Chapel, 60 Feet in the outer Diameter,” [Figure 49, Plates 31 and 32] in particular bear a resemblance to several of Jefferson’s later designs. Jefferson certainly consulted *Select Architecture* during his renovations to Monticello.\(^{350}\)

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Figure 48 - Robert Morris, *Select Architecture*, 1757, pl. 31-32.

Figure 49 - Robert Morris, *Select Architecture*, 1757, pl. 42-43.
In fact, with small alterations, the central volume of Morris’ Ionic octagonal Temple becomes a less lofty twin of Latrobe’s Center Engine House. This garden temple, Morris explained, had inspired some criticisms, since acoustics demanded that, “the inner Part should have been a Circle in the Plan, and the Roof spherical.” If the 40’ octagon were made cylindrical, per acoustical demands, and the 60’ outer octagon were pushed out at the corners to make a square, it would be an exact match in plan for the Center Engine House. A similar manipulation can be accomplished with the Summer House, but its dimensions are 2/3 those of Latrobe’s design. Yet the purpose of this Summer House, “an ornamental Termination of a walk, or for Prospect, or an Evening’s Repast in a Garden, &c.” seems entirely appropriate to the situation of the engine house, fixed at the crossing of two major roads, but also sheltered within a green commons. It seems possible that Latrobe knew Morris through his books. Though there is no mention of Latrobe borrowing Jefferson’s copy of Select Architecture, he did lose an architectural library of 1500 volumes when crossing to America and this volume might have been among their number. Whether Latrobe referred directly to Morris, it is clear that Morris was influential in the development of the eighteenth-century ideas of character and situation, which will be addressed in the following section of this chapter.

There were many historical sources, both ancient and more recent, for Latrobe to have drawn on for his engine house design, but by the late eighteenth century, centralized integrations of a cylinder and square were also a popular topic of investigation for the most advanced modern architects. The geometric problem of adapting a rotunda and a square to modern concerns was addressed most fashionably by Latrobe’s near contemporaries in Europe and England, Claude Nicolas Ledoux and Sir John Soane. While none of their circle in square designs were meant to house a steam engine, they did house other technical water programs, including ice houses, baths,

351 Robert Morris, Select Architecture: being regular designs of plans and elevations well suited to both town and country; in which the magnificence and beauty, the purity and simplicity of designing, For every Species of that noble Art, is accurately treated, ... (London: sold by Robert Sayer, opposite Fetter-Lane, in Fleet Street, 1757), 7.
and more symbolic technical programs, such as the visionary river keeper’s house. Also, Ledoux constructed one of his Barrières du mur des Fermiers généraux immediately adjacent to the reservoir at Chaillot, making it a possible reference for Latrobe. He visited Paris in 1783, and the barrière was under construction between 1786 and 1788, though it is unclear whether he might have seen an engraving of the structure. [Figures 50 and 51]
Figure 50- Claude Nicolas Ledoux, « Plan du Premier Étage, Plan du Rez de Chaussée, Plan des Souterrains ; Propylées de Paris situées sur le Chemin de Chaillot vis-à-vis le réservoir, » L’Architecture considérée sous le rapport de l’art, des mœurs et de la législation, 1804, Pl. 24 (Princeton Reprint, 1983).
Figure 51 - Claude Nicolas Ledoux, « Coupe, Elevation, et Plan Général, Propylées de Paris situées sur le Chemin de Chaillot vis-a-vis le réservoir, » L'Architecture considérée sous le rapport de l'art, des moeurs et de la législation, 1804, Pl. 25 (Princeton Reprint, 1983).
Despite its relative modesty, the neoclassical shell of the Center Engine House might be positioned between its two fashionable European cousins, in the modern style of the day. The first is Ledoux' aforementioned Barrière des Réservoirs sur le Chemin de Chaillot (1786-88), the other Sir John Soane's Hunting Casino (1793). [Figure 52] I would argue that Latrobe’s work also fell at a functional, though not an aesthetic, balance point between these two examples, municipal regulatory structure and picturesque country retreat. The design, especially as rendered by Latrobe, appears as a pavilion in an English style natural landscape, but was constructed as a new type of urban fabrique integrated within the grid of the city. By its position and its public visibility within the primary axis of the city, it declared itself a public structure, a punctuation mark, like the barrières, meant to mark and announce a government function. Yet in the American case, unlike the Parisian, it was the marker not of an act of taking (taxation) but an act of giving, an emblem of the free service provided to all citizens.
Latrobe’s decision to frame Philadelphia’s steam engine and reservoir within a rotunda may have had a good deal to do with his familiarity with John Soane’s work. It is certain that Latrobe had studied Soane’s *Sketches in Architecture* (London, 1793) which included the Hunting Casino and a Mausoleum which may have influenced the design of the Center Engine House. The editors of Latrobe’s drawings say that it is “doubtful” that he knew Soane’s *castello d’aqua*, (1779-80), which were submitted to the Royal Academy of Parma, since these were not widely circulated, but even without access to these, he would have had the opportunity to study Soane’s earlier designs for a series of country pavilions.
The 1778 edition of *Designs in architecture; consisting of plans, elevations, and sections, for temples, baths, casinos, pavilions, garden seats, obelisks, and other buildings; for decorating pleasure grounds, parks, forests, &c. &c.*, (reprinted 1789) included a wealth of rotunda plans, from the scale of garden temples to a grand mausoleum to the memory of James King, Esq. Both the 1793 and the 1798 editions of *Sketches in Architecture* include several examples of unique architectural devices, each of which bears a geometry calibrated to enfold a simple technical function. The first of these instrumental designs, a “belle-vue” designed for Lord Eardly is a cylinder wrapped in an orthogonal base that displays an astonishing verticality to obtain the prospect of the countryside. [Figure 53] The second is a *castello d’acqua*, built for the Earl of Hardwicke to mimic a mausoleum. It has a shallow dome with a strigillated band at the eave quite similar to the pattern that ringed the oculus of the Center Engine House in the presentation drawings of 1799. [Figure 54]

Figure 53 - Sir John Soane, Belle-Vue, *Sketches in architecture. Containing plans and elevations of cottages villas and other useful buildings with characteristic scenery*, 1798, Pl. XL. Courtesy of UPenn Fine Arts Library Rare Books Collection.
These instrumental neoclassical designs demonstrate the affiliation of Latrobe’s engine house with what was then termed “civil architecture.” A third example from Soane’s *Sketches in Architecture* is an ice house, which is an artful combination of a simple arched porch, rectangular in plan, and an embedded spherical room behind that tapers in section as it dives below ground. [Figures 55 and 56] While this design does not at first appear similar to the Center Engine House, it demonstrates the same approach to technical planning. Both designs are based on the manipulation of two strong geometric forms, rectangular and circular, to surround a technical hydraulic function embedded in the ground. These devices both shifted the temperature and therefore the quality of the air, by the architectural manipulation of water. Soane’s small house is depicted in a verdant pastoral scene, similar to Latrobe’s 1799 presentation rendering of his design for the Center Engine House.
Figure 55 - Sir John Soane, Ice House, Sketches in architecture. Containing plans and elevations of cottages villas and other useful buildings with characteristic scenery, 1798, Pl. XLII. Courtesy of UPenn Fine Arts Library Rare Books Collection.

Figure 56 - Sir John Soane, Plan and section, Ice House, Belle-Vue, and Castello d’Aqua, Sketches in architecture. Containing plans and elevations of cottages villas and other useful buildings with characteristic scenery, 1798, Pl. XLIII. Courtesy of UPenn Fine Arts Library Rare Books Collection.
Latrobe’s early drawings in America included similar examples of civil architecture, including dairy houses and other garden temples. Like Soane’s ice house, these designs featured modest temple fronts that served more as prospects from which to view a garden than as entry areas from which to perceive the contents of the house. In 1789 or 1799 Latrobe partially rendered a design for a milk house, and after 1812 designed and built a similar dairy house for Robert Goodloe Harper in Baltimore. The plan and elevation of the earlier design show a distyle-in-antis temple, set astride a cooling stream. [Figure 57] Inside the temple there are locations for milk cans to be set into the water passing below. The porch would have been a partly sheltered place from which to look out over the stream.

Figure 57 - Benjamin H. Latrobe, Garden temple/ milkhouse, plan and elevation, incomplete presentation drawing, in Latrobe, Drawings, I: 172.
Another type of natural retreat which Latrobe considered prior to his work in Philadelphia was the bath pavilion. During his time in London, probably sometime between 1791 and 1793, Latrobe sketched series of studies for baths. [Figure 58] The rectangular base of the engine house bears a strong resemblance to a bath characterized by a tripartite arctuated façade. The Center Engine House contained a more demanding technology, but it might be interpreted as a heightened example in the range of a family of hydraulic garden temples imagined by the young architect. These buildings reposed gently within natural surroundings, and provided retreat and restoration for their inhabitants. A fair number of these civil works were crafted to alter sensation or environment, for instance elevating the eye to frame a dramatic prospect, or channeling water to create a chilled or heated room.

Figure 58 - Benjamin H. Latrobe, "Sketches for Baths," in Latrobe, Drawings, I: 78.
4.3 Architectures of Remediation

The position of Latrobe’s pavilion somewhere between country pavilion and regulatory structure has already been addressed within the context of the neoclassical strains of what Latrobe and others considered modern architecture. A particular problem in discussing the design for the Center Engine House is that it was in its time entirely unique, as Dr. Thornton said, “The centre-house for the water works in Philadelphia, I doubt not, is his own.”\textsuperscript{352} The clean exterior mediated and dampened the technology it enclosed, simultaneously integrating it within square and city. This regulatory architecture would be achieved through a balance of architecture and technology and city and nature. If this balancing act had a long history in architecture, the engine house for Center Square was designed in a way that broke with British and European formal precedent.

Simultaneously, however, the eighteenth century carried a strong tradition of built and unbuilt public works designed to reform and to heal citizens, through the calibration of pure geometries intended to control light, air and views. Latrobe considered himself a member of this class of visionary modern architect and his work was conceived within this wash of ideas and imaginings. Like others working in this way, Latrobe firmly believed not only that climate and situation could influence health, but also that physical geometry could affect moral behavior. He justified pure volumes for acoustical and utilitarian reasons, but also believed in the aesthetic, reformatory powers of geometry. This subject will be addressed more fully in Chapter 5.

Latrobe’s Center Square Engine House was particularly aligned between several classes of remediating architectures: visionary public works, instrumental civil architectures, and scientific theaters, each betraying a different political stance towards the role of nature and art in human improvement. The engine house must be formally assessed as a hybrid of these. It was, perhaps, a modest monument, a more tempered version of the “architecture of social purpose.”\textsuperscript{353}

\textsuperscript{352} Latrobe, \textit{Correspondence}, II: 605.
\textsuperscript{353} In this category I put all of the prisons, hospitals, libraries, and churches that fill Helen Rosenau’s volume that coined the term.
In order to better understand the Center Engine House it will be necessary to examine some of the family resemblances between Latrobe's infrastructural edifice and these healing architectures.

Public Works

It is tempting to classify Latrobe's design within the grand sweep of the French architectural and planning theory with which he was familiar, including Jacques-François Blondel and Jean Nicolas Louis Durand. Yet, the design bears none of the complexity or order of even the smallest “maisons particulières” of Blondel, let alone of the massive undertakings of architects ranging from de L'Orme and Piranesi to Ledoux and George Dance the Younger. While Latrobe did know Blondel and would come to have an affinity for Durand, he would not yet have been familiar with his work when he composed his design for Philadelphia. Latrobe certainly knew Prony and Perronet, but there is no evidence that he was aware of Pierre Patte. The issue of precedent is not, however, the chief determinant for characterizing Latrobe's design for Philadelphia.

In the Philadelphia waterworks, Latrobe designed a central pavilion that was not as massive as the visionary eighteenth-century public works projects, but was marked by similar ambitions. Radical plans, monumental constructions, and idealistic visions characterized the public works architecture of this period, and the design of prisons demonstrated some of the clearest alignments of neoclassical geometries with evolutionary motivations. Latrobe claimed considerable knowledge regarding the ideal penitentiary forms of the time. John Howard was a friend to the Latrobe family in London, and Latrobe explained that Howard's ideas had influenced his own notion of, “what is a good, secure, and humane mode of confinement.”

Planning a visit to Philadelphia's Walnut Street Jail in March of 1798 in preparation for construction of the Richmond Penitentiary, he stated that of course he was "perfectly well...

354 Latrobe, Correspondence, I: 74.
acquainted with every thing that has been done in Europe to render prisons safe, convenient, and wholesome," but still desired to study the Philadelphia model.\textsuperscript{355}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure59.jpg}
\caption{Benjamin H. Latrobe, Virginia State Penitentiary, "Ground Plan of the whole Building when compleated . . .", 1797, from Latrobe, \textit{Drawings}, I: 104.}
\end{figure}

Latrobe's first American civic architectural commission, his 1797 design for the Virginia State Penitentiary at Norfolk, certainly achieved the grandeur, scale, and ambition for improvement of European public works projects of this time. [Figure 59] The building was a semicircular arrangement of cells with twinned central observation parlors framing the entry and courtyard. The geometry of the building is perfectly symmetrical, but the distribution of function reflects the different condition, and numbers, of men and women. The men enjoy use the large

\textsuperscript{355} Latrobe, \textit{Correspondence}, I: 80.
semispherical outdoor courtyard, visible to the keeper and inspector. There are far fewer cells for women, and they all open into the interior of the building, which also houses their yard and communal work rooms. John Van Horne and Lee Formwalt explain that Latrobe's design, "reflected new, international penological and architectural thinking." I wonder also to what extent it reflected Moravian assumptions about divisions of industry and gender as systems which might order adjacencies to bring communal harmony. Latrobe's plan arranged the observation of inmates who labored towards remediation, and also provided modern systems of ventilation to assure their healthy improvement.

Figure 60 - Benjamin H. Latrobe, Virginia State Penitentiary, "Plan of the Basement Story," 1797, from Latrobe, Drawings, I: 105.

The topic of supplying water for the penitentiary also filled several of his correspondences on the construction of the work, and he designed a conduit which entered at basement level, terminating at a circular cistern at the apex of the hemicircle. [Figure 60] In the inscription he penned for the

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356 Latrobe, Correspondence, I: 40.
cornerstone, Latrobe called the building, “an Edifice the Monument of that Wisdom which would reform while it punishes the Criminal.”  

The Center Square Engine House displayed the “simplicity” called for in Helen Rosenau’s assessment of the sublime component to this moral aesthetic, as well as the “noble purpose.” In the American context, it might even meet Rosenau’s third requisite characteristic, “monumental form.” The Center Engine House was only the third marble building in the sparsely settled city of brick, but the fact that most contemporary accounts comment more extensively on the pleasures of the park than the beauty of the architecture seem to indicate that even in the American setting it did not dominate its surroundings, but was a backdrop for them. Many and perhaps most of these grand exercises in social control and betterment featured centralized rotundas to assist in surveillance, introduce light, and expedite air flow. Latrobe similarly constructed his rotunda to contribute to the medical and cultural improvement of Philadelphia. Its clear form can be interpreted as a signal of the invisible changes it promised to the airs, temperature, and salubrity of the city.

Civil Architectures

Latrobe’s architecture bears a relationship to eighteenth-century experiments in small scale agricultural civil architecture, in particular the neoclassical design of garden and farm buildings constructed of monumental materials, and surrounding mechanized contents. Latrobe was very familiar with the publications of Leonhard Christoph Sturm. Sturm’s volume of 1721, *Ein sehr nöthiges Haupt-Stück der vollständigen Anweisung zu der Civil-Bau Kunst*,

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359 In his Review for the APS of a submission entitled, “On Buildings in India,” Latrobe mentions that despite having “none of their works at hand,” he is certain that “Béidor, Blondel, Sturm, Smeaton, Higgins, Adams, and many other French, German, English and Italian writers have all recommended brick dust in some cement or other,” but that it is certainly neither water or frost resistant.”

though a slim 18 page volume, contains several designs that can be related to Latrobe’s Philadelphia works. Sturm’s baroque courtyard plans, meant to convey something like a typical distribution of a nobleman’s self-contained, opulent estate, offer a few fair templates for the design of Center Square. Of course in Latrobe’s version the diagonal rays were banished, and the walls removed to open the estate to the whole city. [Figure 61]

One of the most striking designs for its exterior solemnity and interior machined complexity, a characteristic also of Latrobe’s central engine house, is an idealized plan for a stone dovecote. [Figure 62] Sturm argues, that “It is important for the building to be a round tower made out of stone of a goodly height and mass.” The building was not simply a space, but a machine, with a central ladder that rotated on a spindle, preventing predators from accessing the nest boxes. Another design for a building with a machine interior was the Work House, "for brewing, baking, washing, slaughtering, cleaning, processing fruit and vegetables." Like the Center Engine House, the work house is a place that concentrates and then distributes the products of nature. Sturm also included a country house, integrating a central rotunda and lantern with a square base, which he explained as a mixture of Italian and Teutonic styles.360 This interest in adapting and mixing advanced styles and technologies predicts Latrobe’s idea of combining opposites to achieve the highest improvements in art.

360 Leonhard Christoph Sturm, Ein sehr nöthiges Haupt-Stück der vollständigen Anweisung zu der Civil-Bau Kunst (Augsburg: In Verlegung J. Wolffens, 1721), n.p.
Joseph Michael Gandy was a younger contemporary of Latrobe’s, also designing neoclassical buildings for utilitarian purposes, and similarly borrowing ideal circular plans from French ideal precedent. Gandy was working with John Soane at the time the waterworks was constructed. His *Designs for cottages, cottage farms, and other rural buildings, including entrance gates and lodges* was not published until 1805, so while it does represent the same sheltering of productive content within ideal geometries, it was in no way a precedent for Latrobe’s work. Gandy, like Latrobe, sought to unite utilitarian function with a higher level of
taste. This process resulted in designs that combined clear geometric figures in various arrangements. His introduction made clear his aim, “to unite convenience and taste in a greater degree than has hitherto prevailed in this class of Buildings: they are offered as hints for the consideration of Country Gentlemen.” Gandy appealed to the landed gentry as patrons for social reform. The construction of “Farmers’ Houses” and “the Cottages of the Labouring Poor” according to architectural guidelines would, according to Gandy excite “fine impressions,” and create “a natural good taste,” but they were not intended to alter the social structure of England. Still, Gandy’s idea of the moral reform possible through exposure to beauty corresponds to Latrobe’s ideas regarding the possibility that sensation could improve character. He, like Gandy, aimed to construct a model that would appeal to the city’s most educated patrons, and yet also be immanently sensible to those of all classes and capabilities who viewed it.

This instant natural apprehension of form linked Gandy to the other modern architects of social improvement. Certainly Gandy, like Latrobe, assumed this direct relationship of spare and perfect geometries to mental sensation and development. Brian Lukacher has defended Gandy against criticisms that his designs were diminutive “toys,” ridiculous versions of C.-N. Ledoux’ fully realized concepts for an architecture of rural purity, perfect form and moral improvement. Of the three designers, Latrobe was the sole political radical, firmly on the side of revolution and republican democracy. In this, perhaps, he was also the most idealistic, but his architectural dreams were tempered to the more heated and untamed American environment.

