Siege of British Forces in Newport County by Colonial and French in August 1778

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Recommended Citation
Walsh, Kenneth M; Alvernas, Christina; Marcoux, Jon Bernard; Quinn, John; Analoro, Jessica; Boucher, Allyson; Bradshaw, Aaron; Canfield, Drew; Christopher, Mersina; Jordan, Stephen; Rehill, James; Weiss, Ralph; de la Motte, Dean E.; Pedley, Mary; and Hattendorf, John, "Siege of British Forces in Newport County by Colonial and French in August 1778" (2016). Faculty and Staff - Ebooks. 4.
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The following report has been modified in accordance with the Archaeological and Historic Preservation Act (AHPA). Certain details and images have been removed to protect the locations of archaeological resources for their future preservation.
Acknowledgments

The authors would like to thank the many individuals who aided in this effort. In particular, we would like to recognize Sister Jane Gerety and Dr. Scott Zeman of Salve Regina University for their support and encouragement of the faculty, students and alumni from the university who formed the majority of the research team. We are also grateful to Dr. Matt Stein of Roger Williams University for providing us with an excellent intern, Drew Canfield, who did most of the technical editing. Two Newport authorities, Dr. John Hattendorf of the Naval War College and Bert Lippincott III, C.G. of the Newport Historical Society offered valuable advice to us. Last but not least, we would like to thank Kristen L. McMasters of the National Park Service’s American Battlefield Protection Program, for her consistent support over the course of this project.

We are also grateful to the local historical societies on Aquidneck Island who have provided significant help to us. From the Newport Historical Society, we would like to single out Ruth Taylor, Thomas P. I. Goddard, and Ingrid Peters; from the Middletown Historical Society we were aided by Gary Paquette, Mary Redgate, Patricia Conners; from the Portsmouth Historical Society James E. Garman. We were aided as well by the staffs of the following local organizations: Middletown Town Hall, Middletown Town Council, Newport Artillery Company, Newport Public Library, Portsmouth Public Library, Redwood Library and Athenaeum, and the Rhode Island Historical Society. The William Clements Library at the University of Michigan provided us with numerous excellent maps from the period. Finally, we’re appreciative of the help we received from Dr. D.K. Abbass, Dr. Thomas Boving, Ben Campbell, Barry Clark, Dr. Marian Desrosiers, Rose Durand, Peter Dutra, Sean Hughes, Martha Koziara, Dr. William Leeman, Christian M. McBurney, Francis Quigley, Mark Raebel, and Nicole Smith.
Abstract

During the American Revolution Patriots and Tories alike knew the Americans could not win the war without foreign aid. In 1776 Benjamin Franklin had been sent to France to negotiate a mutual defense treaty. In February 1778, the treaty was signed and Admiral d’Estaing and the Toulon fleet were dispatched to help the Patriot’s. Plans were made for a campaign – comprised of 10,000 Americans under the command of Major General John Sullivan along with d’Estaing’s squadron and 4,000 French troops - to retake Newport, Rhode Island, a significant port held by the British since 1776. It was the first joint military operation of the newly formed alliance.

Just as the allies took action, circumstances changed and a sudden and violent storm hit the area. The hurricane battered and badly damaged the French fleet, which had left Newport Harbor in pursuit of the British, causing d’Estaing to insist on retreating to Boston for repairs. Positioned initially at the top of the Aquidneck Island, following the storm, the Americans had marched to Middletown where both sides became entrenched in the Siege of Newport, cannonading one another for several days from fortified positions on opposing hills. In the wake of the French retreat, Sullivan chose to push on without help. Mired in with swampy terrain as a result of the storm, and anticipating a British landing, Sullivan pulled back to Portsmouth. On August 29 the two sides engaged in intense combat in the Battle of Rhode Island at the end of which Sullivan was able to successfully withdraw his forces.

In the end, both sides sought to claim victory. The British boasted of a successful defense and the Americans stressed their safe, orderly, withdrawal from the island. In reality, Sullivan was furious with the French, blaming d’Estaing for ruining an engagement that could have ended the war. This seriously strained on the Americans’ relationship with their new ally, one Washington had to smooth over. However, the French were not solely responsible for the loss. This study delves into the more technical, often forgotten, aspects of the conflict. It pairs the historical record with scientific analysis of the artillery, fortifications, geography and unforeseen circumstances that had an impact on the outcome of the battle. In the end, although Sullivan wanted to lay blame on the French, there were many other elements that worked against the Americans in this campaign.

While much of the original earthen defense-works used during the Siege have been lost to progress, there are a small number of sites that still exist. This study also covers what sites remain, their condition and what could be done to preserve and commemorate these significant locations.
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Executive Summary

In August 1778, the Siege of Newport took place on opposing hills in Middletown, Rhode Island. It involved Major General John Sullivan’s Continental Army units and regional militias against Major General Robert Pigot’s British, Hessian and Loyalist forces. The two sides bombarded each other for well over a week to no avail, causing the Americans to retreat north to Portsmouth where they became entangled in the Battle of Rhode Island. Often overshadowed by the battle in Portsmouth - listed on the National Register of Historic Places (ID: 74002054) - little attention is paid to the finer details of the Siege, its battlefield in Middletown, and its impact on the campaign as a whole.

