"To Keep the Banks, Dams and Sluices in Repair"
An Historical Context for Delaware River Dikes
New Castle County, Delaware

Prepared for the

New Castle Conservation District

and the

Delaware Department of Natural Resources

by

John Milner Associates, Inc.

December 2013

FINAL

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1.0 INTRODUCTION

1.1 PURPOSES AND GOALS

The purpose of this document is to provide a historical context for five Delaware River dikes in New Castle County. From north to south, these dikes are Buttonwood Dike, Broad (or Outer) Dike, Gambacorta Dike, Army Creek (formerly Mill Creek) Dike, and Red Lion Dike. As defined by the Secretary of the Interior, a historic context is an organizational format that groups information about related historic properties, based on a theme, geographic limits and chronological period. A single historic context describes one or more aspects of the historic development of an area, considering history, architecture, archeology, engineering, and culture and identifies the significant patterns that individual historic properties represent. Historic contexts can be developed at a variety of scales appropriate for local, State and regional planning. The historic context development process should include 1) identification of the concept, time period and geographic limits of the context; 2) compilation and assessment of the existing information and data related to the context; 3) written synthesis of the data, which identifies the important patterns, events, places, and persons of the context; 4) identify and define property types associated with the context; and 5) identify gaps in the existing data to support further refinement of the context.

The historical context for the five dikes presented here is in many ways a supplement and continuation of a context developed previously for marsh resources in Delaware. The *Marshland Resources in the Delaware Estuary, 1830 to 1950 +/-: An Historic Context* (Fisher et al. 1993:92) identifies four property types likely to be associated with marshland agricultural activities, as follows:

- Ditches
- Banks or Dikes
- Sluice Gates
- Hay scows and skiffs.

The *Marshland Resources* historic context notes that all of these property types – particularly the dikes ditches and sluice gates – are "highly ephemeral and possess very low survival rates" (Fisher et al. 1993:92). The document goes on to erroneously state that resources such as ditches and dikes are "nearly vanished from the landscape and are visible only in the documentary record" (Fisher et al. 1993:92). This statement is not supported by the present study, nor by a careful read of the river's coastline. Elements of a number of dikes, including the associated sluices and ditches, are still extant on the landscape. Documentation is also extant to assist in understanding these structures, and that information can be further supported by physical data from the dikes themselves. It is clear that, at the time of the preparation of the context in 1993, the general lack of an adequate informational data base comprised one of the most important information needs identified by the authors of the historic context. The present study therefore can serve to supplement the earlier study.

Omitted from this list of expected property types are the artifacts or objects associated with the creation and maintenance of the numerous ditches, banks, dikes, dams, and sluices. A relatively extensive tool kit was available to the individuals that constructed marshland architecture by the late seventeenth-century. Specialized tools were developed for specific jobs, including draining, trenching, and ditching spades, cleaners, skivers, trenching forks, drain scoops, and a variety of wet soil and drainage plows (Partridge 1973:16-33; Todd 1871:588-590; Wacker and Clemens 1995:125). For the early years of marsh use, the actual creators of the banks, sluices, and ditches are somewhat elusive. Journals and diaries from Salem, New Jersey indicate "hired men" cutting marsh hay in the Tuilbury Marsh in the 1780s (Wacker and

Clemens 1995:237-239). *Pennsylvania Gazette* advertisements describe enslaved laborers as ditchers, and in 1763 an add referring to the St. George's Marsh Company noted that the company needed "any person that understands the stopping of creeks and the making of sluices"(Vandike 1763).

Work by the Mosquito Control Commission for the State of Delaware during the 1930s also developed several unique tools and machines that were used to systematically ditch Delaware tidal marshes, and these should be included as expected property types (Corkran 1937, 1938; Steenis et al. 1954). As an aside, the historic context for Delaware marshes does not include any reference to the considerable efforts of the Mosquito Control Commission, which extensively ditched and drained Delaware marshes in all three counties, but most especially in Sussex and Kent, dramatically affecting marshland cultural resources (Corkran 1936; Pettet 1941; Stearns 1933; Tiner 1985).

1.2 METHODS

The historical research undertaken to create the historic overview of the five dikes included research at the Delaware Public Archives, the Delaware State Museum, the Delaware Historical Society, the Pennsylvania State Archives, and the University of Delaware Library. The historical research at these repositories compiled primary information about the creation, maintenance, development of dikes along the Delaware River. Significant sources of primary documentation included the Enrolled Bills of the State Legislature, where over 229 bills were found that document the development of marsh and ditch companies in the state, individual records of marsh companies, and various manuscript and coast lines maps.

A previous archeological survey complete along the Christiana River above Newport was consulted (Kellogg and Catts 1997; Catts 2002) as was the marshland historic context prepared by the University of Delaware Center for Architecture and Design (Fisher eta l. 1992) and the study of New Jersey's marsh resources by Sebold (1992). In additional to the historic documentation, historic maps and manuscripts, historic aerials, and plats were georeferenced into a GIS workspace using ArcMap 9.3 or ArcMap 10. This georeferencing provided additional documentation regarding the history of all five of the New Castle dikes.

Limited archeological data is available to inform this study as well. In addition to the report referenced above for a dike and sluice along the Christina River, limited archeological and geophysical investigations (ground penetrating radar) were completed at the Red Lion Dike as part of this study, and the results of that study are presented under separate cover (LaVigne et al. 2013).

2.0 OVERVIEW OF DELAWARE RIVER DIKES

Along the bay and river shores of Delaware Estuary, there are over 176,000 acres of fringing tide marsh, extending from Cape Henlopen and Cape May to the head of tide at Trenton (Figure 1). Tide marsh can be defined as an area of grasses, sedges, and other plants that have adapted to continual, periodic flooding. The action of tides is the dominating characteristic, and marshes of the Lower Delaware Valley can be divided into three parts based on the effects of the tide on the types of plants that can be found: salt marshes, fresh-water marshes, and brackish-water marshes. Any given marsh can be further divided into two areas: the low marsh that generally floods and drains twice a day, and the high marsh, that is flooded less often (Chase 1979; Daiber and Roman 1988:95-97; Scott 1991).

The extensive marshes of Delaware have long been an important resource for subsistence and economic activity. Until the early decades of the twentieth century, Delaware's marshes were exploited for their animal resources, such as fish, shellfish, turtle, waterfowl, and muskrat. Moreover, tide marshes along both sides of the Delaware River and Bay during the seventeenth, eighteenth and nineteenth centuries were used by farmers for hay for cattle and livestock during the winter months. One wetland reformer wrote:

> "When the country was first settled these marshes were depended upon a good deal for hay during the winter. Even fifty years ago [circa 1810] they were prized much more highly than they now are....The result of this former high estimate of these marshes is seen in the fact that they are now often owned in small parcels of from five to ten acres, having been inherited by farmers living far back in the country....They are chiefly valuable for yielding early pasturage, and the hay is better for bedding than for fodder" (Clift 1862:343).

In his study of coastal wetlands in Northwestern Europe, archeologist Stephen Rippon suggests that there are three stages of use for coastal wetlands, a framework that serves to help contextualize the historical role of wetlands. The first stage is exploitation, where wetland areas are used for their natural resources, but the landscape is essentially left unchanged. The second stage is modification, where coastal wetlands are altered through minor landscape changes, such as ditching and draining. The third stage is transformation, where major landscape changes, such as dikes and embankments, are constructed in order to reclaim land and permanently remove it from periodic inundation (Rippon (2000), cited in van der Noort 2012:116). The dikes along the Delaware River fall principally in the transformation stage of development, but earlier stages of exploitation and modification are also apparent.

In the Delaware River valley, the action of embanking, ditching, and draining the tidal marshes began as early as the last quarter of the seventeenth century. In 1675, the authorities in the village of New Amstel (today's New Castle) ordered the construction of two dikes to cross marshland north of the town, one each for foot traffic (today's Broad Dike, but more accurately the Outer or Narrow Dike) and vehicular traffic (historically called the Cart Dike, or Broad Dike). The Cart Dike is today part of New Castle County's highway system, while the Outer dike continues to serve foot traffic. In 1681 Dutch merchant Arnold de Lagrange ditched and drained a marsh near New Amstel, in exchange for the right to build a windmill (Weslager 1961:204). A decade after the construction of Broad Dike on the west side of the river, the burgesses of Salem, New Jersey, were given the authority in 1685 to deal with public improvements, such as dike and ditch construction. In 1693 a similar act was passed in Burlington, further up the Delaware River (Wacker and Clemens 1995:122).

Beginning with European settlement, marsh modification and transformation through ditching and diking was undertaken to add to land suitable for agricultural use, especially for pasturage and as a source of hay for fodder, and to create more healthy environmental settings (Fisher et al. 1993; Catts 2000). Marsh reclamation was labor-intensive, and therefore costly. In general, there was a main ditch measuring up to

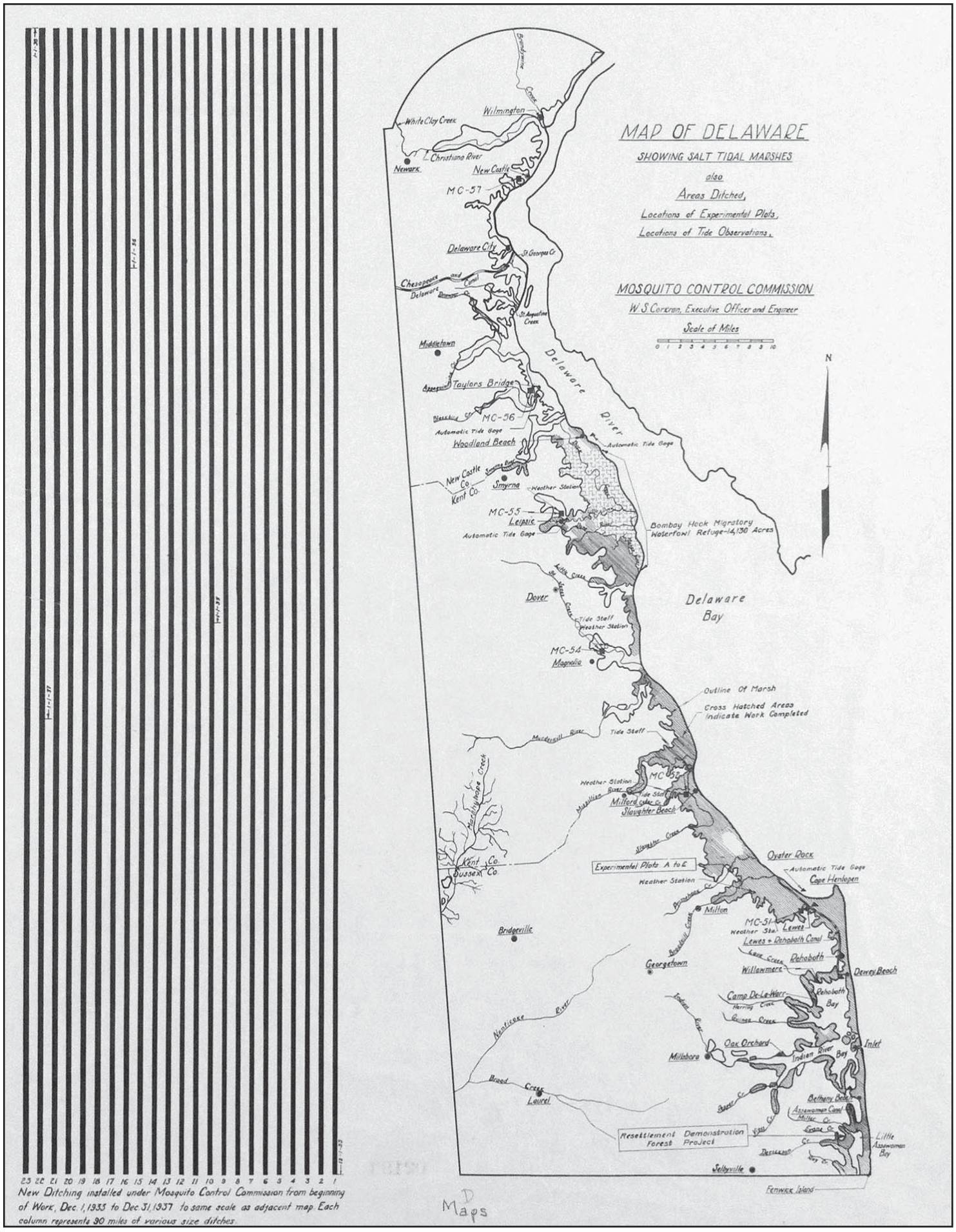


Figure 1. Cross-section views of the sluice installed in 1894 at the Colburn Marsh in Delaware City, Delaware (Warren 1911: Figures 6 and 7).

20 feet across at the top, and five-foot in depth that drained to the nearest creek or river. Off the main ditch were "prongs" that ranged in size from roughly 5 to 10 feet across at the top, and had a depth of about 3-feet. In tidal areas, a dike, or bank was needed to prevent successive flooding. The height of the dike needed to be roughly 3 feet above the mean high tide, which along the Delaware River generally meant a height of from 6 to 8 feet. The breadth was dependent on location, with dikes along the Delaware measuring up to 18 feet across at the base, and 4 feet across at the top (Fisher et al. 1993:87; Catts 2000:5-6).

The manner of dike construction was dependant on the extent of exposure to open waters and tidal action, and the ubiquitous threat of weakening caused by the burrowing of muskrats. A nineteenth century expert on marsh reclamation recommended that dikes exposed to the ocean or subject to the action of heavy tides be faced with stone. Another added that a reed marsh on the river side could offer protection. Dikes along tributaries, however, generally could be less robust (Clift 1862:345; Reybold 1889:55). Keeping standing water away from the base of a dike, and the use of sheet-piling was recommended to discourage undermining by muskrats (Reybold 1889:55; Colburn 1889:52). With respect to sheet-piling, marsh expert A. Colburn wrote in 1888:

> For this purpose use 1-inch boards, 4 feet long, and drive a double row, breaking the joints. If they cut through one row, they will strike the center of the board of the next row, which will stop their progress, as they cannot gnaw through the center of a board. Some 3 miles of this piling, driven two years ago, has in no place been cut through. The piling should be driven as near the foot of the dike as practicable, and the space between the piling and the dike so graded that no water can stand on it, else the rats will work in the back of the piling. (Colburn 1889:52)

Archeological evidence from a dike along the Christina River at Holly Run in Newport, Delaware indicated that the sheet-piling consisted of 0.5- to 0.7-foot wide, primarily triangular timbers that were driven into the mud. The piling was composed of two rows offset from one another, with one row being roughly a foot further into the river. The timbers of the inner-most row rested on an unfinished timber lying parallel to the length of the piling at 3 feet above mean low tide (Kellogg and Catts 1997:23-24, Plate 13). The threat to dikes posed by muskrats was so problematic that it was recognized in legislation passed to protect them. Legislation passed in Delaware from 1875 to 1909 prohibited the killing or possession of a killed muskrat from March to December, except from marshes that were diked or otherwise improved (Enrolled Bills 1875, 1889a, 1889b, 1909)

Dikes were fitted with one or more sluices that held a self-acting gate that allowed water to drain from the marsh, yet kept it from entering. Typically the sluice was constructed of wood, the base of which was placed below the water line at low tide. Sluices were constructed of heavy timber framing, which at times rested on pilings driven in at the base. Gates could be made of wood or sheet iron. As recorded in the area of Delaware City, if the width of the sluice was greater than 3 feet, additional sections were placed, each having its own gate (Colburn 1889:51; Colton 1889:57). As depicted in the historical literature, and found archeologically, sluices were rectangular channels running perpendicular to the length of a dike (Figure 2). Unlike sluices and gates associated with water-powered mills, they did not run the full height of the dike. The method of construction was fitting to the use of self-acting gates, and reduced the cost of having to build a framing and gate substantial enough to withstand the water pressure to which a gate covering the full height of the dike would be subjected.

A sample of eighteenth-century Kent County Delaware inventories reveals that "tussock hoes" (or grass hoes), salt hay, and "stacks of marsh hay" appear in estate inventories by the 1740s (Bushman and Hawley 1987). Real estate advertisements in the *Pennsylvania Gazette* for lands in Delaware contain regular mention of drained meadows and marsh tracts in the 1750s; these tracts generally ranged from 5

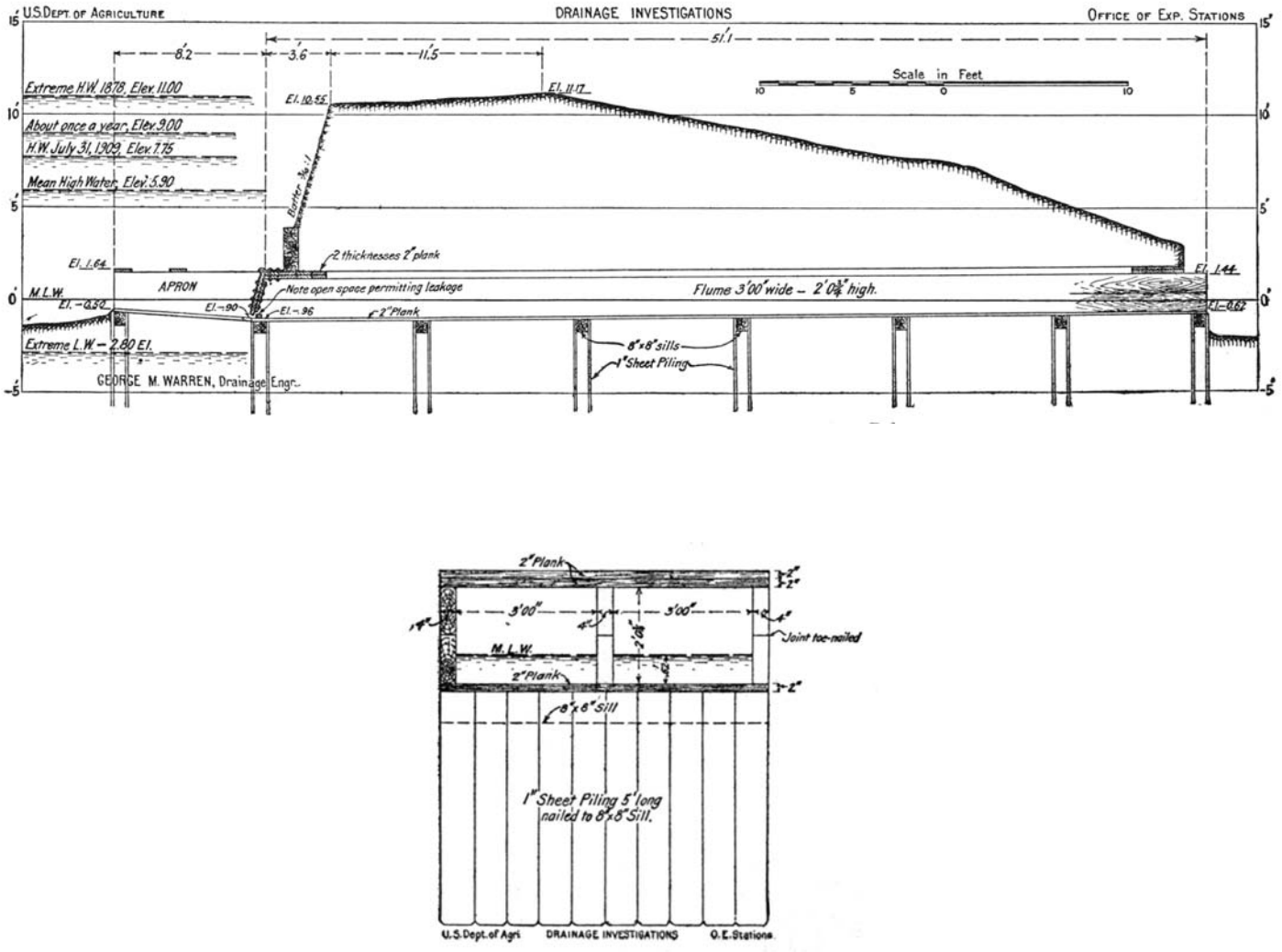


Figure 2. Cross-section views of the sluice installed in 1894 at the Colburn Marsh in Delaware City, Delaware (Warren 1911: Figures 6 and 7).

to 25 acres. Until the second quarter of the eighteenth-century, beyond the settled communities along the Delaware River, such as New Castle, Salem, and Burlington, tide marsh banking was undertaken by individual farmers and landholders on small tracts of marsh, and generally at significant expense.

