

The Evolution of Heat, Light, and Power Systems at the U.S. Naval Academy: 1845-1995

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The vast majority of naval history is written about ships and sailors, but the navy's large (and largely invisible) supporting cast should not be forgotten. One such area of support is the supply of heat, light, and power to shore facilities, and this paper will take a detailed look at this activity at one small but important naval shore installation, the U.S. Naval Academy (USNA). As an integral and long-standing activity at the Academy, such a history is important in its own right, but it has interest to the larger historical community for two significant reasons.

First of all, the Naval Academy is unique as an institution in that its mission of producing naval officers has stood unchanged for 150 years. Sheer physical constraints have limited the facility's use to this purpose, and only minor additions over the years, including the Naval Postgraduate School (temporarily) and various naval hospital facilities, have impacted this activity. This unique institutional purpose, combined with voluminous records kept by federal activities, makes possible a long view of institutional facilities engineering and energy use, the latter being easily quantifiable in terms of energy use and cost per graduate. West Point presents a similar set of circumstances, and is likewise the subject of a similar study.

Secondly, although the Academy's present heat, light and power systems are similar to those found in other installations, its systems developed in a rather unique manner. In 1853 the Academy

¹ I would like to thank Jim Cheevers of the USNA Museum, Brian D. Fors, USNA Archivist, and T. Rex Hamilton (and others) of the USNA Public Works Engineering Division for their assistance in preparing this paper.

built the first true district heating system in the United States, which today is the oldest continuously operating system in the world, save only a small geothermal system in southern France. District heating technology eventually became commonplace for institutions and cities, but its appearance at USNA in 1853 marks a significant historical milestone. Compared to this early use of district heating, electric lights were adopted rather (1900) and then a direct current system was installed, despite the supposed technical superiority of alternating current by that time.

Detailed records of the Academy's heat, light, and power activities are available through the 1930s, but later records can hopefully be made available to permit compilation of a complete record for the 150 years of the Academy's existence. Such data would be of significant historical value.

The Naval School Era

Commander Franklin Buchanan opened the naval school at Annapolis on Friday, 10 October 1845, at Fort Severn, whose ten acres had recently been transferred from the War Department. The school had previously been housed at the Naval Asylum in Philadelphia, but despite the views of some who saw no good in having a naval school ashore, the Examining Board for Midshipmen agreed with Navy Secretary George Bancroft's suggestion to move the school to Annapolis. The facilities of the old fort were adopted to the needs of the new school, including modifying wood fireplaces and stoves with grates to burn anthracite coal. Tallow candles provided dim light, often threatened by Severn wind infiltrating the flimsy barracks. Wood fuel was soon supplemented by anthracite coal burned in fireplace grates, and candles with lamps. Twenty tons of coal were delivered to the Academy its first year, and Commander Buchanan recorded the expenditure of \$511.50 for coal and \$64.60 for lamp oil.² The midshipmen paid for their own fuel and lighting that

² Accounts, 1 September 1846. Unless otherwise noted, all references are from RG 450 of the National Archives, containing records of the U.S. Naval Academy. My thanks to Brian D. Fors, USNA Archivist, for his able and professional assistance with these records.

first year, and at the beginning of the second year they requested that the government meet those expenses, and Buchanan agreed.³ [Cadets at West Point paid for the heat and light in their barracks until quite late in the century.] The results were not entirely satisfactory, and Midshipman (later Admiral) Edward Simpson wrote that “The temperature we were able to sustain in winter with one grate fire was not sufficiently high to melt the snow.”⁴

Commander Buchanan and his successor, Commander George P. Upshur, renovated several old buildings and build some new ones, but as far as is known were not following any sort of master plan for the school’s physical plant, nor any alternative heating and lighting means. These shortcoming were soon remedied.

The New Naval Academy

Two significant events took place on 1 July 1850. The Secretary of the Navy renamed the institution as the Naval Academy, and Commander Cornelius K. Stribling became the Academy’s superintendent. Along with reorganizing programs and personnel, Stribling set pen to paper and drew a plan for developing the newly enlarged Academy grounds. This plan was approved by the Bureau of Ordnance and Hydrography on 27 November 1850, and became the basis for approval of funds to construct several new buildings.⁵ Contemporary views of these new buildings show that chimneys (and thus fireplaces or stoves) were included, but the Superintendent was also exploring alternative heating and lighting technology. Stribling received a detailed proposal from William Helms of Alexandria, Virginia in September 1851 that recommended a gas lighting plant to serve the

³ Sarah Corbin Robert, “The Naval Academy as Housekeeper: Feeding and Clothing the Midshipmen,” *U.S. Naval Institute Proceedings* 72 (April 1946): 120.

⁴ Quoted in Leland P. Lovette, *School of the Sea: The Annapolis tradition in American Life* (New York: Frederick A. Stokes, 1941), 56. The original source is not cited.

⁵ Stribling’s plan and the accompanying drawing are not mentioned in any Naval Academy history this author has seen, and may not be extant.

Academy's buildings, and suggested that "when applying for the appropriation ... it would be well to name not less than six thousands."⁶

In October 1851 the Academy's Board recommended that "the grounds and buildings of the institution be lighted with gas, made on the premises." Six thousand dollars were requested for a gasometer, pipes and fixtures to generate and distribute gas throughout the Academy as a part of \$28,000 in building improvements,⁷ and Congress appropriated the entire amount in August 1852.⁸

The following month Stribling requested \$10,000

for steam-boilers and necessary fixtures for warming by steam the midshipmen's quarters, recitation and mess-halls, chapel, and observatory, and to afford steam for cooking, washing and drying clothes.⁹

The Bureau of Ordnance and Hydrography agreed, recommending "the proposed mode of heating the buildings at the Naval Academy with hot water" for its "superior safety and eventual economy."¹⁰

In November, Stribling's superior officer, the head of the Bureau of Oceanography and Hydrography, ordered him to

...obtain the services of very competent persons to aid you in determining upon the best plans for making and distributing gas to the several buildings in which their use is contemplated, with a view of obtaining the best results.¹¹

In the same letter Stribling was advised to

⁶ Letter, Helms to Stribling, 23 September 1851.