Gandy embraced a more varied architecture than fit within Latrobe’s rigid outline of Grecian purity. Gandy’s designs were an array of formal arrangements that combined circles and squares, not centered within each other, because, as Gandy explained, centralized symmetrical forms lacked variety and should be reserved for churches. “Uniformity, it is conceived, belongs only to the higher classes of Architecture; to places dedicated to the service of the Deity, in which the rotund has the advantage over every other form.” \(^{362}\) Gandy instead proffered picturesque variety for his rural designs. Cylinders were sometimes dovecotes, sometimes kitchens, or parts of homes. [Figure 63] The solitary concentric plan in this volume, the “Cottages

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of the Winds," is a reimagining of the Tower of the Winds (which was also a favorite model for Latrobe) in which workers homes are arranged as pieces of pie. [Figure 64] It is possible to suggest that the very variety that Gandy found necessary for picturesque agricultural designs, Latrobe found impossible when centering a building within the regularity of an urban grid and a public square. It is also true that since Latrobe and many of his fellow republicans refused a "Deity," except as manifested in natural works and natural laws, as the primary orientation point for American democracy, the supplanting of God in the rotunda by a machine that channeled the powers of nature to provide municipal equality and health was entirely appropriate.

Figure 64– Joseph Michael Gandy, "Cottages of the Winds," *Designs for cottages, cottage farms, and other rural buildings, including entrance gates and lodges*, pl. XXXV, 1805. Courtesy of the UPenn Fine Arts Library Rare Books Collection.
The similarity of Latrobe’s design to Palladio’s Villa Rotonda is not its only countryside credential. Latrobe’s design for Philadelphia fits also in the company of the theoretically functional garden pavilions of eighteenth-century France, which wrapped agricultural functions within clear and distinct geometric plans. While the publication of *Maisons de Paris*.

"Reimpression de l'édition Paris 1801-1812," by Jean-Charles Krafft and Nicholas Ransonnette post-dated the construction of the Philadelphia waterworks, Latrobe’s affection for this catalog of French eighteenth-century chateaux and garden pavilions demonstrates the affinity of Latrobe’s taste to currents in European neoclassicism.\(^{363}\) The first volume of Krafft and Ransonnette included Jacques-Germain Soufflot’s Maison de Campagne de M. d’Epinay. The orthogonal base is a two story space, otherwise its volume bears some similarity to Latrobe’s waterworks. Charles de Wailly’s Chateau de Montmusard of 1768, another integration of a circle with a rectangle, is also represented. *Tome 2, Recueil d’architecture civile*, is a veritable encyclopedia of country pavilions. The numerous outbuildings of Joseph-Elie-Michel Le Fèvre’s 1776 Chateau de Thierry at Ville d’Avray includes a dovecote, a rabbit hutch, an ice house, and a cottage, mobilized and composed into perfect circles, squares, and even triangles to rustic effect. [Figure 65] Similarly, a design for a glacière with garde manger and laiterie is a trio of circles in plan, with a conical roof over the larger volume of the ice house. The garden follies of de Monville’s Desert de Retz completed these kaleidoscopically arrayed perfect geometries overlaid upon utilitarian projects.

Scientific Theaters

The Center Engine House was a civic pavilion that demonstrated Latrobe’s European sophistication to the new nation. In the context of his numerous scientific writings and theorizing on the fever, however, it seems likely that Latrobe’s presentation of the works as a public health intervention was simultaneously true, and that he figured the building equally in the context of what he saw as modern scientific buildings. These were, like the Center Engine House, hybrid pavilions, joining natural setting and scientific work. They were often situated adjacent to royal botanical gardens, and devised as devices to observe and operate upon natural phenomena.

Latrobe was very interested in this category of “scientific” architecture. He explained in a journal entry that, “having once found pleasure in the study of anatomy,” he had “attended very many
dissections in England, and on the Europaean continent. One of Latrobe’s favorite rooms was the theater of the Ecole du Chirurgie in Paris. [Figure 66] Latrobe admired this room as, “perhaps the best lecture room in the world for speaking, hearing, and seeing.” Its geometry perfectly accommodated clarity of sensation, and therefore of thought. The Halle au Blé and Sir John Soane’s Bank of England were also favored by Latrobe and of course by Jefferson. Latrobe would compare the acoustics of these buildings in a lecture given in 1803. He concluded that a “hollow Globe” was the best shape for speaking and listening,” but that since the shape was, “impracticable,” then “next to it in perfection ... is a Cylinder covered with a half globe or semi-spherical dome.”


364 Latrobe, Journals, II: 438.
According to Latrobe’s scientific evaluation, the rotunda was a superior modern form, and also the most rational form short of a sphere. Centralized rotundas would appear and reappear in Latrobe’s work, spanning from domestic architecture, to a military academy, to, of course, his inherited project, the United States Capitol. Latrobe’s aesthetic judgment of all of these neoclassical forms was built upon his scientific judgment of their performance as devices to contain and to focus sensory and environmental experience. He must also have considered the Center Engine House in these terms, but designed it to occlude rather than admit views to its technical core. Since he understood the products of nature to fall within scientific systems, and excluded manufactured works from that definition, this reversal seems logical.

While it has already been pointed out that the rotunda was a ubiquitous element of eighteenth-century architecture, it is possible that Latrobe had also experienced a modern scientific building during his time in Prussia that was quite close in scale and volume to his Center Engine House. The Anatomisches Theater der Tierarzneischule (Anatomical Theater of the Veterinary School) was designed by Carl Gotthard Langhans and built in 1789-90 for Friedrich Wilhelm II’s veterinary school in Berlin. [Figure 67] Latrobe’s only travels in Europe were in 1783 and 1786, so he cannot have seen this building, but he may have viewed its image. It was the frontispiece to David Gilly’s 1797 Ueber Erfindung, Construction und Vortheile der Bohlen-Dächer: mit besonderer Rücksicht auf die Urschrift ihres Erfinders, which also featured and illustrated other wooden domed buildings including the Halle au Blé. Latrobe was quite fond of Gilly’s works and though it is impossible to say exactly which published works he may have known aside from the Handbuch der Landbaukunst (which he borrowed from Jefferson in 1805), he may well have seen this book prior to 1799, if it was in Jefferson’s possession. That Latrobe spent his young life in Saxony, and in fact worked for Prussian engineer Heinrich August Riedel,

365 Latrobe, Correspondence, I: 404-406.
who by some accounts toured Holland with Friedrich David Gilly, places Latrobe quite close to this milieu so once again, this may be an issue of shared lineage rather than direct inheritance.  

![Figure 67 - Anatomisches Theater der früheren Tierarzneischule Berlin](https://de.wikipedia.org/wiki/Anatomisches_Theater_der_Tierarzneischule#/media/File:Anatom_Theat_Berlin.jpg)  
[accessed 14 June, 2015]

Whether by intent or by accident, Latrobe’s Center Engine House shows marked similarities to the *Theater der Tierarzneischule*. Gilly’s section shows an overall volume and size that is nearly identical, with the chief difference being the increased vertical dimension of Latrobe’s cylinder. In fact, when compared side by side, Latrobe’s dimension of 60’ x 60’ is an exact match for the veterinary theater, if the 10’ dimension of the veterinary school’s projecting porticos were removed. Langhans’ design also displayed a distyle-in-antis porch, and a shallow dome and paired arched windows at either side of the entry. Latrobe’s Center Square Engine

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367 Latrobe was steeped in Prussian history and culture. While in London, he edited and translated a biography of Frederick II, and a history of the Danish Revolution. (Journals I: xxii) Oddly, however, in his American journals and letters he focuses on France and rarely refers to Prussia. We can speculate that he was well educated in the Prussian tradition, but there is no direct indication of its influence.
House bore a striking similarity to this and other modern scientific architecture constructed to
discover the mathematical laws underlying the natural world, and to heal its inhabitants.

It is certain that Latrobe’s engine house was perceived as a scientific building by
members of Philadelphia’s American Philosophical Society, who attempted to convert the
building into an observatory. The APS holds a lease dated 29 January 1818 signed by the
commissioners of the city, who authorized the addition of a stairway, a terrace roof, a floor within
the “Circular part of said building.” They agreed, “that the said alterations or any of them, shall
not in any manner whatever change the present external appearance of the said Centre Engine
House.” At this date, Latrobe’s student William Strickland had probably already drafted his
plan of the intended modifications to the building. [Figure 41] The desire to preserve this building
seems unusual for the time, indicating that despite its functional failures, the city’s intellectual
and governing elite valued the shell of the waterworks. Robert M. Patterson, in a letter penned to
George Vaux in 1816, argued for the feasibility and importance of “converting the deserted
water-house into a Temple of Science.” Patterson noted that the observatory at Paris was no
higher and expressed hopes that it might “at some future day” match Greenwich and Paris, with
“pensioned astronomers,” but, with early American sensibility, observed that, “at present we must
aim only at such operations as would be both practicable and useful.” It is unfortunate that
Latrobe almost certainly was not aware of this letter. That his engine house was compared, even
tangentially, with Perrault’s great observatory would have pleased him greatly.

While the Center Square Engine House is seen as one of Benjamin Latrobe’s lesser
works, in his own time it was perceived not only as an architectural landmark, but also as a
building that could speak of and serve science. Renderings by Latrobe’s student William
Strickland indicate small changes to the roofline, the addition of shallow domed roofs at each of

368 Philadelphia (Pa.). City Council, Lease: City of Philadelphia to the American Philosophical Society, 29
January, 1818. (courtesy of the APS)
Record Group IIb. 1807-1825, American Philosophical Society, Philadelphia, PA.
the four corners, two of which were planned to house astronomical equipment. The tablet above
the entry, which had been left blank by Latrobe, was to be engraved with the words,
“Philadelphia Observatory.” It seems that his colleagues at the APS understood the building as
Latrobe intended it, as an ambitious intervention of geometry and matter, manipulating the
environment, while conveying the unified progress of the products of man and nature.
Chapter 5 - Man in a State of Nature

Figure 68 – Benjamin H. Latrobe, "The Tollenstein, in the Mountains of Bohemia," from *An Essay on Landscape*, 1798-99, Courtesy of the Library of Virginia.

Ideas of balance and change in nature underlay the dominant medical and political theories of the late eighteenth century, and shaped Latrobe’s vision of an American architecture. The Center Square Engine House was conceived within the same philosophical framework concerning nature, sense, and system that was elaborated by Jean-Jacques Rousseau, John Locke, Thomas Jefferson, and the Comtes de Volney and de Buffon. In the early American republic, ideas of the influence of nature on ethical and physical development were inseparable from a belief in the purity of what was understood to be Greek architecture. The neoclassical container for the waterworks was in keeping with Latrobe’s wish that, “indeed, the days of Greece may be revived in the woods of America, and Philadelphia become the Athens of the Western world.”

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Latrobe’s Philadelphia waterworks was, I believe, conceived as an artwork within the context of at least three simultaneous eighteenth-century dialogues concerning “nature” in relationship to art and sensation. The first discussion concerned the role of impressions on human development, theories that Latrobe studied via Condillac. The second and related framework concerned landscape painting and the aesthetics of taste, as a balance between contrast and harmony. Latrobe penned what is believed to be the first American landscape painting manual at the same time as he was designing and building the waterworks, which featured topographical paintings that emphasized natural features over man-made devices. [Figure 67] Latrobe focused particularly on the beauty of natural masses of stone and the characteristics of individual trees, far more emphatically than on what he called “the works of man,” the castles and ruins typical of picturesque landscape paintings at the time. The third context in which Latrobe’s ideas should be understood was the English picturesque debates of the 1790s. This controversy within landscape design was marked by a war of words between Sir William Chambers, Sir Uvedale Price, Richard Payne Knight Humphrey Repton, and others. Latrobe was friendly with the Repton family in London, and seems to have agreed entirely with Repton’s argument against Uvedale Price, that the English garden should be, “the happy medium betwixt the wildness of nature and the stiffness of art,” rather than a painterly view of “wild nature.”

The three sections of this chapter are aligned with these three separate but related discourses regarding nature.

Prior to introducing the three theoretical frameworks of nature in which the Center Engine House should be interpreted, it is necessary to describe another argument more particular to the American philosophical context in 1798. At this time, American nature and America’s capacity for culture and art had for some time been the subject of an international debate, which heightened conflicts concerning the quality of her landscape. The fertility of American nature was

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371 Humphry Repton, *Sketches and hints on landscape gardening. ... The Whole Tending to Establish Fixed Principles in the Art of Laying Out Ground* (London: printed by W. Bulmer and Co. Shakspeare printing-office, and sold by J. and J. Boydell, Shakspeare Gallery ; and by G. Nicol, Bookseller to his Majesty, Pall-Mall, 1794), 72.
the center of a dispute between the Comte de Buffon and Thomas Jefferson just before Latrobe arrived in America. In fact, Latrobe had read Notes on the State of Virginia, Jefferson's rebuttal to Buffon and defense of American freedom and fertility, and it in part inspired his passionate beliefs about the vitality of the New World. Since climate, soil, character, and morality were believed to be linked, American soil and climate had to be sufficiently healthy to cultivate citizens capable of establishing a democratic republic.

America was a beacon for many of the eighteenth-century philosophes, but within the natural sciences some Europeans questioned the vitality and promise of the new land. To John Locke, 'In the beginning, all the world was America.' And to Hegel, 'America is the country of the future ... the land of desire for all those who are weary of the historical arsenal of Europe.' De Tocqueville also saw America as a new beginning in the face of an exhausted Europe. The Comte de Buffon, however, had a long and lasting influence on natural philosophy, and believed that the American experiment was doomed to failure. Most famously, Buffon argued that in the New World plants, animals, and humans were weaker, smaller, less active, and less fertile than those of Europe. He judged America's "Indians" as too cool and passive to modify their environment through active processes such as agriculture and drainage. Buffon believed that this weakness and lack of activity were fundamentally due to America's cooler and more humid climate. The environment prevented cultural development, and even more problematically, Buffon proposed that if European animals were relocated to America, they would gradually become weaker. Buffon's work inspired other European natural philosophers who judged American soil and climate as incapable of supporting a higher level of culture. The dire implications for the new nation were obvious.

373 Glacken, Traces on the Rhodian Shore (Berkeley: University of California Press, 1967), 680. Peter Kalm, Cornelius de Pauw, and William Robertson were three who continued to argue the weakness of America even after Jefferson's arguments had convinced Buffon of his error.
Jefferson, like Buffon, believed that cultural achievement could only be cultivated in the proper environment, and in *Notes on the State of Virginia* (1781, expanded in 1782 and 1783, Paris 1785) he set out to document the vigor of the New World. To that end he measured and documented the wildlife of his state, and also argued for the vigor of the Indian. Countering that Buffon’s theories were “just as true as the fables of Aesop,” Jefferson described “the Indian of North America,” as “neither more defective in ardor, nor more impotent with his female, than the white reduced to the same diet and exercise.” He further argued for the bravery, faithfulness, endurance, and sensitivity of America’s original inhabitants. When Jefferson visited France he spoke with Buff on, and offered to send the bones of a moose to convince him of the strength and size of animal that was grown on American soil. When the large skeleton was shipped to Paris from New Hampshire, Buffon admitted his error and promised to correct it in his next writing, but died before he could certify the potential of the New World.

When he arrived in Virginia in 1796, Latrobe was in love with America, fascinated by all that he saw, and convinced of the vitality of the land. His early journals are filled with recordings of the plants, animals, and landscapes he encountered around Virginia. In his early writings he commented also on the relationship of manners to climate. He described America’s native population, the “Indians” as more hospitable that the Virginians, for the reason that “the manners of Virginia are English. ... It is the most cold hearted and cautious of any nation I know.” He contrasted the English coolness with the warmer hospitality of the Italians. In fact, again relating temperature and airs to manners and habits, Latrobe relayed this comparison by analogy to the volume of a gas, which might be taken from the English chilliness and “raised to the temperature ... of the Italian sky.” He found that the Indians of America were also warmer than the English. Latrobe argued that they were bound by their more primitive status, to feel the “gregarious

sensation of compassion that belongs naturally to man as an animal.” In other words, the man who lived in closer harmony with nature was more hospitable, because moved by primitive instinct. In his early years in America, and during the time he designed the Philadelphia waterworks, Latrobe was, by his own later cynical account, “in love with man in a state of Nature.” Despite his anti-monarchical sympathies, he was even willing to suggest that America’s native people might claim royalty. Upon visiting Captain Bulling, a descendant of John Rolfe and Pocahontas, Latrobe drafted their family tree and commented, “Should Monarchy and its concomitant, Nobility of blood, ever come again into fashion in this Country, an event which at this moment is most seriously apprehended by, and disturbs the sleep of many of our good citizens, I hope the blood of Powhatan will not be neglected.”

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5.1 Impressions and Inheritance

The Center Engine House must be understood within Latrobe’s ethical-aesthetic belief that human character is formed by its sensory environment. A mission of improvement underlay his concern with a rationalization and simplification of form. This mission took precedence over the direct imitation of prior models, or the invocation of either linguistic emblems or sublime emotion. Latrobe’s judgement of what architectural sensations were most in keeping with his hopes for the balanced, rational improvement of America can be extrapolated from his vehement criticism of the Robert Morris House by L’Enfant. Here we find all of the elements that violated Latrobe’s taste:

Among the buildings of Philadelphia, I did not mention the house of Robert Morris, because I knew not what to say about it in order to record the appearance of the monster in a few words. Indeed I can scarcely at this moment believe in the existence of what I have seen many times, of its complicated, unintelligible, mass. Though I was in the pile, I protest against any enquiries from me as to the plan, for I cannot possibly answer them. ... The plan is not long enough in proportion to its breadth... At each angle is a sort of bow, or tower, or what you please, for it would be difficult to define the sort of thing by any one term. ... The Windows (at least some of them, and others appear unfinished) are cased in White Marble with mouldings, entablatures, architraves and sculpture mixed up in the oddest and most inelegant manner imaginable: something in this taste; all the proportions are bad, all the horizontal and perpendicular lines broken to pieces, and the whole mass giving the idea of the reign of Lewis XIII in France or James I in England. ... The Capitals of the Columns are of the worst taste. They are a sort of Composite, and resemble those of the [..] at Rome, the production of the worst times of the Art. ... The whole Mass altogether gives no idea at first sight to the mind sufficiently distinct to leave an impression for many minutes. I went several times to the spot and gazed upon it with astonishment, before I could form any conception of its composition. ... This is the house of which I had frequently been told in Virginia, that it was the handsomest thing in America.

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379 It is also likely that Latrobe detested the house because wealthy merchant Robert Morris, though one of the funders of the American Revolution, became a target afterwards for radical militias who suspected him of profiteering. He would also become a leading Federalist.

380 Latrobe, Journals, II: 377-378
Latrobe’s efforts in the design of the Philadelphia Center Engine House sought the opposite effect of L’Enfant’s poorly proportioned and highly ornamented Morris House. The engine house at Center Square was, at least externally, uncomplicated and intelligible. It was a composition of clear volumes decorated with consistent and elegant details that did not break the horizontal and vertical lines. As has been already discussed, it may have carried forward some architectural planning traditions associated with more recently executed monarchs, but it did have the clarity to make a distinct and lasting impression on the viewer. Its proportions were unusual, but so were its contents. Latrobe was a declared admirer of “modern architecture,” and the waterworks was an effort to contribute a positive example to contemporary improvements.

**Emblem and Expression**

Latrobe seems to have been certain that he could define modern architecture, if in some cases this definition can most clearly be inferred, as in the case just cited, from his critique of the failures of his contemporaries. In a journal entry of April 1798, Latrobe harshly judged the Capitol building by Dr. William Thornton, years before his association with Thomas Jefferson would give him the opportunity to improve upon the design, and thereafter engage in a very public battle with Thornton. In 1798, Latrobe said of Thornton’s original Capitol design that, “it is faulty in external detail,” but in the same sentence praised it as, “one of the first designs of modern times.”