To defray the costs of construction and maintenance, marsh companies were formed in the first half of the eighteenth century on both sides of the Delaware Estuary (Lanier and Herman 1997; Sebold 1992). Most importantly, legal authority was needed by these companies to compel owners of marsh lots to contribute to the upkeep, either through physical action or taxation. Taxes charged by the companies were proportional to the amount of marshland owned. One of the first to be authorized by the legislature was a large tract of tide marsh called Conrad's Cripple, located along the Christiana River in New Castle County. In 1738 the colonial General Assembly passed an act "authorizing the owners of the Marsh Meadow near Newport, called Conrad's Cripple, to keep the banks, dams and sluices in repair, and raise funds to pay the expenses thereof" (Conrad's Company 1865). The act was revived a year later, and again twenty years later when the colonial assembly passed an act for the banking of the Newport (or Conrad's) Marsh, authorizing the landholders to raise taxes to pay for the maintenance (Denny 1759). Other early marsh companies included Middleburgh Marsh Company, Mill Creek Marsh Company, and Deer Creek Marsh Company, all located east of Newport and west of Wilmington (Deer Creek Marsh Company 1759-1891). Along the river in Delaware companies were formed along Cedar Creek, Appoquinimink Creek, and St. George's Creek by the 1770s, and similar meadow companies were created in Salem, Cumberland, and Cape May counties in southern New Jersey (Chase 1979; Sebold 1992:57-65; Wacker and Clemens 1995).

Maintenance costs for embanked tide marshes were high, and often proved a deterrent to the initial or continued reclamation of a tract of salt marsh. Throughout the northeast, wrote marsh reclamationist William Clift of Stonington, Connecticut, salt marshes generally required "more capital to bring them into upland grasses, and they are usually owned in company--a piece of a hundred acres not unfrequently [sic] having a dozen or more proprietors"(Clift 1862:344). Without incorporation, land owners would bicker over the responsibilities of maintenance and repair, and the costs could be heavy on individual owners (Wacker and Clemens 1995:122). The 1810 preamble to the Act of Incorporation for the Port Penn Marsh Company, allowing the owners to "keep the Banks, Dams, Sluices, and floodgates thereof..." described the problems of salt marsh maintenance, noting that the marsh had "for a considerable time hath been embanked, but of late hath been frequently impaired and out of order for want of proper management and regulation, and as such improvements are from their own nature subject to many casualties, and without constant care and expence[sic] are not only liable to decay, but the defect of one part is often injurious to the whole, and among owners such frequent disputes arise concerning repairs or the means of defraying the expenses thereof that often times from small neglects great damages ensue and the heavy charge of one owner rendered ineffectual through the default of another" (NCCD I-3:385). The extant records of other marsh companies in New Castle County, such as the Cedar Creek Marsh Company, the Cherry Island Company, and the St. Augustine Marsh Company, provide supporting documentation regarding the annual cycles of maintenance and repair (Cedar Creek Marsh Company 1859-1900; St. Augustine Marsh Company 1796-1821).

The minute books of the Deer Creek Marsh Company, kept for nearly a century, illustrate the high level of maintenance required to properly maintain the reclaimed marshland. Land owners were either taxed (according to the number of acres of marsh they owned) for the work, or provided manpower to undertake such repairs as cutting and clearing the banks, repairing tide gates, working on bridges, scouring drains, "stopping muskrat holes," planting herd grass on the banks, building new banks, working on lanes, facing the bank, and working on sluices (Deer Creek Marsh Company 1795-1891). Expenditures also included purchases of lumber, spikes, bolts and other hardware, and stone. Stone was apparently most useful in locations where tidal action was constant.

While the early efforts at marsh reclamation was initially undertaken by an individual, the undertaking was subject to permission being granted by the legislature through passage of a private act (Fisher et al. 1993:89). A landowner, at times in partnership with adjacent landowners, bore the labor and cost of creating and maintaining dikes and drainage ditches. Relations pertaining to ditches were briefly formalized in 1770 in an act regulating fences. In force for only three years, the act stipulated that where a ditch was desired by one party along a property line, both landowners were required to share the expense of digging and maintenance. Further, each was required to erect a fence at least 2.5 feet high within a foot of edge of the ditch (Laws 1797:451-455). Again in 1816, legislation was passed detailing the process of marsh reclamation (Fisher et al. 1993:90).

Beginning in the eighteenth century a number of landowners created formal agreements for marsh reclamation through mutual agreement or the formation of marsh companies (Fisher et al. 1993:89; Catts 2000:2). Modification of a waterway and the formation of a company were enabled by acts passed by the Delaware Legislature, landowners and marsh companies were given the authority to conduct and regulate reclamation efforts (Bendler 2013; Williams 2008:92). Legislation generally specified the individuals or the name of the company and the marsh in question. As applicable, also specified were the marsh company officers and the manner of succession, and the time and place of annual meetings. Stipulated at times were the numbers of acres that must be held to be a part of the company. Those owning less than the stated minimum number of acres could achieve representation by combining their holdings. Most importantly, companies could compel owners of the specified marsh to contribute labor or funding in proportion to their holdings for construction and maintenance of marsh infrastructure (essentially imposing a marsh tax on the individual owner). Changes in ownership of marshland associated with a company periodically resulted in a renegotiation of the terms under which it operated.

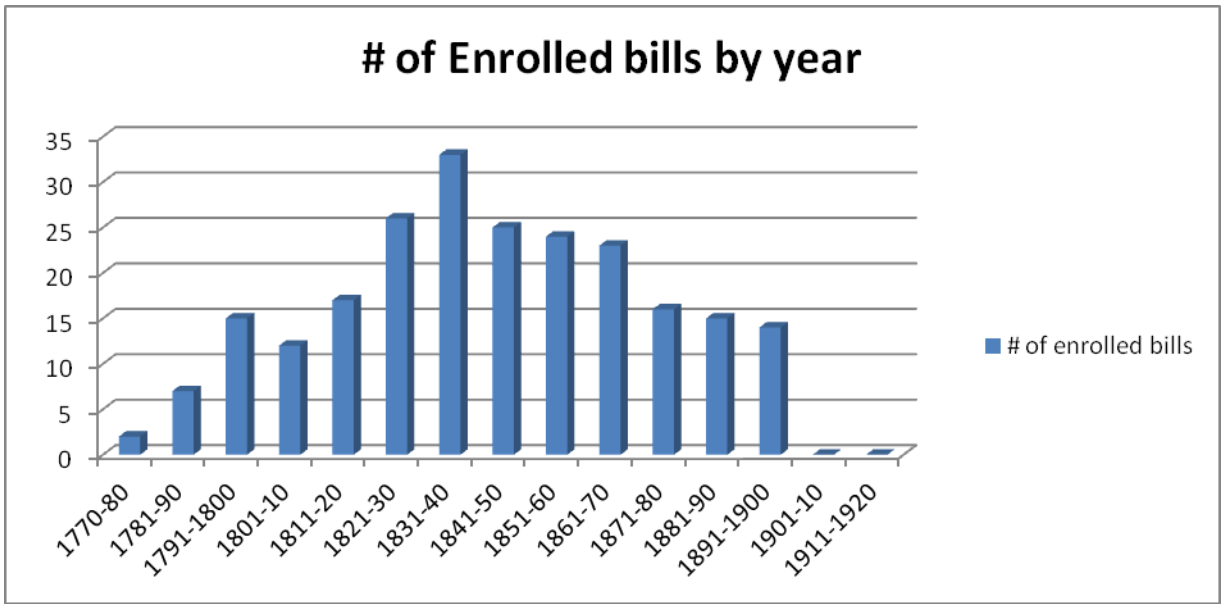
The banking and draining of tidal marshes became more widespread in the northeastern United States after the War of 1812 (Wacker and Clemens 1995:124). Following the American Civil War draining marshes to reclaim the land for agricultural use gained in popularity (Smith et al. 1989). The reasons offered were numerous, including ridding the country of “plague-breeding swamps”, and the rich condition of the highly organic soils for agriculture (Clift 1862:344; Collins 1871:611). The economic benefits were also cited as incentive, particularly since “the subject of the reclamation of marsh lands is one which must claim the attention of the country in the immediate future, as agricultural lands advance in price and population increases”(Dodge 1871:600). Beginning in the 1860s, numerous agricultural reformers and civil engineers published “how-to” reports on the methods and techniques of draining and reclamation, including Delaware and New Jersey agriculturists (Grettler 1990; Lanier and Herman 1997; Sebold 1992).

Between 1779 and 1897, the Delaware legislature passed 229 bills pertaining to the creation and maintenance of marsh companies (Figure 3). Marsh companies were formed throughout the state in all three counties, along the Delaware and its tributaries and on inland rivers such as the Nanticoke. The six decades between 1820 and 1880 were the efflorescence of marsh companies in Delaware. The peak decade for passage of bills dealing with marsh companies was 1830-40, when 33 acts for marsh companies were passed. By 1885, Delaware was considered to be a model of successful land reclamation and had more diked land in proportion to its area than New Jersey (Nesbitt 1885).

Beginning in the last decade of the nineteenth century, marshes in Delaware began to be abandoned for agricultural use. The abandonment was a result of the overall decline in agriculture in the state, and the extensive damage to dikes and marshes caused by the 1878 hurricane and other s damaging storms. The 23 October 1878 hurricane was of truly epic proportions and one contemporary wrote that “every embankment from Cape May to Trenton was broken, and many of them swept from their very foundations. No such storm of wind, and consequences, was ever known in our country before…” and the

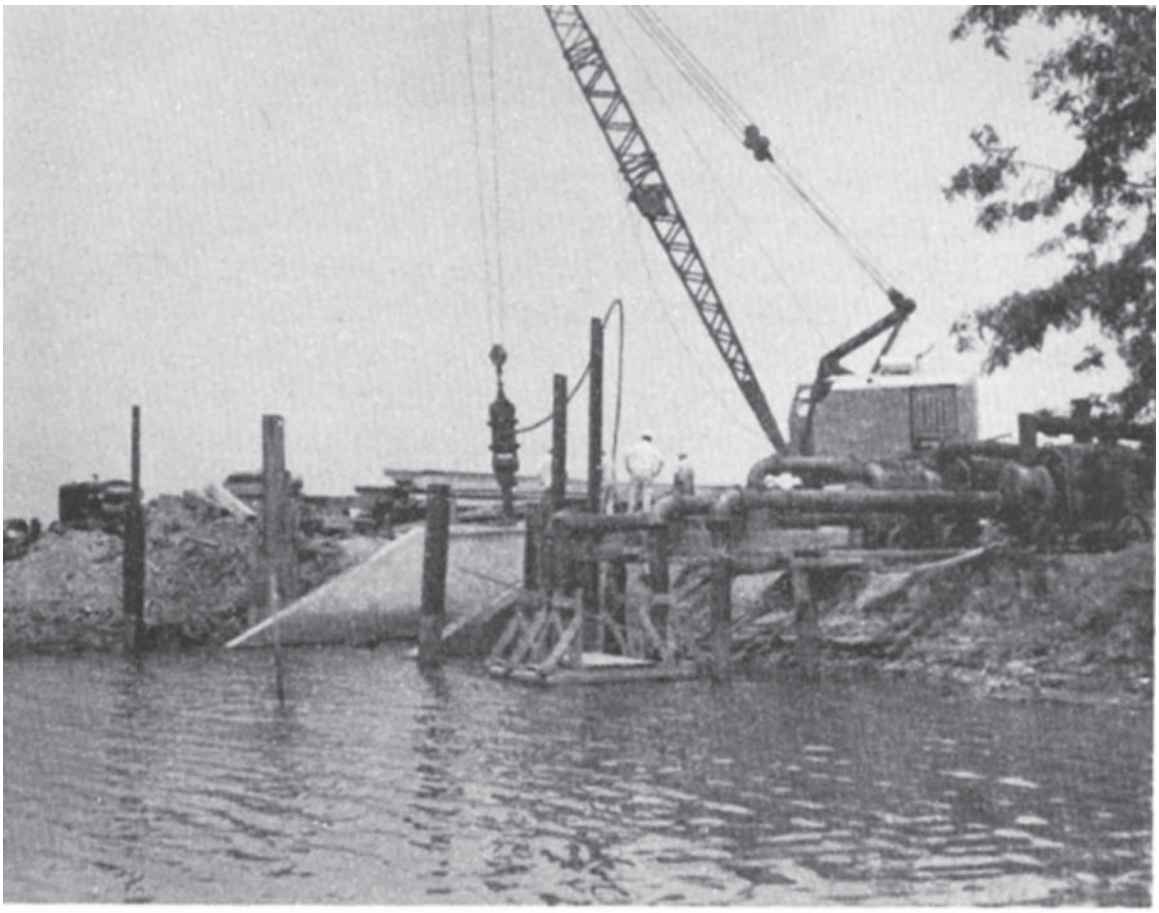
economic implications were unprecedented as "…many [marsh owners] on both sides [of the Delaware River] were completely ruined financially" (Clark 1879).

Figure 3: Summary of Enrolled Bills passed by the Delaware Legislature pertaining to Marsh Companies, 1770-1920



Following another hurricane in the 1930s, Delaware farmers gradually abandoned marsh reclamation and the agricultural use of marshes (Fisher et al. 1993:90; see also Ramsey and Reilly 2002). The high cost of dike and sluice maintenance, the general aging of the structures (many on the Delaware River were a century or more in age by the 1930s), and the decline in the need for salt hay in packaging (it was used in the packaging of glass from southern New Jersey glass houses and in the packaging of ice), all contributed to the dissolution of the marsh companies and the degradation of the marsh structures (Sebold 1992).

Beginning at about the same time, the state and federal governments began focusing on marsh drainage as part of efforts to control the mosquito population (Delaware State Highway Department 1940:23; Delaware State Highway Department 1942:41; hereafter DSHD). By the 1950s, repair and maintenance of dikes and related infrastructure fell into the hands of Public Works Division of the State Highway Department, where efforts focused on preventing the flooding or roads (DSHD 1954:74-77). The concerns for the state's transportation infrastructure and public health issues were the determining factors for the state's assumption of what was by this time referred to as a dike "system." In the discussion of the Port Penn dikes and tide gates, the Highway Department noted that "the unchecked forces of nature have accomplished progressive erosion and breaching of dikes and deterioration of tide gates in the Port Penn area. As a result, flood and storm tides have brought extensive flooding of lands. State and private roads are rendered impassible, wells are made unsafe and conditions detrimental to the public health are created by periodic flooding" (DSHD 1954:74). The scope of work at Port Penn included construction of new "protective dikes, including new sluices with tide gates," core walls for dike construction, removal of an existing sluice, and the raising and surfacing of two roadway sections (Figure 4). This level of effort was repeated at many of the dikes along the Delaware during the 1950s, and marks the beginning of state involvement in the maintenance of the dikes, and likely the period when the concept that the dikes represent a system of tidal control became generally accepted.



REPLACING AUGUSTINE SLUICE, NEW CASTLE COUNTY.
DESTROYED BY STORM NOVEMBER 25, 1950.
CONSTRUCTION STARTED FEBRUARY 1952. PROGRESS
JUNE 30, 1952.

Figure 4. Replacement of the sluice at the St. Augustine Marsh (Delaware State Highway Department 1954).

2.1 ELEMENTS OF MARSH ARCHITECTURE

As the *Marshland Resources in the Delaware Estuary, 1830 to 1950 +/-: An Historic Context* (Fisher et al. 1993:92) points out, there are three principal elements or property types associated with marsh architecture: 1) Banks or Dikes; 2) Ditches; and 3) Sluices Gates. Each is described below in order to provide the reader with some background on methods and materials of construction, placement of elements, and some of the hazards associated with the repair and maintenance of the dikes.

2.1.1 Banks and Dikes

Along the Delaware Estuary and its tributaries are the remnants marsh architecture required to drain the wetlands and bring them into agricultural "production." The most obvious and indeed crucial elements of tide marsh architecture are the banks and dikes. Embankments were generally made of soils excavated from within the marsh, but several contemporary observers noted that sometimes soil could be brought in, at a fairly great expense, to create the embankment (Colburn 1889:52). Soil banks ranged in size, but were intended to form a trapezoid when seen in profile. Along the Delaware River banks could be from 12 to 18 feet broad at the base, 3 to 4 feet broad at the top, and of necessity had to be extend at least three feet above the high water mark (Colton 1889:56; Riddle et al. 1813; Weslager 1961:206). Embankments along tidal streams that did not get direct ocean tides were often less massive. As prescribed in the literature by a Connecticut marsh reclamation expert: "if the marsh does not face the sea, and is not exposed to heavy tides or floods, a much less expensive embankment will answer. It may be made without stone, by having a section of clay or clay loam, about eighteen inches in thickness, running through the middle of the embankment....This kind of embankment is well adapted to land upon small creeks and streams, where little violence is offered by the waves or by the pressure of high tides"(Clift 1862:345).

The remains of the vertical or upright timbers are called sheet piling (Colburn 1889:52) or, as it is known today, as Wakefield Sheeting or Piling (Chester Stachecki, personal communication May 1997). In many cases, because of lack of maintenance of the banks, piling may only be visible at low tide. In a section of sheet piling recorded at the Christina River dike, the timbers used in the piling ranged in width between 0.5' and 0.7' (Kellogg and Catts 1997). The timbers, with few exceptions, were triangular in shape, and were not anchored or fastened to each other or any other support, but were instead driven into the mud of the embankment. Several of the pilings were leaning at angles from 30 to 45 degrees. A large timber or log was observed protruding horizontally from the embankment, and the sheet piling was leaning on this log. The sheet piling was composed of two parallel line of driven timbers, one offset and further out in the river than the other. The ends driven into the mud were clearly sharpened by axe.