⁷ 10 November 1851.

⁸ 32nd Cong. 1st sess. Ch. 109 (31 Aug 1852)

⁹ Estimate, Bureau of Ordnance and Hydrography, 13 September 1852.

¹⁰ *Annual Report*, Bureau of Ordnance and Hydrography, 13 Sept. 1852.

¹¹ Letter, C. Morris to Stribling, 4 November 1852.

have the buildings about to be erected, and for which it is contemplated to heat by means of water pipes, to be arranged ready to receive the pipes, if the necessary appropriations should be obtained.

The Superintendent received several proposals for the gas plant and piping in December 1852 and January 1853, some of which also addressed the proposed steam plant and piping.

Walworth and Nason of New York, historically the most prominent American heating company of this period, submitted a bid of \$10,500 for the steam system, but added that

In view of the extraordinary distances through which steam has to be carried to reach the most distant point it may be questioned whether each of the buildings may not be more economically fitted up and warmed by a separate hot water apparatus and pipes led through the rooms.¹²

By the end of January, however, it was clear that existing appropriations would not be sufficient to construct the entire gas and steam apparatus. In a letter to Morris, Stribling attributed this to increases in the "price of iron and wages since the estimates had been made", but "in order to prevent a failure in having these works done," Stribling suggested that

with the assistance of Mr. Wm. R. Hopkins have them done ourselves, and by this means save the expense and profits to contractors, and at the same time have the works done equally as well. Mr. Hopkins is a practical Engineer and Machinist, and would be willing to undertake the direction of this work.

If you approve this suggestion, I request authority to send Mr. Hopkins to New York, for the purpose of examining in person, such Gas and heating establishments, as would give him the latest information and ensure our having these establishments erected in the best manner, with the most approved improvements.¹³

The bureau chief approved Stribling's plan and Congress appropriated the requested \$10,000 for the heating plant in March, 1853, and both were operating by the following November or December, which was a good thing since the midshipmen, considering themselves "gentlemen and officers," complained in November that

¹² Proposal, Walworth & Nason to Stribling, 12 January 1853.

¹³ Stribling to Morris, 29 January 1853.

we have been compelled from time to time not only to light our lamps, but bring up our wood and make our fires, but also to black our boots and in some cases to bring our water from the pump.¹⁴

While considering the plight of these poor souls, it will do to pause here and consider the technological future to which Commander Stribling had committed the Academy. The selection of manufactured gas for lighting was not an enormous technological leap, as many cities by this time were served by gas companies, although service was limited to street lighting and interior lighting for businesses and wealthy homeowners. The U.S. Capitol and White House were served by utility gas in 1848, although there was a proposal to install an experimental gas plant on the White House grounds in 1829.¹⁵ The Naval Asylum in Philadelphia also installed gas lighting around 1852. A market had also developed for “isolated” gas plants to serve consumers without access to urban gas supply, although little is known about this industry prior to the Civil War. No other college or naval installation is known to have had a gas plant at this time. Stribling was somewhat more daring in choosing coal as a lighting plant fuel rather than the more common rosin, but this proved a wise choice as the entire industry was soon converting to coal gas. Although modified greatly over the years, the 1853 gas plant proved reasonably reliable and economical, and remained in service until 1900.

Dates of Gas Lighting in Principal Cities, from Louis Stotz, <i>History of the Gas Industry</i> (1938)	
1816	Baltimore
1823	New York
1828	Boston
1832	Louisville; New Orleans
1836	Philadelphia; Pittsburgh
1840	Cincinnati
1841	Manchester, NH
1846	St. Louis
1847	Fall River, MA; Newark
1848	New Haven; Paterson, NJ; Rochester, NY; Washington; Buffalo
1849	Norfolk; Cleveland; Detroit; Syracuse; Utica
1850	Chicago; Columbus, OH; Hartford; Worcester; Kingston, NY
1851	Hamilton, OH
1852	Indianapolis; Memphis
1853	Milwaukee

¹⁴ Letter, Midshipmen to Superintendent Goldsborough, 2 November 1853.

¹⁵ William Seale, *The President's House: a history*. (Washington: White House Historical Association, 1986), 1:173, 268.