Latrobe called James Hoban’s White House (1792-1800) “Hoban’s Pile,” and argued against Jefferson’s colonnade, saying it was a “litter of pigs worthy of the great Sow it surrounds, and of the Irish boar, the father of her.” Latrobe’s refrain was consistent. He opined during his battles over the renovation of the U.S. Capitol in 1806 that, “All the books for the last three or four hundred years up to 1760, are against me,” but offered that, “as the arts continue to

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381 Latrobe, *Journals*, II: 378
382 Latrobe, *Correspondence*, I: 260

Hoban was, like Latrobe’s draftsman Frederick Graff who constructed the second (successful) Philadelphia waterworks at the Fair Mount, a carpenter until he became an apprentice draftsman.
be improved, --simplicity gains daily more admirers." His refrain was consistently one for achieving greater clarity of volume, less ornamentation, and avoiding direct imitation of decadent prior models.

Latrobe’s dislike of emblem and allegory was one of the fuels beneath his heated exchanges with Dr. Thornton, in which Latrobe consistently took a tone of bemused condescension. In 1819, Latrobe remembered in his journals Thornton’s suggestion for an allegorical statue to be placed in front of the U.S. Capitol. It was to feature a woman on a rock, embodying eternity, with a serpent around her neck swallowing its tail. Children and a woman should surround the rock, symbolizing the current state of agriculture, arts, and sciences, reaching upwards. General Washington should be moving upwards at the invitation of immortality, showing some regret at leaving his people behind. After a brief pause, “unwilling to disturb his good humor,” Latrobe recalls pointing out that future viewers might be interpret the statue as a woman of bad character inviting a man to leave his family and join her on a “dangerous precipice.”

Thornton and Latrobe had engaged in warfare through the public press during 1808 in a series of letters that placed them on either side of a divide concerning the roles of emblem, sublime emotion, and rational expression in modern design. Dr. Thornton sarcastically addressed Latrobe as “this scientific architect” questioning Latrobe’s choice of figures and manipulation of scale in the Representatives’ chamber, and wondering whether so many eagles, occasionally presented in flattened relief, might in some cases be taken “for the skin of an owl,” or if, in combination with the female figure of Liberty, they might be mistaken for “Leda and her Swan.” Elsewhere he asked whether one eagle was so large that it might suggest “the Rock in the Arabian Nights Entertainments.”

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383 Latrobe, Correspondence, II: 306
384 Latrobe, Journals, III: 265.
In light of Latrobe’s theories of American purity and potential, the issue of language and history within these debates is of stark importance. Thornton could not describe architecture except emblematically, by mythological and literary allusion. Emblem is a language not easily accessible to all. Emblems require reading, and cannot be read without a knowledge of languages, literature, art, allusion, symbol, and history. While this chain of cultural intelligence could root a design and give it a richness of meaning, it would also exclude those lacking adequate education and understanding. Latrobe made it clear, at least during this period of his career, that there would be no place for this type of exclusivity within architecture, or within the new nation.385

385 Latrobe’s theories on education in America underline his beliefs that could only erode emblem, and also demonstrate the tensions within his evolving argument. In May of 1798 he was asked to review the bylaws of a new academy in West Virginia, and was vehement in his argument against the teaching of Latin and Greek, offering that, having “shaken off the shackles of the dead Languages, ... Now no man of Genius, or clear Understanding devotes himself to the settling of doubtful readings in useless works, or to the acquisition of the command of a language which he will never be required to speak or write.” He admitted that some knowledge would be useful to apprehend the “technical terms of science,” but suggested that in that case the language should be taught “subordinate” to science. Of course, since his own command of Greek and Latin was excellent, and Latrobe was aware that the Ferdinando Fairfax, a friend of Washington’s and the recipient of the letter, would not remove these languages from the curriculum, Latrobe then advised which texts should be taught. He valued Xenophon and Herodotus, as well as Cicero’s de Oratore, and absolutely banned Ovid, Phaedrus, “and other poets from whom no one ever learned a single useful fact.” Homer’s Iliad suffered the worst censure, because, “It poisons the minds of young men, fills them with a rage for military murder and glory and conveys no information which can ever be practically useful.” (Latrobe, Journals: II: 419-422)

If Latrobe opposed the teaching of “useless works” while he was devising the Philadelphia waterworks, it seems likely that a decade later his battles with Thornton, and with members of the House of Representatives, were the crucible that melted his hopes for clarity and usefulness in American education and thought. In February of 1808, Latrobe wrote to William Duane, documenting the chain of reason that had resulted in so much ignorance in the United States government:

"Education produces superiority of influence in those who possess over those who want it: that is educated Men are of themselves an aristocracy governing the majority: ergo, education is an anti-republican machine by which the few coerce the many; ergo it ought not to be suffered in a republic; ergo there can be no reasonable complaint that two thirds of our representatives want a knowledge of language, of men and of things, for to acquire them they must have been educated and education makes aristocrats &c. &c. &c. Besides, the people, ‘in their own image create they them.’ ...Therefore, to be a good republican we must go on another tack: retire to a farm, let politicians do what they please, and look into ones own heart and principles for the grounds of equal laws, equal justice, and equal rights.” (Latrobe, Correspondence, II:529)
Latrobe’s choice to position himself as a scientific architect placed him at the advanced edge of a rapidly changing profession in a quickly growing young nation, but his distaste for emblem and interest in direct expression were opinions that had been unfolding over the prior century in English art. John Dixon Hunt, in “Emblem and Expressionism in the Eighteenth-Century Landscape Garden,” traces this shift away from literary reference and meaning in landscape gardening, and towards more expressive elements. He cites Thomas Whately’s *Observations on Modern Gardening* of 1770, which argued against emblem on the grounds that, “they may be ingenious contrivances, and recall absent ideas to the recollection; but they make no immediate impression.”

Ronald Paulson, in his book *Emblem and Expression: Meaning in English Art of the Eighteenth Century*, explores this idea of immediacy in gardens and paintings, and elaborates the trajectory that ends with Thomas Gainsborough’s paintings, in which figure and ground become intertwined in tension, with nature becoming as much a subject as the human figure.

In the turn towards expression, Paulson explains, the viewer’s interpretation collapses with the painter’s intent, both joined in a transformative search for an “authentic meaning.” Paulson finds the roots of this shift in empiricism, which allows the artistic conclusion that, “man gets all human knowledge through his senses and from them fabricates abstractions, personifications, and fictions.

Accompanying the reduction of literary allusion and meaning, this empirical approach also reduced the standing of the man-made in the face of nature, demanding a different relationship of scale and intricacy. This issue also separated Latrobe from his nemesis in

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387 Gainsborough was one of Latrobe’s favorite painters, the sole English painter he “ranked” alongside Claude Lorraine, Salvator Rosa, and Poussin. He judged, however, that the “dutch school has produced most painters of trees, worthy of being studied, because they most correctly copied Nature.” In this group he placed Hobbima, Ruysdael, and Ferg.

Washington. Dr. Thornton demanded a certain size and magnificence in an architecture fit for the federal city and its governing elite. In response to Latrobe's condemnation of his own applied decorative elements, including oak leaves and festoons, Thornton railed against the humility of modern architecture. He explained that, "The Ancients" built such massive works that by, "simple grandeur alone they produced works truly sublime," and complained that since the American Capitol was so small, "variety" and "minute beauty" must compensate for the impossibility of "grandeur and sublimity." This letter concluded with a vitriolic attack on Latrobe's entry arch for the drive to the President's house, which Thornton judged a "humble imitation of a triumphal arch" that "looks so naked" that "instead of being adapted to the termination of a grand Avenue, and leading to the Gardens of a Palace, is scarcely fit for the entrance of a Stable Yard." His upset at the humbleness and nudity of this arch was equaled by his fear that Latrobe's renovations to the Capitol would displace the monument to General Washington intended to be centered on the dome.

Thornton's language and the basis of his argument indicate an understanding of the scale, ornament, and emblem appropriate to the American republic that diverged completely from that of Latrobe. In fact, Thornton's architectural assumptions seem from a much earlier time, relying on the ancients, grandeur, and the sublime, though he was in fact only five years older than Latrobe. To his credit, the rest of the nineteenth century would be spent fighting battles over past styles and the proper heightening of emotional state in proximity to nature and art. Latrobe had no interest in recycling emblems associated with myth, legend, or literature, and very little concern with elevated emotions. Latrobe refused to respond to Thornton's architectural criticisms, replying, "It is not my intention to pay any regard to that part of the letter which does not implicate my moral character."  

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389 Latrobe, Correspondence, II: 601-605.
390 Latrobe, Correspondence, II: 607.
The attacks leveled by Thornton against Latrobe's character and standing as a professional architect are also instructive of the gap between the two men's understandings of the basis and the role of architecture. Thornton accused Latrobe of being a Moravian missionary who had been a carver of chimney ornaments in London. Interestingly, Thornton claimed that his own medical credentials and world travels to "several of the master pieces of the ancients," as he judged them, "some of the grandest of the ancient structures," as well as his "knowledge of the orders of Architecture," provided him sufficient knowledge to practice architecture. To seal his point, he humbly suggested that, "The case of Perrault will apologize for my pretensions."\(^{391}\) Thornton was of a wealthier class than Latrobe, an heir to sugar plantations, but perhaps less deeply educated. Also, he could not have the benefit of a professional apprenticeship, as such a thing would have been beneath his standing. In this terrible battle we see the sparks that preceded the decline of the class of the gentleman-architect.\(^{392}\) Architecture based on imitation and allegory, however, would not disappear, but would take a new shape in America. Questions regarding the proper amplitude of variety and emotion in architecture will always remain.

**Habits of Motion**

Latrobe designed the Philadelphia waterworks according to a theory of strong volumes and clear sensory impressions, which tolerated no superficial or symbolic ornament or emblem. Latrobe's aesthetic theories were in keeping with the philosophies of John Locke, filtered via Condillac. Yet it would be insufficient to simply conclude that Latrobe's aesthetic theory was one of strong volumes and strong impressions. It is certainly true that Latrobe was a proponent of the theory that thought was shaped by sensory impressions, and therefore by environmental influence. Latrobe's development of this concept, however, like most of his theories, was not

\(^{391}\) Latrobe, *Correspondence*, II: 602.

\(^{392}\) Even Thornton's insults are weighted with a heavy, pre-modern tone. A vitriolic second letter called Latrobe a blackguard and "BOBADIL realized!" (Ben Jonson), and closed with the offer to fight a duel. Latrobe filed a libel suit in response. Latrobe, *Correspondence*, II: 616-17. (1 May 1808)
entirely consistent, rather it was an interesting mixture and balance between existing and partially conflicting ideas that left a role for both the inheritance of sensory habits from parents and the evolution of sensory capabilities through the perception of new impressions.

In 1806 Latrobe was working on a translation of the chapter on logic from Condillac’s *Cours d'étude* (1779-80). In his translation of this work, Latrobe frequently inserted asides, expressing dismay at Condillac’s sweeping theory, while certainly never discounting the importance of impressions in shaping the mind. The *Cours d'étude* was by no means the most important or original of Condillac’s works, but like all of his writings, the *Cours* were built upon his theory of sensation. Volume Six, *L’Art de Penser*, begins with the distillation of Condillac’s primary theory: «nous trouvons, dans nos sensations, l’origine de toutes nos connaissances et de toutes nos facultés». (we find, in our sensations, the origin of all of our knowledge and all of our faculties.) That there is no thought or idea that does not arise directly from sensations, «nous n’avons point d’idées qui ne nous viennent des sens», is the most radical, but consistent point threaded through Condillac.

Latrobe differed strongly with Condillac on several points, all traced apparently to his allegiance to the ideas of Erasmus Darwin. In 1798, Latrobe was already familiar with Darwin’s *The Botanic Garden* when he asked his closest friend in America, Giambattista Scandella, to obtain a copy of Darwin’s new work, *Zoonomia*, for him. *Zoonomia* (1794-96) is mentioned throughout Latrobe’s letters and journals, and is central to his painting manual, *An Essay on Landscape*. Latrobe believed, like Darwin, that men inherited certain sensory habits from their ancestors. (Darwin’s ideas would achieve their modern scientific form in his grandson Charles’ work during the next century.) The editors of Latrobe’s collected works credit Latrobe with building upon the ideas of Darwin to conclude that “dispositions of the sensory apparatus,” might

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394 Latrobe, *Correspondence*, I: 73.
be inherited, marshalling this physiological argument against Condillac’s theory that all knowledge was the result of observation and sense impressions.\textsuperscript{395}

Latrobe did not argue with Condillac’s notion that sensations, particularly of Nature, were instrumental in the shaping of man’s thoughts. Condillac’s belief that “true ideas” were based on a type of “analysis” which acknowledged its own incompleteness, its own separateness from the observed object, was also certainly in line with Latrobe’s ideas about scientific thought. Latrobe’s radical departure was his belief that sensation shaped, if not the organs themselves, then their “habits.” Latrobe, in his journals of 1806, stated what were somewhat complicated beliefs quite clearly. He said, in opposition to Condillac, that if it is “heretical to believe in innate ideas,” then “I must be a heretic. By innate ideas, I mean, \textit{habits of the organs of sense inherited from parents.”}\textsuperscript{396} By this statement, one must assume that if one’s parents had cultivated good habits of sense, those might also be passed down. This would make the natural and man-made works one perceived doubly important, and therefore the proper calibration of architecture and landscape a pressing matter for the development of a more cultivated society.

Latrobe’s ideas regarding sense impression were based on systems of motion. He explained that he believed, like Erasmus Darwin, that what Locke called \textit{ideas} were “actual \textit{motions of the Organs of sense},” which operated either due to a stimulus or through association. He described this as a \textit{system} which gained easier motion with repeated stimulus or excitement, at least in an adult who had, “no defect in his organization.” Children inherited this \textit{system} shaped by the patterns that influenced the parents’ organs’ habits of motion. As evidence he pointed to the similarity of handwriting of Aaron Burr to his father, who had died when he was young; and of the similarities between his own handwriting and his brother’s though both were raised separately in the Moravian schools. He also argued that his sister who could dismantle and rebuild watches at age 13, was clear evidence of the, \textit{“organs habituated to mathematical and}

\textsuperscript{395} Latrobe, \textit{Journals}, III: 53.
\textsuperscript{396} Latrobe, \textit{Journals}, III: 53.
mechanical Associations,” that were common in his mother’s family. Latrobe also said that of his own “Genius,” such as he displayed in his designs that “come of themselves unasked in multitudes,” he certainly was never “coxcomb enough” to take credit for what was inherited ability. He did believe that education could improve habits, but that in later life inherited habits of sensation might regain hold. Latrobe directly connected sensation to mental development, noting that as systems combine with systems, bringing their “ideas (motions) into action,” these allowed an almost limitless, “activity of the mind.”

To this mix of Darwin and Condillac, we must also add Latrobe’s environmental theory to explain why the aesthetics of strong volumes was not simply a matter of taste, but also an argument for civic ornament to reshape the habitual motions of sense, and by extension to improve the minds of Americans. As mentioned in chapter 1, Latrobe believed that America’s climate was so different from that of Europe that it might alter the convexity of his eyeballs. This belief in a direct connection between body and environment adds another element to his aesthetic theory. If parental experience can shape the “motions” of sensory organs, and environment can alter the shape of the same, then new impressions must be calibrated to inspire appropriate new habits also calibrated to temperature, humidity, and air. Aesthetic experience and education might therefore be marshalled to rebalance thought and mind. Latrobe believed that political and environmental climate were at the root of great art, and of course by his theories, the reverse was also true. He went to great lengths to explain that truly great art grew from the soil of a free and temperate republic, and proposed that America’s freedom would increase with a greater support of its arts. Within this sophisticated integration of sense, art, and nature, a balanced art might in turn generate a more balanced temperament.

397 Latrobe, Journals, III: 48-49, 54.
398 Latrobe, Correspondence, I: 73.
399 Latrobe, Anniversary Oration Pronounced Before the Society of Artists, 16.
It was the fashion in England, and indeed all over Europe less than a century ago—a fashion which our ancestors transplanted hither to admire nature in every shape but her own. In an age, in which the elegant forms of the Ladies were cooped up in Whalebone stays, and fenced in by the vast circumference of a hoop, when the Men were confined by ten dozen of Buttons, and smothered by enormous wigs; it would be unreasonable in the trees to have complained of being cut into Cones and Pyramids (see Vignette of this Volume), twisted into spires, and clipped into Lions and Elephants. We cannot help smiling at the folly of our Grandfathers, who laid out their gardens by the rules of Heraldry, and planted their crests and coats of arms in box, and lavender. But modern Philosophy, as much as she has been abused for her innovating spirit in politics and religion, has done this good— to banish, whenever she has appeared, that arrogance, which exalting the arbitrary fancy of man above the simplicity of nature, taught us to set a higher value on that which it is difficult to obtain, than on what it is useful to possess.


Figure 69 - Benjamin H. Latrobe, Vignette, from “An Essay on Landscape,” vol. II, 1799, in Latrobe, Journals, 498.
The balanced volumes of the waterworks may be read in light of Latrobe’s *Essay on Landscape* (1798-99), likely the first American landscape painting manual, in which he delivered a condensed synopsis of his ideas concerning the relationship between nature, politics, manners, and art. Within these two short volumes, penned as his conducted travels through Virginia, and began work Philadelphia, Latrobe laid out several interrelated theories. First, as depicted in the “Vignette” and the described in the excerpt above, Latrobe explained the connection he understood to exist between politics, manners, dress, taste, and attitudes towards nature, and lauded the improvements that accompanied “modern Philosophy.” [Figure 69] Under this topic Latrobe argued for the value of natural works over man-made, arguing simultaneously against excessive ornament or emblem, and rejecting what was most expressive in the tradition of sublime and picturesque art.

**Technique and Taste**

The construction of the Center Engine House was executed within the ground of the city, but Latrobe’s picturesque rendering of the Center Square Engine House can be read as a direct expression of his practical instructions regarding landscape composition and painting. The image of the Engine House that appeared in *Designs of Buildings Erected in the Year 1799 in PHILADELPHIA*, which Latrobe compiled for his brother, followed all of Latrobe’s guidelines for watercolor painting. In the *Essay*, Latrobe explained that, following the “Dutch painters,” “the art of massing light and shadow is ... now much better understood than formally.” The rule, which he obtained from “the Italian masters,” is that a picture should have “three equal portions,” light, shadow, and “demitone.” In tinting, in order to convey perspective, he suggested “Prussian blue and Gumboge” for distant green; “Good Sap green” for nearer; and “Burnt Terra di Sienna,” as “the most useful of Colors.” As a presentation rendering, I would argue that this painting portrayed the Engine House in an idyllic state of nature, representing the natural powers on which

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it drew and marshalling all of Latrobe’s picturesque techniques. [Figure 40] “East and West Elevation facing Market Street,” frames the engine house against a backdrop of Prussian Blue trees, soft and rounded to set off the stark geometry of the building. The smooth marble walls of cylinder and pedestal are awash in bright light, meeting the sky. The portico is half-shadowed, “demitone,” and the window openings are in deepest shadow. The starkness and depth of the window openings provide a contrast, accentuated in the constructed building by an inset sash, which made the frames invisible from the outside.