Historically, pilings were generally placed as close to the low water mark as possible. Sheet piling was necessary to protect the embankment from muskrats, and the double row of piling was one method used to exclude muskrats from burrowing into the earthen wall. One tide marsh engineer described the problem and the solution as follows: "Muskrats are very abundant and destructive if the dikes are left without protection. They can be protected from rats by sheet-piling. For this purpose use 1-inch boards, 4 feet long, and drive a double row, breaking the joints. If they cut through one row, they will strike the center of the board of the next row, which will stop their progress, as they cannot gnaw through the center of a board. Some 3 miles of this piling, driven two years ago, has in no place been cut through. The piling should be driven as near the foot of the dike as practicable, and the space between the piling and the dike so graded that no water can stand on it, else the rats will work in the back of the piling" (Colburn 1889:52).

The problem of destructive water rats was as old as the use of artificial embankments to hold back the tide. In the winter of 1749, Swedish naturalist Peter Kalm wrote of the efforts that settlers along the Delaware expended in order to destroy the muskrats. Kalm recorded that muskrats

> "make their nests in the dikes that are erected along the banks of rivers to keep them from the adjoining meadows; but they often do a great deal of damage by spoiling the dikes with digging and opening passages for the water to come into the meadows.....As they damage the banks so considerably, the people are endeavoring to destroy them when they can find their nests....It is very difficult to extirpate these rats when they are once settled in a bank. A Swede, however, told me that he had freed his dame or piece of dike along the river from them in the following manner; he sought and found their holes, stopped them all up with earth, excepting one, on that side from whence the wind came. He put a quantity of sulphur into the open entrance, set fire to it, and then closed the hole, leaving but a small one for the wind to pass through. The smoke of the sulphur then entered their most remote nests, and stifled all the animals. As soon as the sulphur was burnt, he was obliged to dig up part of the ground in the bank where they had their nests; and he found them lying dead in heaps"(Benson 1937:240-41).

The use of stone along the bank wall close to the sluice, and in places where the bank met the fast or upland, was advocated by several contemporary authors, particularly in places where the berm was subject to continuous tidal action (Clift 1862:345; Colburn 1889:52). In the case of the 1814 Red Lion Marsh embankment, where the earthen banks met the fast land they were to be secured to piers or wharfs "constructed of substantial logs well spiked together and filled with stone and mud" or by "substantial piles, well driven, and backed by brush and stone" (Riddle et al. 1813).

2.1.2 Ditches

The second element of marsh architecture was ditching. During the construction of the dike, the soil used for the dike was excavated from the interior of the bank, creating a ditch. These ditches were necessary to help carry water away from the embankment, and to drain the marshland for agricultural use. Along the interior (or marsh) face of the berm a drain or ditch followed the inside of the bank until it connects with the sluice gate. Other ditches were excavated leading from the upper marsh to larger "trunk" ditches that also connected to the sluice.

2.1.3 Sluice Gates

The third element of marsh architecture is the sluice gate. Sluice gates are still extant in tidal marshes throughout the lower Delaware Valley, and are a relatively typical tidal marsh architectural feature (Mr. Chester Stachecki, personal communication, May 1997). Sluice, or tide, gates were necessary to regulate the flow of water in and out of the salt marshes located along the eastern seaboard (Collins 1871:607). The materials and construction of sluice gates varied according to where on the shoreline they were situated. Along the sea edge, tide gates and the associated berms and banks were of more substantial construction, often using stone in the creation of a sea-wall (Clift 1862:345). For tidal rivers and streams the construction was often of timber.

The length of the sluice depended on the size of the base of the overlying bank. A sluice gate investigated along the Christina River was approximately 44 feet long; a sluice described in 1813 along Red Lion Creek was nearly identical in length, suggesting that the embankment associated with the sluice was originally about 16 feet broad at the base (Riddle et al. 1813). The sluice investigated along the Christina River was constructed of two parallel sills with wooden planking in two sections, linked by a scarf joint in the center and fastened by large iron, square-headed bolts. The horizontal planks formed the upper and

lower surfaces of the sluice (Kellogg and Catts 1997). The 16d common nails, made of steel wire and used in the construction, exhibited evidence of gripper marks on the shanks and flat, although somewhat bulbous, heads (Nelson 1968). The use of wire nails in the sluice suggests a date of construction sometime after circa 1880-1885, when nearly seventy-five percent of the nails produced in the United States were wire (Inashima 1994). No evidence of repair or maintenance of the sluice was apparent, such as replaced nails, or new nail holes.

In the vicinity of Delaware City, located along the brackish portion of the Delaware River, local resident A. Colburn wrote in 1889 that:

> "the sluices used in this section are built of wood, about 2 feet in depth and wide enough to vent the water. If a greater width than 3 feet is required they are divided into sections about 3 feet wide, in each of which is hung a self-acting gate. The sluices are placed below low-water mark. Great care is required to prevent the water running under or over them" (Colburn 1889:51).

Another contemporary reported that chestnut and white oak were the most durable types of wood to be used in building a sluice (Clift 1862:345). The Christina River sluice, since it was situated on a tidal river, but sheltered from extreme storm tides, was a smaller version of these Delaware River sluices.

A good description of a sluice was provided by agricultural reformer Sereno Todd. In an article published in 1871 on underdraining land, Todd described what he termed "outlet drains," stating that a wooden outlet was made "by placing a board or plank on the bottom of the ditch, while the ground is soft, then by setting a strip four inches wide one each side and covering with short pieces, as shown by the cut. A board is frequently laid on lengthwise, which is objectionable, as the covering will not be so strong as if the same board were cut in pieces and laid crosswise. The water channel beyond the outlet should always be kept clear of mud and gravel, so that the water will flow away rapidly from the drain" (Todd 1871:595).

The sluice gate was generally fitted with a self-acting tide gate that remained closed during high tides and opened during low tides so that marsh waters could drain. Throughout the centuries, Delaware tide gates were of simple construction. In 1889, one marsh improver remarked that "the doors open and shut with the tide, and can be either of the "barn-door" or "trap-door" kind" (Reybold 1889:55). Seventy-five years earlier the technology was the same, and a trap-door gate was described in 1814 when the Red Lion Marsh embankment was realigned; the gate was to be constructed of "substantial white oak posts and Two inch plank and to work with two perpendicular Doors or flood gates fixed in at the Bottom on platforms"(Riddle et al. 1813).

It was common for sluices to not be permanently attached to the berm or bank. At the time of its construction the dike wall would extend over the sluice. The Red Lion Marsh sluice mentioned above specified that the sluice was to be placed at least six inches below the low water mark, ensuring that the sluice was always wet (Riddle et al. 1813). The weight of the earthen berm and the eventual waterlogging of the timbers served to hold the sluice in place, a practice still observable in Delaware tidal marshes (Mr. Chester Stachecki, personal communication, May 1997).

The Christina River sluice gate provides physical evidence of the problems of repair and maintenance associated with marsh architecture (Kellogg and Catts 1997). The portion of the sluice extending into the river has been stripped of its planking, probably through years of storm tides and particularly ice flows. Damages caused by rotting timbers were apparent on several of the planks and sills, and because the sluice was not continuously maintained the portion of the berm holding the sluice in place has been allowed to deteriorate, exposing the entire length of the sluice at low tide. Finally, muskrats were a major cause of destruction of timber sluices, and one observed noted that "it is also desirable that the gate

should be lined with yellow metal, or with copper sheathing, to prevent the gnawing of muskrats, which are one of the greatest pests about these reclaimed marshes"(Clift 1862:345).

These problems were known to contemporary proponents of marsh reclamation. In 1870 a New Jersey civil engineer, Jerome Collins, reported extensively to the United States Commissioner of Agriculture about the efforts in several states to reclaim marshes. An advocate for the use of steam-powered pumps rather than sluices for drainage, Collins described the shortcomings of wooden sluice gates as follows: "the connection made between the embankment and the wood-work or masonry of the sluice is, in nine cases out of ten, the site of numerous leaks, which are continuously enlarging and are the more dangerous on account of their apparently trifling character....If made of wood, it [the sluice-gate] is liable to rot away under water, and be unexpectedly destroyed by a violent storm or other cause" (Collins 1871:607).

Flooding caused by storm tides was a major and very real fear and could result in the destruction of the dikes, financial ruin for individuals and bankruptcy for marsh companies (Higgins 1969). For example, high storm tides damaged the Cedar Creek marsh dikes in 1836, but these were repaired and the marsh company reorganized by 1859. However, the "Great" storm of October 1878 was a complete disaster, when "every embankment from Cape May to Trenton, was broken, and many of them swept from their very foundations" (Clark 1879). The embankments protecting the Chesapeake and Delaware Canal were all destroyed, and the losses on both sides of the Delaware River were astounding; according to one chronicler, "many men on both sides [of the river] were completely ruined financially (Clark 1879).

3.0 HISTORICAL DEVELOPMENT OF THE NEW CASTLE DIKES

This study covers the historical background of five dikes located along the Delaware River in New Castle County. Of the five, three dikes, the Buttonwood Dike, the Broad Marsh Dike, and the Gambacorta Dike, are located in the City of New Castle. The other two, the Army Creek Dike and the Red Lion Dike, are south of the city. At times more than one dike is depicted on a historical map or aerial photograph. Therefore, for the sake of the reader, all maps and aerial photographs are arranged chronologically, and can be found in Appendix A. They are captioned with "Map" followed by a number indicating their placed in the sequence. A reference in the text to a map or aerial photograph indicates the relevant map number.

3.1 THE ARMY CREEK DIKE

Army Creek was referred to historically as Mill Creek. The Mill Creek Company formed in 1775. A copy of the original act forming the company may be in county deed records, but was not located. The original enrolled bill no longer exists, having been taken by the British during the Revolutionary War. However, the legislature upheld its validity when the company petitioned to supplement the act in 1781. When passed, the 1781 act nullified the previous agreement (Enrolled Bills 1781).

Typical of bills submitted for the formation of a marsh company, the owner's of the marsh, stipulated as being those who held at least five acres of meadow, marsh, or cripple behind the dike, were to be taxed proportional to their holdings. Uncharacteristically, the act also divided proportionally sections of the dike among the owners, for which they were responsible for repair and maintenance. Excluded from the division of the dike were two sections allotted to the manager of the company, that which would contain a new sluice and that containing the old sluice, which was called Yeates's Trunk (Appendix Map 2; Enrolled Bills 1781). In essence, individual owners were responsible for an assigned section of the bank, while collectively, everyone belonging to the company contributed to the costs associated with the sluices.

The proposed new sluice, whose location matches that of the present-day sluice, was to be built 13.25 perches (218.6 feet) northeast of the old sluice. The old sluice fell within a 37-foot long space along the dike. The new sluice, stipulated as needing to be "large and sufficient," was to be constructed within a 123-foot space along the dike. When installing the new sluice, the manager was instructed to take the soils removed to fill the location of the old sluice. The manager was also made responsible for building a wharf or abutment at the southwest end of the dike beyond to keep the river from eroding the bank, and for providing a means of keeping the uplands at the north end from eroding (Enrolled Bills 1781).

Depictions of the dike, which are available starting in 1901, indicate that the path and location of the sluice, which matches the location described for the "new sluice" in 1781, has remained unchanged (Maps 9, 10, 12, 15, and 19).[1]

3.2 THE BROAD MARSH DIKE

The dike presently referred to as the "Broad Marsh Dike" historically was called the "Narrow Dyke," the "Town Dyke," or the "foot dyke." (Appendix Map 1). The earliest known reference to the dike is dated

[1] The dikes that are the subject of this study were not depicted on some maps from the second half of the nineteenth century that were consulted, which were Rea and Price 1848, Beers 1868 and Baist 1893. In these instances only the waterway was shown at the location of a dike, except at the Gambacorta Dike, which was depicted as a road, and later a railroad bed.

January 1675. The course of present-day Wilmington Road crosses what was historically referred to as the "broad," "horse," or "cart" dike (Weslager 1961:205-206, n.88; New Castle County Land Surveys, p.126). Both dikes were referenced in a June 4, 1675 order by English authorities that called for the construction of a new dike on the north end of New Castle (the historical broad dike) to enable a highway to be built. The order also called for repairs to "…the outer dyke [the historical foot dike], which runs along Mr. Hans Block's marshland" (Gehring 1977:85-86). The outer dike, or foot dike, linked the located north of New Castle, such Swanwick, Crane Hook, and Verdrege's Hook, with the town.

The order sparked protests among the town's inhabitants since it was perceived that public aid would benefit private interest. The dissent was especially strong regarding the charge to work on Block's dike. In a petition submitted to the authorities of New Castle, it was stated that the sentiment expressed in the protest was that there was a willingness to work on the highway and associated dike, it being in the public interest. Also likely of relevance, but not stated directly in the petition, the associated marshes were to be considered a public resource. However, there was an unwillingness to serve the private interest of Block. Nonetheless, the petition closed in stating a willingness work on both dikes, since each contributed to the common good. That the work on Block's dike was in the public interest was reiterated by the town magistrates, who argued that the dike enabled a substantial reduction in the distance to be travelled to nearby Swanwick, thereby serving as a public convenience, and ensuring a speedier response to outside threats to both communities (Gehring 1977:88-89).

The outer dike's dimensions were specified by the magistrates. The dike was to be 10 feet wide at its base, five feet high, and three feet wide at the top. It was also to be furnished with "well-made and strong sluices" (Gehring 1977:86).

The Broad Dike cart road was deemed vital to develop a road system that linked villages along the Delaware. The Broad Dike crossed a marshy area variously known as Carr's Meadow, the Town Valley, and Broad Creek (Gehring 1977:76; NCCD G1:89). Carr's Meadow belonged to the heirs of Sir Robert Carr, the commander of the English military force that seized Fort Casimir and pillage the town of New Amstel in 1664. In 1675 Carr's Meadow at the north end of New Castle was described as a great nuisance, "there being no bridge or fitting way to pass, and the Town being in great ruin thereof" (Gehring 1977:76). It was the need for a way to cross Carr's Meadow that led to the near mutiny regarding Hans Block's dike.

By 1722 Carr's Meadow/Town Valley tract, described as being at "the north end of the town of New Castle," was owned by the heirs of three New Castle merchants: Robert French, John Donaldson, and the Richard Halliwell (Cario 2001:42). A dozen owners were identified who were responsible for pieces of marsh (Table 1). The value ranged from 20 shillings/acre to £7/acre, depending on the level of improvement, with a total of £342 available to support the dikes (NCCD G1:435). In 2010 dollars, that equates to more than $63,000 necessary to maintain the dikes. Each of the owners were required to maintain the sluices and dikes "in good repair," thus underscoring the collective community nature of marsh ownership.

Both the cart dike and the foot dike appeared on Latrobe's 1805 Plan of the Town of Newcastle (Map 3). The overall plan and extent of the Broad Marsh Dike, labeled on the plan as "Little Dike," resembled that of 1682. However, Latrobe illustrated more of southwestern end of the dike, and included the Delaware River shoreline. As compared to the present condition, the extent of the dike at the southwest end has been obscured by infilling along the bank of the river, as well as within the marsh to the northwest. While not illustrated, it is reasonable to assume the sluice was located where the creek intersects with the dike. It is not clear if the current sluice is in the same location, since distortion makes it impossible to place the plan precisely on current maps and aerials. Nonetheless, it appears that its location in 1805 is the same vicinity as the sluice today.

Table 1. Summary of marsh ownership, Carr's Meadow, 1722 (*aka* Broad Dike Marsh)

Name	Acreage	Value/Acre	Total
Robert French's Estate			
Improved marsh on the southwest side of the creek	5 acres	£7	£35
North side of the creek	12 acres	£3	£36
Not improved	[Not given]		£29
Major Donaldson's Estate			
Joseph Hill	4 acres	£4	£16
Daniel Mercer	2 acres	£10 [?]	£20 [?]
John Vangezell	4 acres	£4	£16
John Sylsbye	4 acres	£4	£16
Isaac Gravenraet	6 acres	£3	£18
Nathaniel Caruthers, not improved	6 acres	20 shillings	£6
Thomas Elliot	6 acres	£4	£24
The Unimproved [acreage]	[Not given]		£25
M. Halliwell's Estate			
In the hands of Mr. Ross	12 acres	£4	£48
In the hands of Mr. Ross	4 acres	£3	£12
Nicholas Meers	4 acres	£3	£12
Jonathan Savage	4 acres	£3	£12
The unimproved [acreage]	[Not given]		£30
Witness our hands this 31 July 1722. John French, Samuel Lowman, James Sykes & Jacobus Williams			

The location and extent of the dike, as well as the location of the sluice appears to have remained unchanged through to the 1990s, at which time a new sluice was constructed immediately north of the existing sluice (Maps 9, 10, 13, 16, 18 and 20). Otherwise, the only change apparent from maps and aerial photographs is the progressive infilling of portions of the marshes, and periodic erosion and redeposition of sediments along the shoreline. While appearing to remain unchanged, and despite the paucity of documentation of repairs, it is certain that over time modifications occurred more frequently than documented, especially periodic replacement of a sluiceway that rotted, and reinforcement of the banks where eroded.

The only documentation found regarding modifications appeared in a 1954 report from the State Highway Department, and a newspaper article that commented on the work. Regarding the dikes and sluices, which are referred to as "tidal gates," the Public Works division of the Highway Department reported:

> For several years the Town of New Castle has been subject to periodic flooding of roadways, marshes and low-lying areas adjacent to and within the town. These conditions were the result of tidal waters of the Delaware River forcing their way inland through breaches and low sections in the existing dike system and through gates which were unable to perform their proper function because of structural inadequacy or breaches in adjacent dikes (DSHD1954:76).

The annual reported noted that reconstruction of a dike north of town, and one south of town were in progress (DSHD 1954:76). A news story on the work noted that the repairs were to be made to the "sluice gates at the Dyke on the north of Bull Hill and for other work to the River levee below the battery" (McIntire 1986:84). The author implied that on the north side of town, repairs were being made to the Broad, or Horse Dike, but the reference is vague. Work "below the battery" likely is a reference to the Gambacorta Dike (see discussion in the next section of this report).

3.3 THE BUTTONWOOD DIKE

The Buttonwood Dike may be the descendant of what was called Swanwick, or Swanwyck, marsh. The latter had a marsh company formed in 1786 (Enrolled Bills 1786). Swanwick was an early colonial community situated north of New Castle, in New Castle Hundred. A house called Swanwyck was situated at 65 Landers Lane, and references the earlier community. It is possible, though not documented at this time, that what is now called Buttonwood Dike was an early foot dike that, together with Hans Blocks foot dike, linked the Swanwick community to New Amstel (Castle).