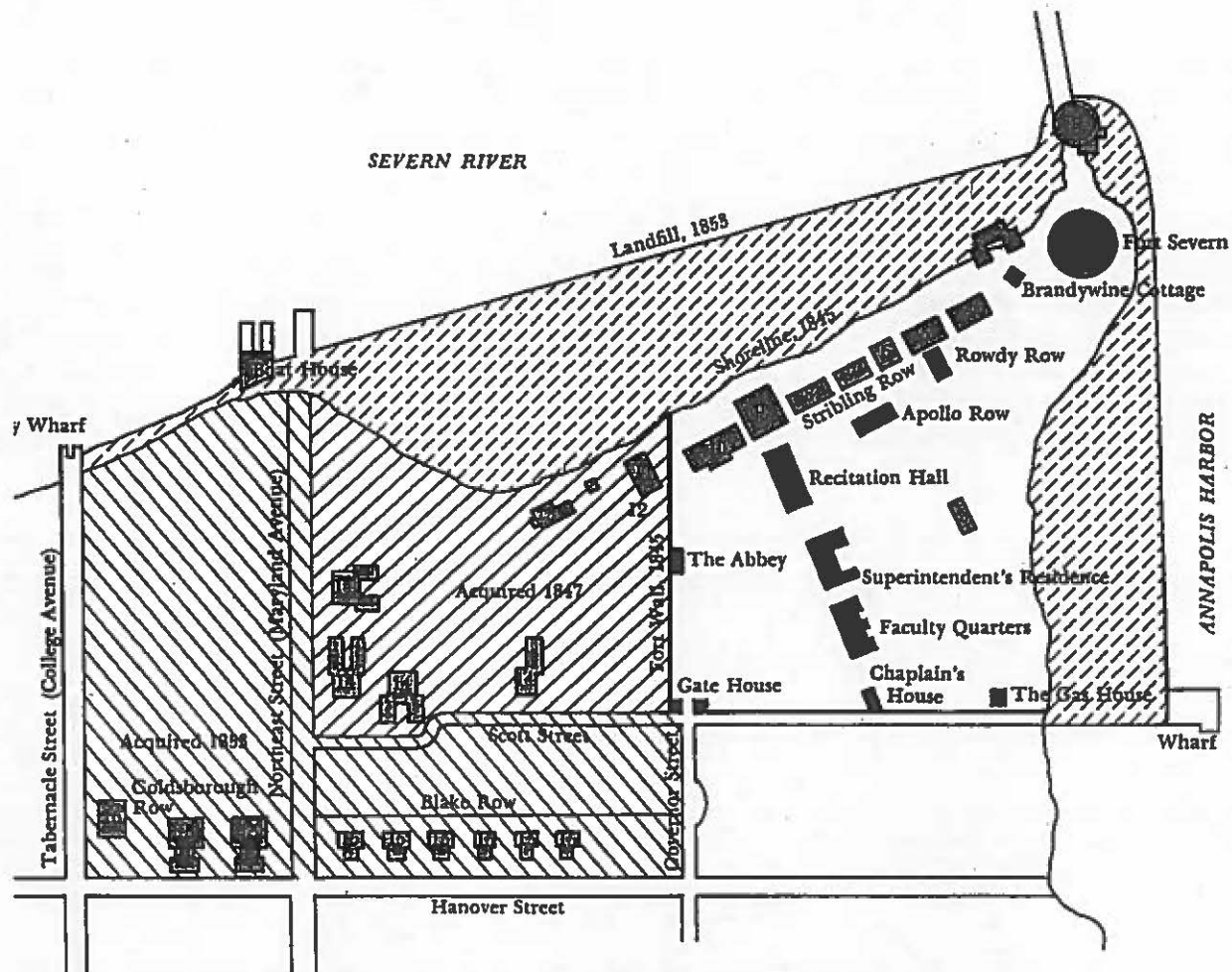


Figure 1 - USNA in the 1850s. The gas and steam plant is item 1 on the map, just above Fort Severn.

The steam system represented much more of a leap into the technological unknown. Steam and hot water had come into common use for heating buildings of all description, but in general each building had its own apparatus. Some Roman heating systems are known to have served multiple buildings, but the earliest modern use can be found in the small village of Chaudes-Aigues in the volcanic Cantal region of southern France, where water from a natural hot spring had been distributed for heating and cooking since the early fourteenth century.¹⁶ Accounts of this system were widely distributed, and likely inspired Cornelius Drebbel's 1622 proposal to install a similar

¹⁶ P. Raynal, J. P. Gibert, and C. Barthomeuf, "Chaudes-Aigues: historique des utilisations de la géothermie" *Réseaux & Chaleur* 16 (1992): 67-75.

system in London so that inhabitants of that smoky city could heat and cook without burning coal or fuel.¹⁷ Drebbel (who also demonstrated a workable submarine) was unable to bring his plan to fruition, but heating systems developed in parallel with improved steam engines. Several examples of steam and hot water apparatus can be found in the eighteenth century, including a rather extensive 1785 hot water system serving the three buildings of Prince Potemkin's Taurida Palace in St. Petersburg (likely built or designed by a Frenchman named Bonnemain) and some British factories designed by Boulton and Watt that had separate boiler plants. In 1802 Benjamin Thompson, Count Rumford, proposed that the French Academy use steam heat, with the boiler placed some distance away for safety and to simplify fuel handling. At least a few large multi-building systems were built in England in the 1810s and 1820s, and during the 1830s it was proposed to use the waste heat from steam engines to warm public baths and worker housing. American expatriate Angier March Perkins built large hot water systems throughout Europe, and boasted that he could "heat an entire parish from a single fire." A few Perkins systems were built in the United States, including a Philadelphia prison and the 1840 Custom House in New York City.