Latrobe’s presentation rendering for the Center Engine House could be dismissed as a marketing exercise, irrelevant to the architectural understanding of construction or site. However, I believe that it is this painting of a pavilion within a country park, surrounded by untrimmed and irregularly planted trees that might be considered the “emblem” of Latrobe’s design thinking concerning the unity of nature, art, and technology. The engine house could not be occupied by Philadelphia’s citizens, but it could embody the harmony of the works of nature and man. The center of the rotunda was filled with the engine’s noise, heat, and motion, but this novel inflammation was dampened, sheltered, and controlled within the quiet resolution of cylinder and square. Latrobe’s rendering of simple volumes combined within a natural landscape represented the mutual alignment and improvement of art and nature. The position of the building within the square at the heart of the new nation’s first capital made its harmony the perfect backdrop for modern metropolitan democratic recreation.

The improvements of modern philosophy, the reduction of ornament and emblem, and the dampening of the powerful emotions associated with the sublime are all elements that have already been discussed to some extent, but one peculiar personal element of An Essay on Landscape might be worth briefly noting. It was penned for an audience of one, Susan Catharine Spotswood, a woman of Latrobe’s acquaintance during the year before he moved from Virginia to Philadelphia. As such, for this lonely widower, the Essay might be considered a love letter. In
this case, it is striking that he made no attempt to wax poetic regarding the power of beauty over
the emotions, or the sublimity of vast, dramatic scenes or dark grottoes. His most emphatic praise
was reserved for Claude Lorraine, but what Latrobe most praised in Claude was his realism, his
ability to transmit sensation directly, allowing the viewer to feel the warm sun, or cool breeze, or
to hear the waves. As Latrobe said, “Words cannot describe his pictures. They live.” Latrobe’s
technical advice on painting was also quite rational. He informed Miss Spotswood that “the
whole of your object” is to “record any striking scene in Nature, so as to renew the pleasure you
felt in beholding it, and to communicate it in some degree to your friends.”402 That Latrobe could
admire Claude most for his naturalism and praise paintings as recordings, even in a letter to the
beautiful Miss Spotswood, seems a sign that he did not place much value on the elements of
picturesque theory that conjured strong, and even sublime, emotional expression. Emotion, for
Latrobe, was likely too much a creation of man, as well as an element of imbalance in a natural
rational world. As he wrote in the first surviving lines of the Essay, “had I been appointed to
settle the ceremonial of the arts, I believe I should have given the precedence to the representation
of the Beauty of Nature, and not to that of the actions of Man.”403

Within the Essay, Latrobe drew on theories concerning the natural laws underlying all
aspects of improvement, and also elaborated his version of aesthetic theories concerning taste,
balance, and the combination of opposing parts. Latrobe’s interest in natural and artistic harmony
fills the pages of An Essay on Landscape. In connection to this point, Latrobe made it clear that
he believed that taste must be calibrated to be in harmony with each situation and character. He
also believed that the mind could instantly determine whether compositions were correctly
balanced. He began the Essay with his description of a particular type of equilibrium. “Taste,” he

402 Latrobe, Journals, II: 469.
403 Latrobe, Journals, II: 468.

In light of Latrobe’s far stronger connection to beauty and nature than to emotion and man, the
population of the pages of the second volume of the Essay with Linnaean tales of hybrid combinations,
especially of voracious and sexually active plants, and of crabs and oysters living symbiotically within
the same shells, can be read as a fairly provocative, if unsuccessful, flirtation with Miss Spotswood.
wrote, is “that talent which seizes and executes what is most generally exquisitely pleasing, and
knows how to combine contrast with harmony.” Contrast, he warned, could be “harsh,” whereas
harmony might become “dull.” Taste locates the balance of the two, not veering too far in either
direction. This idea is solidly placed by the editors of Latrobe’s papers in the tradition of the
picturesque topography, and they locate Latrobe within the “upper, quasi-professional rank of the
amateurs,” in this type of painting. But if Latrobe drew on an established English and
European tradition, his illustrated manual was the first of its kind in America.

Harmony and Propriety

The Center Engine House must have posed a compositional problem for Latrobe, as it
occupied a solitary position that, according to Latrobe’s artistic theory, made harmony difficult to
achieve. The Essay begins with a pair of images, painted to explain the difficulties of achieving
contrast, harmony, and taste within a composition. Latrobe explained that, in “the simplest form
of a Landscape ... a single object with the Ground that supports it.” In this case it was “difficult
to produce much effect” because of the limits to combination. [Figure 70] The Engine House bore
a similar relationship to its site as the lighthouse Latrobe painted to demonstrate the problem of
solitary contrast. The engine house, too, fell alone at a simple center, set on flat, open grounds.
In the Essay, Latrobe noted the embedded contrasts, the “danger and roughness” of the rock
against the “safety and regularity” of the building, and warm earth against cool sky. As Latrobe
explained of his lighthouse example, a single object might be brought into balance, “but then it
will depend upon the contrast and harmony of the separate parts of these objects, among
themselves.”

404 Latrobe, Journals, II: 470.
405 Latrobe, Journals, II: 462.
406 Latrobe’s landscape painting was a much tamer view than the dramatic well-known image of
  Smeaton’s Eddystone Lighthouse, from the book published while Latrobe worked in Smeaton’s office
during 1788.
407 Latrobe, Journals, II: 472.
Latrobe explored different techniques for establishing propriety of parts within a composition. He explained that in the case of the lighthouse, "The harmony of the piece consists in the Solidity, and propriety of the position," of the tower upon its ground, assisted by the tint that tied house and ground together, and the lightness that combined "into one Mass the luminous side of the building and the gleam of the heavens." One might note that the white marble of the Center Square Engine House also allowed this unity between the light of the sky and the gleam of the building. With no possibility for an underpainted layer of matching tint to join the building and ground in Philadelphia, Latrobe spun echoes of the building's geometries across the landscape to knit the Center Engine House to its site. This geometric harmony will be addressed in the following section of this chapter.
Latrobe found more ease in obtaining harmony in the Essay’s second painting example [Figure ] of a scene containing multiple objects and distances, each appropriate to its situation. This image shows similarity in arrangement, if not in quality, to the works of Claude Lorraine. It features a castle on a cliff with a very dark rock in the foreground, and a body of water separating near and far, and an even less distinct mass of green-tinted land in the furthest distance. This painting easily achieves the necessary fore, middle, and background, and contrast between dark and light; earth, water, sky, and trees; man-made and natural; and warm and cool. Latrobe specifically noted that all of the parts contrasted but despite being “wholly distinct in their natures and forms,” they could still, “fraternise easily in the mind’s eye.” This issue of fraternal mental relationships between disparate objects can be seen as a certain reference for Latrobe’s architectural theory.

Variety in composition might make it easier for an artist to achieve harmony, but this also required a sensitivity to “situation” and to “character.” Latrobe explained that with all of the diverse elements of his Lorrainesque composition, “Harmony however may exist in the whole, every object being appropriate to its situation.” Situation called for a particular honestly, as well. In a critique of painter whose talents he admired, Latrobe commented that he fell among the ranks of talented artists who take such “licenses … that it is impossible to recognize the character of the countries they represent in their pictures.” expressed gratitude for being himself “a very indifferent painter,” but at least a “correct” one. 408

The ideas of character and situation can be seen to underlay the eighteenth-century effort to reestablish a unity of architecture and nature, and to reweave a system that would allow both rules and change, in order to recover from Claude Perrault’s forensic dissection. As David Leatherbarrow has demonstrated, Robert Morris, the author of Lectures on Architecture (1734)
and *Rural Architecture* (1750), was influential in this reconsideration of the conditions which might support and shape architecture, and be in turn supported and shaped by it. These conditions, what Leatherbarrow calls “topography,” were called “situation” by Morris and others during the eighteenth century. Leatherbarrow judges the idea of situation as “an important transformation in the history of architectural thought.” The foundation of this shift was, “an attempt to interpret landscape as the radical source of architectural order.” Character became the element that bound together what Leatherbarrow terms, “a unity of built and unbuilt elements.”

This unity bound together not just visible site and situation, but also climate. Morris made this clear in his opening sentence of the introduction to *Rural Architecture* (identical in *Select Architecture*, 2nd edition, which was owned by Jefferson):

> The Science I am treating on, is made universal through Necessity: it sprung from Distress, and Utility was the View of the Designer. In the first Ages of the World, its Extent was from the Torrid to the Frigid Zone. In the burning Sands of Lybia, and Greenland’s icy Banks, its Vestigia may be traced; and in every Structure, in every Climate, Nature has dictated the Architect to the Disposal of it, for Use and Convenience: Dress, and Decoration, were the Refinements of a long Series of Ages, the Improvements of Greece, and afterwards the Source of Roman Greatness.

Latrobe argues for a similar unity of elements, adapted according to situation, including what we now call the “environment” in his *Essay on Landscape*. I hope to demonstrate that he attempted to achieve this elemental harmony in his design for Center Square.

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I cannot help seeing great affinity betwixt deducing gardening from the painter's studies of wild nature, and deducing government from the uncontrolled opinions of man in a savage state. The neatness, simplicity, and elegance of English gardening, have acquired the approbation of the present century, as the happy medium betwixt the wildness of nature and the stiffness of art; in the same manner as the English constitution is the happy medium betwixt the liberty of savages, and the restraint of despotic government; and so long as we enjoy the benefit of these middle degrees betwixt extremes of each, let experiments of untried theoretical improvement be made in some other country. 411

- Humphry Repton, Sketches and Hints on Landscape Gardening, 1794

In America we have been, in our taste in Gardening, a little behind our scale of improvement in other respects.


Latrobe's Center Square Engine house was a dissertation on the balance between city and nature. The idea of bringing the country into the city, rus in urbe, or of doing the reverse, was one of the balance points that split the factions in the landscape debates of the 1790s. Latrobe's ideas were in particular alignment with those of Humphry Repton, with whom he claimed to have been "very intimate" during 1794, the year Repton was compiling his *Sketches and Hints on Landscape Gardening*.112 Latrobe also had strong opinions regarding others involved in these debates, especially the picturesque landscape painting proponents who vehemently argued against the excessive artifice of the antique method of gardening. Latrobe's examples of elements that would lack propriety in his watercolor landscape paintings make his sympathies explicit. As elements that would destroy harmony in a picturesque painting, Latrobe gave the examples of a "bridge with a Chinese railing" or a "row of trimmed poplars."113 But if Latrobe judged manicured poplars as out of keeping with certain situations, natural poplars planted in regular allées and concentric rings would fraternally unify his architectural design for the Center Square Engine House within its cultivated urban site.

The Happy Medium: The Center Square within Landscape Theory

Latrobe calibrated his landscape plans to an urban environment, positioned between "the wildness of nature and the stiffness of art." In particular, the laying out of walks and plantings around the Center Square Engine House reflects a Reptonian approach to the regularizing of nature in proximity to architecture. As has already been discussed, this regularity must be interpreted within theories of the interrelated natural fabric of mind, body, and environment, and within the eighteenth-century emphasis on balance in all of these. Repton's invocation of the

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112 Latrobe, *Correspondence*, I: 761.

The Chinese bridge as an element that violated the natural landscape garden was a common refrain, and an easy target for proponents of the picturesque landscape. In 1773, William Mason would mock William Chambers' bridge "a la Chinois" at Richmond gardens. (Mason, *Heroic Epistle*, 1773, p. 4) Richard Payne Knight would also target "the thin, fragile bridge of the Chinese" as "The child of barren fancy turn'd to whim ...". Payne Knight would also condemn the poplar, "Something is more required than size and height; Which shewn in shapes, thus formal, thin, and tall; Make us regret they ever grew at all." (Richard Payne Knight, *The Landscape, a Didactic Poem*, 1794, p. 33, 62)
“happy medium” between the wild and the stiff, and between freedom and despotism, directly predicts Latrobe’s Essay, in its call for combination and balance as the gifts of “modern Philosophy.” One area in which Latrobe can be seen to have agreed with Repton is in his distancing of the art of landscape gardening from the art of landscape painting. Latrobe’s position simultaneously modulated some of the more expressive romantic concerns of eighteenth-century artists and gardeners. In his *Sketches and Hints on Landscape Gardening*, Repton argued that there is, “a great different betwixt a scene in nature, and a picture on canvas.” Latrobe seems to have been accord with this view. He used different types of representations for different purposes, and nowhere in his *Essay on Landscape* did he suggest that landscape painting was a valid basis for landscape plans.

While Latrobe’s restrained and contingent theories placed him closest to the position of Repton, Latrobe expressed sympathies that also connected him with others engaged in the landscape debates. Several times Latrobe paraphrased William Mason, though always conflating Mason with Richard Payne Knight. In his journals of 1796, Latrobe recounted a day of beautiful scenery in Virginia, describing endlessly balanced views of “water, trees, and ground,” and offering contrapposto praise for, “the *dignified playfulness* of nature in the composition of these three ingredients into Landscapes as various as they were harmonious.” He expressed the challenge that if the “Poetaster” who had written the mocking lines, “Search, as you will the whole creation round, ’Tis after all but water, trees, and ground,” could view this land without recanting, he would be punished as a “blasphemer.”

Latrobe’s quotation of William Mason’s *An heroic epistle to Sir William Chambers, Knight, comptroller general of His Majesty’s works, And Author of a late Dissertation on Oriental Gardening* actually placed him in agreement with Mason, who was reworking the words

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414 Latrobe said that he was “uncertain about the Versification,” of the landscape triad of water, trees, and ground. Latrobe, *Journals*, II: 469.

415 Latrobe, *Journals*, I: 153
of William Chambers to produce a satire against bringing too much of wonder, terror, and novelty into the garden. In the epistle, Mason took Chambers to task for his suggestion that art must correct nature’s meager palette by adding a sequence of amusements and surprises such as cascades, bridges, reptiles, monkeys, giants, and other follies. Mason’s critique was that for Chambers, “a perfect garden must contain within itself all the amusements of a great city; that Urbs in rure, not Rus in urbe, is the thing, which an improver of true taste ought to aim at.” The issue of bringing city to country, as well as country to city, was the essence of Latrobe’s efforts at Center Square in Philadelphia.

Latrobe’s design for Philadelphia can be seen to be in alignment with Repton’s ideas which attempted a balance between city and nature, between grid and green. The two men seem to have shared a close position in the picturesque landscape battles, if, in fact, all participants held certain ideas in common. The idea of balance as the essence of composition and taste was agreed upon by all, including Sir William Chambers and Richard Payne Knight. Chambers hoped for a balance in which gardens would be “natural, without resemblance to vulgar nature,” and “new without affectation.” Payne Knight claimed that, “True composition all extremes rejects, And just proportions still, of all, selects.” Repton similarly claimed that, “Extremes are equally to

416 Sir William Chambers, A dissertation on oriental gardening; by Sr: William Chambers, Knt: Comptroller General of His Majesty’s Works (Eighteenth Century Collections Online. Gale. London: printed by W. Griffin; sold by him; and by T. Davies, also by J. Dodsley; Wilson and Nicoll; J. Walter; and P. Elmsley, 1772).


418 Chambers, A dissertation on oriental gardening, 64. “But wherever a better style is adopted, the Gardens are to be natural, without resemblance to vulgar Nature; new without affectation, and extraordinary without extravagance : where the spectator is to be amused, where his attention is constantly to be kept up, his curiosity excited, and his mind agitated by a great variety of opposite passions; there Gardeners must be men of genius, experience and judgment; quick in perception, rich in expedients, fertile in imagination, and thoroughly versed in all the affectations of the human mind. ”

be avoided."⁴²⁰ Landscape as a salve that healed through balance and combination was also an idea beyond reproach, with Payne Knight’s explanation, "‘Tis just congruity of parts combin’d; To please the sense, and satisfy the mind."⁴²¹

The difficulty, as the eighteenth century waned, was where to locate that balance and justness of composition in order to construct a new, unvulgar nature. The “surprising, or supernatural scenes, … of the romantic kind,” that Chambers had earlier praised for their “horror and sublimity, … calculated to excite in the minds of the spectators, quick successions of opposite and violent sensations,” were clearly out of keeping with modern manners as Latrobe understood them.⁴²² Payne Knight drew from a less violent palette of emotions, and Uvedale Price found a place for the picturesque between the sublime and the beautiful.⁴²³ But if Mason, Payne Knight, and Price could together mock the Chinese bridges and lizards and giants of Chambers, they still valued the full range of sensation, and were suspicious of tame, workmanlike shaved lawns.

The issues of work and professionalism, and of class, were elements beneath this battle which also at times interfered with the aesthetic of tidiness embraced by Latrobe and Repton. As John Dixon Hunt has explained, Humphry Repton was a working landscape gardener arguing against a class of gentlemen artists whose theories were based on experiments with their own substantial holdings. From their elevated positions, they could argue for landscape art as a derivative of the fine art of painting, and could fault Lancelot ‘Capability’ Brown and his self-appointed heir as mere gardeners. Today we might judge the upper class Payne Knight and Price as amateurs and Repton as a professional, but at the time, again as noted by J. D. Hunt, Repton’s

⁴²⁰ Repton, Sketches and hints, 63.
⁴²¹ Richard Payne Knight, The Landscape, a Didactic Poem in Three Books (London: Printed by W. Bulmer and Co. and sold by G. Nicol, Pall-Mall., 1794), 5.
⁴²² Chambers, A dissertation on oriental gardening, 28.
⁴²³ “PICTURESQUENESS, therefore, appears to hold a station between beauty and sublimity; and on that account, perhaps, is more frequently and more happily blended with them both than they are with each other.” Uvedale Price, An Essay on the Picturesque (1794) in John Dixon Hunt and Peter Willis, ed., The Genius of the Place: the English landscape garden 1620-1820 (London: Elek Books, Ltd., 1975), 354.
ability to build according to his own theories was constrained due to his reliance on wealthy clients with their own tastes. Latrobe found himself in a similar position, accused of being a workman at the level of “a Glazier or Upholsterer” by the amateur architect Dr. Thornton, who was a man of relative eminence and wealth.424 Latrobe in turn insulted Thornton as an amateur, and at times even ventured to criticize the untrained tastes of Jefferson, and his “prejudices in favor of the old French books, out of which he fishes everything.”425 This split between the gentleman architect and the hired professional underlay several conflicts during Latrobe’s American career. Andrew Schocket has argued that Latrobe’s financial battles with the Philadelphia Corporation’s Common Council were in part a schism between Latrobe’s European understanding that a professional would receive expenses, plus a percentage of the cost of the work, and the position of a wealthy American elite who saw budget overages as Latrobe’s fault, and treated him as an "employee."426

Latrobe was by no means a member of the common class, but he did rely on his income from work, and he, like Repton, called for a more stable form of sensation, closer to beauty than to the sublime, a salve to the passions and excitations of the mind rather than a stimulant.427 This is an interesting political and aesthetic position, because it places Latrobe on the side of Dr. Rush and the medical students he taught at the University of Pennsylvania, who argued that the vitality and youth of America called for soothing remedies. This is the antithesis of the argument made by Payne Knight and others who called for the variety of cascades, dryads, copses, and thickets instead of the “dull, vapid, smooth, and tranquil scene,” enacted by the professionals with their “charts, pedometers, and rules in hand.”428 It was in a sense a fight between an upper class, defending their heightened artistic sensitivities, and the self-appointed professional spokesmen

424 Latrobe, Correspondence, II: 602.
425 Latrobe, Correspondence, I: 260
426 Schocket, Founding Corporate Power in Early National Philadelphia, 45.
for the laborer and agriculturalist, arguing that the fertility of earth, water, and trees was in most cases stimulant enough for any healthy man. This was especially ironic in the American context, in which the old world was seen as exhausted and enervated. Meanwhile, most of the Democratic Republican leaders were from America’s own class of landed gentry, and many would soon be anointed and cast in marble for their glorious roles in the founding of the nation.