The use of the name Buttonwood first appears in an 1893 Act establishing the Swanwicke Ditch Company stated that agreement had been between James Booth, who owned the farms, "Hawthorn," "Buttonwood," and "Boothhurst," and Thomas Speakman, who owned, "Bloomfield." No obvious dike or berm is depicted on early maps of the nineteenth century. However, map evidence suggests that the dike had been built around the mid-nineteenth century, as indicated by farm ownership. By the later part of the nineteenth century, ownership of the farms had changed, and it was anticipated that the lands would be divided further (Enrolled Bills 1893).

The 1906 USGS *Wilmington* Quadrangle and aerial photographs showing the location of the dike, indicate that the location of the sluice was consistent through the twentieth century. In the 1930s the dike was breached southwest of the sluice, and repaired by the 1950s. By 1961 a roadway was constructed over the top of the dike. Later in the 1960s, vegetation was cleared, possibly as part of reconstruction efforts that might have included widening. By the 1990s, much of the vegetation had returned (Maps 10, 13, 16, 18, and 20).

3.4 THE GAMBACORTA DIKE

Mention of embanking a marsh in the vicinity of the Gambacorta Dike was made in the papers of historian Jeanette Eckman. In reference to properties near Delaware Avenue, she mentioned that in 1706 property confiscated from Peter Alrichs, who had failed to drain the marsh, was granted to George Deakyne, "who drained the marsh, and built a dike along the river…." (Eckman 1947). Property records from the period New Castle was governed by the Duke of York do not mention a dike, and suggest that the area of marsh embanked and drained by Deakyne was located within what is now Battery Park (Heite 1978:77-81, 86-89). Latrobe's map of New Castle County identifies Deakyne's Marsh as the area immediately south of New Castle.

The path of the Gambacorta Dike was illustrated in maps produced by the middle of the nineteenth century. In the Rea and Price map of 1848 and the Beers atlas of 1868 the path of the dike is depicted as being part of present-day Route 9 (Maps 5 and 7). In 1893, the path of the dike was depicted as a spur of the New Castle and Frenchtown Railroad leading to the Delaware Iron Company (later called the Tasker Iron Works), located at the southwest end of the marsh (Map 8). Route 9 was depicted in its present location at the west end of the marsh. The conversion of the path of Route 9 to the rail spur occurred in the decade before 1878, presumably as the iron works was developed. As reported in a newspaper article following the Hurricane of 1878:

> The banks [in New Castle] were broken all along the river front. A bank refers both to the shore of a stream and to artificial dikes that were placed along the shores of a stream to keep out abnormally high tides. Tasker's Bank suffered the worst, with the employees at the Iron Works being driven from their avocations. The railroad along the shore was completely destroyed even though the bank was stone-faced and over 60 feet wide at the top. (*Daily Republican* 1878:1)

While it is evident that a dike was in place by the nineteenth century along the path of the present-day Gambacorta Dike, none of the maps definitively indicate the location of a sluice or sluices. In fact, the marsh itself is not depicted as such (Maps 5 through 10). Similarly, aerial photographs from the twentieth century are not of sufficient resolution to clearly depict the location of a sluice (Maps 12, 15, and 19). However, the paths of ditches within the marsh, when compared to that on present-day aerials, suggest that since 1937 a sluice existed at its current location.

3.5 THE RED LION DIKE

In 1802 the Delaware Legislature passed an Act forming the Red Lion Marsh Company (Enrolled Bills 1802). In the Act it was noted that the company had formed November 2, 1762; however, the original had been lost and a surviving copy was damaged to the extent that it was not intelligible. The marsh encompassed both sides of the Red Lion Creek where it met the Delaware River, and was delineated on the river side by a dike extending from "Eaton's Island on the north, to Hanes's Island on the south".

Disagreement among the officers of the company resulted in an 1813 supplement to the 1802 Act (Enrolled Bills 1813). At issue was whether the existing bank should be repaired, or if a new bank should be constructed further inland. The act provided for the appointment of commissioners to review the merits of repairing the existing dike in whole, repairing the existing dike in part and erecting new segments, or building an entirely new dike. A map was prepared in 1813 showing the existing dike, and the locations of proposed new banks (Map 4). The depiction of the old bank of the dike does not include a segment crossing the Red Lion Creek, suggesting that it had been eroded, or otherwise damaged, or that it had never been constructed.

The return of the commission stipulated that three segments of the old bank nearest the Delaware River be rebuilt, and that four proposed segments of the new bank, also nearest the river, be constructed (New Castle County Road Petitions and Returns 1814). The majority of the dike was to measure 16 feet wide at the base, and 4 feet wide at the top. The segments of the dike that projected into the marsh were to measure 18 feet wide at the base, with the width at the top to be the same as the rest of the dike, except where it crossed the Red Lion Creek, which was to be 10 feet wide. The top of the entire dike was to be 3 feet above the high water line. Other work to be performed was repair of the existing sluice, and placement of a new, 9-foot wide sluice at a place in the dike decided by company managers.

Depictions of the Red Lion Dike, or the lack thereof on later maps provide inconclusive evidence as to whether or not the dike was constructed as stipulated in 1813. A Coastal Survey map from 1861 does not illustrate a dike across the Red Lion Creek; however, it depicts only the shoreline, and a notation on the map stated that only changes thereto were highlighted. What is depicted at the location of the creek is a bench mark for the survey, which was located slightly inland at roughly the location for the proposed part of the dike that extended back in to the marsh (Map 6). However, the proposed section does not exist along the dike as it was depicted in 1901 and 1906, nor is it evident on twentieth century aerial photographs (Maps 9, 10, 11, 14, 17 and 21). Instead, the section of the dike that crosses the creek runs in a straight line between the two existing sections depicted in 1813. Also illustrated in 1906 is a short

section of dike connecting the mainland with the west end of the island. No other documentation has been found describing this section of dike.

While the location of the new sluice called for in the 1813 agreement was not described or illustrated, it is possible that it was placed to the south of the old sluice, where an additional sluice is depicted in 1906 (Map 10). As illustrated in 1906, the location of the old sluice, and of a new sluice are both places where the marsh drains. This indicates that both sluices were operational. By 1926, the ditch leading to the old sluice had silted in, indicating that at best it was marginally functional (Map 11).

Following a major hurricane in the 1930s, the dike was breached, causing the marsh to be inundated (Map 14). The dike was neglected during the decades of the 1930s and 40s and continued to be in disrepair into the early years of the 1950s. Like several of the other dikes in New Castle County along the Delaware River, the Red Lion Dike also came under state jurisdiction at this time and the Highway Department took over the repair and maintenance of the dike (DSHD 1954:75). In the discussion of the Red Lion Dike in 1954, the report noted that "for several years, the shore road between New Castle and Delaware City had been flooded periodically at the Red Lion Creek Causeway," a problem brought about by "the inoperative condition of the timber box sluice at the mouth of Red Lion Creek, which permitted almost unrestricted entrance of tidal water from the Delaware River." The flooding of the Red Lion Causeway "had reached the point where the road had to be closed to all traffic," and "a large area of low-lying land behind the barrier was kept continuously flooded, thereby reducing, if not completely destroying, its value for agricultural purposes" (DSHD 1954:76).

To correct the Red Lon Dike problems, the State Legislature directed the State Highway Department to repair or reconstruct the dike and sluice area. The improvements included construction of a new sluice, with tide gates, the demolition of the old sluice, the placing of two new tide gates on two existing 30-inch corrugated metal culverts, and the repair, reconstruction, and rip rap protection of approximately 2,300 lineal feet of the Red Lion Dike (DSHD 1954:76).

A 1961 aerial photograph showed the marsh reemerging, with the channel of the creek having realigned to its older course, which ran to the location of the old sluice (Map 17). However, it appears that the marsh drains only from the new sluice. Also evident on the aerial is infilling at the south end of the dike, which covered a portion of the southern bank, and the section between the island and mainland, effectively erasing evidence of the island and the section of dike to the west.

After 1968, a new sluice was installed at the location of the old sluice depicted in 1813 (Map 21). The location of the sluice installed after 1813 is evident today by the remnant of a concrete channel. The use of concrete suggests that the original sluice, assuming that it had been installed ca. 1814, had been replaced at some point in time. A short distance to the north of this location the dike retains a section lined with stone. It is not clear from aerial photographs if a larger portion of the dike had been stone-lined, but is not longer extant.

4.0 NATIONAL REGISTER ELIGIBILITY

The historical background presented above for each of the five New Castle Dikes suggests that the time period of significance varies for each. Documentation indicates that the oldest of the dikes is Broad Marsh (Outer) Dike (c1675), followed by Red Lion (c1762), Army Creek (c1775), Buttonwood (c1786), and Gambacorta (c1845). It should be noted that Buttonwood may be a later incarnation of the Swanwick Dike, and could actually be dated earlier (potentially late seventeenth century, similar to the Outer Dike). The end of the historical period of significance for each of these dikes also varies, but in general the end of their use as agricultural structures should be used to determine their periods of significance. For several of these dikes (Gambacorta and Buttonwood), the severe storms in the 1930s are used here to provide an end date for significance, while for Red Lion, Army Creek, and Broad Marsh, the date that the State Highway Department assumed control of the dikes (c1954) is used to provide the end date of significance. For Delaware River dikes in general, the areas of significance that may be applicable are agriculture and landscape architecture. It should be clearly noted that, with the exception of Gambacorta Dike, none of the dikes considered here were created for anything but agriculture. The dikes supported the land reclamation and agricultural use of the individual property owners, enabling them to harvest salt hay and other crops, and to graze livestock. The exception, Gambacorta, was created as a transportation causeway and possibly secondarily as a protective berm.

Within the Delaware Comprehensive Plan (Ames et al. 1987) the time periods of that the marsh dikes and their associated elements span all of those detailed by the plan: 1630-1730 (exploration and frontier settlement), 1730-1770 (intensified and durable occupation), 1770-1830 (early industrialization), 1830-1880 (industrialization and early urbanization, and 1880-1940 (urbanization and suburbanization). Historical Themes that would apply include Agriculture, Landscape change, and community organization (Ames et al. 1987:82). The geographic zone for the five dikes is the Upper Peninsula. Within the historical archeological context developed for agricultural in New Castle County the dikes would be considered agricultural structures (DeCunzo and Garcia 1992:239).

As the primary consideration for eligibility, National Register criteria require that a historic property possess integrity. As defined by the National Park Service, seven aspects of integrity must be considered: location, design, setting, materials, workmanship, feeling, and association (Townsend et al. 1993:16-21). With respect to the New Castle Dikes, each of the dikes is considered separately (Table 2).

Buttonwood Dike, created circa 1786, retains its location and its original setting along the Delaware River, although its agricultural setting (inland from the dike) is no longer present. The design elements of the dike are still evident (berm, sluice), although the berm's southern terminus has been altered. The materials used in the construction of the dike, particularly the stone facing present along all of the tidal dikes of the Delaware River, is still evident. The aspect of workmanship is apparent in the remnants of the sluices and the berm itself, but these are degraded. The aspect of feeling is compromised, since the landscape inland from the dike has become industrial, rather than agricultural, which was the reason the dike was created. The association of the dike is also compromised due to this change in land use.

Broad Dike, also known as the Foot Dike, the Narrow Dike, Hans Block's Dike, the Town Marsh Dike, and/or the Outer Dike, was present by circa 1675, making it the oldest dike structure of the New Castle group. The dike retains its original location and setting, and has been remarkably stable in both of these aspects. Elements of design, materials, and workmanship are readily apparent, although the sluice gate has been replace on several occasions. The berm still retains its nineteenth-century outer stone mantle or armoring, a common characteristic for tidal dikes. The dike retains its original function as a foot dike, still carrying pedestrians from New Castle north up the river, and its original function of water control. The

Table 2. Summary of National Register Aspects of Integrity

Name	Date	Period of Significance	Location	Setting	Design	Material	Feeling	Workmanship	Association
Buttonwood Dike	c1786	1786-c1930	At original location	Retains original setting	Retains design elements	Evident, but degraded	Evident, but degraded; no longer agricultural	Evident, but degraded	No longer associated with agricultural practices
Broad Marsh Dike (*aka* Narrow dike, Foot dike, Town Marsh Dike, Outer Dike)	c1675	1675-c1954	At original location	Retains original setting	Retains design elements, such as stone facing, although sluices have been replaced	Evident, but degraded	Evident; dike still retains transportation original use, as well as water control	Evident, but degraded	No longer associated with agricultural practices, but still retains association with New Castle and the Broad Marsh
Gambacorta Dike	c1845	1845-c1930	At original location	Retains original setting along Delaware River, but industrial setting no longer extant	Compromised due to damage, infilling, and shoreline erosion	Evident, but degraded	Not evident; dike does not retain its original railroad transportation use	Not evident	No longer associated with industrial development along New Castle shore
Army Creek Dike (*aka* Mill Creek)	1775	1775-c1954	At original location	Retains original setting	Not longer retains design, due to breaches and damage	Evident, but degraded	Not evident	Not evident	Not evident
Red Lion Dike	1762	1762-c1954	At original location,	Retains original setting	Evident but degraded; new sluices, altered berms	Evident, but degraded	Evident, but degraded	Evident, but degraded due to repairs (multiple sluices, etc.)	No longer associated with agriculture

Aspects, or qualities, of integrity; after Townsend et al. (1993:17-21)

aspects of feeling and association are somewhat compromised due to the changing landscape surrounding the dike, since the lands behind the dike are no longer agricultural and the dike no longer functions as a land reclamation feature for members of the marsh company to harvest salt hay or forage their livestock.

Gambacorta Dike, situated south of the City of New Castle, apparently dates to circa 1845. Unlike the other dikes in this study, the Gambacorta Dike was created primarily as a transportation causeway, and secondarily as a water or flood control feature. The dike's location is unchanged, but its setting has altered considerably, since the railroad is no longer present, and the industrial facilities serviced by the rail line are no longer extant. The design of the dike is no longer evident, nor is the dike's workmanship or materials. Feeling and association are also compromised at this dike, due to the changing landscape functions.

Army Creek Dike, known earlier as Mill Creek Dike, was initially created in 1775. This dike is severely degraded in all of its aspects of integrity save location and setting. Due to numerous breaches and several episodes of reconstruction, the dike does not retain design, workmanship, or materials to any great degree. Feeling and association are also compromised, although of all the New Castle Dikes, the aspect of association with a large marsh area is readily apparent, evocative of the dike's initial agricultural purpose. Red Lion Dike, established in 1762, still retains the aspects of location and setting, although, like the other dikes, its agricultural setting has been compromised, and the surrounding landscape is now fallow, unused agricultural lands, or industrial. The dike retains aspects of design, materials, and workmanship, but each of these is somewhat degraded due to the accretional character of dikes (built up over time, sluices replaced, etc.). The historical record for the Red Lion Dike clearly demonstrates the changes that occurred on Delaware River dikes over the centuries, with new sluices, replaced sluices, added earth to the berms, new ditches, stone facings, and sheet piling added. The dike does not retain aspects of feeling or association.

In addition to integrity, a historic property must meet one or more of the specific criteria for evaluation (A through D) in order to be eligible to the National Register. The historic context for Delaware's marshland cultural resources (Fisher et al. 1993:132) suggests that identified cultural resources should be evaluated under Criteria A and C of the National Register of Historic Places (Townsend et al. 1993). The dikes may also be eligible under Criterion D

The Buttonwood Dike, Broad Marsh (Outer) Dike, Army Creek Dike, and Red Lion Dike significant under Criterion A for their relation to the broad patterns of marsh reclamation for agricultural use, and as structures related to transportation and conservation. However, the three elements do not necessarily apply to each dike. Table 3 lists each dike, and which element is applicable for each.

Table 3: Elements of Criterion A for which each dike is eligible.

Dike	Agriculture	Transportation	Conservation
Army Creek	x	x	x
Broad Marsh	x	x	x
Buttonwood	x		x
Gambacorta		x	x
Red Lion	x	x	x

Land reclamation for agricultural purposes resulted in the creation of arable land and meadows, thus altering the character of marshes along the coast of Delaware (Fisher et al. 1993:132). While the larger agricultural landscapes surrounding these dikes have been supplanted by suburban and/or industrial

development, they are sufficiently significant as landscape elements to warrant consideration under Criterion A, as each evokes its past purpose.

As elements of transportation networks, the dikes are significant for different reasons. The Broad Marsh Dike served to ease the travel of people, and, to a lesser extent, goods, between the colonial settlements of New Castle, and Swanwick. In contrast, the Gambacorta Dike was created to serve the transportation needs of the industrial operations of the Tasker Iron Works. While neither serves its original purpose, each has the ability to evoke its past use. For the Army Creek and the Gambacorta, and the Red Lion Dikes, while not directly serving transportation needs, they were, and continue to be a significant element in flood control efforts, helping to keep open Route 9 during period of high water.

Each is significant today as a structure contributing to marsh (ecological) and historical resource conservation efforts. The flow of water through the sluices is controlled in such a manner as to promote a healthy ecosystem within each of the marshes. Moreover, as elements of flood control, the Broad Marsh and the Gambacorta dikes help to limit the damage to the historical resources within the Town of New Castle during period of excessively high water.

They may also be significant as vernacular architectural elements under Criterion C. Each of the dikes retains its historical course and approximate massing, with the exception of the Gambacorata Dike, which is now less than half of its original width. Changes over time include reinforcement and reconstruction of the banks, and in some instances moving the location of the sluice gate, and likely replacement of elements of the infrastructure. However, each of these changes are consistent with operation of dike, and therefore do not detract from its eligibility under Criterion C. What is not known is if the massing retains integrity, or if the materials from which the dikes were constructed have been replaced altogether. Even at the Army Creek Dike, which retains evidence of accretional development of the bank, no evidence was gathered to ascertain the historicity of its development.

Also to be considered during assessment under Criterion C is the persistence of structural elements no longer functional or visible. Studies at other dikes have shown the potential for the persistence of earlier elements, whose presence would bolster the argument for integrity under Criterion C. For example, at both Christiana Marsh and at the confluence of Blackbird Creek, elements of a sluice way and the remains of sheet piling were documented (Kellogg and Catts 2007; personal communication with Craig Lukezic 2013). At Red Lion Dike, the remains of a sluiceway were visible at the surface, and evident from the results of a ground-penetrating radar survey (Mancl et al. 2013). As such elements would not be affected by the proposed restoration efforts, the dikes were not investigated for them. Therefore, eligibility under Criterion C for the Army Creek, Buttonwood, and Gambacorta dikes is cannot be determined. Red Lion Dike is an exception, it being investigated using ground-penetrating radar. The results of the investigation suggested the accretional development of the dike, which is supported by documentary evidence, and indicated the persistence of an earlier sluice. This evidence indicates integrity of historical structural elements, thereby making the Red Lion dike eligible under Criterion C.