American heating system development lagged behind European, mainly due to the smaller number of large buildings on this side of the Atlantic. Benjamin Latrobe had proposed steam heat for the U.S. Capitol in 1807, and several large steam systems were operating in mills within a few years, many using steam engine exhaust for heating. One notable system existed at the Harmony Society's community of Economy, Pennsylvania, where exhaust steam from the mill engines were used to warm the Society's workshops. The Society's records show that its head, George Rapp, became a sort of steam heating resource for others seeking information. The American heating

¹⁷ Morris A. Pierce, "The Road to Lockport: historical background of district heating and cooling." *ASHRAE Transactions* 101 (1995), part 1.

industry was really started by Joseph Nason, who had gone to Europe in 1840 to sell gas lighting fixtures, and when that failed ended up in Perkins' employ installing heating systems. He and a friend, James Walworth, bought out the Perkins' distributor in New York City in 1841 and shortly thereafter moved to Boston. Demand was substantial for better heating apparatus, and the partners prospered, even after Nason split off and returned to New York in 1852. Nason's most famous system was installed in the 1855 U.S. Capitol expansion, which added wings for new Senate and House chambers.¹⁸

The key element to be determined here is the source of Stribling's idea to heat all of the Academy's buildings from a single heating plant. Aside from than the small Harmony Society community outside Pittsburgh, no American district heating system is known to have existed in 1852. Again, there could have been many, but for any number of reasons they do not appear in the historical record. A survey of material about Navy Yards yields no clues about central boiler facilities prior to this time, although they became quite common by the 1870s. In 1877, when Lockport, New York inventor Birdsill Holly began marketing his new district heating system, he clearly admitted that was not inventing district heating itself, which he said had been tried unsuccessfully elsewhere.¹⁹

Such ideas are rarely *sui generis*, and it is almost certain that Stribling had either seen such a system or heard about the idea from another source. Barring discovery of some evidence to clarify this, we can only speculate on the potential sources, of which the following seem most likely:

¹⁸ Susan Reed Stifler, *The Beginnings of a Century of Steam and Water Heating by the H.B. Smith Company*. (Westfield: H.B. Smith, 1960)

¹⁹ Indeed, this author wrote his entire doctoral dissertation on Holly's system and only discovered mention of the Naval Academy system in an 1893 speech given in Liverpool, England. "The Introduction of Direct Pressure Water Supply, Cogeneration, and District Heating, in Urban and Institutional Communities, 1863-1882." Ph.D. Diss. University of Rochester (1993).

1. In May 1851 the Crystal Palace Exposition opened in London, and its enormous iron and glass hall was warmed from a separate heating plant. Accounts of this were widespread in America.
2. The heating industry in Russia was marked by construction of systems quite large compared to those elsewhere. One of those in this business was the Swede Immanuel Nobel, who also built underwater mines and steam engines. Immanuel's son Alfred (later famous for dynamite and Nobel prizes), took a two year tour of Britain and America from 1850 to 1852 for the purpose of gathering information on steam and other naval technology that might be useful to the Nobel enterprises in Russia. Nobel met with John Ericsson in New York, but other stops on his journey are not known. The new Naval Academy could well have been of interest to young Alfred, and Russian heating systems could have interested Commander Stribling.
3. Another potential source of information about Russian heating technology were the many American engineers involved in building the Czar's railroads. Among these were several West Pointers, including an 1825 classmate of USNA Professor William Fenn Hopkins. One of these American engineers, Thomas Winans, returned to Baltimore in 1852 and built an enormous estate, Alexandroffsky, in Baltimore, whose twenty buildings were heated by a Russian-style system installed by the Baltimore firm of Bartlett Hayward.

Stribling himself might have seen such a system during his career, but no obvious clues leap from his service record.²⁰ Alternatively, any number of other individuals might have suggested such a scheme to him, but for now it will have to remain a mystery.

The installation of the new system appeared to go smoothly, and its operation forever relieved midshipmen from carrying fuel, although it is likely (but not certain) they still had to light the gas lights in their rooms, just as they now turn on light switches. Several problems appeared with the steam system during the first year of operation, which W. R. Hopkins documents in several reports. The two biggest obstacles appear to have been the negative impact of the high water table on the buried steam pipes, and the second was the poor quality of well water used in the boilers, which soon corroded them into disrepair. Little biographical information is available about W. R. Hopkins, but he apparently lived from 1805 to 1876 and designed railroads prior to his service as an assistant professor of Natural and Experimental Philosophy. It is also of interest that for several

²⁰ William B. Cogar, *Dictionary of Admirals of the U.S. Navy: 1862-1900* (Annapolis, Naval Institute Press, 1989), 1:184-5.

years in the 1850s his letters indicate that he worked in the "Department of Engineering" at the Academy, although no records I have seen list such a department. In addition to his heating and lighting duties, he also instructed midshipmen about the steam engine. In December 1853, Hopkins wrote

The steam is very abundant. The boiler was calculated to heat all the buildings of the institution (except for professors' houses) and to give steam for a laundry (a large quantity) and for a machine shop and baths. It is more than sufficient for these purposes. The steam at 1170 feet from the boiler issues from the pipes hot and dry. I would not be willing to carry steam for heating much further than we now do. The distance it is already carried is much farther than has ever been attempted in other places.²¹

A report on the steam plant by the Academy's faculty in February 1854 reported that "it has not been perfectly successful," and that the works needed to be placed in "the charge of some person, experienced in such matters, who can devote his whole undivided time to the work."²²

The gas and steam plant at first had only two attendants, but after receiving the faculty's report Goldsborough asked for more attendants

to afford relief for the night and day service at the gas and steam works. When this method of heating the establishment is in full operation, it is believed that the wages of these men will be saved in the decreased consumption of fuel.²³

The gas and steam systems were expanded throughout the 1850s, both services being provided to the school ship Constitution, which while stationed at Annapolis

was connected with the shore by a light bridge, which was supported upon piles, and upon this bridge pipes were also laid for the gas and steam which lighted and warmed the ship in the most perfect and economical manner. It was doubted, at first, whether steam could be carried so far in pipes which were so much exposed, but the success of the experiment was complete.²⁴

²¹ W. R. Hopkins to Superintendent Goldsborough, 11 December 1853.

²² Faculty Report to Goldsborough, 7 February 1854.

²³ *Annual Report*, Superintendent of the U.S. Naval Academy, 1855.