The Siege was part of the larger Rhode Island Campaign, which was an effort to retake the strategic port of Newport from its British occupiers. With help from America’s brand new ally - France - American and French forces descended on Narragansett Bay in the hopes that a large scale victory with a powerful ally would end the war. The campaign that ensued involved an army of 10,000 Americans, including some of Washington’s top officers and aides, and the Toulon Fleet lent by His Majesty King Louis XVI. The allies expected victory and their morale was high but the operation was fraught with problems from the start. Changing circumstances, a lack of coordination, an unexpected hurricane, and a near diplomatic disaster made an operation with much promise completely unravel. Today, the campaign is at best considered a draw, making it an easily forgotten chapter of the war. It was, however, American’s first joint military operation with the French. Lessons were learned the hard way and diplomatic mistakes made here would not be repeated later in the war. The British learned just how vulnerable their position in Newport truly was and would abandon the city in the following year. This vacancy, in turn, unintentionally made way for Lieutenant General Jean-Baptiste Donatien de Vimeur,
comte de Rochambeau to use Newport as a staging area for French forces in America before heading south to Yorktown.

In 2015, the Middletown Historical Society (MHS) received a $67,000 grant from the American Battlefield Protection Program (ABPP) to investigate the Siege of Newport and its battlefield in Middletown. In the *Siege of British Forces in Newport County by Colonial and French in August of 1778*, the MHS sought to not only highlight the town’s role in the larger conflict but also to determine how much geography and the available technology affected the campaign’s outcome. To accomplish this, an in-depth analysis was conducted of the artillery and earthen fortifications used and their place within the battlefield landscape. In addition, identifying the remaining defenses and their condition has provided meaningful insight for their future preservation and commemoration, and a better understanding of the battlefield as a whole.

To carry out such a large scale, multi-disciplinary project, the Middletown Historical Society Research Team was formed. It primarily involved a collaboration with Salve Regina University, including faculty, students and alumni from both the History Department and the Cultural and Historic Preservation Department. Students conducted research and Ground Penetrating Radar (GPR) surveys, while faculty and alumni helped research and write portions of the report. Additionally, engineers from Roger Williams University and the University of Rhode Island were brought on to assist with the technical analysis.

The introductory sections of the report provide the proper historical context for the Siege, detailing the lead up, major players, and troop movements prior to the engagement. It is in Chapter One that the landscape of the battlefield and beginning of the Siege are discussed. It provides an understanding of key terrain features, observations on both sides, cover and concealment used, obstacles, dead spaces, and the avenues of approach. Chapter Two takes this
further by delving into the evolution of the Siege, including fields of fire, elevation considerations, and a detailed technical analysis of the artillery used during the engagement. It is in these chapters that the impact of geography and technology on the outcome become apparent.

Chapters Three and Four provide more of a historical background on what happened next, both for the troops and the battlefield. Chapter Three discusses the Americans’ decision to abandon the Siege and move north to Portsmouth. Here, after an intense battle, they retreat entirely off the island. The cover and concealment used during their abandonment of both the Siege and the campaign, as well as their mobility corridor used during the retreat, are discussed. Chapter Four builds on this by examining what happened to the landscape after the Americans left. British activities post-August 1778 are detailed including the repair and destruction of their own lines. The later restoration of and addition to the defense lines by the French are also covered. Excerpts from numerous contemporary accounts (British, Hessian, American, and French) have been included to provide depth on the subject. Additionally, the use of historic maps from the William L. Clements Library at the University of Michigan and the Library of Congress has provided visual evidence of the battlefield’s evolution from 1778 to 1780.

Following the Revolution, Middletown returned to the farming community it had been. Like so many of the country’s other battlefields, the major changes and threats came in the 20th century. Assessing the location and condition of remaining fortifications and other features during this period was essential. In Chapter Five, the existence, preservation and integrity of the battlefield and its sites were studied and evaluated in three specific time periods including the turn of the 20th century, pre-WWII and the present day. Historic photographs, atlases, written accounts, aerial photographs, and site visits were used to assess changes to the battlefield over time and provide insight into what is left today. For convenience, Table ES.1 below lists all
relevant features still present on the battlefield today, and Figure ES.1 shows a map of the battlefield with important features and movements marked.

**Table ES.1: Relevant features on the battlefield today.**

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card’s Redoubt</td>
<td>earthen fortification</td>
</tr>
<tr>
<td>Tonomy Hill Fort</td>
<td>earthen fortification</td>
</tr>
<tr>
<td>Little Tonomy Hill</td>
<td>site of earthen fortification</td>
</tr>
<tr>
<td>Bailey’s Brook</td>
<td>natural feature</td>
</tr>
<tr>
<td>Easton’s Pond</td>
<td>natural feature</td>
</tr>
<tr>
<td>Easton’s Beach</td>
<td>natural feature</td>
</tr>
<tr>
<td>Honeyman Hill</td>
<td>natural feature</td>
</tr>
<tr>
<td>Bliss Hill</td>
<td>natural feature</td>
</tr>
<tr>
<td>Green End</td>
<td>natural feature</td>
</tr>
<tr>
<td>West Main Road</td>
<td>street</td>
</tr>
<tr>
<td>East Main Road</td>
<td>street</td>
</tr>
<tr>
<td>Bliss Road</td>
<td>street</td>
</tr>
<tr>
<td>Green End Ave.</td>
<td>street</td>
</tr>
<tr>
<td>John Bliss House</td>
<td>Historic home used as British field headquarters during the Siege.</td>
</tr>
</tbody>
</table>

Evidence beneath the surface was also analyzed in Chapter Five, including the existence of a cannon ball recovered in a yard on Honeyman Hill and through the use of archeological equipment. Ground Penetrating Radar surveys were conducted in three associated sites, each
chosen based on the historical record and access to the property. These include a British outpost located on the Aaron Lopez Farm site (NRHP ID: 80000082. listed as “Greenvale Farm” for a later occupation of the site); the former site of Fort Fanning, and the Redoute de Saintonge (constructed by the French in 1780 but frequently mislabeled as Green End Fort).