The persistence of structural elements at dikes along the Delaware River also may indicate that the dikes are significant under Criterion D. Supporting eligibility is the recordation of bank construction at the Army Creek Dike, wherein episodes of filling to create and/or heighten the bank were evident, as does the results of the GPR survey at the Red Lion Dike were a buried section of an earlier sluiceway was evident. A GPR survey at the Broad Marsh Dike resulted in a signature that varied greatly from the adjacent upland at the southern end of the dike. These three instances and the studies at the Christiana Marsh and at Blackbird Creek illustrate the potential for dikes along the Delaware to retain information significant to their development and maintenance. In sum, there is a high potential for the persistence of structural remains, and for the ability to read the stratigraphy created by natural and cultural accretional and erosive

episodes. However, as such elements would not be affected by the proposed restoration efforts, the dikes were not investigated for them, and therefore, eligibility under Criterion D for the Army Creek, Buttonwood, and Gambacorta dikes is cannot be determined. Red Lion Dike is an exception, it being investigated using ground-penetrating radar. The results of the investigation suggested the accretional development of the dike, which is supported by documentary evidence, and indicated the persistence of an earlier sluice. This evidence indicates integrity of buried historical structural elements, whose study archeologically could provide answers significant to an understanding of methods of construction and modification, and how these changed materially over time. Therefore, the Red Lion Dike is eligible under Criterion D.

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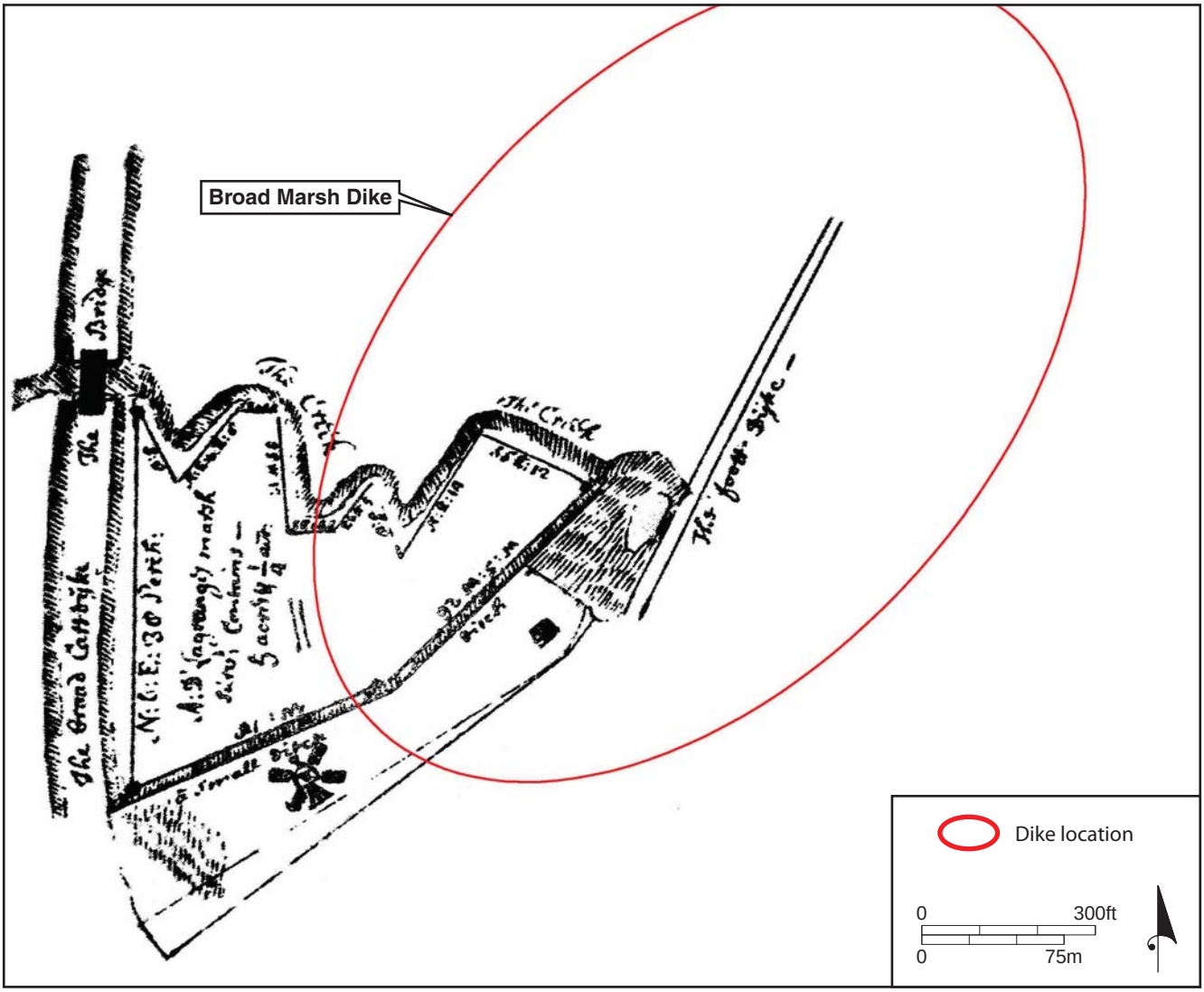
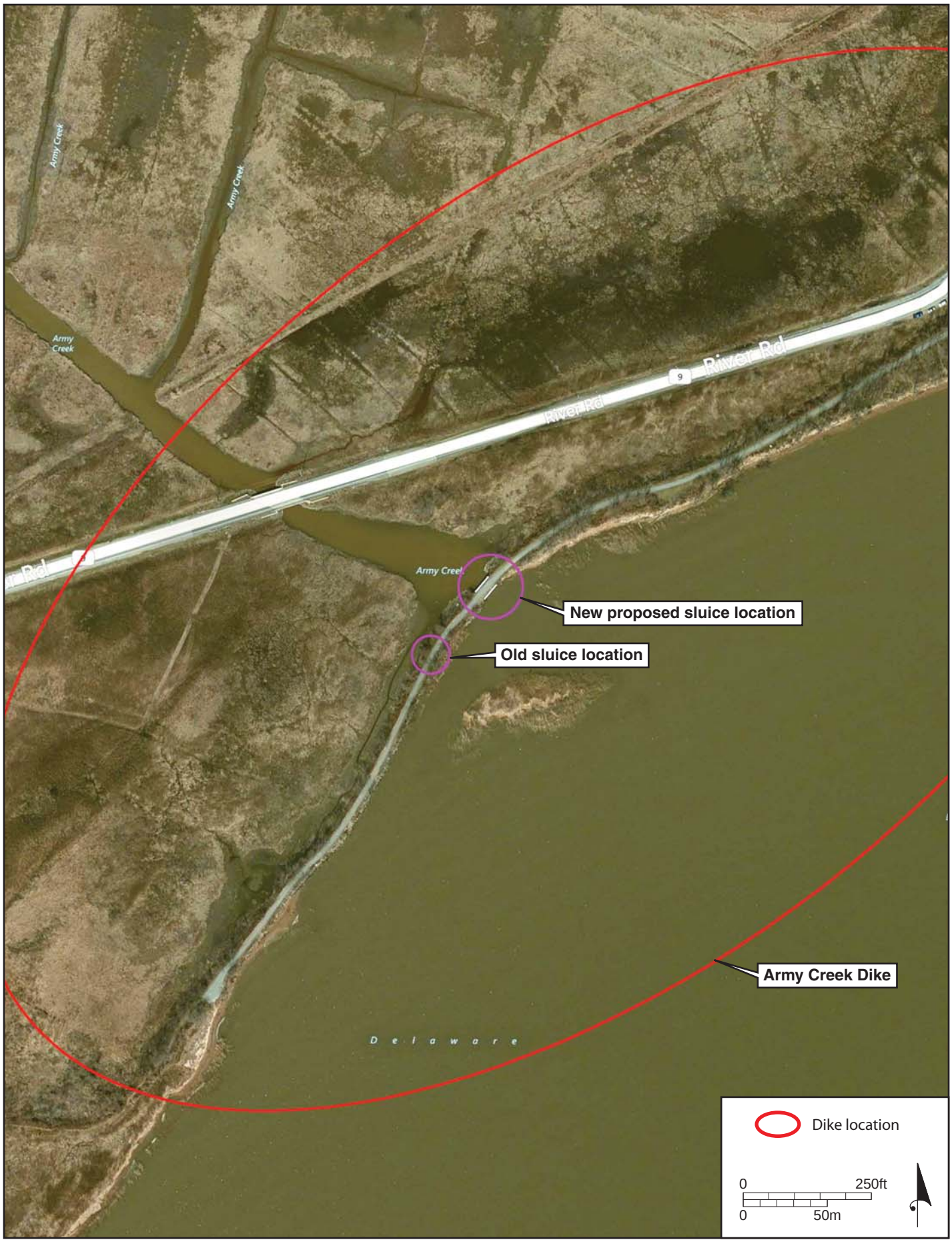
APPENDIX I:

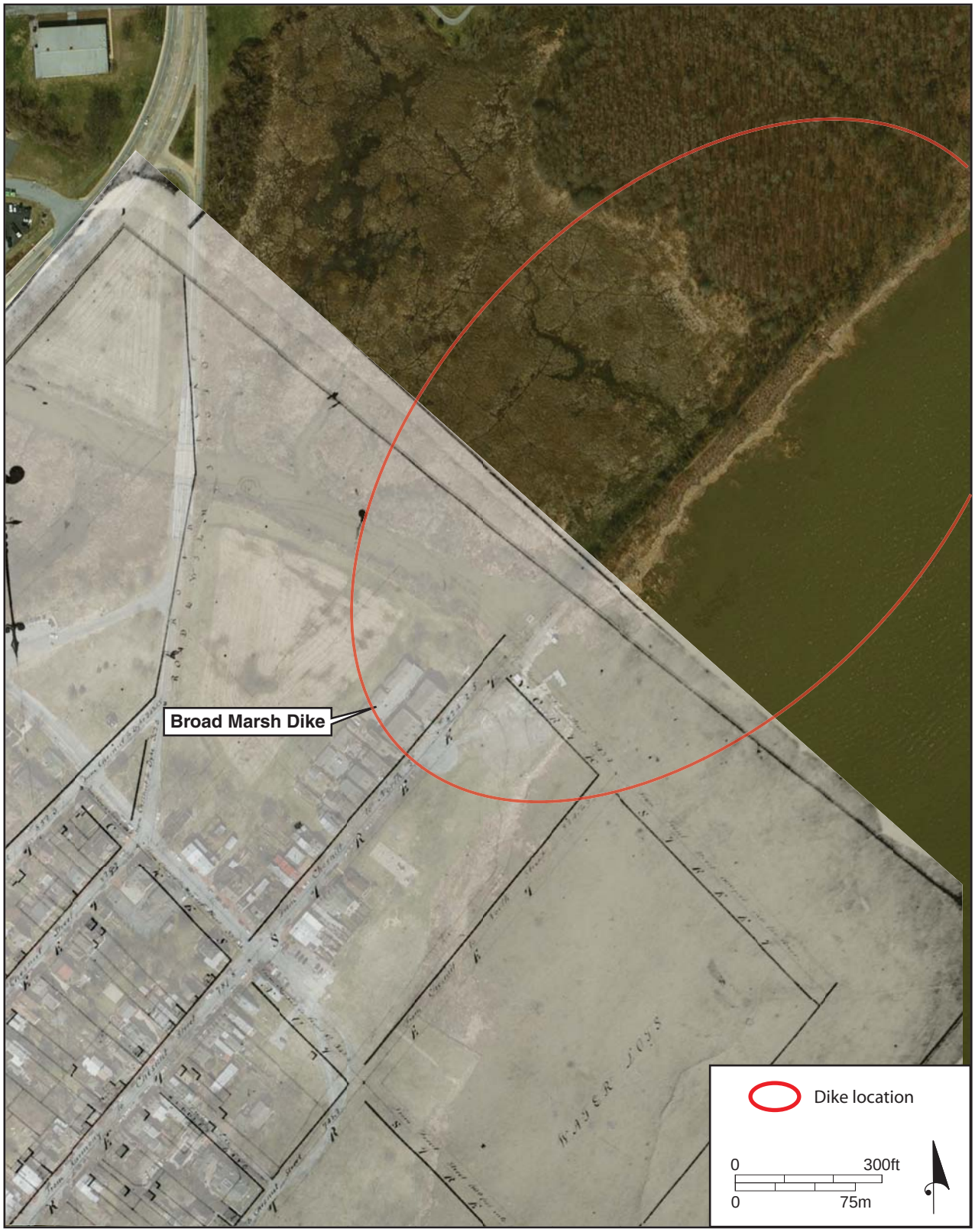
MAPS IN CHRONOLOGICAL ORDER



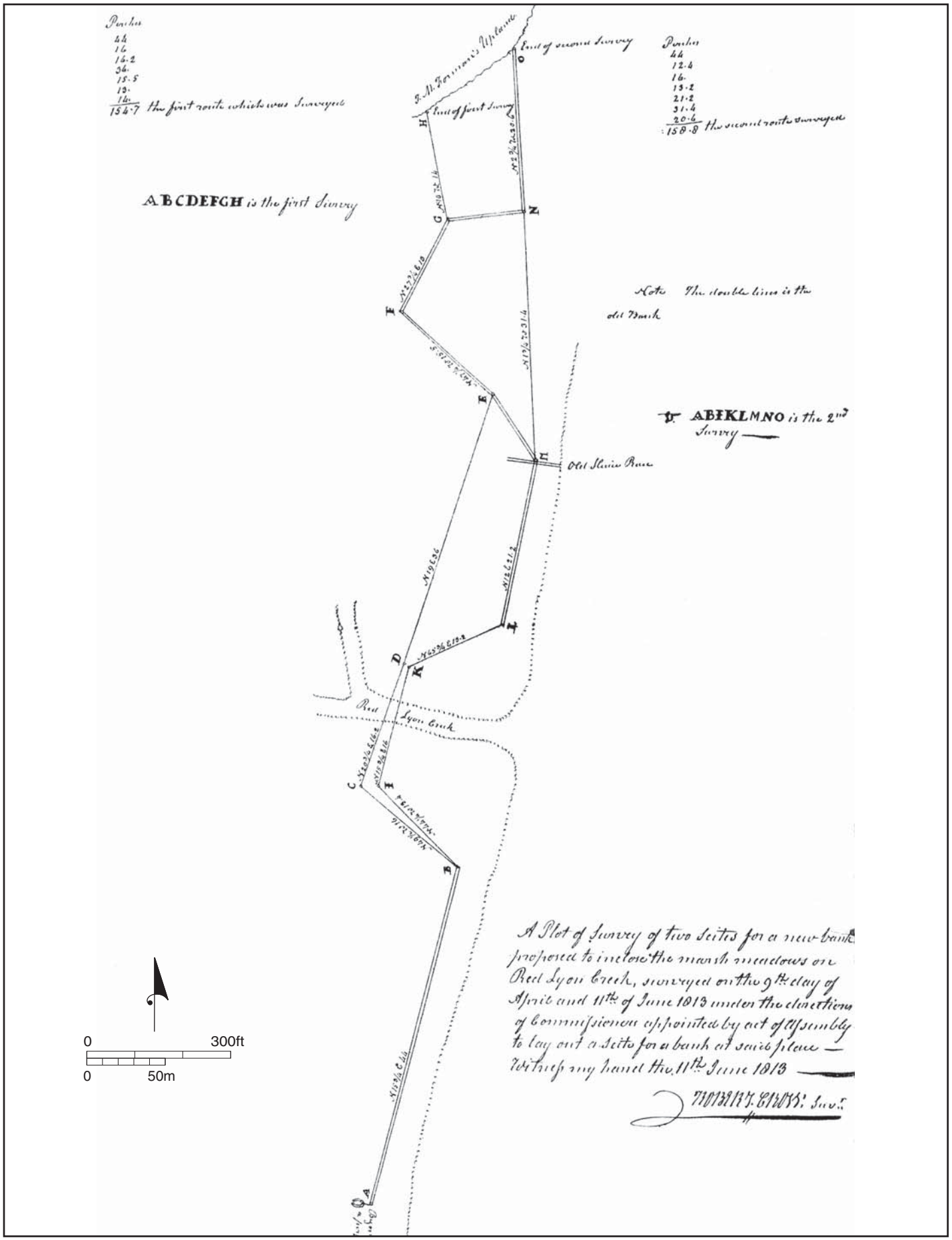
Map 1. Map showing the Broad Marsh Dike in 1682. At the time it was referred to as the "foot dyke," while the dike along Wilmington Road was referred to as the "Broad Cart Dyke" (Weslager 1961:Figure 2).



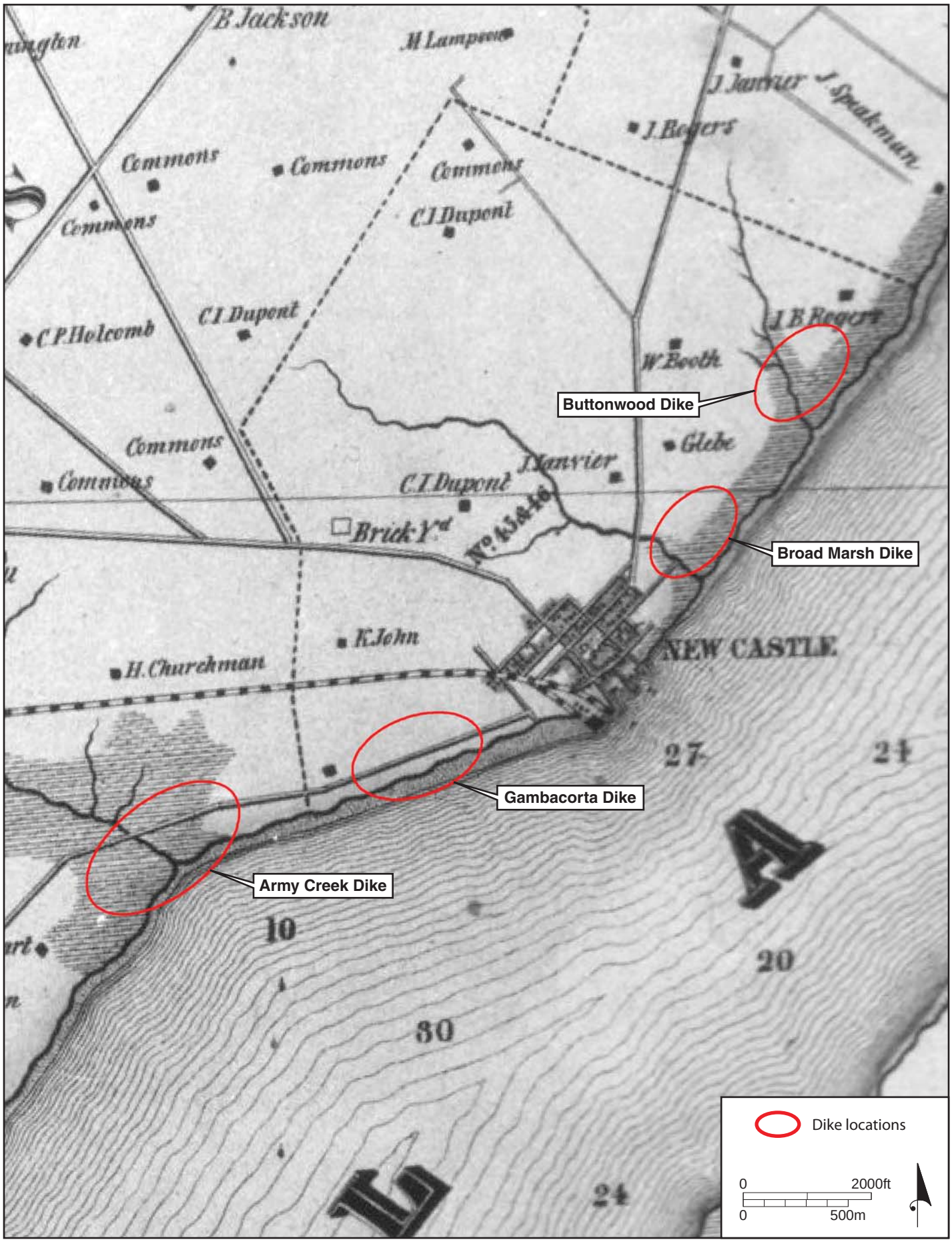
Map 2. Current aerial photograph showing the location of the new sluice proposed for the Army Creek Dike in 1781, and the location of the old sluice, which was to be filled.