²⁴ Edward C. Marshall, *History of the United States Naval Academy* (New York: D. Van Nostrand, 1862), p. 62.

Gas was provided to each building, including officers' quarters, and in 1854 the Superintendent was reminded that officers were required to pay, but not students.²⁵ Here the policy differed significantly than that of West Point, where cadets were required to pay for the heat and light provided in their barracks. In 1858 the commander of the Washington Navy Yard solicited advice on building a gas plant there, as the service from the gas utility was inadequate. Adjacent to the Academy grounds was Maryland's Governor's Mansion, and in 1857 the state asked the Superintendent if it might be possible to obtain a supply of gas for this house from the Academy, which was apparently arranged, at least until early 1861 when the Academy moved to Newport, Rhode Island to avoid impending hostilities. The Academy grounds were turned into a military hospital for the war's duration, and it is known that gas was not made during the war, and although the fate of the steam works is not mentioned, the Academy's budget continued to pay for the plant operators, who seem to have taken charge of the apparatus in Rhode Island.

The Navy returned in 1865 to find the grounds in general disrepair, but new Superintendent David Porter, the first Admiral to hold that position, quickly got things back in order. He was also able to obtain funding for a new midshipmen's barracks to hold the enlarged classes, which was completed in 1869. Porter also doubled the plant's operating staff, as a second steam plant had been constructed on the opposite end of the grounds from the original plant (see figure 2), which continued to supply all of the Academy's gas requirements. Porter also acquired the Maryland Governor's Mansion, which was remodeled into a library.

In 1866 the cost of gas at the Academy was determined to be \$2.00 per thousand cubic feet, which officers were required to pay for gas to light their quarters. At this time the steam was still apparently not used for heating the faculty residences, although they were connected at some point.

²⁵ Letter to Commander Goldsborough from Bureau of Ordnance and Hydrography, 16 June 1854.

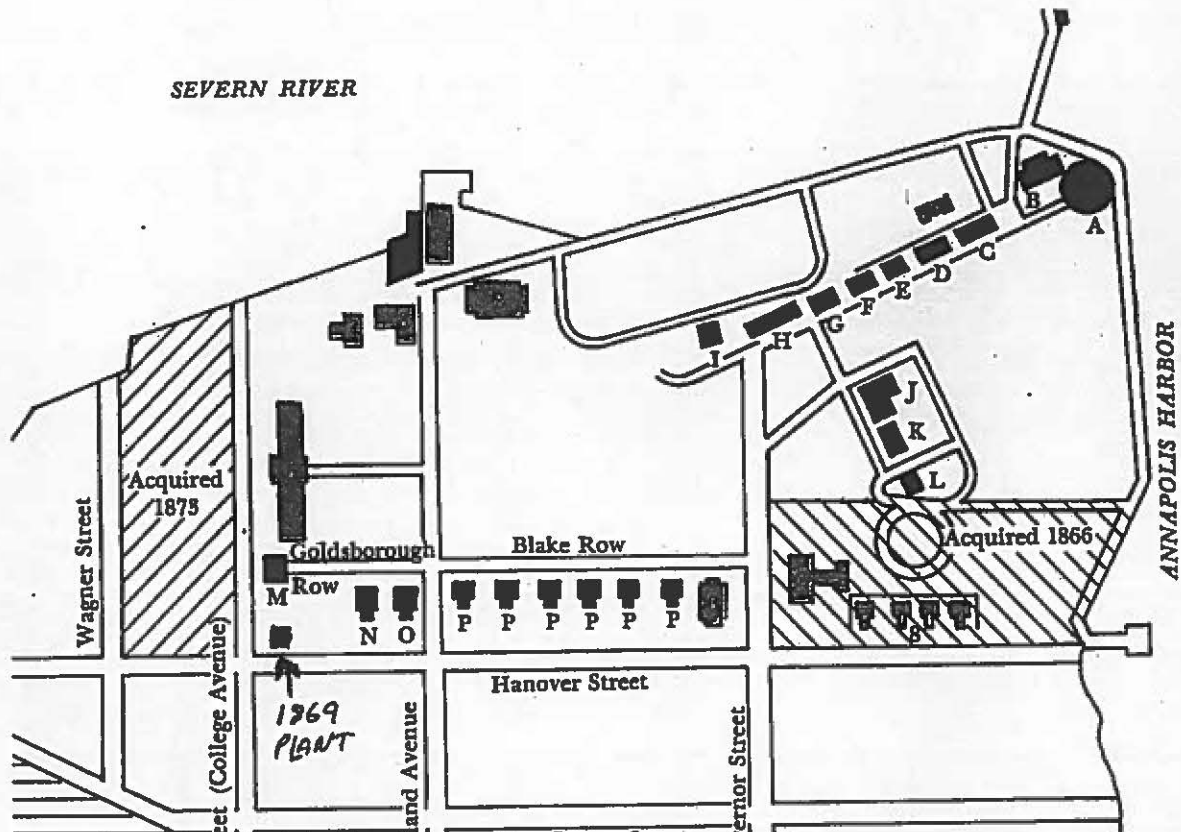


Figure 2 - Location of 1869 heating plant.

The safety of the USNA's district heating arrangement was demonstrated during this period, as West Point lost its laundry (23 September 1869), the cadet guard house (13 March 1870), and a substantial portion of the Cadet Barracks (15 February 1871), all from defective heating apparatus. Shortly thereafter West Point's administration centralized its heating plant in a separate boiler house.