Chapter Six is the conclusion of the report, covering a summary of the project and preservation recommendations. New insights on the history of the Siege, its outcome, and the role geography and technology played are discussed in detail. Recommendations are provided for the preservation of the battlefield’s remaining features, and a proposal is offered for a small museum at the center of the battlefield.
Battlefield Map

Figure ES.1 Map of the Battlefield of the Battle of Rhode Island. Important fortifications, troop movements and the Siege of Newport core area are marked.
Preface

In August 1778 the newly formed United States and France conducted their first joint military operation of the American Revolution. Referred to as the Rhode Island Campaign, its leaders, Major General John Sullivan\(^1\) of the Continental Army and Admiral Jean-Baptiste-Charles-Henri-Hector, comte d’Estaing\(^2\) of the French Navy, were instructed by General George Washington to descend upon Newport, in an effort to reclaim this strategic port. The fight that ensued is known today as the Battle of Rhode Island. Ultimately a loss, the battle is largely overlooked in most history books, in part due to its outcome. However, it is a significant moment, as it marks the beginning of French military involvement. It also underscores the turning point of the war, reached by the decisive American victory at Saratoga a year earlier. With such momentum behind the patriot cause and a newly formed alliance, the war could actually have been won in Newport had the outcome been different. Instead, the Campaign put a severe strain on the new alliance as each side blamed the other for the loss. America would have to wait two more years before another French force under Lieutenant General Jean-Baptiste-Donatien de Vimeur, comte de Rochambeau\(^3\) would come to their aid and ultimately lead them to victory at Yorktown.

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\(^1\) An attorney from New Hampshire, Sullivan joined the Continental Army as an officer in 1775 and took part in the Siege of Boston the following March. After being promoted to major general, he was captured during the Battle of Long Island in 1776 but was exchanged in time to lead Washington’s right column at the Battle of Trenton. After commanding the Rhode Island campaign at the age of thirty-eight, he found success on the battlefield defeating the Iroquois Indians in western New York, but ultimately resigned before the war’s end due to illness. He went on to become a delegate to the Continental Congress, presided over his state’s ratification of the Constitution and later in life became governor of New Hampshire.

\(^2\) A nobleman with many years in the French military, first in the army, then in the navy, d’Estaing was commander of the Toulon fleet ordered by King Louis XVI to aid the American colonies in 1778. Years later, he was guillotined in Paris during the Reign of Terror.

\(^3\) A French nobleman and the general in command of French forces in the later years of the American Revolution. Rochambeau was stationed at Newport from July 1780-1781. He led the French Army to aid Washington in the defeat of British forces under Lord Cornwallis at Yorktown, VA, virtually ending the war. During the French Revolution he was nearly guillotined but ultimately evaded execution and was later pensioned by Napoleon. (For more on Rochambeau’s roll in Newport and the war see Chapter 4.)
The Americans had started angling for French aid shortly after the Revolution began, aware that they would need foreign help if they were going to have a chance of defeating the British. In the fall of 1775 the Continental Congress sent Benjamin Franklin and three other American diplomats to Canada in an effort to enlist support from their French neighbors to the north. When the Canadians rejected the American overtures, Franklin was then sent to France in December 1776.\textsuperscript{4} Franklin wanted to draw the French into another conflict with the British, who had decisively defeated them in the French and Indian War\textsuperscript{5} in the previous decade. The French were charmed by Franklin and sympathized with his cause, but they needed to be persuaded that the Americans had a chance to win before they would commit resources to the effort. Franklin would have to bide his time until the Americans proved themselves on the battlefield.

Meanwhile, the British, having been forced out of Boston in March 1776, wanted to maintain a foothold in New England and so they set their sights on Newport. A bustling, cosmopolitan trading center, Newport at this time ranked with Boston, Philadelphia, New York City and Charleston as one of the colonies’ leading cities. Its deep harbor was especially attractive for the British fleet. Even the largest British ships would be able to enter the harbor without fear of running aground. Additionally, Newport’s location at the southern end of an

\textsuperscript{4} Stacy Schiff, \textit{A Great Improvisation: Franklin, France and the Birth of America} (New York: Henry Holt, 2005), 1-35.

\textsuperscript{5} The American theater of the multi-continent conflict known as the Seven Years War.
island - Aquidneck Island⁶ - at the mouth of Narragansett Bay⁷, would make it all the easier to defend.

In December 1776 the British forces under Lieutenant General Henry Clinton⁸ landed in Newport in full force: seventy-two ships—including fifteen warships—anchored in and around Newport and 4,000 British troops and 3,100 Hessians occupied the island.⁹ Newport’s residents made no effort to resist the invasion and many of the town’s Loyalists heartily welcomed the British officers on their arrival. However, as much as half of Newport’s population had fled the island, reducing their numbers to 5,300 by the time the British arrived.¹⁰ Among those who took flight was the Reverend Ezra Stiles, a Congregational pastor, director of the Redwood Library and outspoken patriot.¹¹

Having taken Newport and nearby Jamestown without firing a shot, the top British officers ensconced themselves in the town’s finest homes and waited for orders from their commanders. In the summer of 1777, the British began an ambitious campaign to cut off Boston—the epicenter of the Revolution—from the rest of the colonies. General John

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⁶ Comprised of the towns of Portsmouth (to the north), Middletown (in the center) and Newport (to the south) it is the largest island in Narragansett Bay in the State of Rhode Island. Originally called “Aquidneck” by the Narragansett tribe, it was later renamed “Rhode Island” by early English settlers. Both the State of Rhode Island and the Battle of Rhode Island are named for this geographic feature. Today it is widely referred to as Aquidneck Island, although its official name remains Rhode Island. Throughout this report it is called Aquidneck Island to avoid confusion with the state.