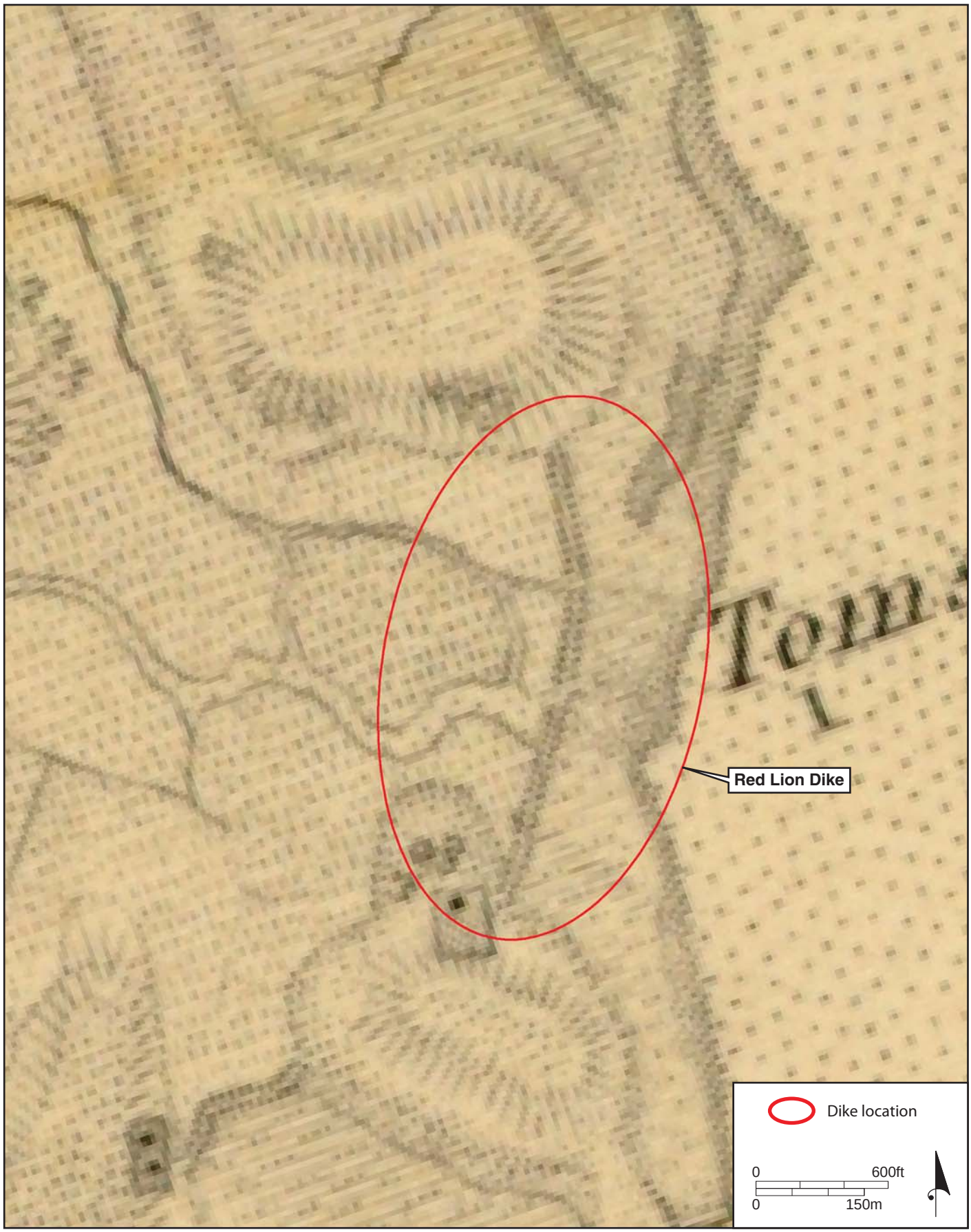
Map 3. Detail of *Plan of the City of New Castle*, showing the location of the Broad Marsh Dike (Latrobe 1804).



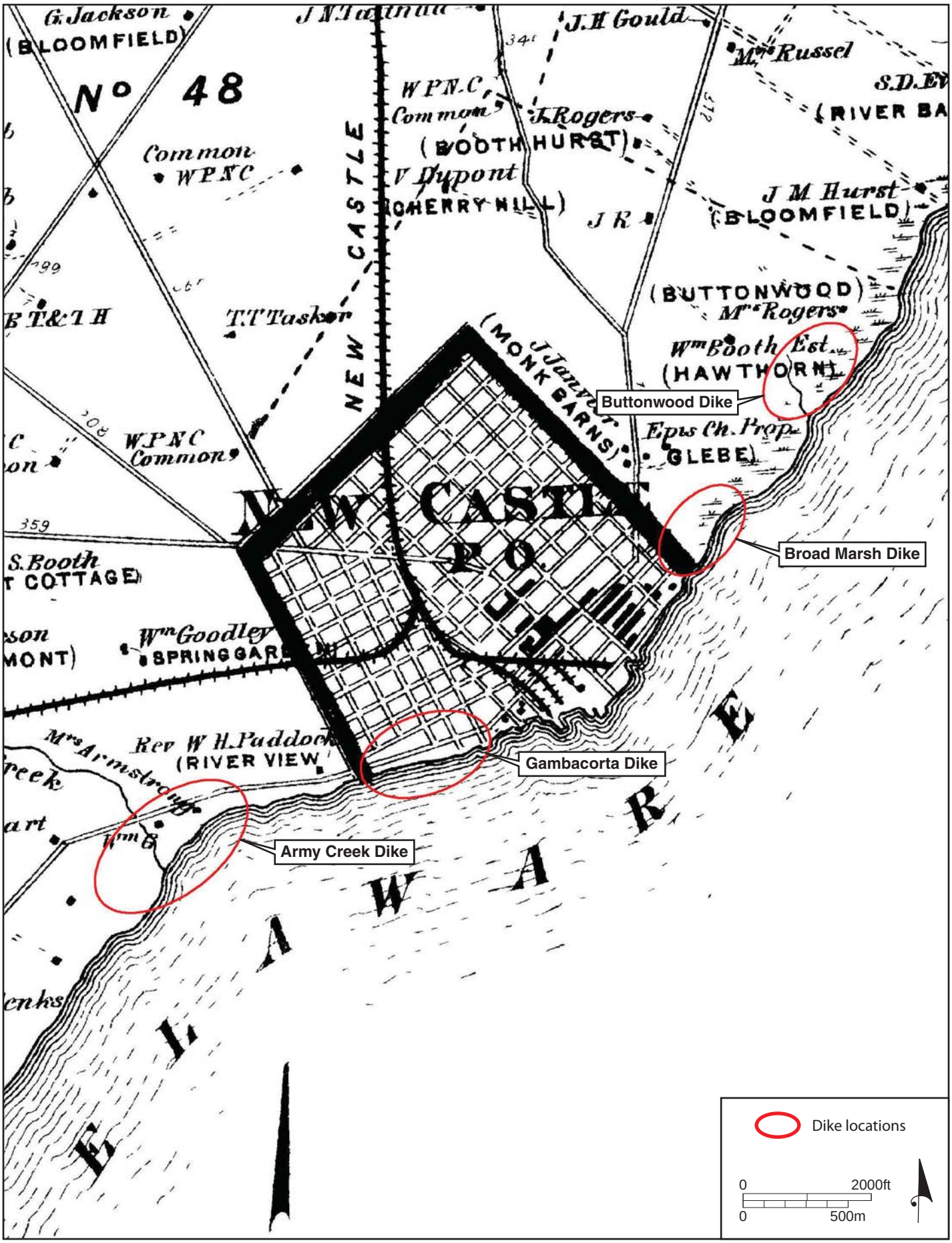
Map 4. Detail of *Survey of the Red Lion Dike*, showing existing sections with a double line, and proposed new sections as a single line (1813).



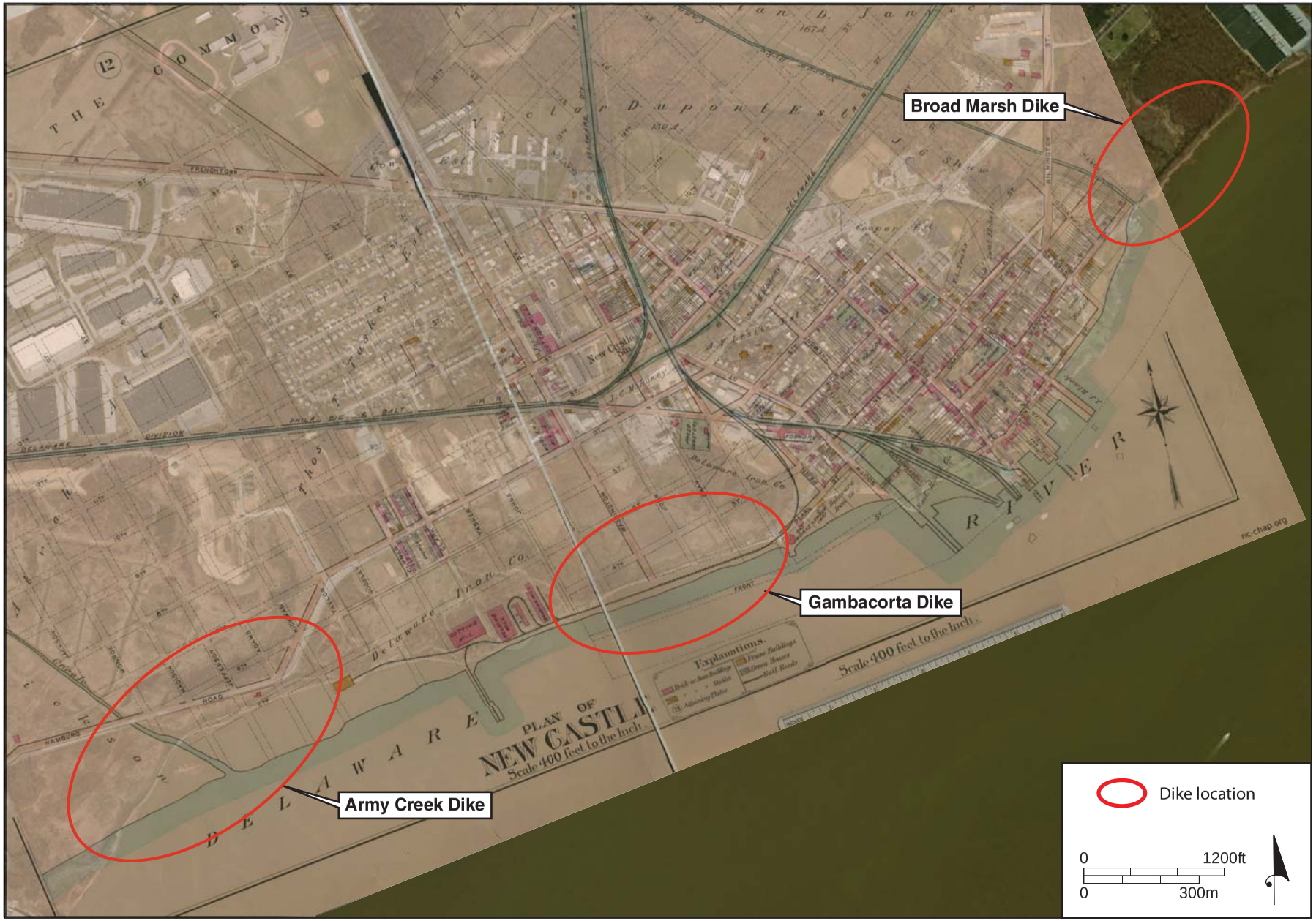
Map 5. Detail of *Rea and Price Map of New Castle County*, showing the locations of the Army Creek Dike, the Gambacorta Dike, the Broad Marsh Dike, and the Buttonwood Dike (Rea and Price 1844).



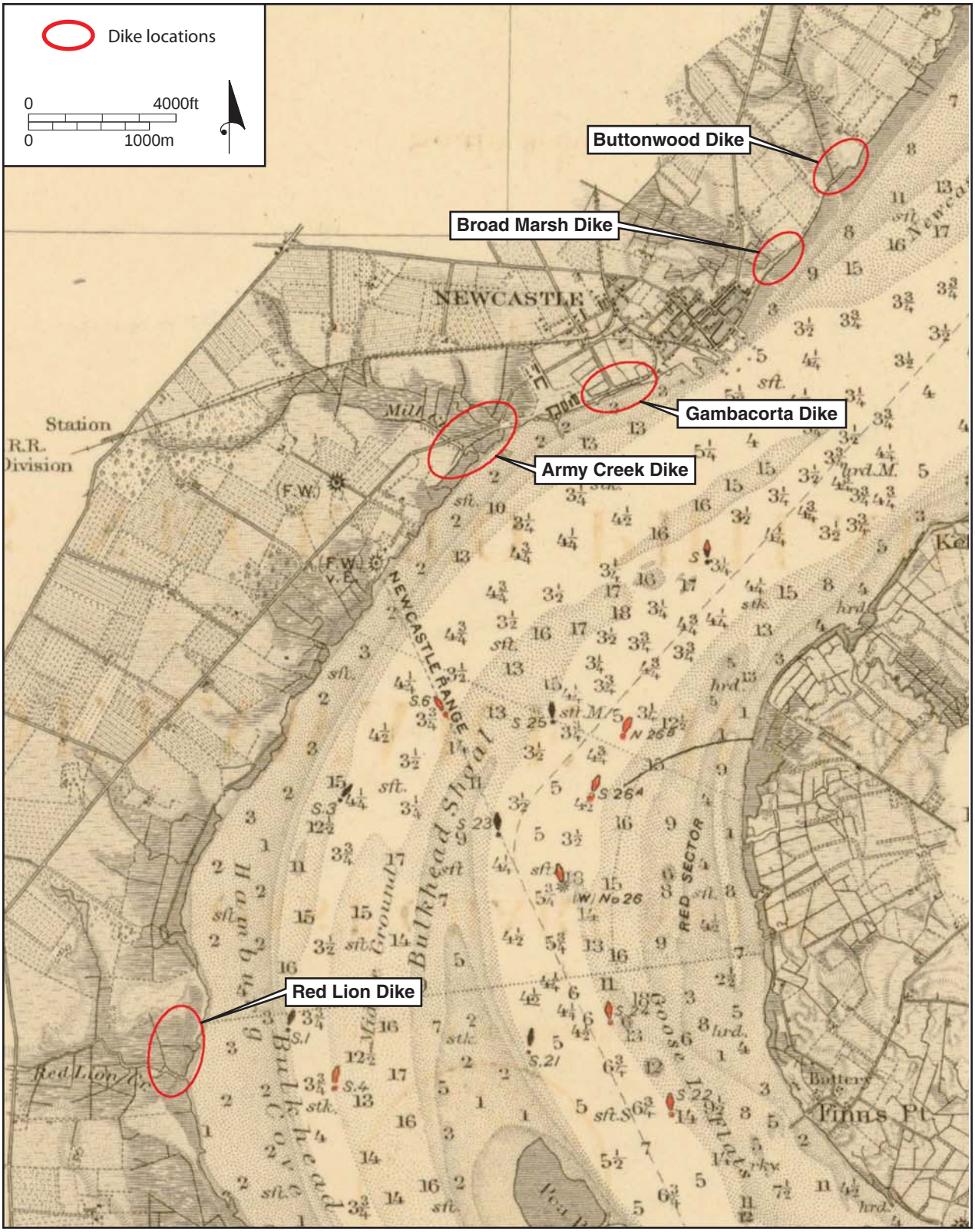
Map 6. Detail of 1861 U.S. Coast Survey map showing the location of the Red Lion Dike.