Navy physician Albert L. Gihon inspected the Academy's sanitary condition in 1876 and reported in some detail on the Academy's utility systems. Daily gas consumption in the winter was 30,000 cubic feet, which was supplied from two gasometers with a [total?] capacity of 20,000 cubic feet. He included an analysis of the gas made by Charles E. Munroe, the Academy's professor of chemistry:

The gas contains only a trace of carbonic acid [CO₂], is free from ammonia and the sulphides of hydrogen and ammonium. It contains 1.325 grains of sulphur in 100 cubic feet, and has an illuminating power of 21.2 candles.

According to Gihon, the method of heating the buildings by steam was “probably as convenient and economical as can be devised.” Four-inch wrought iron pipes, covered with felt, covered a distance of 1,775 feet.²⁶

The 1870s and 1880s were not boom times for the Navy or USNA, but saw extensive gas and district heating system development in American cities. Holly’s 1877 invention inspired many competitors, one of whom, William E. Prall, proposed the use of high temperature hot water rather than steam. Prall convinced telephone magnate Theodore Newton Vail to invest in his scheme, and Vail bankrolled an extensive system in Boston in 1886, but only after the scheme had been blessed by Benjamin Franklin Isherwood, who as Chief Engineer of the U.S. Navy had been instrumental in developing a steam engineering program at the Academy.

In 1892 the Academy’s boiler plant was in such disrepair that a new one had to be funded and built, and which began operation in early 1894 (figure 3). Superintendents for many years had sought to have electric lights installed, but to no avail, as the gas plant continued to serve reliably, and at a price calculated at 85¢ per thousand cubic feet in 1888. The Academy’s lagging fortunes changed significantly in the late 1890s as a result of the European naval race and the sorry state of the institutions buildings, which Robert M. Thompson (USNA 1868) undertook to correct. He obtained the services of prominent architect Ernest Flagg, who prepared what is apparently the first comprehensive master plan since Stribling’s work in 1850. The newly-built heating plant, unfortunately, conflicted with the new plan, and its demolition was strongly recommended by assistant Secretary of the Navy Theodore Roosevelt. Flagg’s concept was approved, and its first phase included a new combination power house and heating plant. The 1894 facility, or at least its

²⁶ Albert L. Gihon, Report of Medical Inspection, 1 January 1877. My thanks to James W. Cheevers of the USNA Museum for this reference.

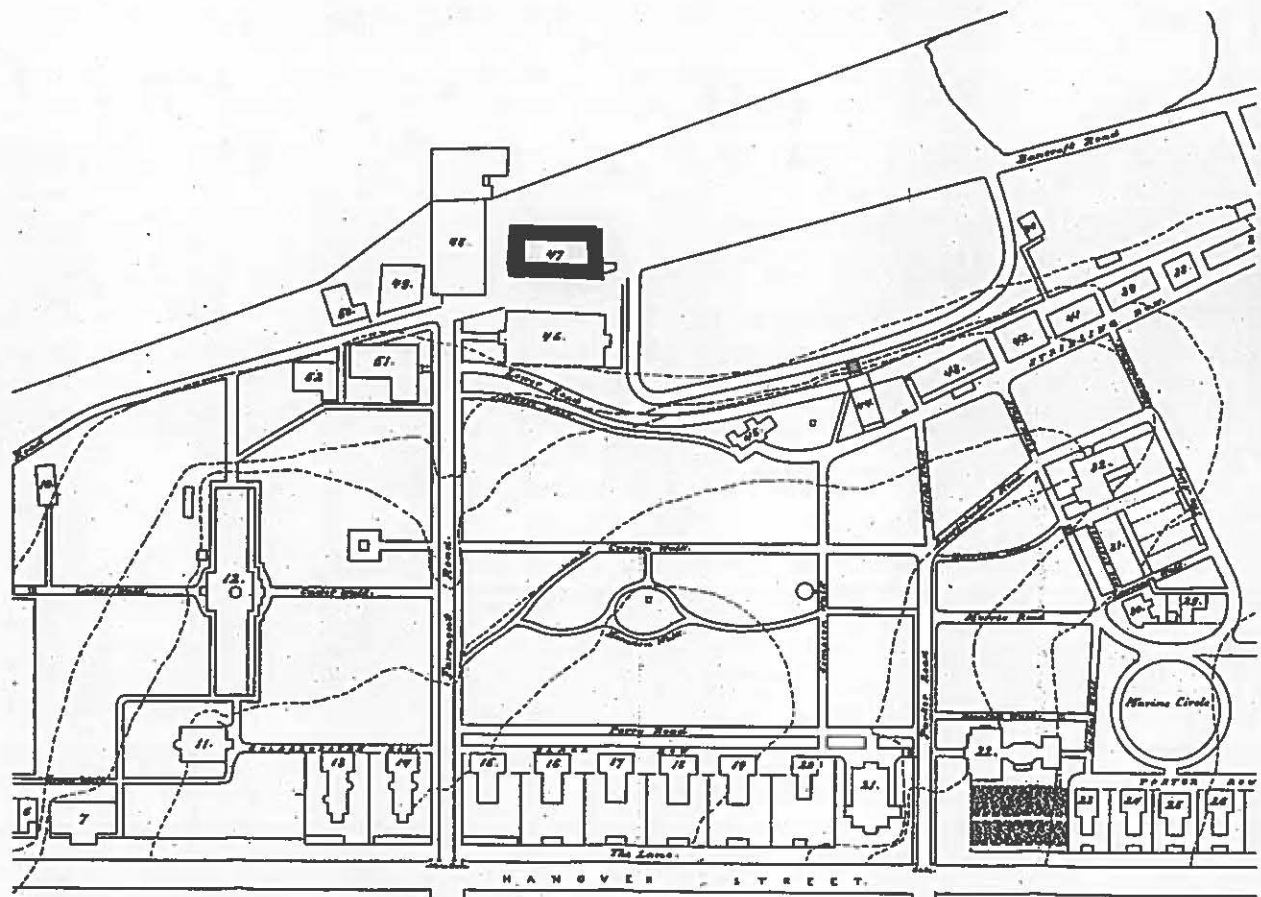


Figure 3 - 1895 map showing 1894 heating plant (in dark border).

components, were moved to the new site (figure 4), to which the electric generating plant was attached in early 1900, finally bringing electric light to the Academy's buildings.