The nineteenth century saw not only a retrospective adulation for America’s early heroes, but also an explosion of urban growth that made a balanced combination of rus et urbe, nature and city, largely untenable. In his critique of Payne Knight’s picturesque poem, Latrobe said it was “elegant, but illnatured.”429 The idea of an illness of nature is like a magnifying glass that, if applied to the narrow theoretical divide between the slightly domesticated positions of Repton and Latrobe and the more romantic, elevated ideas of Price and Payne Knight, reveals what would become a chasm during the next century. At the moment that the Philadelphia Center Engine House was constructed, both Latrobe and Repton were exploring the possibilities for an art that integrated city and nature through ordered geometries that bound together the products of man and nature. With the rise of the industrial city, and the explosion of pollution and disease that accompanied it, tastes would turn rapidly towards an artfully constructed pastoral nature as a counterbalance to the devastating disequilibrium that accompanied rapid technological changes.

429 Latrobe, Journals, II: 469.
Art Declares Herself Openly: The Center Square Plan


In the due attention to the training and trimming such trees by art consists the difference between a garden and a park or forest; and no one will, I trust, contend that a public square should affect to imitate the latter. 430

- Humphry Repton, An Enquiry into the Changes of Taste in Landscape Gardening, 1806

The perfection of landscape gardening depends on a concealment of those operations of art by which nature is embellished; but where buildings are introduced, art declares herself openly, and should, therefore, be very careful lest she have cause to blush at her interference. 431

- Humphry Repton, Sketches and Hints on Landscape Gardening, 1794

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430 Humphry Repton, An Enquiry into the Changes of Taste in Landscape Gardening. To which are added some observations on its theory and practice, including a defence of the art (London: Printed for J. Taylor, 59, High Holborn, 1806), 63.

431 Repton, Sketches and Hints, 13.
Latrobe and Repton argued neither for rus in urbe, nor urbe in rus, but rus et urbe, a particular combination and balance that would find a particular expression within urban squares. Both Repton and Latrobe were concerned with “the interference of Art.” Repton used the phrase often as a negative term to describe unwarranted intrusions of man’s hand into natural scenes, but also to note particular situations in which art subtly improved nature. Latrobe used the term to describe General Washington’s estate, Mount Vernon, noting appreciatively, “Towards the East Nature has lavished magnificence, nor has Art interfered but to exhibit her to advantage.”

Repton’s theory helps to clarify two matters concerning the interference of art, which may be equally applied to an analysis of the design of Center Square. The first part of this theory was that within the garden art should remain hidden, “but where buildings are introduced, art declares herself openly.” The second part of this theory was that, “There appears to be in the human mind a natural love of order and symmetry.” The ability to perceive symmetry was innate, instantly understood by children according to Repton. This theory of perception which resembled Latrobe’s ideas about sensation and natural order, required symmetry of any landscape adjacent to a “regular building” because a lack of correspondence would make the architecture “appear twisted and awry.” Repton drew on Montesquieu’s explanation to split the picturesque from proper declarations of art, explaining that things seen sequentially should have variety, but that anything perceived ‘at one glance, ought to have symmetry, … which pleases the soul by the facility it gives her of taking the whole object at once.’

Perhaps this is the key to understanding the architecture of both building and ground at Center Square, that it was, and had to be, equal to all, owned by every citizen, viewed on all sides, and apprehended at one glance. The Center Engine House was a small pavilion within an open field, positioned at the primary crossing for the city. Market Street linked the port at the Delaware River to the ferry, soon to be replaced with a permanent bridge, to the Lancaster

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433 Repton, *Sketches and hints*, 13, 44, 45.
In the flat plain of the city, the engine house fell within the view of anyone traversing across, or going to market, in short, everyone. The house aligned its primary facades with Market, and its secondary faces with Broad, the city’s widest street, cutting through at this time to end abruptly at the suburban hills to the north, and the farms to the south. Within the square itself, the marble edifice stood in alignment with these axes, but also fixed itself firmly apart, its white volume visible at one glance, surrounded by greenery and encircled by walks that reinforced its command of the park. It bore no statues or inscriptions, yet was sensible to all.

In a position of both eminence and immanence, the engine house and its grounds required the open declaration of art in her most orderly dress. In his painting manual, Latrobe had recommended that poplars would provide a jarring contrast within a picturesque background. A few years after he made this argument, he would have seen the planting of arranged rows and rings of poplars around the Center Engine House, which helped the garden pavilion to achieve harmony within its open, urban setting. These trees, and the house itself, would appear differently in various representations from the time. There is no doubt that it was an ordered landscape, but it had aspects that were both domestic and civic, wild and cultivated. Different artists, including Latrobe, gave weight to one aspect or another depending on their intended audience. Birch’s engraving, printed even before the building was complete, shows an informal scene, while a later drawing by William Strickland emphasized the perfect symmetry of the carefully clipped allées. [Figures 72 and 73] This difference was not, I think, due only to the difference of decades passed, but also to each artist’s understanding of the civic function and face of Latrobe’s design.

434 The issue of clothing was one that concerned Latrobe, as we saw in his statement on hoop skirts and topiary trees as elements of the decadent days of the French monarchs. It was equally a part of the landscape debates. Again via John Dixon Hunt, William Mason informed William Gilpin that, painting and gardening, as much as he had ‘endeavoured to bring them into sisterhood,’ were truly ‘half blood,’ since landscape always chose neatness, ‘starched apron, & Ruffles; whereas Landscape Painting loves to have her things rumpled about her, and her hankerchief hardly pinned to her Stomacher.’ (Dixon Hunt, The Picturesque Garden in Europe, 88)
The engine house was never the simple pavilion within a wooded clearing. W. Birch & Son's engraving of 1800, "The WATER WORKS, in Centre Square PHILADELPHIA," completed prior to the construction of the works, depicts a rustic scene [Figure 73], but considerably more "improved" than as Latrobe chose to render it at around the same time. [Figure 40] A footpath enters from what appears to be the east, or city side of the site. The footpath leads to the portico as well as to a narrow circular path around the base of the building. The site is ringed by a circular carriage road planted around with evenly spaced trees that appear to be untrimmed but regularly spaced Lombardy Poplars. Birch and son show an improved site, but one that is still natural. The roads and paths are compacted earth, not gravel, and, possibly for
contrasting color effect, or to indicate the more natural area towards the west, they have included several of what Repton would call "round-headed trees" of a more natural profile lingering behind and setting off the white of the marble cylinder. A faint building in the background is likely meant to be the Schuylkill engine house to the west at 22nd and Chestnut Streets. The image is, oddly, composed similarly to Latrobe's typical perspectival renderings of private residences, including the mother and children playing on the lawn.435

If the square was at first depicted as the domestic lawn of a country manor, from the start the site was arranged to suit the most current tastes in landscape plantings, in imitation of eighteenth-century European designs for urban settings. It is known that William Hamilton of Philadelphia introduced the Italian Lombardy Poplar to North America in 1784, first in his West Philadelphia estate, the Woodlands. The tree was most famously known for encircling the island tomb of Jean Jacques Rousseau. The hearty tree was widely dispersed from Italy across Europe during the eighteenth century, and became a common avenue tree, used to create screens or planted more closely to form green walls. The fad was so widespread that by the mid-nineteenth century the tree had fallen out fashion not just for the tendency of its roots to penetrate and destroy sidewalks and, ironically, buried pipes, but for its ubiquity. In 1840, Andrew Jackson Downing called the Lombardy Poplar "tiresome and disgusting."436

435 Latrobe's rendering for the Sedgeley House of 1799 included a similar scene.
Figure 74 - W. Birch & Son, HIGH STREET, From the Country Market-place PHILADELPHIA, with the procession in commemoration of the Death of GENERAL GEORGE WASHINGTON, 1800. Courtesy of the Historical Society of Pennsylvania. Figure 74a – Detail.
The planting design of Center Square was entirely in keeping with Repton’s rules, as well as in accord with contemporary medical theory. Repton argued that “trees of a pointed or conic shape have a beautiful effect” when placed in contrast with “Grecian edifices.” This assumption of the interrelationship of architecture and landscape was embedded in Latrobe’s design and at the same time, this taste in plantings was also very stylish in Philadelphia. Within the Birch collection that also included the domestic lawn scene of the engine house, an engraving of General Washington’s funeral as seen from High (Market) Street shows Lombardy Poplars planted along the road’s edges, with the waterworks in the distant background. 

Most engravings and renderings show Center Square as place of softened order. Trees are planted in orderly rows, but left unmanicured, probably adding greater improvement to the atmosphere. These Poplars were generally believed during the early decades of the 19th century, “not only greatly to ornament the city, but to promote public health by the circulation of air they produce, and the shade they afford during summer: —enough to overbalance the trifling inconvenience arising from the tendancy of the roots to force up the pavement.”

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437 Repton, Sketches and hints, 17.
Figure 75 – Bloomsbury, plan in 1795 (left) and in 1813 (right), UPenn Fine Arts Library Image Collection. http://hdl.library.upenn.edu/1017/d/fisher/n2007092359 [accessed 4 June 2015]

A further demonstration of the accord between Latrobe’s ideas and those of Humphry Repton can be found in a comparison of Center Square with Repton’s design for Russell Square in London. Repton was likely commissioned to undertake the renovations of the square in 1802, a year after the construction of the Philadelphia waterworks, and published his comments on the design in *An Enquiry into the Changes of Taste in Landscape Gardening* four years later.\footnote{Stephen Daniels, *Humphry Repton: Landscape Gardening and the Geography of Georgian England* (New Haven: Yale University Press, Published for the Paul Mellon Centre for Studies in British Art, 1999), 181.} [Figure 75] Repton, like Latrobe, was faced with the problem of green in a grid, and explained that the “character and situation” of “one level plain” was an “insipid shape” that presented unique problems.\footnote{Repton, *An Enquiry into the Changes of Taste in Landscape Gardening*, 61.} He planned the square with his own favored interventions of art, namely, the
“convenience” of “close mown grass” and “firm gravel walks,” mentioned in his *Sketches and Hints*, as well as evenly planted hedges to separate the walks from the street.442 Like the Center Square plan, Repton included an inner, circular, “cloister-like walk” lined by evenly planted trees that separated inner and outer lawns. In Russell Square, Repton allowed this circular path to straighten to meet the pedestal on which a statue of the Duke of Bedford greeted visitors at the entry to the park. In the center of Russell Square, Repton designed a “perfectly secluded” area, a “Reposoir” area with shaded seats for rest and repose, a quiet, sheltered site.443 This calm center ringed by paths and shade trees shows a similar hope for a fixed orientation point both in the city and within nature as Latrobe’s design for Center Square.

Center Square was a cultivated urban landscape, and one that must be seen as in accord with modern landscape theory. A plan of Center Square dated 1800, and recently acquired by the Library Company of Philadelphia, confirms William Strickland’s undated image of the site as a manicured urban park with promenades and poplar allées.444 [Figures 77 and 72] This plan is characterized by a strong interplay between lines and circles, centered on the engine house. The plan seems to have been drawn by Latrobe’s draftsman and superintendent, Frederick Graff, who continued to add annotations until 1827. In 1800 when the plan was first drafted, Graff had not yet left Latrobe’s employment, so even with the loss of Latrobe’s journals from this period, and in the absence of any theoretical statement by Latrobe on this plan, I will address it as his design.

The design of Center Square was in keeping with Latrobe’s other landscape plans, all of which seek a balance between areas where art declares herself through the imposition of strict geometries, and others where her hand is more subtle. The degree of regularity is adapted according to each area’s adjacency to, or view from, architecture, as well as to its status as more or less public. Even prior to his arrival in America, Latrobe designed two private commissions in

442 Repton, *Sketches and Hints*, 61.

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Sussex with landscapes that spoke of the interference of art in areas adjacent to the house. At both Hammerwood and Ashdown, which were built in 1794 when Latrobe claimed to have a close acquaintance with Repton, he excavated and constructed earth terraces around the manors, and oriented the primary face towards lands sloping downwards and to the south. At Ashdown, formal gardens were placed on the terrace adjacent to the house, although it is possible this aspect may have been a remnant of a prior plan.

Latrobe’s 1807 drawings for the President’s House show his tendency to design a public front based on axial symmetrical geometry, a central circle, and formal allées of trees. While some give credit for this drawing to President Jefferson, analysis by the editors of Latrobe’s papers demonstrates that the plan was composed by a draftsman under Latrobe’s direction, and was likely reworked in his hand. Latrobe distinguished the geometrically rigid formal front from the eastern, private grounds through which he traced a serpentine carriage path wending its way through “wood,” “Garden,” and “Clump.” In this insertion of regular geometry adjacent to building and road, he again closely followed the Landscape technique recommended by Repton.

445 Latrobe, Drawings, II: 499.
Most similar to the Philadelphia design is a plan of 1819 that Latrobe drafted in the last years of his life for the Place d’Armes in New Orleans, now known as Jackson Square. This square was also within the middle of an urban area, though much more developed than Center Square was at the time of construction. The New Orleans design features a central circular path around a fountain, with three paths entering from the middle of each of the four sides, just as in Philadelphia. [Figure 76] On March 20th of 1820, Latrobe informed his wife that he’d been working all week on “a plan for the decoration of the public square,”446 He informed the city on the same day that his design had been created in cooperation with surveyor Joseph Pilié, and

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446 Latrobe, *Correspondence*, III: 1028.
based on an existing scheme, but did list as one of his interventions a reduction of the number of walkways inside the square, so it is clear that the plan of the walks was his own.\textsuperscript{447}

Figure 77 - Frederick Graff, Untitled manuscript plan of Centre Square, c.1800, with additions to 1827. Courtesy of the Library Company of Philadelphia.

The “Untitled manuscript plan of Centre Square,” drafted by Frederick Graff under the supervision of Latrobe around 1800, and updated through 1827, shows a striking image of the Center Square Engine House as a pavilion within an urban square. [Figure 77] This design is far more calculated, cultivated, and urban than either that depicted by Latrobe in 1799 or by Birch in 1800. The waterworks looks diminutive, its footprint only 60’ by 60’ within a square that measured, by Graff’s account, 686’ to the east and west, and 637’ to the north and south. The major cross streets that center on the square are wider than the engine house, with Broad Street

\textsuperscript{447} Latrobe, \textit{Drawings}, II: 737.
measured at 113’ across, and Market Street 100’. The waterworks sits within a cleared circle, and is intersected by triple paths crossing from each side. The bounds of the site design are the rectilinear streets of Filbert, Chestnut, Juniper, and the fourth, unnamed street to the west. The location of William Rush’s fountain added outside the east front in 1809 is marked, as well as the body found in 1813, and the demolition of the building in 1827, marking the high and low points of the site.

The measurements and alignments of the geometrically rigid interferences of art on the grounds of the site are composed as extensions of the square plan of the Engine House, allowing the small pavilion to weave its footprint out to the grid of the city. The widest central landscape paths coming from each of the cardinal points are centered directly on Broad and High Streets and also align perfectly with the width of each portico, drawing the roads and ground into direct alignment with Latrobe’s marble pavilion. These broad allées measure 260’ in length from the outer ring road to the center of the engine house. The distance between the face of each portico and the edge of the sidewalk at the road is just less than four of the 60’ building footprints. The central path from each side and aligning with the porticos is flanked by two narrower paths, which fall exactly outside the footprint of the building and align with the sidewalks of the major axial streets, carrying the grid through center square, and allowing travelers on foot to pass directly through the site.

The circular form of the center of the house also echo across the square. The park is ringed by a 26’ wide circular “cart way” lined by three sidewalks labeled “foot way.” The center of the carriage ring road is marked at 1853’ in circumference, slightly more than fifteen times 120 feet (15*2*60). The pedestrian walk on the outside of the circle is 12’ wide. There are two separate walkways of 17’6” on the inner edge of the ring road. One of these sidewalks, the “inside grounds walk,” measures 480 yards in circumference (exactly 1440 feet = 12*2*60), and the other is an “outside grounds walk” is 532 yards (exactly 1596 feet=13*2*60). This double
layer of generously wide walking paths allowed citizens to promenade and exercise in the air cleansed and cooled by the poplars. The division of the two adjacent footpaths by a fence must have allowed the choice of a more protected or more open walking path, one aligned with the balanced view within, one connected to the wider grid and movement of the city. It is interesting that the circular arithmetic of the site extrapolates easily from the 60' by 60' plan dimensions of the engine house.

An investigation of three drawings from 1799 and 1800 reveals layer within layer of geometric balance and calculated interplay between center and grid, circle and square, apparently based on an elemental module of 12 feet, arrayed at harmonic intervals.

![Figure 78 - Geometric Study Overlay, Landscape Plan - base drawing: Frederick Graff, Untitled manuscript plan of Centre Square, c.1800, with additions to 1827. Courtesy of the Library Company of Philadelphia.](image)

The untitled Graff plan for grounds, walks, fences, and plantings demonstrates a strict arrangement of concentric circles and crossing lines. [Figure 78] This plan shows the
aforementioned concentric circles for pedestrian walkways, laid out with lengths falling at intervals of 60', or five times 12'. An extrapolation from other dimensions noted in Graff’s hand, while cross-referencing architectural dimensions, reveals that the paths that cross through the site weave a 1-2-2-2-1 rhythm, which allows the 12' wide flanking foot paths to align with the sidewalks of Broad and Market. The rings of concentric circles that bound the engine house are also extrapolated from this base 12, making the total width of the leveled ground that encircles the house a perfect diameter of 144' or 12' by 12', the square of the module.

![Geometric Study Overlay, Elevation - base drawing: Frederick Graff, "North and South Front of Center Square Engine House (1799), in Latrobe, Drawings, I: 247.](image)

Using the lost Graff elevation of 3 August, 1799, we can see a similar balancing act of elemental dozens. [Figure 79] This also exposes the fact that this module is not exact in all places. The exposed cylinder and rectangular base were each 24'6" high, in fact, but I have allowed some
room (a foot) for error, or for the fascia that divides top and bottom. It seems that the vertical
height of the civic faces were calibrated at an even interval equal to the 24’ width of the portico
on the east and west facades. The overall plan dimension of 60’ is, not surprisingly, matched in
the overall height of the dome.

Figure 80 — Geometric Study Overlay, Section — base drawing: Benjamin H. Latrobe, Section of the Center Square
Engine House (probably 1799), in Latrobe, Drawings, I: 243.

It is at the level of the section that the complexity of this balanced machine geometry
unfolds, or cascades. [Figure 80] Here we can see the work, quite literally, behind it all, and
understand the rules that link the house's public face and technical center. This working drawing features a “regulating line” drawn 9’ above the finished floor elevation of the portico, which Latrobe labels, “Ground Line.” In fact, the regulating line would fall approximately 12’ above the actual level of grade. The crossing of the regulating line and the center line of the cylinder give the center point of the diameter of the brick inner dome. The circle pulled from this pivot point reveals a roughly 60’ diameter (five 12’ modules). The hard core of the building, the area for the engine, measures approximately three 12’ modules in height and width. In this geometrical game, the center of each element slips gradually downwards. The center of the technical inner cube falls 9’ below the center of the overall 60’ cube of the visible exterior. The center of the inner sphere of the dome drops 9’ again below that. This ascension from the center point of the brick dome on which the reservoirs rested to the center of the oculus is a necessary result of Latrobe’s insistence on an orthogonal and radial symmetry pinned within the grid of the city.