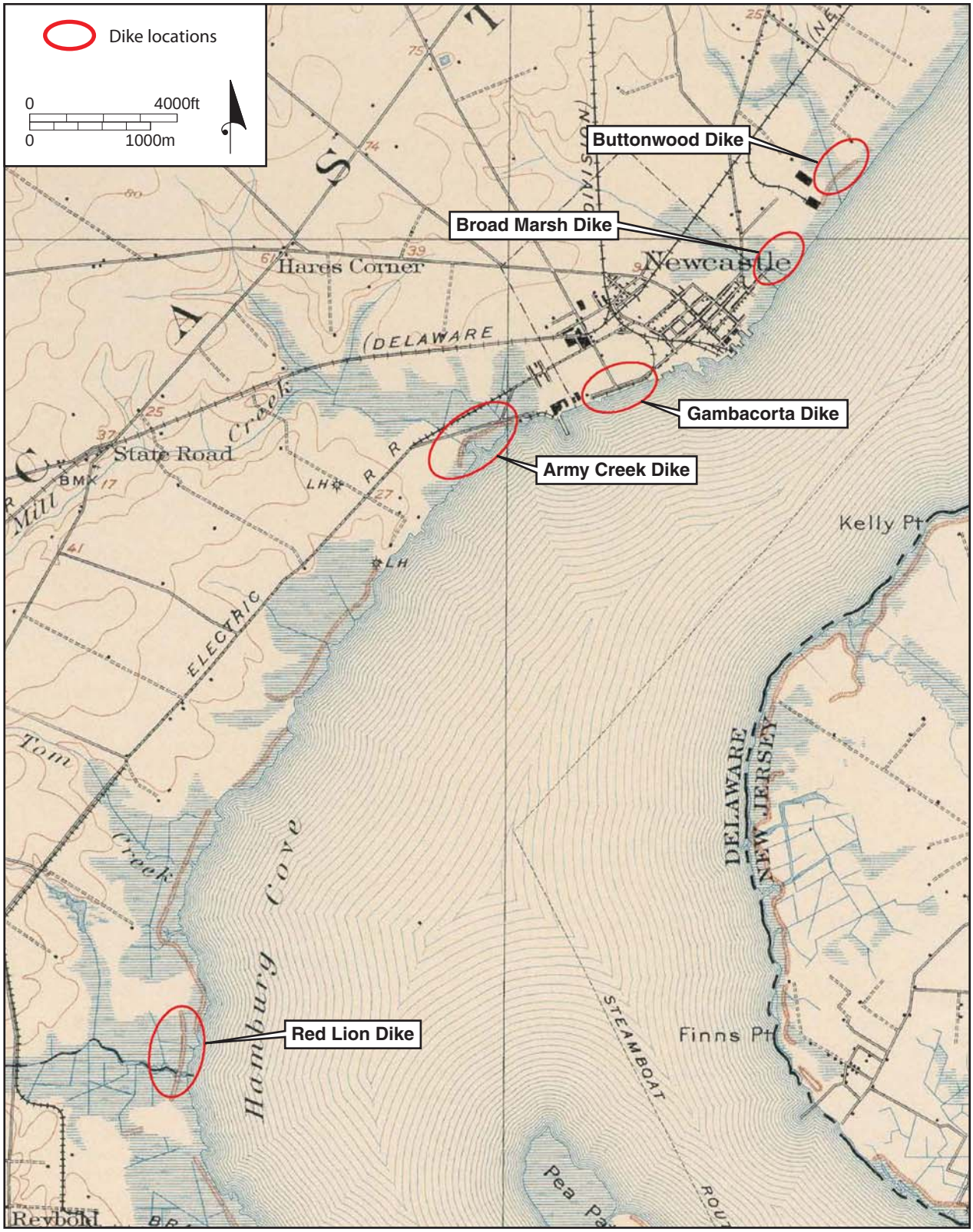
Map 7. Detail of *Atlas of the State of Delaware, New Castle*, showing the locations of the Army Creek Dike, the Gambacorta Dike, the Broad Marsh Dike, and the Buttonwood Dike (Beers 1868, Plate 21).



Map 8. Detail of *Atlas of New Castle County, Delaware*, showing the locations of the Army Creek Dike, the Gambacorta Dike, and the Broad Marsh Dike (Baist 1893).

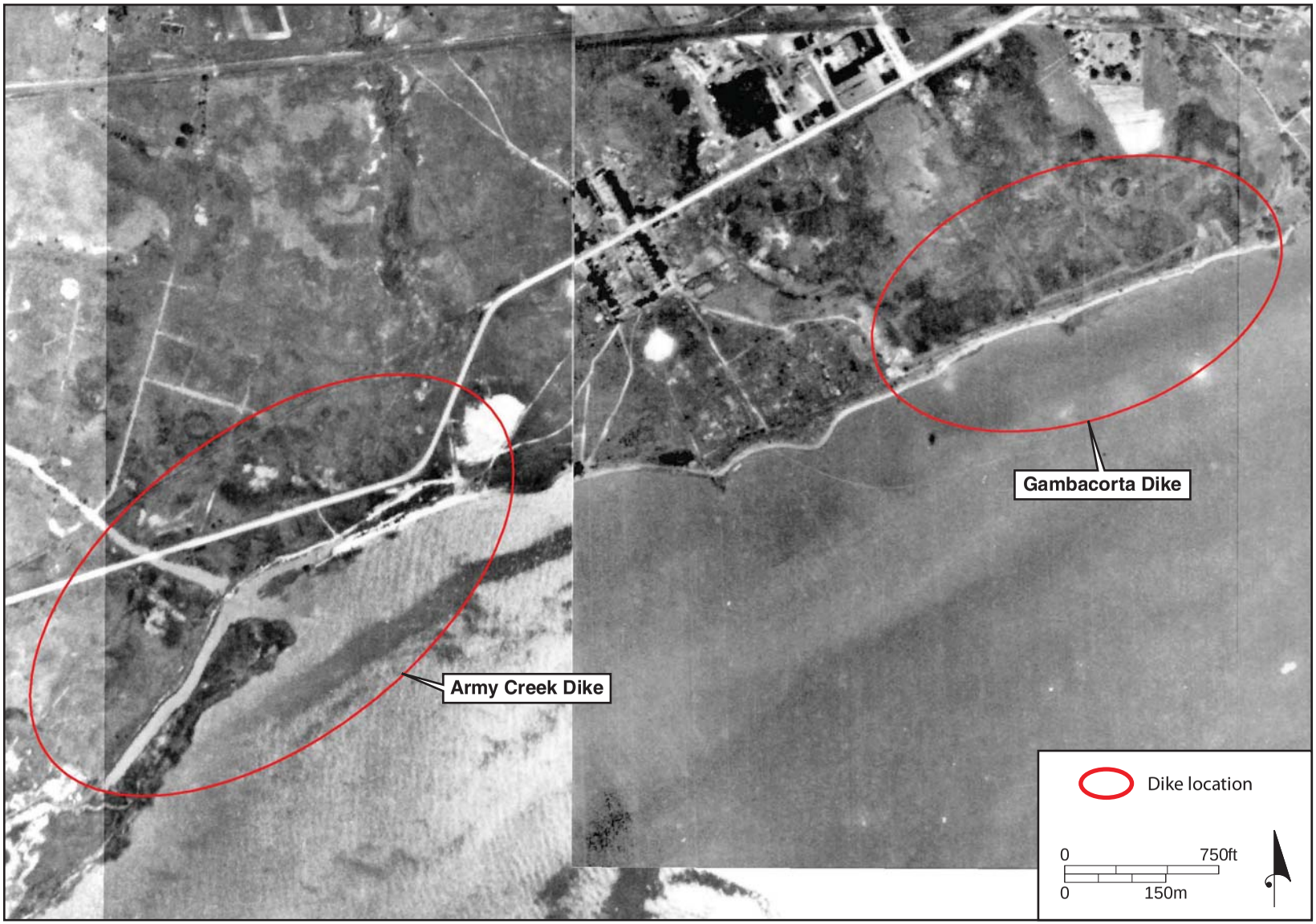


Map 9. Detail of 1901 Coast and Geodetic Survey map showing the locations of the Broad Marsh Dike, the Gambacorta Dike, the Army Creek Dike, and the Red Lion Dike.

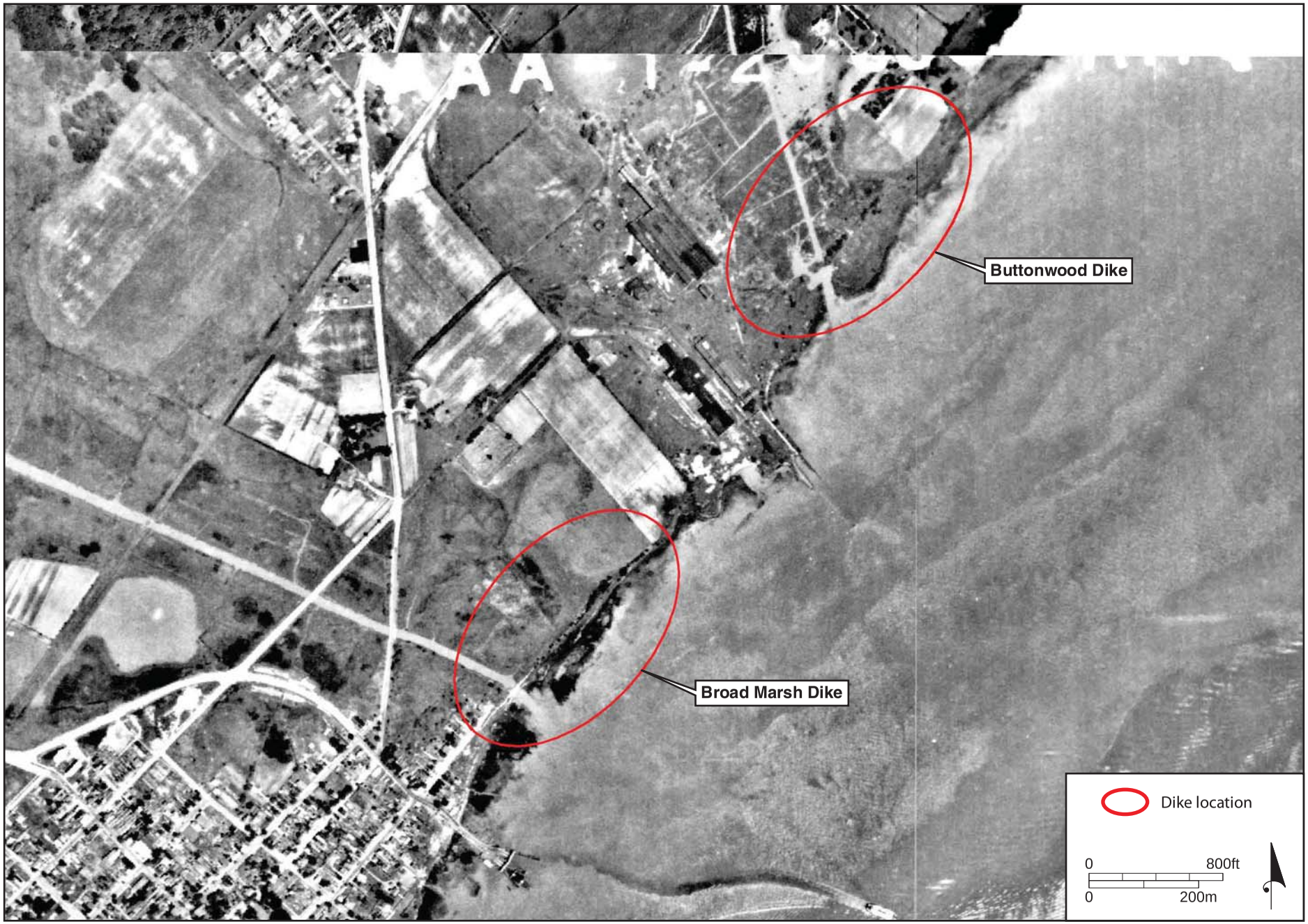


Map 10. Detail of 1906 USGS *Wilmington* quadrangle showing the locations of the Buttonwood Dike, the Broad Marsh Dike, the Gambacorta Dike, the Army Creek Dike, and the Red Lion Dike.

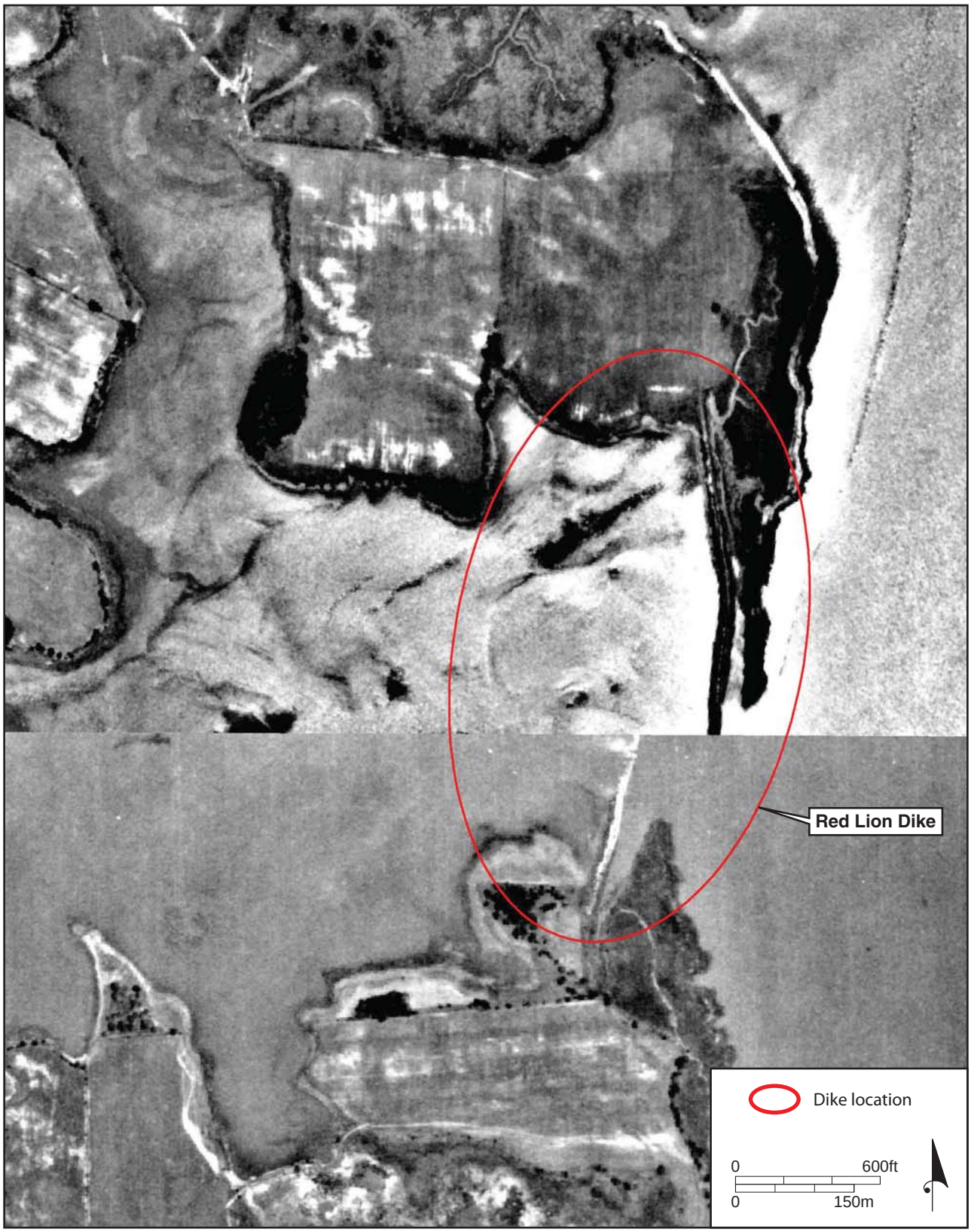
Map 11. Aerial photograph showing the Red Lion Dike (USDA 1926).



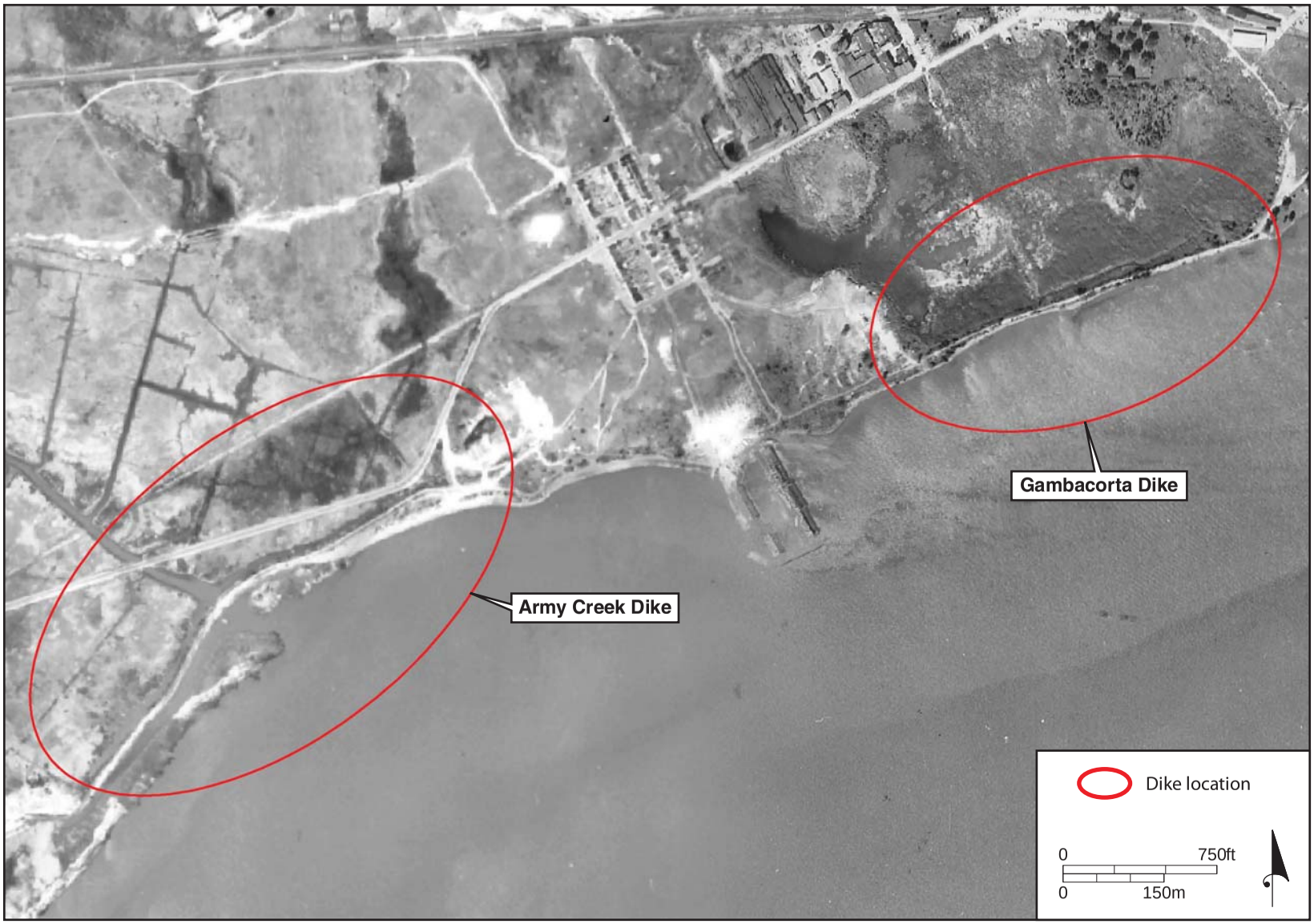
Map 12. Aerial photograph showing the Gambacorta Dike, and the Army Creek Dike (USDA 1937).