⁷ A large bay in the state of Rhode Island, fed by the Providence, Taunton, and Sakonnet Rivers. Its islands include, Rhode (Aquidneck), Conanicut, and Prudence Islands.

⁸ British army officer whose forces first captured Newport in 1776. In 1778 Clinton became commander in chief of British forces in America. Although his second in command, Lord Cornwallis, was responsible for the loss at Yorktown, it was Clinton and not Cornwallis who received much of the blame upon returning to England, after the war.


¹⁰ McBurney, 9.

¹¹ Literary Diary of Ezra Stiles, ed. Franklin Bowditch Dexter 3 vols. (New York: Charles Scribner’s Sons, 1901); 1:661-662.
Burgoyne\textsuperscript{12} would bring his forces south from Canada to Albany, New York, where he would connect with General William Howe\textsuperscript{13} who would travel north from New York City. These two armies would be met by a smaller force led by Colonel Barry St. Leger who would come from the western region of New York. The plan was bungled from the start: Howe chose to take his troops to Philadelphia and St. Leger was pinned down in western New York. By October, Burgoyne, outmaneuvered by the American troops, surrendered his 5,900 British and Hessian troops at Saratoga.\textsuperscript{14}

At Saratoga, the Americans had scored a major victory. When the news of the American success reached Franklin in Paris, he wasted no time in pressing his argument that the war could be won if the Americans had the assistance of France’s powerful army and navy. By February 1778, King Louis XVI\textsuperscript{15} agreed to ally with the Americans and promised them that aid would be forthcoming.\textsuperscript{16} Leading the French expedition would be the comte d’Estaing, a forty-eight year old admiral who had begun his career in the army but had switched to the navy in the 1760s. D’Estaing set off from France in April with sixteen ships and 4,000 troops and traveled at an agonizingly slow pace through the Mediterranean and then across the Atlantic.\textsuperscript{17}

\textsuperscript{12} British general largely remembered for the outcome of the Battle of Saratoga.
\textsuperscript{13} Commander and chief of British forces in America from 1776 to his retirement in 1778.
\textsuperscript{15} King of France in the late 18th century who supplied military aid to the American colonies during the Revolutionary War. He was the last in the Bourbon line of monarchs before the French Revolution and was ultimately guillotined in 1792.
\textsuperscript{16} Ketchum, 440-448; Schiff, 110-134.
\textsuperscript{17} John Hattendorf, \textit{Newport, the French Navy and American Independence} (Newport, RI: Redwood Press, 2005), 3-8.
News of the French entry into the war alarmed the British in Rhode Island. In May one of the British officers in Newport, Lieutenant Frederick Mackenzie, noted in his diary that “great rejoicings have been made of late all over the Country, on account of their Alliance with France…I am of opinion that they really will attempt something soon, for as the spirits of the people are now high…numbers of them will be found willing to engage for a short time in an enterprize of that nature.”

To thwart any potential attack on Aquidneck Island, the British engaged in harsh preemptive strikes against nearby towns. General Robert Pigot, who assumed command of Newport in July 1777, ordered attacks on Bristol and Warren to destroy any boats and weapons that the patriots might use in an invasion. In their raids, the British carried out what the historian Christian McBurney calls a “campaign of burning and plunder,” taking dozens of prisoners, torching a church in Bristol and numerous homes and storerooms in both towns. A few days later, the British entered Fall River and burned a sawmill which had been producing planks for the Patriots’ ships.

At long last, d’Estaing arrived off Sandy Hook, New Jersey in early July (Figure P.1). He contemplated an attack on the British fleet guarding New York City but eventually decided that the water might not be deep enough for some of his larger ships. Figuring that d’Estaing

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18 British officer in the Royal Welch Fusiliers, who kept a detailed diary during the American Revolution, recording his time stationed in Boston, Newport and New York. His diary provides enormous insight and is widely quoted and cited throughout this report.
20 Officer in command of the British land forces stationed at Newport, RI during the city’s occupation and the Battle of Rhode Island.
21 McBurney, 58.
22 A barrier spit in northern New Jersey, protruding into and sheltering part of Lower New York Bay. Located just south of New York City, ships headed for this port had to pass by Sandy Point *en route*. The British Navy stationed at New York used the strategic geography and location of Sandy Hook to their advantage to protect both the city and their fleet.
might bypass New York City and sail on to Rhode Island, General Clinton, who was then in command of British forces in New York, moved to bolster Pigot’s forces. In early July, he dispatched 1,850 British and Hessian troops to Newport.

Figure P.1 Overview of French and American troop movements during the summer of 1778 (marked in blue). These include Sullivan’s forces moving from Providence to Tiverton and eventually Middletown, Lafayette and the Continental Army troops on their way to join the campaign, and d’Estaing’s route from France to Sandy Hook, NJ to Newport, RI. Cities held by the British, such as Newport and New York are marked in red and the Patriot stronghold, Boston, is marked in blue.  