The Center Engine House provided simple orderly sensations radiating from a fixed point at the center of the city which could immediately be appreciated by all. In this, the mathematical regularity was as much an instrument for improvement as was the engine itself. Latrobe marshalled a precise geometry echoing from his central pivot. At the scale of the Center Square, Latrobe traced the architecture of cube and sphere across the landscape, simultaneously allowing the vectors of motion from streets and sidewalks to penetrate and cross. The solid white entry façade and smoking copper dome lifted above played a less active elemental game, a push and pull between ground, fire, water, and air that united curve and line in harmony. If the ritual of the baroque garden was one intelligible only to initiates and dedicated to the elevation of a king, the quadrants and orbits of Center Square invited all citizens to enter the play of civic life.

448 This working drawing was drafted after construction was underway. For that reason I’m rounding to the module of 12’ which seems allowable in a building constructed rapidly of wood and stone. The dimensions are good near approximations, however. For instance the internal block which I’ve labeled “technical center,” would in fact have been 35’2” high by 35’6” wide, rather than exactly 36’x36’. The radius measured based on the field dimensions given from the inside of the dome to the center point at the regulating line would in fact have been 31’10”, rather than 30’.
Benjamin Latrobe conceived an architectural balancing act, uniting a technical core with a public face, and attempting to harmonically connect them to the city. Here in these interwoven lines and circles, overlapping, pressing together, drawing up from underground and rising to the oculus and to the sky above, art has declared herself openly. This was a work based on primitive elements, elevated to a sophisticated composition. In this balance of basic form and complex arrangement, we see the strongest hopes of Latrobe's republican democratic architecture, which could strike the eye of a child, or of a scientist, and provide each with the possibility of improvement. The regular axes linked to the even and equal grid, while the circular center concentrated attention on the patrician improvement provided by the city's cultured patrons.
Latrobe’s design for Center Square was radical in its design, and revolutionary in projecting towards an urban future that was not yet certain. Yet, this advanced plan for Center Square seems to have been easily approved by city officials. The Watering Committee of the City Council, which was charged with the management of the project, reported in October 1801 that, “the Centre-Square has been partially levelled and planted with trees, with the view of affording an agreeable and useful place of recreation to the citizens.”

Looking back from 1820, Thomas Pym Cope proudly described the waterworks encircled by a railing that “left room for carriages & foot passengers outside of the railing,” and which also left the four corners of the square open, to be filled with “public fountains, baths, c., & the grounds were laid out in gravel walks & planted with ornamental trees, shrubbery, &c.” William Rush’s sculptural fountain, *Nymph and Bittern*, erected at the eastern front of the engine house in 1809, was one of the first civic fountains in America.

Latrobe was in conflict with the Watering Committee from the beginning, so the seeming lack of complaint about the costs spent on the grounds seems to indicate that the city council saw the civic landscape as uncontroversial even though it was unusual for Philadelphia at the time.

The design borrowed from European precedent, creating a cultivated green space that could one day become an oasis within a dense urban fabric. That Cope could discuss leaving the corners

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452 By August of 1800, just six months into the project, Latrobe was accused in the diaries of the usually reserved and temperate Quaker Thomas Pym Cope, of having a “manner hasty, intemperate & indecorous.” (Cope, *Philadelphia Merchant*, 4) Cope, a leading member of the Watering Committee, elsewhere describes Latrobe as dishonest, a leech, and most importantly, as lacking adequate knowledge to design a water system. In light of the records of cost overruns, mechanical failures, and constant reconstruction, Cope’s analysis must be deemed largely correct, at least as regards Latrobe’s knowledge of such systems. The Committee Report of 1801 which listed the improvements to Center Square also enumerated the difficulties with Latrobe and Roosevelt, and announced that Latrobe had received, “six thousand three hundred and fifty dollars as a full compensation for his services, on the completion of the work in all its parts,” and that additional charges had been rejected. His clerk of the works, John Davis, who would go on to build Baltimore’s water system, was praised for his “essential and satisfactory work.” [Philadelphia. Councils. Joint Committee on Water Supply, *Report of the Committee* (Philadelphia: Poulson, 1801), 11]
open for "public fountains" and baths at a time when most of the city was still uncultivated was truly ambitious. Latrobe's cultivated European taste in the area of landscape was in keeping with desires for a more healthful and balanced city.

The issues of cultivation and of balance were of essence to the health and manners of the new nation, and particularly to Center Square as it existed prior to Latrobe's renovations. If Latrobe hoped that art and nature could be marshalled towards modern improvements, this central green space was an area very much in need of balance and improvement. Historically the square was an area marked by lawlessness and wildness. Susan G. Davis has argued that Center Square was a site of tension between staid "Quaker authorities" and the lower immigrant classes, who followed less restrained practices of religious and seasonal celebration. Davis points out that "dramas and gatherings were neither easily contained nor easily abolished," and that popular fairs held twice yearly in Center Square aroused concern almost as soon as the city was settled. These festivities, she explains, "were called disruptions of the peace and corrupting influences on apprentices, servants, and youth." The carnivalsque events continued until they were banned just prior to the American Revolution, but afterwards worries about 'irrational' gatherings continued.\textsuperscript{453} If the area continued to be an untamed site for licentious behavior, it also gained an association with punishment. After 1750 a gallows was installed to the south of the square.\textsuperscript{454}

Center Square had been intended by William Penn to be the city's rational center, a site for, 'houses for public affairs, as a meeting house, assembly or state House, market house, school-house, and several other buildings for public concerns.' Unfortunately, since it remained past the outskirts of the built city for over a century, it did not become that central commons. The State House was built between 1732 and 1744 at Chestnut and Sixth Street, obviating the possible use of Center Square for civic government buildings. The State House was planned with the area


\textsuperscript{454} Elizabeth Milroy, "Repairing the Myth and the Reality of Philadelphia's Public Squares, 1800-1850," 58.
south of the site intended for use as a ‘public green and walk,’ but that plan was not executed until 1784. Its construction and planting with holly and elms was undertaken by Samuel Vaughan to create, ‘a place of general resort as a delightful promenade.’ At the time the waterworks was built, the small State House walk was the only cultivated park in the city.455

With the construction of the engine house and associated improvements, Center Square became a type of urban park that was new in Philadelphia, yet connected to a long history in Europe. At the time, the two western squares remained open land, and the two eastern squares were burial grounds, grazing land, and a potters’ field. Americans of African descent, freed and slave, were allowed to bury their dead in the southeast (now Washington) square, and also used this site for gatherings and celebrations.456 Thomas Holme’s *A Portraiture of the city of Philadelphia* of 1683 plans the four squares located in the quadrants of Philadelphia as cultivated sites with walks and plantings, to be recreational areas based on the Moorfields of London. In fact, the Moorfields was designed with walks, ‘in the fashion of a cross,’ a plain parterre that Latrobe reproduced in his design for Center Square.457 [Figure 82]

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While much of this appears and reappears in writings through the nineteenth century, Elizabeth Milroy’s excellent essay, “Repairing the Myth and Reality of Philadelphia’s Public Squares, 1800-1850,” provides the most succinct and accurate summary, as well as an argument regarding the change in attitude towards these areas of Philadelphia, and the revival of Penn’s plan during the 1820s.
If by 1798, there were no signs of healthful recreation in Philadelphia’s squares, this was publicly noted as a problem both by citizens and by medical professionals. Dr. Mease noted that Holme’s ‘like uses as the Moorfields in London,’ referred to the character of those fields, as, “the great gymnasium of London, the resort of wrestlers, runners, and foot-ball players, and every manly recreation.”458 As Elizabeth Milroy has discovered, in 1792, some action was attempted to improve the eastern squares on the grounds of public health. This year before the worst outbreak of the yellow fever, 180 citizens, including illustrious figures such as Robert Morris, Caspar Wistar, Mathew Carey, and William and Moses Bartram, signed a petition requesting that the squares be cleaned and standing water and ‘filth’ removed, to be replaced by planned walks and

458 Mease, Picture of Philadelphia, 17.
trees to, 'conduce to the health of the city, by the increased salut[brity] of the air; for it is an established fact that trees and vegetation have this happy effect.' This petition seems to have gained no direct response, possibly due to the city's devastation by fever and its near abandonment the following year. Yet, this idea of a park for healthful pursuits in idyllic surroundings was gaining public support at the time Latrobe constructed the waterworks.

There was a technical difficulty the city faced in improving the lands Holme had marked as shared commons, because Penn's original charter was unclear regarding whether these plots were under the legal jurisdiction of the city. In 1797 a committee was appointed by the City Corporation to determine whether the city had claim to parts of what had been laid out by Penn's original charter to be the northeast square at 6th and Vine Streets, and determined that they could recover territory encroached upon by the German Calvinist Society. The 1790s were a time when the city was reestablishing claim to Penn's original squares as places of civilized public recreation, and Latrobe's design was certainly in line with these desires.

A lack of clarity in ownership of, or intent for, the green squares of the city was in part the deciding factor in the location of the waterworks. Thomas Pym Cope, one of the city's prominent Quakers, explained in his diaries that he and other members of the Watering Committee were unsure whether the Corporation of the city of Philadelphia had the right to impede the intersection of Broad and Market (High) Streets. They determined to bring the decision to the Select & Common Councils. During the meeting, even the hesitant members of the Watering Committee, Samuel Fox and Henry Drinker, were convinced when the Holme plan was retrieved showed a public building on the exact center of the square. Interestingly, the map of 1687 shows blank squares in the quadrants, and a central edifice and four corner buildings in

460 Broadside, "The Committee appointed to examine into the title of the corporation to the north east public square, and the boundaries of the same; and also to enquire, whether any, and what, encroachments have been made thereupon, Report," (Philadelphia: Poulson, 22 February 1797).
Center Square, whereas the first Portraiture of 1683 shows the four quadrant parks ringed by aisles of trees, and the Center Square empty. [Figures 83 and 84]

The waterworks was a civic intervention that allowed the city to position a claim on what would be the heart of future development. As such, the city had interest in making it a cultivated square surrounding a permanent structure. Since the state had jurisdiction over roads, and might, because of the lack of clarity of the charter, claim the area, this was a controversial issue. Cope revealed in his diaries that “not a hint was given,” except to a very few, that one reason for having “the building fixed where it is,” was to stake a permanent claim on the square. As it turned out when planning began, the original Center Square had already accidentally been sold as private property. The state controller, finding the error, simply moved the square to the west and informed Cope of the transaction.461

If municipal desires for control at first supported the construction of the Center Square park and pavilion, as the city grew citizens’ claims to some measure of power hastened its demolition. At the most basic level, the square was intended to recenter the city and to promote healthier, more even development. Ironically, the settlement of the city to the west of the square gave rise to complaints from residents that the building obstructed their connection to the rest of

461 Cope, Philadelphia Merchant, 208-209.
the city. Dell Upton has located a “Petition of Residents and Owners of property in [the] western part of the city, for improving Penn Square,” dated 1827, in which the signatories argue for the demolition of the engine house because their view towards the east had been “intercepted.” The building interrupted an imagined “prospect” as well as pedestrian traffic, forming a blockade between “Eastern and Western Inhabitants.” They entered their official plea, to be “connected with each other as well in point of Interest as feeling.”462

By the time citizens petitioned for its demolition in 1827, Latrobe’s Center Engine House and its square had already fallen out of use as a water house, and had then fallen out of fashion. Latrobe’s Philadelphia waterworks had been a sophisticated and successful effort to construct a civic square as a convergence of city and nature, at a time when the city was still largely uncultivated, but it was precisely this lack of cultivation that made Latrobe’s victory short-lived. The technical difficulties that inevitably required the engine’s replacement have already been addressed, but the removal of the works inside were not the primary reason for the demise of the engine house. Latrobe’s careful calculations could not encompass all aspects of human nature, or account for all of the realities of the American climate.

Conclusion – American Equilibrium

The American war is over: but this is far from being the case with the American revolution. On the contrary, nothing but the first act of the great drama is closed. It remains yet to establish and perfect our new forms of government; and to prepare the principles, morals, and manners of our citizens for these forms of government. ... The Revolution is not over.

—Benjamin Rush, “The Defects of the Confederation, 1787

In fluid dynamics, the word equilibrium suggests a moving balance. For a moment, forces are equal. If for a few decades Center Square functioned as a fixed point within the city that represented republican ideals and served democratic needs, pressures soon shifted those functions elsewhere. Latrobe could not have accounted for all of the natural proclivities of man, or for the American class system and its turns of fashion, or for the budding wishes of citizens and politicians for self-reflexive monuments. Public opinion evolved between 1801 and 1827, and the perfectly fixed geometries of the engine house and the square could not move with it.

The ideas embodied in Latrobe’s design for Philadelphia, the perfection of its symmetry and the concentrating of its systems, mark its historical significance. It represents a fleeting, and perhaps imagined, moment of balance. Latrobe’s design froze in stone the most important elements of early republican thought. These theories of natural law, human sensation, and common equilibrium would so radically alter the nation that the design soon seemed irrelevant and unintelligible, or insensible. We might categorize this early work of Latrobe’s as proto-engineering, proto-urbanism, or even proto-environmentalism. Which is to say, the powerful theories that promoted the construction of this artifact also rendered it first “advanced” and then “primitive,” in rapid succession. My own hope is that it is more interesting to assess it for all that it captured before the equilibrium shifted, to view it as an essential pivot in the history of American infrastructure, urbanism, and ideas.

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Equilibrium underlay all aspects of natural and political philosophy during the eighteenth century, and always described a state that was both powerful and tenuous. From the word’s first known use in English, a sermon from the year 1608, it was used to describe a mental and emotional balance in conjunction with conditions of political stability. By 1660 the term would be used by Robert Boyle to describe the same experiments with hydraulic and pneumatic pressures which would lead to the invention of the explosive steam engine. Whether the word was used by Boyle, or by Jefferson, or later John Stuart Mill, it was understood as a state that touched all aspects of the natural world and human experience within it. Conditions might fall “in equilibrium,” but the balancing act was not always symmetrical, and rarely perfect.464

The Philadelphia Waterworks represented a momentary faith in perfectibility, that within the climate of democracy, natural law and common interest would simultaneously prevail. In this Latrobe’s design aligned with ancient ideas of balance, rather than with the more fragmented, complex, asymmetrical understanding of equilibrium that would be developed through later nineteenth-century science and engineering. Benjamin Rush and Thomas Jefferson also embraced this neoclassical theory of a stable and harmonious balance, and believed that citizens cultivated within this atmosphere of measured equality would gain new “principles, morals, and manners.” Rush’s statement in 1787, that “The Revolution is not over,” acknowledged that there was need for vigilance in making the improvements, both physical and intellectual, to prepare citizens adequate to the soon to be perfected form of government.


1608  Bp. J. King Serm. St. Maries Oxf. 26 “Salomon a man in the perfit æquilibrium and stablest state of his age.”
1660  R. Boyle New Exper. Physico-mechanica i. 36 “The pressure on all hands being reduced as it were to an æEquilibrium.”
1754  J. Edwards Careful Enq. Freedom of Will i. i 4 “Where there is absolutely no preferring or chusing, but a perfect continuing Equilibrium, there is no Volition.”
1755  Gentleman’s Mag. Apr. 164/2 “Being at the vernal equinox in an equilibrio.”
1798  T. Jefferson Writings (1859) IV. 231 “The fate of Sprigg’s resolutions seems in perfect equilibrio.”
1861  J. S. Mill Considerations Representative Govt. i. 13 “A government so situated is in the condition called in mechanics unstable equilibrium, like a thing balanced on its smaller end.”
This wish for an ordered perfection, whether of nature, government, art, or morals would soon lead to doubt and disillusionment for many of the early republican leaders, including Latrobe and his closest associates. In 1813 Rush would ask Jefferson if he regretted any of the sacrifices they had made as young revolutionaries. Rush expressed his dismay at the form American democracy had taken, of competition and earning and acquisition. His own opinion was incontrovertible, and bitter. In comparison with remembered battlefield scenes of “dead bodies putrefying in the open air,” he judged that “a nation debased by the love of money and exhibiting all the vices and crimes usually connected with that passion, is a spectacle far more awful, distressing, and offensive.” Rush believed that selfish “passion” had inflamed Americans to reject the noble patrician republic of temperance and common sense.

Function

Such a public building as the Engine house in Center Square which can never require enlargement, or a Church, or a Monument may with propriety be placed in the Center of a square, but no building of business ought ever to stand there unless large enough to enclose a Court Yard in its Center. Such a one is beyond the demands of our country.

—Benjamin H. Latrobe, “Remarks on the Plan of the town of Nescopeck, Pennsylv., Wilmington, Delaware, March 30th 1805 (addressed to Samuel Mifflin)

If the theory and technique that underlay the design of the Center Square Engine House were based on ideas of balance and improvement, the rigid building form and material prevented easy modification. Latrobe would later write that a public building should never be centered on a square, since with the expense of four facades, each would “suffer,” while the placement “confines the building to its original Dimension;” and forces auxiliary functions such as wood yards and privies into the cellar or into the grounds where they would obscure a facade. He stated explicitly that the Centre Square Engine house was the exception, as it “can never require

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enlargement."\(^{466}\) In this he was, of course, wrong. From the start the engine house had a coal shed built nearby. During the coal shortage of 1807, the watering committee would complain that in the absence of any room for storage, one thousand cords of wood would need to be stacked in the pathways to the south and west of the house.\(^{467}\) As steam technology changed, and the population of the city grew, power and demand exceeded what could be served by the two cramped reservoirs hovering between engine and dome. In literal fact, utility was squeezed between these elements, the technological instrument and the external expression of its actions.

Latrobe attempted to design an equilibrium between a perfect pavilion and plan and a revolutionary machine that served the wider environmental framework of the city. He could not have predicted which elements of his ambitious project would prove most influential during the next century. Most obviously, the steam engine would, after this formal introduction to the city, drive the industrial and capital revolution that changed Philadelphia and other American cities beyond recognition. Somewhat less inevitably, the waterworks can be judged influential as the first American experiment with the governmental provision and management of utilities. And finally, the innovative funding structure devised to build and maintain Latrobe's system would become a favored technique for the construction of urban public works. The construction was funded by a hybrid of municipal bonds, property taxes, and individual subscriptions that, after 1810, allowed bond holders to claim a return on their investment. Andrew Schocket has used the analogy that the management of the waterworks concentrated wealth within a system of patronage, and diffused the benefits to the residents of the city.\(^{468}\)

The Center Engine House offered a public spectacle designed to counter the inflamations unique to America and to cultivate an urban metropolis, and it is necessary to

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\(^{466}\) Latrobe, *Correspondence*, 47.


assess the design on those terms. Latrobe attempted to locate a simple, strong manner for an American architecture, modeled after what he understood as Greek purity. Yet the Center Engine House was perceived as extravagant and excessive even before it had been completed. One of the original features that were deleted from the design of the Engine House was a tripod chimney, which the editors of Latrobe’s papers believe was borrowed from Stuart and Revett’s analysis of the Choragic Monument of Lysicrates. The tripod was speculated to have stood atop the monument as a prize given to the wealthy dramatic patron Lysicrates. The removal of this accessory from the engine house is somewhat ironic, as it was precisely his lack of a patron that denied Latrobe a buffer from public criticism over the expense of his works.