The 1900 plant was enlarged and modified several times, and was supplemented in 1939 by a new heating-only plant to serve new facilities built across College Creek (figure 5). Both of these facilities remained in use until the late 1960s, when another redevelopment program forced the removal of the 1900 power plant, which along with the 1939 plant were replaced by a new high-temperature hot water plant built adjacent to the 1939 steam heating plant. The 1960s redevelopment also introduced air conditioning to the academic buildings, and rather than install chillers in each building two large district cooling plants was built, one each in the basements of Rickover and Michelson Halls. The Academy's cooling system is today perhaps the largest closed

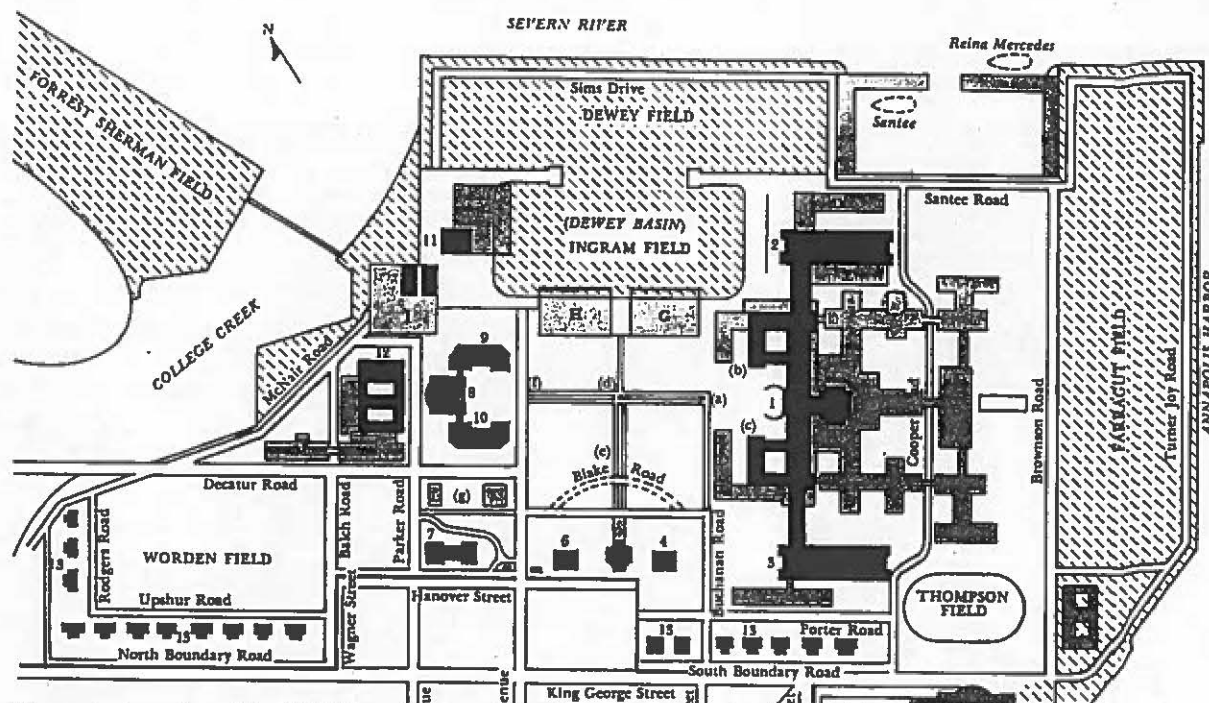


Figure 4 - Location of the 1900 Heat & Power Plant, item 11. Currently site of Rickover Hall.

loop chilled water system in the world.

It is interesting to note that the hot water district heating system installed at the Academy in the 1960s was a direct descendent of the system that engineer Isherwood passed judgment on in 1886, and although Isherwood Hall was torn down to make way for the 1960s development, his name remains as an entrance to Alumni Hall. It is also to be noted that the existing central heating plant has no name, and perhaps some further research will show that it should well be named after Superintendent Stribling as the pioneer of modern heat, light, and power at the U.S. Naval Academy



Figure 6 - Aerial view of USNA, 1935, showing 1900 heat & power plant.