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Washington had the same idea as his British rival: he hoped that d’Estaing would sail into Narragansett Bay and help the Patriots retake Aquidneck Island. Washington sent his trusted aide Lieutenant Colonel Alexander Hamilton to meet the admiral on his flagship, the *Languedoc*. The two men agreed on the wisdom of a Rhode Island campaign and Washington then sent Major General Nathaniel Greene\textsuperscript{24} and another trusted aide, the Major General Marie-Joseph-Paul-Yves-Roch-Gilbert du Motier, marquis de Lafayette,\textsuperscript{25} to Rhode Island with two brigades from the Continental Army. Greene and Lafayette would report to General Sullivan who was in charge of a force of 8,000 militiamen in Providence. With these American troops and d’Estaing’s French ships joining forces, Washington was optimistic that they would be able to dislodge the British from Newport and thus provide a crucial follow up to the American triumph at Saratoga.

\textsuperscript{24} Hailing from Rhode Island, Greene was manager of his family’s iron foundry before the war and became commander of the State army in 1775. After joining the Continental Army, he was quickly promoted to Major General and became one of Washington’s most skilled and trusted officers. He was assigned to help Sullivan retake Newport, in the hope that his local knowledge could be of use. Greene is largely remembered for his strategic mind and for his part in the war’s Southern theater. His actions proved crucial in the lead up to Yorktown, luring and exhausting Lord Cornwallis’ army throughout the South. After the war, he settled in Georgia, where he died in 1786.

\textsuperscript{25} French aristocrat and army officer who volunteered for the American Continental Army prior to French involvement in the war. Lafayette became a close friend and aide to Washington and participated in numerous engagements throughout the war, most notably helping to blockade Lord Cornwallis in the lead up to the Siege of Yorktown. He was also vital in America’s dealings with France, both during the Rhode Island Campaign and later helping Benjamin Franklin to secure 6,000 French soldiers under the command of Rochambeau. Lafayette went on to be a key figure in the French Revolution of 1789 and in the July Revolution of 1830.
Project Background

The origins of this project, focusing on Middletown’s role in the Rhode Island Campaign, center around a Revolutionary War era earthen fortification on Vernon Avenue in Middletown wrongly associated with the British occupation and the Siege of Newport, and misidentified as Green End Fort (Figure PB.1). The site was actually constructed as a French fort after the arrival of comte de Rochambeau in 1780. Its proximity to another fortified position on the British front lines, Card’s Redoubt, had led to confusion about its origins. The misidentification fueled further historical research and scientific analysis in an effort to correct this mistake, which in turn renewed interest in the battlefield as a whole.

Situated amidst farmland, high on Bliss Hill, the site was acquired in 1894 by William Watts Sherman, John Nicholas Brown, Harold Brown, Francis S. Barker and Stephen P. Barker
in an effort to preserve it. Two years later, it was included in Edward Field’s *Revolutionary Defenses in Rhode Island*, where it was identified as the fort at Green End and described as having been built by British forces. It was eventually deeded to the Newport Historical Society (NHS), which (following Field’s example) wrongly identified it, again as a British fort, on a 1919 map of Revolutionary War sites. After a celebration of the American use of the fort at Butts Hill in Portsmouth in 1923, the NHS and its president, Roderick Terry, chose to hold a similar ceremony for the opposing side, dedicating the site on Vernon Avenue with a stone marker (Figure PB.2).

![Figure PB.2 The marker placed in 1924 by the Newport Historical Society (NHS) at the fort on Vernon Avenue in Middletown, RI. Today, the site is still owned by the NHS. Photo by author.](image)

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26 Roderick Terry, “The Story of Green End Fort,” *Bulletin of Newport History* No. 51 (October 1924); 13.
Terry went on to publish an article covering the day’s festivities and the history of the fort in an October 1924 issue of the NHS’s *Bulletin of Newport History*.\(^{28}\) This article reinforced the idea that the fort existed during the Siege of Newport, a belief that stood uncontested for over fifty years.

In 1976, engineer and historian Kenneth Walsh, submitted a paper to *Newport History*, the same bulletin Terry’s article had appeared in. In it he argued that the earthen fortification was actually the Redoute de Saintonge, built by the French in 1780.\(^{29}\) He had uncovered the mistake by accident but went on to support his theory using geometry, historic maps from the time and the diary of a British officer, Lieutenant Frederick Mackenzie, a source that had not been available to Terry in 1924. He hoped something could be done to rectify this and as a result, the Middletown Historical Society (MHS) came into being. A second article of Walsh’s ran in 1981 addressing concerns of the skeptics and further explaining how the truth had gone unnoticed for so long.\(^{30}\)

In the intervening years, several notable works have been published concerning the Battle of Rhode Island and the State during the Revolutionary Era. Dr. D.K. Abbass of the Rhode Island Marine Archaeology Project (RIMAP) has produced a massive and indispensable four-volume report, *Rhode Island in the Revolution: Big Happenings in the Smallest Colony*. Another vital work on the subject is Christian M. McBurney’s *The Rhode Island Campaign: The First French and American Operation in the Revolutionary War*. The book covers the entire scope of the “Americans” various campaigns and activities in their effort to reclaim Newport from the

\(^{28}\) Terry, 3-5.

\(^{29}\) Kenneth M. Walsh and David S. Walsh, “Memo on Location of ‘Green End Fort,’” *Newport History* No. 161, Vol. 49, Part I (Winter 1976), 1-16

British but mainly focuses on the Battle of Rhode Island. McBurney is also the author of *Revolutionary Spies of Rhode Island* and several articles on Rhode Island during the war. The works of both Abbass and McBurney are essential reading to anyone looking to study the Battle of Rhode Island in depth, and this study seeks to build upon their scholarship.