The visibility and expense of the waterworks made it a target for Democratic-Republican politicians. It is ironic in light of Latrobe’s fervent republicanism that by 1805 the expenditures and failures of the waterworks had made it so unpopular that the Democratic Republicans overturned Federalist control of Philadelphia’s common council by running on an anti-waterworks platform. Latrobe’s original estimate was for $127,000. He judged that an alternate plan to bring waters from Mill Spring would cost $327,000 and thus swayed the decision towards his design. He also proposed his system as more easily accomplished and less costly than the completion of a competing canal project. Latrobe promised initially that the works would be operational by July of 1799, in time for yellow fever season. This would have been a 7 month construction schedule, so of course was impossible from the start. Unfortunately, by November of 1799, expenditures were already over $200,000 for a system that would not be operational until January of 1801. By the time of an inquiry conducted in 1802, the expenditures totaled

469 Latrobe, Drawings, I: 229
471 Latrobe, View of the Practicability and Means of Supplying the City of Philadelphia with Wholesome Water, 3.
472 Cope, Philadelphia Merchant, 57.
$244,556. Within the next decades, the wooden boiler and wooden pipes would be replaced with iron to prevent leaks and explosions. According to Thomas Pym Cope, the Democrats, “gained their ascendency in this City in a great measure by the outcry they raised against the water works. In their first council, frequent attempts were made to put an end to further improvements & to destroy what had already been done.”

The Philadelphia waterworks was built at a time when engineering and architecture were splitting into separate disciplines, and when luxuriance in public manners and buildings aroused suspicion of royalist tendencies. The works was the design of a young architect unsure of his standing in a young nation that had yet to determine the rules of propriety for public architecture. While Latrobe would become known primarily as an architect in America, it might have turned out otherwise had the Philadelphia waterworks been a more successful project. On 28 February of 1801, after numerous delays and arguments, and just a month after water began to flow to the city, Latrobe petitioned Cope to be hired as the City Engineer, and allowed to regulate municipal water distribution for Philadelphia. Cope denied his request. His assessment of Latrobe was that he was vain, a liar and a leech who, “undertook more than he understood & has been making experiments at the expense of the City.”

If the financial failures of the design have generally overshadowed its memory, in fact the successes of the system may be more nuanced. In most cases, what Latrobe required was so unusual for America that it gave rise to new support systems, which would prove valuable to the city’s future. Technically, the underpinnings of the Philadelphia waterworks are the easiest to judge. The machine was problematic from the start, because it was modeled on one of the most advanced steam-engine designs in the world, built in a country with only a handful of skilled steam mechanics. Yet despite its failings, it succeeded on several levels. In an odd reversal, the

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474 Cope, Philadelphia Merchant, 179.
475 Cope, Philadelphia Merchant, 93, 60, 87.
necessary repairs required the training of skilled steam engineers, and so contributed to Philadelphia’s industrial preeminence during the nineteenth century, and provided a model for other cities. Even with its faults, the Philadelphia waterworks surpassed any water supply system that would be established elsewhere in the country for decades, and was the only system to provide clean water to all citizens for free. The Schuylkill River’s water was immediately preferred to other water sources, and, when not under repair, provided adequate clean, safe water for drinking, sanitation, and fire protection.

The economic balance of the waterworks is also a matter of mixed judgment. At the time it was constructed, the cost of the waterworks did nothing to cool the tempers of citizens or city councilors. The controversies that arose immediately after construction began signaled a fundamental difficulty with constructing luxurious public works in the American setting. Within the fabric of a baroque garden or city, marvelous water devices might symbolize the magnanimity of the King or other patrons. Modern English water companies managed private investment to generate workmanlike but rustically scenic water houses. Within Philadelphia’s hybrid funding model of public subscription, government investment, and private bonds, neither architect nor patrons could claim glory in a project that was constructed at such expense. The radical expenditures and efforts required for this infrastructural edifice gave rise to a creative funding mechanism, however, a partnership between public and private, which was perhaps one of the chief innovations of Latrobe’s design for Philadelphia.

Latrobe’s design harnessed a uniquely American balance between public need and private investment that would be the key to nineteenth-century urban improvements. In his famous work on Philadelphia called *The Private City*, Sam Bass Warner described “the essence

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476 New York’s Croton Aqueduct would be constructed between 1837 and 1842, and Boston’s Cochichuate Aqueduct between 1846 and 1848. Baltimore’s system would be constructed by John Davis between 1805 and 1806.

of the American, urban experience” that occurred in Philadelphia. Democratic goals and political forms were “grafted upon a society of private economic aspirations.” In relation to the waterworks, his summary is apt, “Philadelphia pioneered in building America's first municipal waterworks and thus operated for forty years an experimental water supply project for all other large cities in the nation.” This proved to be an altruistic investment for many years. By 1811, there were only 2,127 subscribers out of 54,000 residents. As Warner points out, the water supply system was operating at a loss for years, supplying water for free to address public health. For the citizens of Philadelphia, however, the free provision of water was an unmitigated success.

Latrobe attempted a design not only in the public interest, but also in keeping with political balance; addressing Jeffersonian theories of environment and health, while catering to Federalist wishes for a metropolitan center of investment and trade. Sadly, both parties seem to have rebuked Latrobe. Although he had originally been celebrated as a talented European engineer and welcomed into the American Philosophical society, within a few years he was publicly criticized in the press. Committee members, even those who had been his friends, allowed Thomas Pym Cope’s detailed and critical 1801 Watering Committee report to be published in Poulson’s Advertiser. By the time water flowed to the city in January of 1801, Latrobe had lost the support of both Republicans and Federalists on the Committee. In addition to the overexpenditures and delays on the project, the praise sung to him by the Republican Aurora had offended his original supporters, the Jeffersonian Republicans, who, according to Cope, now believed that Latrobe was “complimented at their expense.” In short, they felt that the architect might claim more of the credit for the public project than the politicians and business leaders who had in fact approved and funded the expensive, and by then controversial, urban intervention. As supporters of the common man, they were in an excellent position to take up arms against what

479 Cope, Philadelphia Merchant, 91.
was now perceived as an extravagance. Yet upon its construction, the house would provide a backdrop for the city’s political rallies and jubilees. It became a site popular to people of all politics, and explicitly connected to civic events.

Fashion
If journalists and politicians attacked Latrobe for his arrogance and extravagance, this did not entirely damage public perceptions of the waterworks. Center Square became a site for celebrations and the hub of an entertainment district. In May of 1804, Philadelphia Repository and Weekly Register reported:

*THIS day will be celebrated by the citizens of Philadelphia, the important event of the acquisition of LOUISIANA to the United States—an event, which, in the annals of American history, will be traced with no less astonishment than satisfaction by every friend to liberty and peace, whilst recurring to an epoch when an infant country, without animosity, without hostility, without bloodshed, acquired an extensive, rich, and fertile territory, broke the chains of despotism, and caused a numerous wealthy, and respectable people to inhale the genial air of freedom.*

The paper went on to advertise the JUBILEE procession, which would begin on Second Street and wend its way to Center Square, “where the marshals will regulate the dispositions for the oration.” No better backdrop for the celebration of this extension of “the genial air of freedom” to the Louisiana territories could be imagined than Latrobe’s republican ornament.

In the early days of the square’s cultivation, Philadelphia remained a seat of fashion and commerce and Center Square was celebrated for its pleasantness and natural beauty. In 1804, the author of “Sketch of the Origin and Present State of Philadelphia” simultaneously decried the relocation of the capital to Washington, a site “far removed from the chief resort of wealth and population,” and acclaimed the square as an attraction within “the chief city of the United States, in point of size and splendour.” He informed the reader that “the centre square has lately been

thickly and regularly planted with poplars, and will, in a very few years, vie in pleasantness with any thing [sic] of that nature in the United States." He also praised the nearby Lombardy gardens, a private garden recently established across from the southwest corner of the park, for its "luxuriant herbage." 481

By the following autumn, the poplars were well established and the Square a place for civilized evening strolls, but already the class distinctions which would plague the area were apparent. A visitor to the park writing under the pseudonym "Charles Civil," praised the "poplar grove," in which one might "enjoy the delightful sweetness of the evening air, a view of nature arrayed in her silver robes, and the pleasures of conversation." Yet the same author complained that a band of boys accosted his party. The hooligans' "vexatious and annoying" behavior included "sallies of loud and boisterous mirth." Furthermore, these rough youths intentionally entered into such proximity to "put the dresses of the ladies in jeopardy." Mr. Civil requested that the editor publish a rebuke to "such rude interruptions." This method of management, the publication of rules for public manners within The Literary Magazine, was a regulatory method entirely in keeping with the aspirations of the early republic. That an educated youth might read and apprehend the flaw in his conduct is the essence of the idea of rational improvement.

Center Square began as a sylvan grove, and soon became an anchor for an expansion of popular entertainments nearby, similar to the public gardens and entertainment halls that surrounded the suburban water supply houses in London. These diversions offered far more variety and excitement than Latrobe's tempered retreat could. In 1809, T. Swann relocated his riding school to a "much enlarged" location on Center Square, and simultaneously announced that he would offer instruction in "the new exercise of the BROAD SWORD," according to the

principles of Major La Merchant. By this time Lombardy Garden had expanded its repertoire to include fireworks and turtle soup. Tivoli Garden, which offered pantomimes, was on the north side of Market near Thirteenth Street. The Vauxhall, which occupied the area between Broad, Juniper, Sansom, and Walnut just south of the square, also staged fireworks and would expand to include a music hall and decorative promenades.

Center Square, in the heart of these lively entertainments, was known as a place for quieter romantic thoughts and assignations. In 1813, "Mercutio" would offer his tale of his love, "As I wandered beneath the tall poplar tree branch; That grace the sweet walks of the broad centre-square; I thought of the maiden that governed my heart; Of her bosom of snow so enchantingly fair." "Horace in Philadelphia" would paint a picture of the square as the unthinking man's destination to encounter the fair sex: "What different sports our youths amuse! Some prone to literature and news; Lounge at the Athenaeum, Whilst others stroll to centre-square; To meet the promenading fair; And ogle when they see'em."

Even in the early days of its success, trends in fashion could be discerned, which would eventually tip the scales against the Center Square. In 1806, a visitor explained that the State House walks "were once frequented by fashionable people: they had their day." He went on to offer, "Centre Square is now as fashionable amongst the pedestrians, and this also will probably share the fate of the others, when once its walks shall too deeply impressed with vulgar footsteps."

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vision. He assumed a level of culture available to all, but he did not take into account the divisions of the American class system, or the degree to which those divisions might color perceptions regarding the appropriate uses of civic space.

The square never gained sufficient gravity of position to ensure its place within the city, and soon became a corrupting influence on its environment. In 1815 the new Fairmount works began operation, and the Center Engine House was reduced to a junction point through which Fairmount water passed into the city pipes. After 1818, when the center engine was sold, the reservoirs would be used to store the city’s lamp oil, which “frequently sent forth an abominable smell.” The engine’s house was now polluting, rather than remedying, the city’s atmosphere. By 1818, the roads were not yet improved in the vicinity of the square, and residential development had still not reached the city’s center. Though Market Street was paved to a few blocks west of the square, Arch, Chestnut, Walnut, and Spruce Streets were paved and “built up” only as far as Eleventh or Twelfth Streets. Pine, South, and Vine were improved only to Ninth.

The radial growth of the city from the piers and markets at the Delaware had continued, but as the engine house stood empty, it became one of the less active gardens at the edge of the city.

Center Square’s place beyond the blocks of respectable development allowed actions to take place there that were outside the bounds of civic balance and civil manners, at a time when Americans worried about the character and future of their nation. In December of 1813 a summary of recent news in *The Olio* gave reports of the naval battles against the British, the capture of the schooner Comet, and the burning of the town of Newark. On the same page, a wit complained that the modern state of ladies’ dress inflamed onlookers: “By the Devil once tempted, they now tempt the Devil.” Alongside these troubling changes in American tastes and

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fortunes, it was noted that Matthew Henderson was found “barbarously murdered” in Center Square, “stabbed in 46 different places.”

During the existence of the metropolitan square between 1801 and 1829, it passed from a place for civilized recreation to an area less savory. Incidents of violence erupted nearby, revealing the strata within democratic society, and the inflammation still present. The Vauxhall was destroyed during a riot of 1819. A crowd, by some estimates thirty thousand people, gathered around the gardens, unable to afford admission to a balloon launch. When Monsieur Michel failed to inflate the balloon quickly enough, a rock was thrown, guards reacted, chaos ensued, fires were set, and the gardens and its buildings were destroyed. By 1822 there was enough development beyond the square that an elderly gentleman passing through to reach his home in the “western suburbs of the city,” was accosted, “collared by a surly looking fellow, with a large club, who being mistaken in his object, made a slight excuse and fled precipitately across the lot.” In short, within the civilizing geometries of the square the entire range of human behavior erupted.

The most famous, or notorious, celebrations in Center Square were held on the Fourth of July. A comparison of John Lewis Krimmel’s two well-known depictions of the scene, one from around 1812, the other 1819, demonstrates the shift from a civilized place for leisure to a raucous place for carousing, and also documents America’s passage from a republican experiment to a world power. The painting of 1812 shows a gathering of city and country folk, distinguishable by their dress, but equal in their upright postures. [Figure 85] The fashionable young women wear pastel gowns in the latest Empire style, after the fashion of Josephine, and carry parasols and flowers. The gentlemen wear top hats and double-breasted silk waistcoats. One well-dressed young black boy stands near a group of children whose mother appears to be considering
purchasing fruit for them. An elegant couple, perhaps his parents, lean on the railing at William Rush’s decorative fountain. A less cultured family stands near the center, still dignified in loose fitting clothing and wide brimmed hats. The scene is friendly and calm. Even the dogs seem to meet happily, tails wagging and alert. Smoke spills forth from the oculus of the engine house. The structure sits warmly adjacent to the scene, its marble blocks a range of gentle hues from brownish grey to a rosy ivory. A few of the double-hung windows that ring the cylinder are open, and it must be imagined that the rhythmic thud of the beam engine would have been an audible pulse. The house is a stable presence, but is not the hinge of the scene. The Water Nymph and Bittern gleams white, spouting water towards the sky, falling in the center of the image, balanced on one side by Latrobe’s monument, and on the other by a row of poplars.

By 1819, America had changed, and while the reproduction of the painting is of a low quality, that is not the only reason for the brassiness and discord of the image. [Figure 85] Regiments muster in front of the engine house, which appears to be draped in a bunting. The
figures in the foreground are captured in poses of activity and disequilibrium that convey the excitement, and also the inebriety, of the scene. This is not an image of harmonious recreation. There are very few women present, and many of the figures are caught in a state of sartorial disarray. A man, perhaps meant to be an Indian, bares his chest. Several of the men are hatless, though most are in military uniform. There are young dandies with open collars accompanied by young women in frivolously ruffled collars and bonnets. An angry woman hands out leaflets. Young boys have crawled under a vendor’s table and stolen a bottle of liquor.

The military banners are a cue to the excitement, and to the violence of the scene. A broadsheet remembers the Battle of New Orleans, and the flag flies high. “Don’t Give Up the Ship,” the famous battle flag emblem of war hero Commodore Oliver Hazard Perry, is printed on a banner above a tent filled with boisterous entertainment. By this time America had defeated Britain in the War of 1812, and in February of 1819, President Adams had signed a treaty with Spain establishing permanent possession of the areas that would become Georgia, Alabama, and Florida. Andrew Jackson had successfully done battle with the Indian population of the southeast, though his victory, or decimation, would not be complete until the Indian Removal Act of 1830. The engine house is in the distant background, silent and empty, but also monumental. For a time it held its position in the new America.

The early republicans had fought and survived the revolutionary war, and dreamed that American freedom would allow them to pursue rational cultivation and natural harmony. With the country’s expansion west, and gradual expulsion of the European powers, as well as a rise of commercialism and industry, that idyll evaporated. Yet simultaneously, these men would be apprehended as heroes, as it became increasingly important that the nation create its own historical emblems, and its own pantheon of heroes. Empty monuments like the Center Engine House would have no place in the new culture of American patriotism and exceptionalism.
Center Square had been established as a civilized outpost, but after a few decades the experiment was over, and only legislation could be invoked in an effort to establish control of the site. In June of 1823, the *Saturday Evening Post* would describe preparations for Independence Day celebrations, the author giving thanks for “the finest system of government in the world.” He would simultaneously inform the public:

*The Mayor it seems, has taken measures to prevent the recurrence of those disgusting scenes which have been regularly transacted on each return of the fourth of July, in the most public grounds and highways of the city, to the disgrace and danger of the morals of the rising community. The erection of tents, booths, &c. within the precincts of the city, are strictly forbid [sic] under the penalty of law. ... A prohibition, by this energetic chief magistrate, against crowding the centre square and commons with petty gambling establishments has also added to the obligations for which the community are already so much indebted.*

The militias, gamblers, and vendors would relocate to Fairmount, so that they could continue their traditions, including the *feu de joie*, a simultaneous firing of guns. Labor leaders argued for the lower classes to improve their public comportment on this holiday. In 1829 the *Mechanics’ Free Press* asked its membership, the “Working People,” to “adopt the most dignified and established mode of conducting *The Day,*” keeping in mind that “the more wealthy classes” had come to consider the holiday “ungenteel.”

It was perhaps exactly this tendency towards division, either by class or by politics, and a desire to contradict it, that drove efforts to improve the other squares of Philadelphia with emblems of national unity, rather than more abstract ideas. Elizabeth Milroy argues that “the celebrity” however brief, of Center Square provided a momentum towards the renovation of the

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492 “Article 4 -- No Title,” *Saturday Evening Post* [1821-1830]; II, no. 26 (Jun 28, 1823). American Periodicals Online. [Accessed 5 November 2011]
four outer squares. In 1805, there was a legislative petition to the state to recognize Philadelphia’s squares as places reserved for health, in particular to fight ‘sedentary habits of life.’ In 1816, when it appeared that the city had attempted to lease the squares, one of the city councilors put forward a proposal to rename each one for a national hero and to erect memorials to their memory. Yet it would not be until 1825 that sufficient support was mustered to pass a modified version of the bill of 1805. Milroy argues convincingly that the civic support for these patriotic improvements, and for the protection of Penn’s green squares, came as the fiftieth anniversary of the signing of the Declaration approached, and also as a flush of national pride in anticipation of the visit of the Marquis de Lafayette in 1824. Nationally, she sees the tendency to historicize Philadelphia, and its heroes surging after 1826, when Jefferson and Adams both died on the Fourth.\footnote{Milroy, “Repairing the Myth and the Reality of Philadelphia’s Public Squares, 1800-1850,” 62-63, 71, 54, 68.} The State House, now refurbished and polished by its association with independence, would regain its fashionable status as the site for mourning America’s revolutionary royalty.