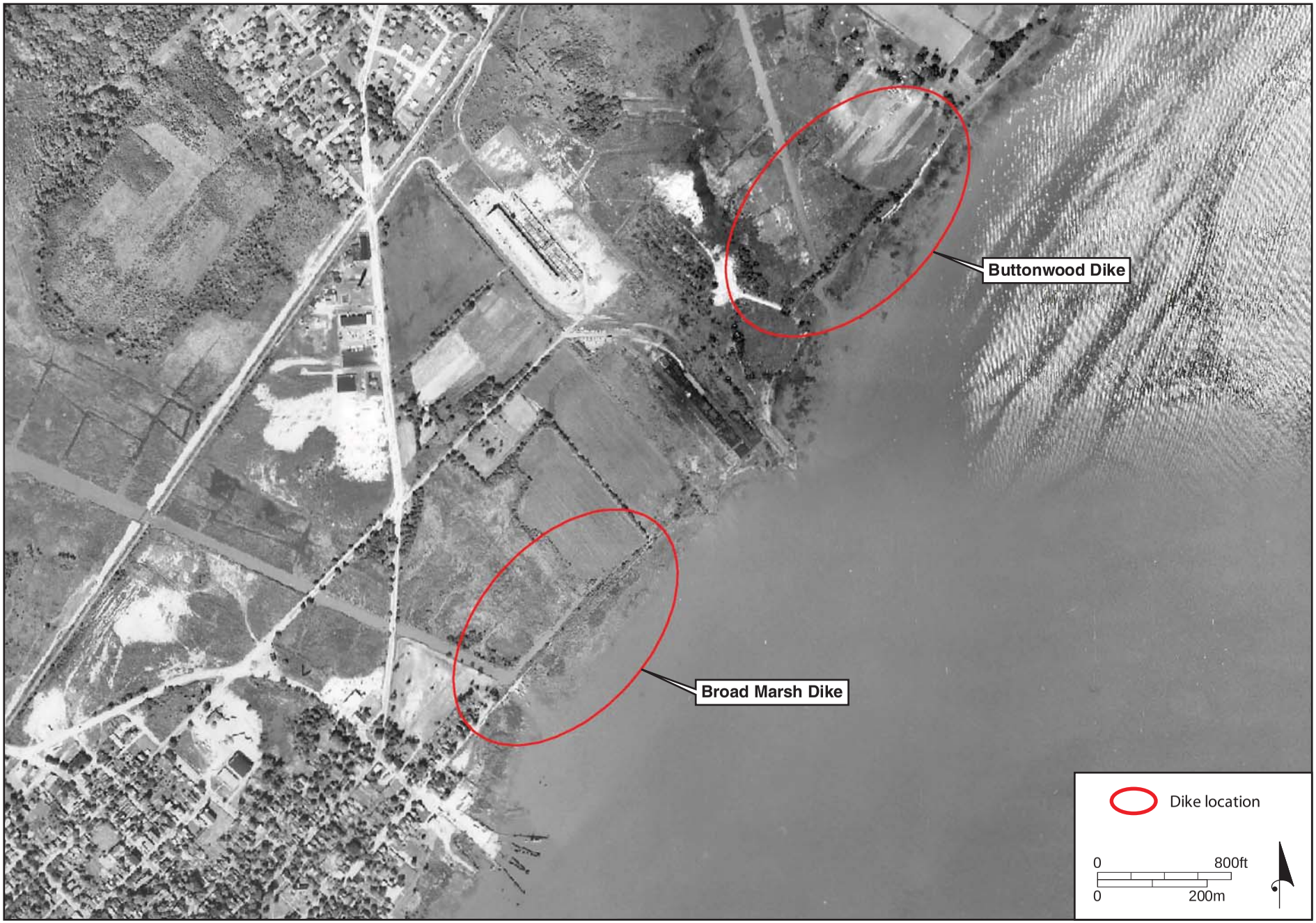
Map 13. Aerial photograph showing the Buttonwood Dike, and the Broad Marsh Dike (USDA 1937).



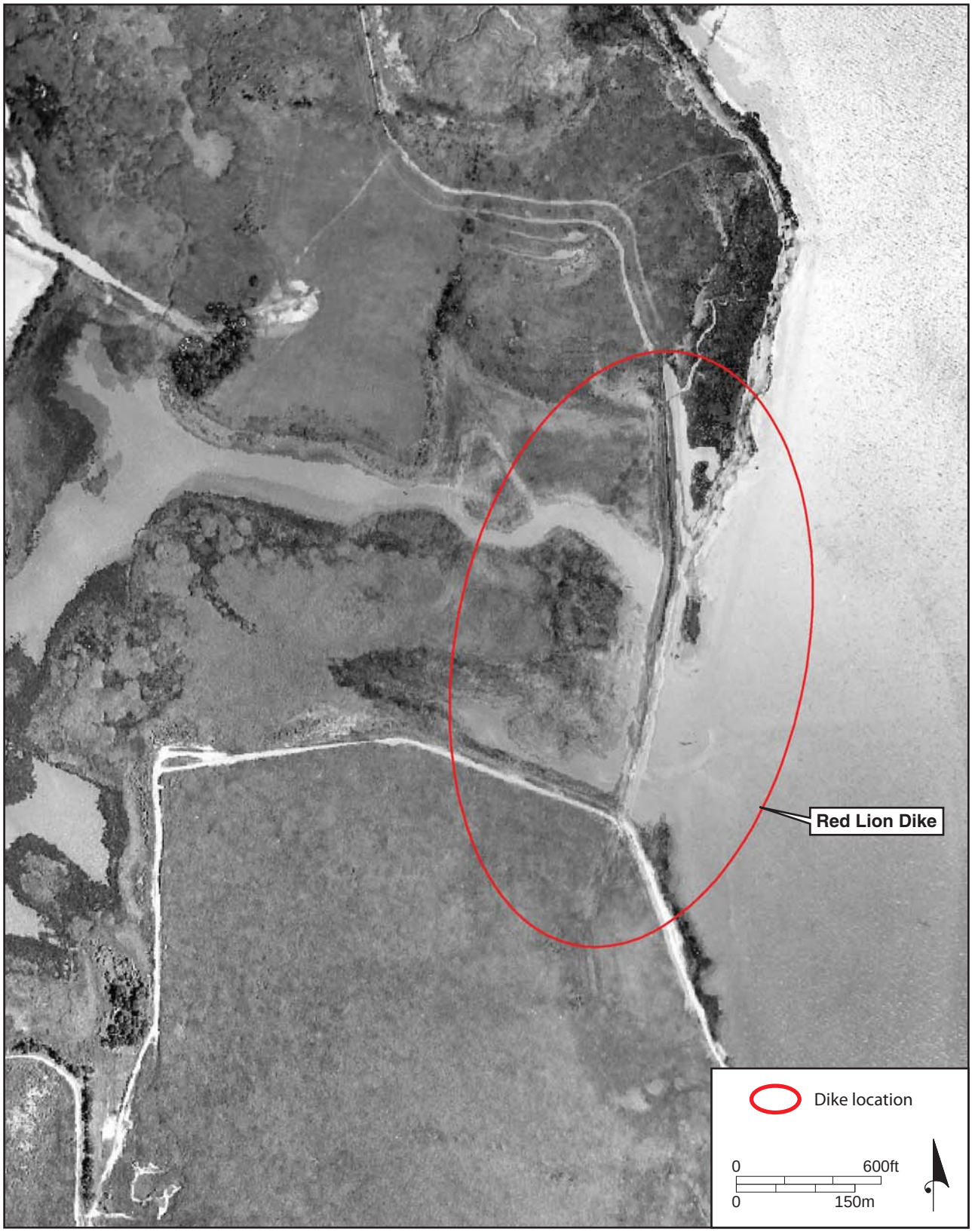
Map 14. Aerial photograph showing the Red Lion Dike (USDA 1937).



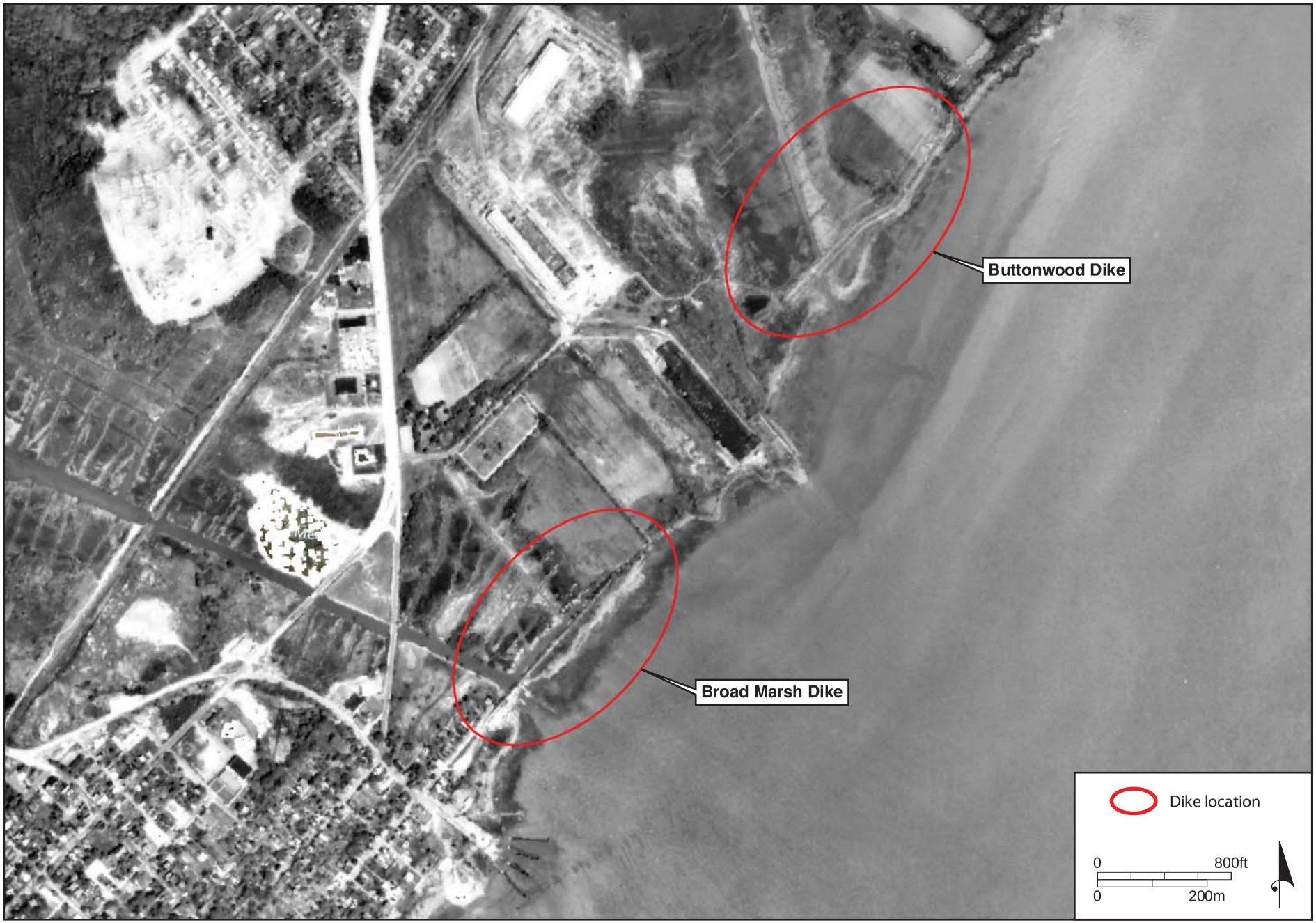
Map 15. Aerial photograph showing the Gambacorta Dike, and the Army Creek Dike (USDA 1961).



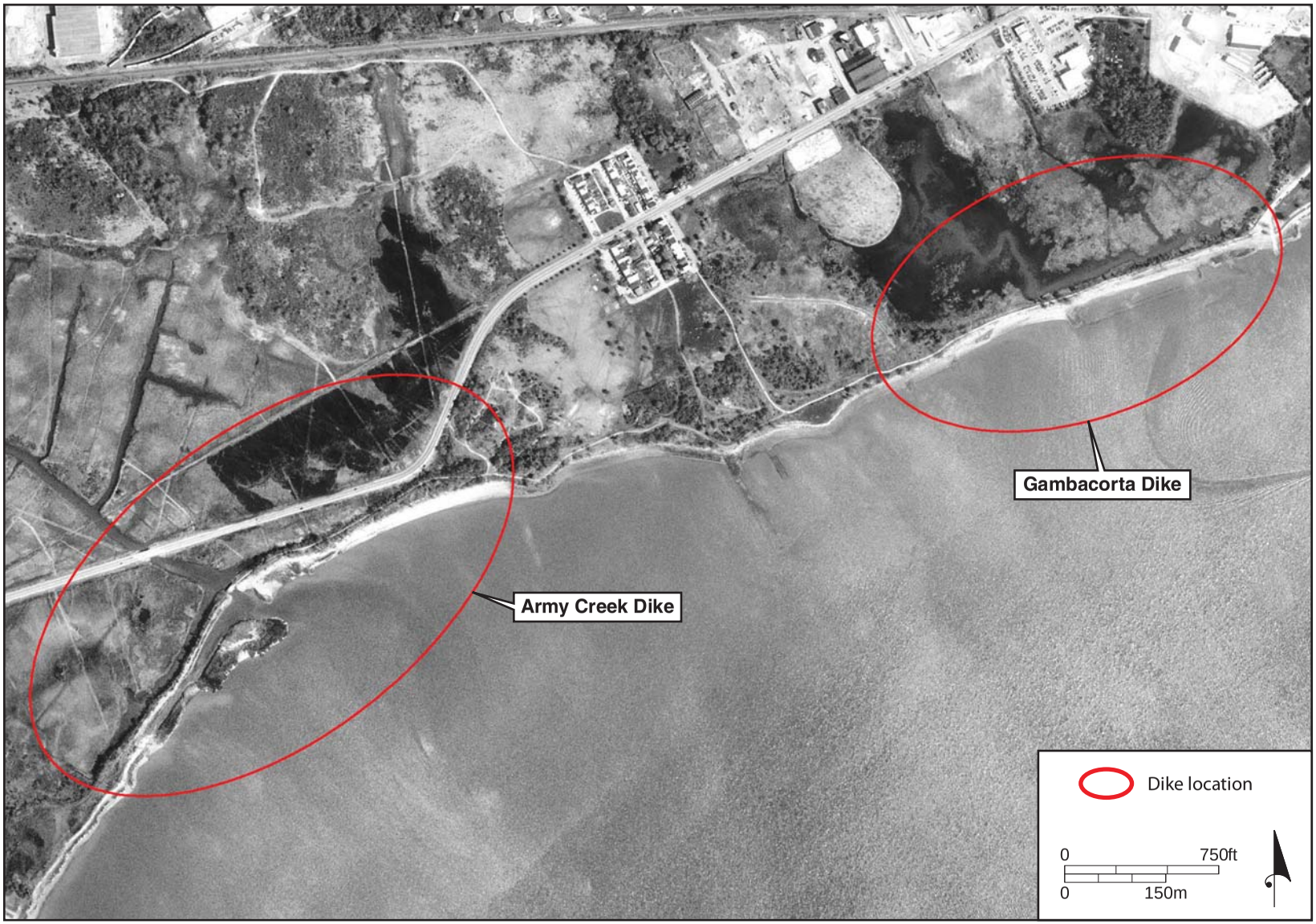
Map 16. Aerial photograph showing the Buttonwood Dike, and the Broad Marsh Dike (USDA 1961).



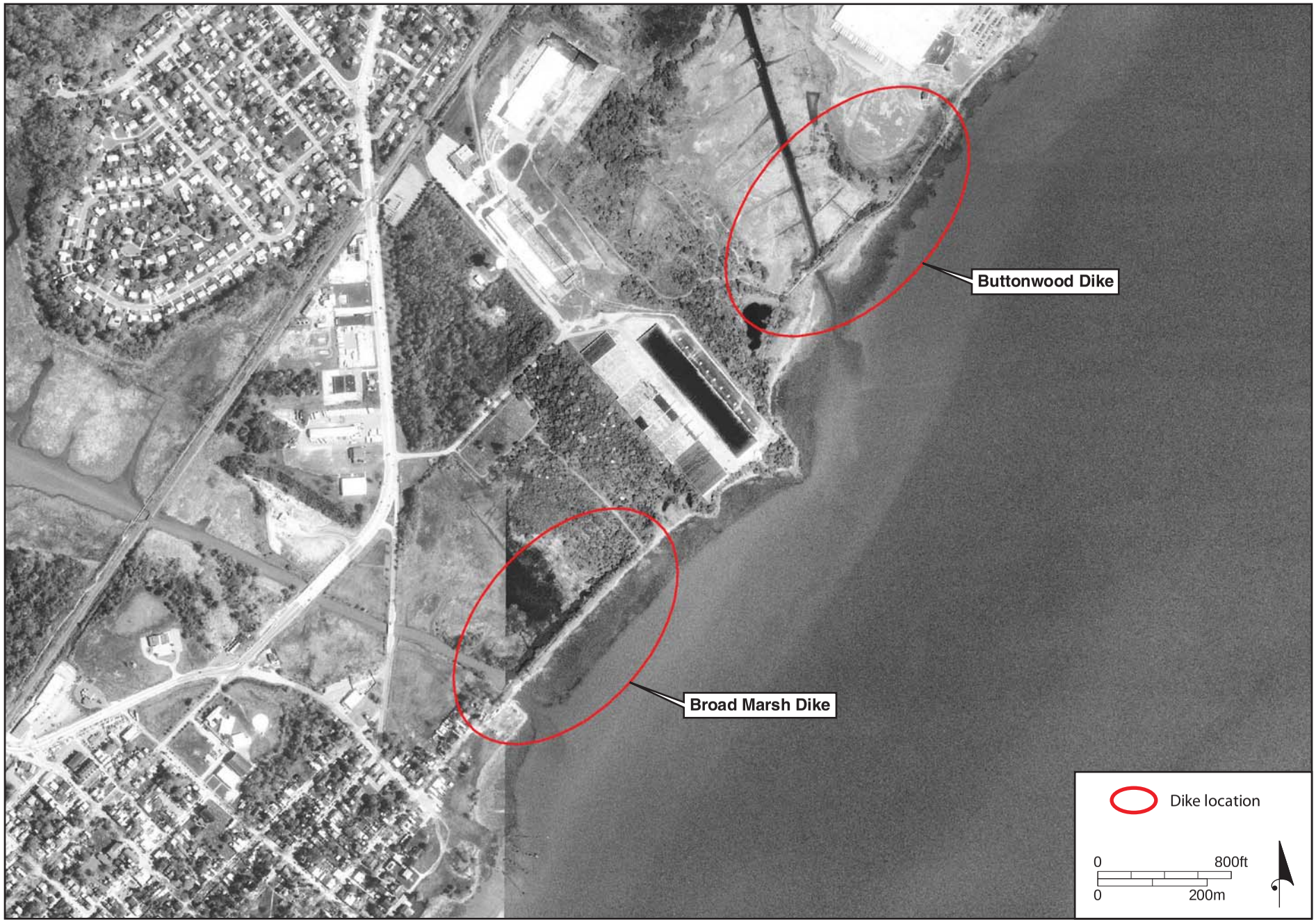
Map 17. Aerial photograph showing the Red Lion Dike (USDA 1961).



Map 18. Aerial photograph showing the Buttonwood Dike, and the Broad Marsh Dike (USDA 1968).



Map 19. Aerial photograph showing the Gambacorta Dike, and the Army Creek Dike (DelDOT 1997).



Map 20. Aerial photograph showing the Buttonwood Dike, and the Broad Marsh Dike (DelDOT 1997).

Map 21. Aerial photograph showing the Red Lion Dike (DelDOT 1997).