In 2008, the MHS received a parcel of land through a bequest of long time member Ray Durfee. The property was situated at the corner of Green End Avenue and Valley Road, right at the heart of the battlefield. Now with a sizable tract of land located in the valley between the British and American lines, the MHS took a renewed interest in the Siege of Newport and what remained of the battlefield. Hoping to tie the land, the area’s history and its existing historic resources together, an attempt was made to create a historic district from the battlefield and surviving sites. The bid was unsuccessful and so the MHS decided a new approach was needed. It was determined that an in-depth study of the Siege of Newport battlefield was necessary and would provide an opportunity to clear up any remaining questions concerning the fortifications.

As the Siege was examined more closely it became clear that the report should not only identify the defenses but also address the accuracy of the cannons used against them and the overall feasibility of the operation. As with the identification of the Redoute de Saintonge, mathematical equations and scientific analysis have been paired with historic primary resources to determine how effective the cannonading actually was on the defenses given the distance, troops, materials and conditions. This paired with an analysis of a number of unfortunate events suffered by the Americans and the resulting actions taken by them, will ultimately tell whether they ever really had a chance to dislodge the British from Newport.

This project, the culmination of many earlier events and works, will be the first in-depth analysis of the battlefield from the Siege of Newport, in Middletown, Rhode Island. Using
historic resources and scientific analysis, the remnants of British and American defenses will be identified, the effectiveness of the cannons (both in range and power) will be studied, and the viability of the campaign will be analyzed. The aim is to create a resource for anyone going forward who wants to better understand where and how this significant portion of the battle played out, what physical evidence remains, and how likely victory would have been had circumstances been different. It will answer any lingering questions over the origins of remaining fortifications, give accurate context for any future discoveries, and provide a cannon study model that can be applied to other existing battlefields.
Introduction

On July 29, d’Estaing’s formidable fleet, which included twelve ships of the line, four frigates and several small crafts, was sighted off the Rhode Island coast.\footnote{DFM, 2: 319.} Forming a line of battle in preparation to enter Narragansett Bay, d’Estaing anchored and awaited word from the Americans. He had originally planned to act quickly and take the British by surprise but held off at news that Sullivan’s force was still trickling into camp and his numbers small.\footnote{McBurney, 83.} Eventually, Sullivan was taken out to the Languedoc to discuss plans for recapturing Newport.\footnote{Hattendorf, 15.} Their original plan called for a pincer movement to divide British troops stationed at either end of the island, with American troops landing on the east side and French from the west.\footnote{McBurney, 87.}

Meanwhile Sullivan’s army, which would eventually include 10,000 men from Continental Army units and various militias, had been gathering in Tiverton across the Sakonnet River\footnote{The east passange of Narragansett Bay, running between Aquidneck Island to the west and the mainland towns of Tiverton and Little Compton to the east.} from Portsmouth where the British were positioned (See Appendix A for the full Order of Battle). From there, the Americans had been easily able to observe the British and had detailed information about the terrain and disposition of their forces. The closest point of transit between the mainland and Aquidneck Island was Howland’s Ferry, a narrow passage of the Sakonnet River between Tiverton and the eastern side of Portsmouth (Figure I.1). It was located not far from Tiverton’s Nannaquaket Pond, which would serve as a good mustering place for the large number of boats needed to invade the island.
Figure I.1 Sketch by Lt. Frederick Mackenzie, as seen in his diary. The Americans gathered at Tiverton and would eventually cross by flatboat to Portsmouth at Howland’s Ferry (circled in red).  

36 DFM, 1: 133-134.
Figure I.2 Sketch of forts on the north end of Aquidneck Island by Lt. Frederick Mackenzie, as seen in his diary. British fortification were built mainly on high ground, where they could monitor the Americans’ activities in Tiverton.  

37 DFM, 1: 172-173.
With the arrival of the French in Rhode Island waters and Americans gathering across the river from Portsmouth, the British needed a plan. General Pigot knew the terrain of the island well. It had been mapped by Charles Blaskowitz and his team of surveyors in 1770 and Lieutenant Edward Fage kept the General’s maps current. Pigot had men stationed at the northern portion of the island with four strong earthen redoubts in Portsmouth (Figures I.2 and I.3), and additional forces on Conanicut Island, but their main objective was to defend Newport, not all of Aquidneck Island. Controlling the entire island helped to maintain their foothold in Newport but Middletown and Portsmouth were mostly comprised of farmland, and had few useful resources left to offer. The port was the reason the British were there and Pigot grew concerned that with portions of his forces stationed to the north and elsewhere, his troops could be split up and beaten. He sent to New York for help but the French fleet jeopardized his

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39 Also known as Jamestown, RI, it is the second largest island in Narragansett Bay and is located between Aquidneck Island to the east and the mainland to the west.
supply line. The decision was finally made that all outlying British forces must withdraw from their positions and return to Newport should the French fleet enter the bay. The British objective now was to hold the port at Newport until reinforcements could arrive.