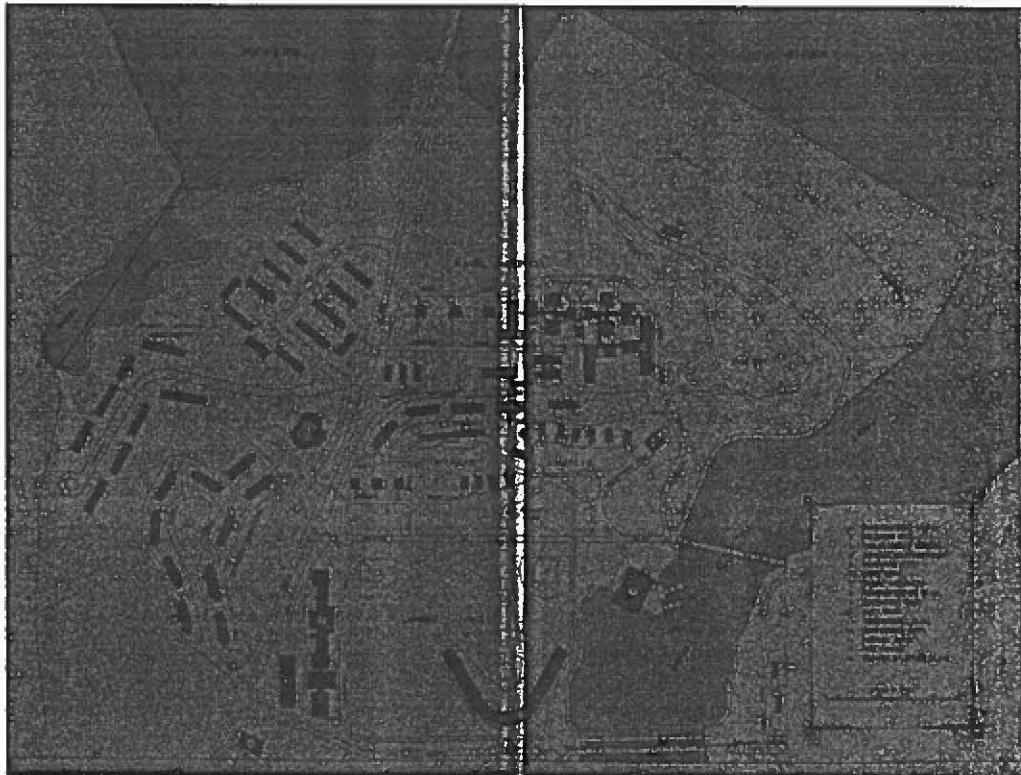
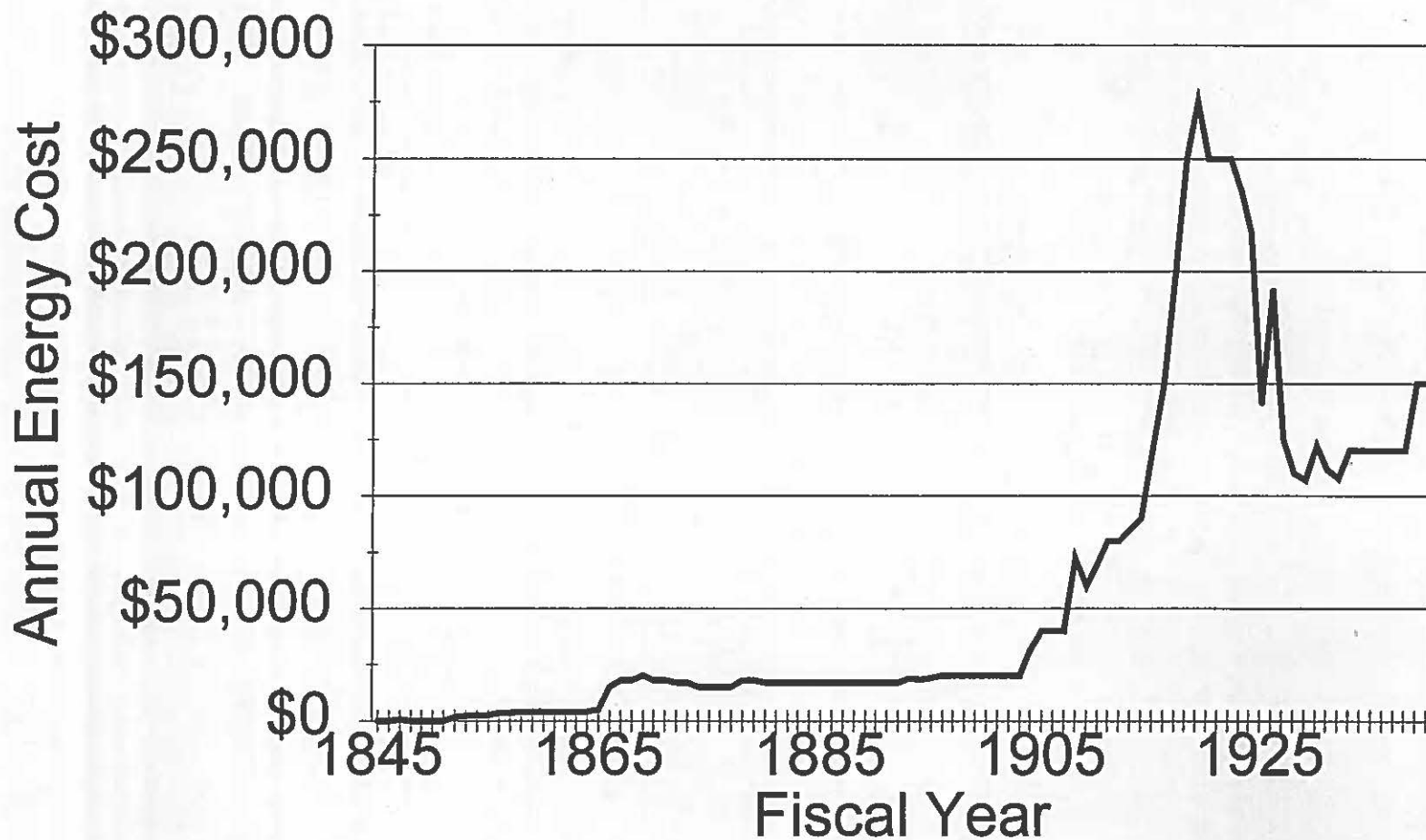


Figure 5 - Location of heating plant (4) built in 1939 to serve USNA service and housing area.

USNA Energy \$

1845-1940



USNA Energy \$/Graduate

1845-1940