At the end of that halcyon year, the fiftieth anniversary of 1776, the Center Engine House would be condemned. In December of 1826, the National Gazette notified the public that City Council had voted to “raze the edifice” at Center Square. The author protested, not against the destruction of the building, which he judged “unsightly,” and not against the trees, for “the same doom might be executed on the \textit{poplars} without heinous guilt.” The engine house was humorously compared to a “great bake-oven.” Of course, its more typical nickname was The Pepper Box. The tragedy, he felt, was that the streets would be carried through the square, and “the ground as it is, being committed to men of taste for embellishment, might be rendered highly ornamental to the city, and grateful to the citizens. It is a most eligible site for an obelisk, equestrian statue, or marble fountain.” He hoped that such an improvement, based on a “policy ...
followed in the great cities of the European continent,” might resolve the “rather rough or uncouth business aspects of Market and Broad.” 495

By its demolition in 1827, the Center Square had fallen entirely out of fashion, but immediately after its disappearance it became a nostalgic image in the minds of citizens. One poet asked in 1830, “Where is that dome, which rear’d its head; In silent majesty? And where the grove that round it sp[read]; As ‘twere, but yesterday?” He traced his fond memories and sadness at its loss to his “infant hopes” and “childish joys,” now gone, faded like “ancient friendship.” 496

The image of the Center Engine House would be recycled periodically for notable municipal anniversaries. Its appearance remains relatively stable through the years; Latrobe’s formal clarity brooks very little modification. Yet in every reincarnation it reflects the ideals, and idylls, of the moment of resuscitation. In 1908, for Founder’s Week, the engine house appeared pristine and

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495 “No Title,” The National Gazette and Literary Register (Philadelphia: 2 December, 1826).
496 “Poem 1 -- No Title,” Casket [1826-1830]; no. 11 (Nov 1830). American Periodicals Online. [Accessed 5 November 2011]
alone in a broadly paved courtyard, positioned between William Penn and the Treaty Tree.

[Figure 87] In memory, it rests as a compelling, if inscrutable, emblem of a simpler, cleaner, more balanced past. Latrobe’s instrumental geometries speak of aspiration, but convey very little of their function.

The Kaleidoscope is Broken

Latrobe’s faith in republicanism and democracy traced approximately the same arc as the rise and fall of Center Square. When Latrobe first arrived in America he was enraptured by its landscape, its people, and its politics. While he designed the Philadelphia waterworks, he was actively involved in republican politics and scientific society, and believed in the vitality and potential of the nation. After two decades and numerous personal losses and professional failures, Latrobe’s outlook darkened. In a journal entries beginning in February of 1819, Latrobe described the cruelty, particularly of the women, of New Orleans creole society. In his journal, he recounted a story of a woman stripping a servant naked and whipping her until she bled. Latrobe also ranted against the idle, drunken, naked, disgusting appearance of the Indians he saw on the streets of New Orleans. This was not a gradual shift towards conservatism, but a radical rebuking of his first impressions of the country.

During the last decade of his life, Latrobe experienced waves of sadness, during which he rejected most of his initial notions of America. A few days after his descriptions of the “disgusting” Indians in New Orleans, he mused over the false impressions that “excite benevolent feelings in the young,” and then observed, “what must it be in respect to nations at a distance, whose manners, and vices and virtues we know only from books: and those books compiled from hearsay, and very often with a view to create or uphold a particular system of philosophy.” Although the comment was directed at Chateaubriand, it could equally have been an indictment of Jefferson’s Notes on the State of Virginia, which had inspired Latrobe’s youthful admiration.

497 Latrobe, Journals, III: 207, 237.
Latrobe continued his assault, "I remember the time when I was over head and ears in love with \textit{Man in a state of nature}. ... Social compacts, were my hobbies, the American Revolution (I ask its pardon for it deserves better company) was a sort of dawn of the golden age, and the French revolution the Golden age itself. I should be ashamed to confess all this if I had not had a thousand companions in my kaleidoscopic amusement." Latrobe sarcastically indicted his, "residence at the republican court of Washington," as the final element that "assisted wonderfully the advance of riper Years." Latrobe would conclude that "experience has destroyed the illusion, the kaleidoscope is broken."\textsuperscript{498} A kaleidoscope is a perfect analogy to Latrobe's hopes that America's wild and diverse natures could be bound within one balanced and centered image.

The link between nature, man, and culture fueled Latrobe's optimism in youth, and that link now finalized his disillusionment with America. Latrobe's journal entry concluded with an assault on Chateaubriand and his naive theories of the Choctaw Indians as "innocent savages." Latrobe spewed the last of his hatred against, "our Scalping, woman and child murdering North American Indians," and concluded that, "the sum of human happiness would be greater in the same space, if the Indians did not exist, and the country were peopled by a civilized nation."\textsuperscript{499} Latrobe's judgment was severe, and the native people who had once embodied the charity of nature were now condemned, because America was at war inside her own borders.

Latrobe portrayed his fall from faith as falling out of love with \textit{Man in a state of nature}, but a good deal of his difficulty arose from his political, financial, and personal difficulties. His considerable financial losses drove him to attempt to construct a second waterworks in New Orleans. After his financially debilitating experiences in the capital, Latrobe acted on the advice of Jefferson to pursue a franchise for the New Orleans waterworks. The city was expanding rapidly, and dependent on Mississippi waters either sold by water carriers or carried by servants. Governor Claiborne, a supporter of the plan, had informed Jefferson that the city's difficulty

\textsuperscript{498} Latrobe, \textit{Journals}, III: 237-238.
\textsuperscript{499} Latrobe, \textit{Journals}, III: 238, 240.
obtaining adequate water might be an opportunity for an entrepreneur. Latrobe applied to the city in 1809 and after a few years of effort, his proposal was accepted. In 1811 he was granted a 15 year franchise and the right to set the price of water. Latrobe promised that the works would be "an ornament to Your city, as well as the means of salubrity & pleasure." \(^{500}\)

Figure 88 - Benjamin and Henry S.B. Latrobe, architects, engine house, New Orleans Waterworks. J. Tanesse, engraved Vignette, Plan of the City and Suburbs of New Orleans ... 1815 (New Orleans, 1817). In Latrobe, Drawings, II: 332.

Between 1811 and 1820, again in response to public health concerns, Benjamin H. Latrobe and his son Henry designed and almost succeeded in executing a water supply system for New Orleans. Like the Philadelphia waterworks, the pump house was a public pavilion, though in this case the technological core was an octagon in plan, entered through a single temple front.

\(^{500}\) Latrobe, Engineering Drawings, 36-36.
Very few drawings survive so it is difficult to analyze the work. It is irregularly arrayed in plan, with the entry, or *avant-cour* facing Ursulines Street, and a wing extending from the rear of the building following Rue de la Levée. This arm enclosed a pipe mill, and also created a small courtyard facing the open vegetable market, now the French Market. The plan is an assemblage of parts, each serving a different orientation, and the exterior volumes, as shown in a Vignette by Tanesse, fit together somewhat gracelessly. The design of the engine house was in part contrived by Latrobe, but his son Henry also was engaged in the process. The house was built quickly in 1812 under Henry’s supervision, and in a letter of the same year, Latrobe commented, ‘your Castle is certainly the strongest thing since the days of Sesostris.’

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Figure 89 – Henry Boneval Latrobe, “Design of a pier to cover the suction pipe of pump for supplying water to the city of New Orleans,” 29 January, 1819. Courtesy of Special Collections at the New Orleans Public Library.

God bless you my dear boy. ...I think I shall say nothing to you before, ‘take care of your health.’ Bollman has written to me a long letter for your benefit. The long and short of it [is] this: ‘Never sleep with your windows open.’ Be very temperate in your drink, and fly to Pensacola in the case of yellow fever. 502

Benjamin H. Latrobe, Letter to Henry S. B. Latrobe, 1 June, 1812

The Mississippi delta was low ground, damp and unstable, the most unhealthy miasmatic conditions and poor grounds for improvements. The soft river banks could not support foundations for a canal or tunnel, so father and son planned to construct an iron suction pipe that projected out through a wooden pier. 503 [Figure 89] The pier seems to have been built by the same methods Latrobe used for the forms for the dewatering, excavation, shoring, and

502 Latrobe, Correspondence, Ill: 311.
503 Latrobe, Engineering Drawings, 37.
construction of the masonry embankments in Philadelphia. Progress in New Orleans was slowed by worker illnesses, and the site was plagued by mosquitos. Latrobe dedicated a lengthy journal entry to the insects, noting the various markings of different mosquito species and almost connecting their presence to the fever. He noted that the city might be “one of the most delightful abodes of affluence … were it not for the Muskitoes. I say nothing of the Yellow fever, because I believe that this calamity may be moderated, if not entirely eradicated, by a good medical police, and under a better understanding of its origin and treatment than now prevails at New Orleans.”

Latrobe’s observed the citizens of New Orleans with the same scientific interest that he applied to the city’s insects, and judged the people with a mixture of appreciation for their constant motion, and criticism of their cruelty and avarice. He reported that, “their business is to make money. They are in an eternal bustle. Their limbs, their heads and their hearts, move to that sole object.” Perhaps appropriately, the New Orleans waterworks was placed near the active if not the geographic heart of the city, at the French Market. [Figures 89 and 90] Sadly, both Latrobe and his son would die of yellow fever while attempting to complete the works, Henry in 1817, and Benjamin Latrobe, replacing his son as supervisor, in 1820. With the company’s assets frozen, the city of would purchase the company and complete the project two years later.

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506 Latrobe, *Correspondence*, II: 811.

Sadly, or perhaps ironically in light of Latrobe’s assessment of the city, based on my investigation, it seems likely that a corrupt streets department sold several original Latrobe drawings of the waterworks sometime within the last 30 years.
The shift from Latrobe’s early ideas of the Philadelphia waterworks, embedded at the center of a natural System of order, sensation, and improvement, to his more modest and irregular plans for New Orleans, provides a picture of the promise and the problems of American balance, or indifferentism. Close to the end of his life, Latrobe reflected on a sermon he heard as a youth. Latrobe remembered the minister’s argument that “earnestness” even towards “erroneous” belief was preferable to “indifference,” which was “the sure way to perdition.” Latrobe related that even as a young man he recognized that he was “already very much of an Indifferentist.” He ascribed his conversion to his friendship with an “exjesuit” baron von Kalkreuth of Neisse, who was “a confirmed Deist, and of course a rational Indifferentist.” Latrobe recounted the pastor’s attack on the “heresy of the modern times (that is of the Year 1783) –Indifferentism! Der Seelverderbende Indifferentismus!” (Soul-corrupting indifferentism!) Reading over his New Orleans journal entries, Latrobe noted that his descriptions of the booming American city, “bear a really strong character of Indifferentism.” 507

Indifferentism bore a negative connotation for the Polish preacher, but was the source of evenness, of tempered manners and environment, for theorists of democracy. This lack of difference also underlay ideas of evenly distributed topography. In Jeffersonian terms, the grid betrayed a fascination with the geometric possibility that homogeneity could accomplish equilibrium in both the natural and the social environment. This is a version of what David Leatherbarrow refers to as “toleration” in his writing on Friedrichstadt, an undifferentiated atmosphere of disengaged but adjacent peace, organized in abstract, characterless non-hierarchical squares.\textsuperscript{508} Jefferson’s Land Ordinance of 1784 was drafted just a year after the 19 year-old Benjamin Latrobe recognized his own indifferentist traits within the preacher’s sermon. The Land Ordinance would spread the Jeffersonian grid across the United States, defying both space and time.\textsuperscript{509} For the next century, American land would be segmented according to subdivisions within meridians and parallels, without regard to existing land definitions by native inhabitants, or adjustment according to topographical character.

Latrobe liked to portray himself as a scientific modern man, and as such he aligned his Indifferentism with a systemic perspective according to which all men were equal, inflamed passions tempered with rationality, and culture and nature mediated through the grid. Unfortunately, Latrobe deceived himself regarding the true character of American indifferentism, which was not even and homogeneous, but uneven and fractious. Early republican thought was derived from the European scientific and theoretical currents of the time, characterized by a faith in the works of nature, and in the possibility of shepherding all free citizens into a balanced state of common sense. This faith excluded inflammatory issues of difference and volition, branding them as remnants of past political systems. It was exactly this collision between the forces of nature and the volition of man that unraveled Latrobe’s faith, and undermined his works.


While its first task was the democratic and even distribution of water to all citizens, Latrobe's Philadelphia waterworks also embodied the scientific idea that sensations, whether of nature or of art, could directly influence manners and morals. Simultaneously, it was constructed as a new symbol, or expression, of that improvement, and of its aim of commonality and equality, as well as of the unification of diverse elements around one center. In this the concentric architecture, struck at the heart of primary grid axes, reiterated the epistemological essence of the American conflict between individual democratic freedoms and central federal control.

Strikingly, Latrobe designed his work at the last moment when theories of ordered geometry and efficient function could conceivably be combined. By the mid-nineteenth century, the dominance of sanitation theory, industrial engineering, and the politics of individual liberties would submerge these Democratic-Republican theories.

This fleeting moment in which expression and instrument were entwined makes his design for the waterworks the perfect emblem of Latrobe as "America's First Architect." Not only was this an unusual moment in America, it was an extraordinary project in Latrobe's career. The Center Engine House may be the work within his lifetime which most clearly revealed his thinking about art, nature, and society. It was a project unconstrained by context, client, or precedent, executed in the flush of Latrobe's happiest years. The schism between Latrobe's theories of natural philosophy and technological utility was legible at the time as a financial failure. Latrobe's project should not, however, be judged solely on those terms. Latrobe earnestly marshalled and adapted a waning baroque mentality that imagined the city as a fabric punctuated by marvelous perspective points symbolizing and supporting urban power and practice. If his placement of a marble water pavilion in the city center established a hierarchy, it simultaneously anchored and solidified an abstract equalizing grid. This was an admirable balancing act, but untenable in the climate of dynamic American indifferentism.
Latrobe’s Legacy – the Machine in the Garden

The cost of the Schuylkill and Centre Square works, with yearly expenses added, from March 1799, to September 1, 1815 ... was $675,398.91, the whole gross receipts amounting to but $105,351.18, leaving a deficiency of $552,047.73, without interest.

Yet it cannot be said this sum has been lost to the City, as many indirect advantages have arisen from it, character and impetus was given to the City, and much was done to improve the sanitary condition, an important feature which added to its many attractions as a place of residence.

—Annual Report of the Chief Engineer of the Water Department of Philadelphia for 1875

The Philadelphia waterworks would be praised almost fifty years after its demolition for having provided the city with “character and impetus,” or otherwise stated, culture, direction, and a degree of pressure. Even before Latrobe’s machine and garden had been removed and roads paved through Center Square in 1829, a second technological wonder would spring from the first. In 1812, Latrobe’s chief draftsman and superintendent of the waterworks, Frederick Graff, along with Latrobe’s apprentice, John Davis, would propose a plan for the second, more efficient water supply system. If Latrobe had centered a public work within a subdued and balanced geometry, attempting a subtle, balanced link between nature, machine, and culture, Graff’s waterworks would achieve a less regular and self-surrounding design and allow a more exuberant expression grounded in the movement of the river itself.

The neopalladian engine houses of Philadelphia’s second waterworks, set on the banks of the Schuylkill River with a view of the falls, were operational in 1815 and soon became an international destination. During her visit in 1830, Frances Trollope found Philadelphia disappointing, noting that Americans “give it preference, in point of beauty, to all others in the Union,” yet she found it lacking in beautiful monuments, and judged it all “even strait, uniform, and uninteresting.” She found Graff’s Fairmount waterworks to be the “one spot ... which

presents a lovely scene,” and judged it deserving of the same “wide-extended fame as those of Marley.” Trollope would praise the “vast yet simple machinery” open to visitors, as well as the lawns, willows, gardens, fountains, and views. Graff’s design was not only embedded in various and diverse elements of art and nature and removed from the city, it was also topographically well-sited, and relatively easy to service and to expand. His proposal took advantage of a high site north and west of the city, locating the reservoir on the Fair Mount, where landform shifted from rocky piedmont to coastal plain. The engine houses were sited near the upper ferry landing, a location connected to the western grid of the city by a diagonal road. The Fairmount waterworks continued to serve the city for most of the 19th century, and its original buildings still stand as a museum and attraction for visitors. By 1837 the second Philadelphia waterworks was making a profit, serving a population of 196,000 with approximately 20,000 subscribers.

The construction of the Fairmount waterworks resulted in two of Philadelphia’s most notable integrations of art and nature. The surrounding land was consolidated in 1858 to protect the city’s water source, and in 1868 an act was passed to create Fairmount Park, a pastoral retreat from the rapidly industrializing city. The park would be the site of the International Exhibition and Centennial Fair of 1876. Competing plans, in part inspired by the Columbian Exposition in 1893, were then put forward to develop a diagonal boulevard from Fairmount and the Park to Center Square, incidentally the path that pipes once followed to conduct the Fairmount waters to the distribution pipes at the Center Engine House. David Brownlee’s, Building the city beautiful: the Benjamin Franklin Parkway and the Philadelphia Museum of Art explores debates over the design. Brownlee explains that for Paul Phillipe Cret, modern architecture was ‘this art of the

democracy.' Cret projected a grand axis lined with monuments to what he considered cultural evolution. To this echo of one part of Latrobe's argument was added the opinion of Jacques Gréber, who was invited to review the Cret's plan of 1909. In his own design of 1917, Gréber would shift the equilibrium from architectural regularity to profuse greenery and watery perforations, claiming that his design was 'the opening of the very heart of the city to the sanitary breezes of Fairmount Park.'\textsuperscript{514} This second French perspective prioritized airs over buildings. Neither vision would be directly executed, but even today this grand diagonal axis, and the proper balance to be achieved along its path, continues to be discussed and designed. Raucous Fourth of July celebrations also continue, spilling over from the Parkway that connects the two most important sites of Philadelphia's hydraulic history.

If ideas of system and equilibrium have changed significantly during the past two centuries, the balanced connections between water and democracy, expression and infrastructure, nature and city, environment and health are ancient ideas that have survived and adapted to the modern American climate. Over time, these relationships have shifted in location, tenor, and scale. During the nineteenth century, with the crush of steam and coal-driven industry and the escalation of water-borne epidemics, most metropolitan governments constructed extensive water supply projects stretching conduits beyond the reach of urban growth. Frederick Law Olmsted's park systems would enfold and enliven the entry points of several of these important hydraulic systems to their urban destinations. He, like Latrobe, hoped his pastoral constructions would sooth the heat and corruption of the city, and improve the behavior and outlook of its citizens.\textsuperscript{515}

The Federal Works Progress Administration built numerous hydraulic infrastructures during the


\textsuperscript{515} Speaking in 1870, Olmsted expressed his concern that the city air was full of, "corrupt and irritating matters, the action of which tends strongly to vitiate all or sources of vigor." In this and in his argument for a gridiron plan to facilitate the flow of airs, "disinfected by sunlight and foliage," we hear echoes of Latrobe, Jefferson, Gwynn, Evelyn, de Caus, and many others. Frederick Law Olmsted, "Public Parks and the Enlargement of Towns," in \textit{Civilizing American Cities: Writings on City Landscapes}, ed. S.B. Sutton (New York: Da Capo Press, 1997), 65, 70.
New Deal, reshaping the nation’s hydrology and settlement during another time of crisis and imbalance. These works walked in heavy boots of concrete but also served subtle symbolic and cultural needs. The Art Deco shell of the Hoover Dam, like Latrobe’s marble rotunda, demonstrated the power of the nation through a careful and expressive integration of water, art, and infrastructure.

Today chemical treatment, privatization, and fear of terrorist attack have driven water companies into hiding, but debates concerning water, technology, health, environment, civic art, and urban manners continue elsewhere. With the retreat of nineteenth-century heavy industry, cities are reclaiming their riverbanks. In this new remediation, we try to reimagine the shape of human occupation, and to locate man-made instruments, geometries, and orders according to our current understandings of natural systems and civilized health. Art still has a role to play in this process, as ancient ideas of balance persist, and are adapted to new theories of environment, technology, sensation, and improvement. If in 1799 Latrobe’s design for the Philadelphia waterworks was a unique hinge and pivot between ancient and modern ideas of urban equilibrium, it was not the last dramatic turn.
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