With a new strategy in place, the British hastily began making preparations for battle. More of an administrator than a campaigner, Pigot made his decisions in part based on intelligence from men he had recently interrogated, including one who claimed Sullivan had 20,000 American troops *en route* to invade the island.\(^{40}\) This dwarfed Pigot’s force of roughly 5,500 regulars and some Loyalist troops. The British had also captured two Jamestown residents that claimed Sullivan had 15,000 men, further fueling their belief that the American force was larger than it actually was.\(^{41}\) As a result, the British troops were kept busy building an abbatis\(^ {42}\) for their defensive line around Newport and clearing fields in anticipation of an American attack.\(^ {43}\) Pigot ordered two battalions of Hessian and Brown’s Regiment of Provincials to evacuate their guns and positions from Conanicut Island and return. With a shortage of oxen to move the artillery, the cannons were spiked and some pushed off the island into the water, rather than let them fall into enemy hands.\(^ {44}\) The 54th Regiment was recalled to Newport to thicken the parapet\(^ {45}\) of the harbor-facing North Battery. General Francis Smith, stationed in Portsmouth, sent baggage and all guns back to Newport.\(^ {46}\) To create further barriers for the French, the British scuttled four of their own supply ships (the *Cerberus*, *Orpheus*, *Lark*, and *Pigot Galley*, with more to be scuttled later) in the harbor by running them aground and setting them on fire.\(^ {47}\)

\(^{40}\) *DFM*, 2: 325. In actuality, there were about 10,000 American troops in Sullivan’s army.

\(^{41}\) *DFM*, 2: 345.

\(^{42}\) A barrier of cut trees with sharpened branches toward the enemy.

\(^{43}\) *DFM*, 2: 326.

\(^{44}\) *DFM*, 2: 321.

\(^{45}\) A protective wall or earth defense along the top of a trench or other place of concealment for troops.

\(^{46}\) *DFM*, 2: 328.

\(^{47}\) *DFM*, 2: 329-330.
The crews, organized into a battalion, would eventually be put to use in the gun batteries. By August 6, Admiral Richard Howe was en route from Sandy Hook with thirty-five warships to defend Newport.49

The French fleet sat off shore, awaiting direction and d’Estaing pressured Sullivan to act. He had hoped to act quickly, before the British fleet could arrive, and was now growing impatient. Sullivan, did not disagree but was stuck awaiting the arrival of more militia and the construction of the boats needed to transport the Americans to the island.50 Until his force was large enough and their transportation secured, he could not justify taking action. On August 3, word came via dispatch that a British fleet was on its way to attack the French. American officers were directed to prepare their men.51 A day later, 100 oarsmen with officers moved boats to Tiverton.52

The next series of maneuvers, on both sides, set the stage for the battle to come. On August 8, d’Estaing’s warships entered Narragansett Bay via the east passage and engaged in a gun battle with British shore batteries.53 When the fleet advanced, Pigot gave the order for all troops to withdraw from the north of the island and pull back to the British defensive line near the Newport-Middletown border.54 The maneuver would take roughly three hours at standard marching conditions (30 inch steps, 100 steps to the minute). Both the east and west roads could

48 Commander of naval forces during the American Revolution and brother to General William Howe, who commanded the land forces.
49 Hattendorf, 15.
50 McBurney, 103, 108.
52 Fletcher, 29.
53 DFM, 2: 339.
54 DFM, 2: 339.
be used and the troops from the east defenses would evacuate via Bramans Lane to East Main Road then down East Main Road to Newport.\textsuperscript{55}

As the British troops pulled back to Newport on August 8, American troops moved to occupy positions in Portsmouth. American scouts appeared near British lines and were fired upon by cannon at Irish’s and Card’s Redoubts. At this point the area east of the British front line, where Bailey’s Brook meets Easton’s Pond, was shallow and the north 400 feet were fordable.

In the meantime, d’Estaing had disembarked his troops on Conanicut Island, and went ashore to assess the situation.\textsuperscript{56} After receiving a report that the British fleet was approaching the bay, he determined it was too dangerous to dismount his main artillery.\textsuperscript{57} Sullivan sent word to d’Estaing of the shift in British forces and requested immediate support. Initially, he agreed and urgently made plans to land on Aquidneck. Then on August 9, Admiral Howe’s fleet was spotted anchored off Point Judith,\textsuperscript{58} leaving d’Estaing feeling vulnerable in the bay.\textsuperscript{59} On August 10, the course of the battle changed dramatically. As the Americans, now in Portsmouth, prepared themselves for battle, d’Estaing made a fateful decision. Fearful of being outmaneuvered and trapped in a foreign harbor, he left Newport to pursue Howe on the open ocean.\textsuperscript{60}

The Americans had largely been in good spirits since the arrival of their new ally, and d’Estaing’s pursuit of Howe had not dampened Sullivan’s outlook much. He assumed the

\textsuperscript{55} DFM, 2: 340.
\textsuperscript{56} Hattendorf, 15.
\textsuperscript{57} Hattendorf, 15.
\textsuperscript{58} A small cape on the southwestern side of Narragansett Bay, where it opens out onto Rhode Island Sound.
\textsuperscript{59} McBurney, 114; Hattendorf, 16.
\textsuperscript{60} Hattendorf, 17.
French fleet would defeat Howe and return to finish off the bombardment of Newport. So plans were made to march closer and begin the Siege in Middletown, while they awaited d’Estaing’s return. But on August 11, while the troops prepared to move out, rain started and over the coming days grew to gale force winds. Sullivan’s army of 10,000 now took cover wherever they could: some in abandoned British barracks, others in tents and some with no shelter at all.

While the storm slowed Sullivan’s advance down the island, it would prove much more damaging to d’Estaing’s fleet. On August 12, the powerful fleet was seriously damaged; the *Tonnant* and the *Marseillais* each lost two of their masts, and the *Languedoc*, d’Estaing’s flagship, lost all three as well as its rudder. “The skeleton of this beautiful vessel was drifting in silence at the mercy of the storm and the waves,” reported a soldier on another French ship. D’Estaing’s fleet, now scattered and still under occasional enemy fire, limped back to Narragansett Bay where he would consult with Sullivan and determine how to proceed.

Meanwhile, Sullivan’s army had weathered the storm and was now recovering in Portsmouth. It had been a cold, violent, rain but luckily claimed few if any casualties. As soggy soldiers attempted to dry themselves, fresh supplies of dry gunpowder began to arrive from Providence, Boston, and Connecticut. Their plans to leave for Middletown on August 11 had been delayed by the gale but by the morning of August 14, the rain had stopped and soon orders came down to prepare to march.

Scouting parties had gone ahead to provide Sullivan with information about his options and he had decided on Honeyman Hill, which was east of and higher than the British position on

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61 McBurney, 135.
62 McBurney, 136.
63 McBurney, 127.
64 Quoted in McBurney, 127.
65 McBurney, 137.
66 McBurney, 138.
Bliss Hill. The troops stepped off at 6 am, making their way down the island in three separate columns (Figure I.4). Brigadier General James M. Varnum’s Brigade came down West Main Road and Brigadier General John Glover’s Brigade on East Main, with Brigadier General Ezekiel Cornell and Colonel Commandant Christopher Greene’s Brigades between them. The lead units arrived at Honeyman Hill after roughly a 2.6 hour march at 8:36 am. Although the French had not yet returned, Sullivan’s army began to dig in and prepare to lay siege to the British on Bliss Hill.

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67 The standard marching rate of the Continental Army was 30 inch steps and 100 steps per minute (equating a speed of 2.84 miles per hour).
Figure I.4 Marching paths of Sullivan’s army from their camp in Portsmouth to Honeyman Hill.\textsuperscript{68}

Chapter 1 Detailed Description of the Battlefield at the Beginning of the Engagement

1.1 Position at the Start of the Siege

1.1.1 British Position

When the Americans were busy regrouping on the north end of the island, the British wasted no time in better fortifying Newport. They completed two lines of defense along the outskirts of town, to protect against attacks from the north (Figure 1.1). The first line was steep and would make infantry attack difficult. It was built along high ground in Middletown, west of Valley Road and Easton’s Pond, known as Bliss Hill. Among the defenses facing east, were three redoubts, Card’s, Dudley’s and Bannister’s, and two sunken gun batteries (a 7-gun and a 10-gun battery) (Figure 1.2). From there, the line continued north toward Two Mile Corner, turning west at Irish’s Redoubt and ending at Tonomy Hill (Figure 1.2). The dirt from the ditch, which connected the defenses, was piled on top to make a wall four feet high and six feet thick and an abattis was constructed 40 yards in front of the line, providing an extra obstacle for anyone who tried to storm the area. The second defense was the inner line, constructed closer to town in Newport (Figure 1.1). It went from Easton’s Beach, north along Easton’s Pond, and to the junction of Bliss Road and West Main Road. It then turned toward the harbor and ended at the North Battery. The harbor also had additional protection from batteries at Brenton Point (where today’s Fort Adams is located) and on Goat Island. (See Appendix B for additional maps of the battlefield).

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A small detached outwork as part of a larger defensive plan, usually square without defensive flanks. Could also be polygonal or hexagonal shapes.
Figure 1.1 Key terrain features and locations of the British 1st and 2nd lines of defense built in 1778, for the defense of Newport. The inner line was constructed in Newport and the majority of the outer line was in Middletown. Both lines included redoubts, trenches, gun batteries and abattis.\textsuperscript{70}

\textsuperscript{70} Abraham D’Aubant, \textit{Plan of the town and environs of Newport, Rhode Island / Exhibiting its defenses}, 1779, William L. Clements Library, University of Michigan.
Figure 1.2 Key defensive features of the outer line (circled in red), built by the British for the defense of Newport. The outer line was the one primarily involved in the Siege of Newport. Note, this map details both works used during the Siege and those completed afterwards. This includes Fort Fanning, which was completed in December 1778, and was not in existence during the Siege but is visible here.  

Edward Fage, Plan of the works, which form the exterior line of defence, for the town of New-Port in Rhode Island: Also of the batteries and approaches made by the rebels on Honeymans Hill during their attack in August 1778. This plan surveyed and drawn by Edward Fage, lieutt of artillery, November 1778. 1778. William L. Clements Library, University of Michigan.
1.1.2 American Position

Since the storm ended, Aquidneck Island had been trapped in a blanket of fog. Then, on the morning of August 18, as the fog cleared, British lookouts spotted American forces in Middletown. They were positioned on Honeyman Hill, east of Bailey’s Brook and across the valley from the British on Bliss Hill, and were hard at work constructing a battery. At 176 feet high, their position overlooked the British outer line giving them altitude advantage (Figure 1.3). The Americans built their camp and a secondary line safely beyond the range of the British first line batteries on the east side of Honeyman Hill (Figure 1.4).

At the beginning of the Siege, the Americans had few defenses constructed. Unlike the British who had had time to fortify, the Americans’ position in Middletown developed over the course of the Siege (Figure 1.5 shows what it would eventually look like, by August 26, 1778). At the beginning, though, Americans and British were not close enough to one another to be truly effective. Smoothbore cannon had a maximum range of about 2,000 yards but was only

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72 DFM, 2: 358.
73 Plan de Rhode Island et les différentes operations de la flotte-françaises et des troupes américaines commandées par le Major General Sullivan contre les forces de terre et de mer des Anglois depuis le 9 aoust jusqu’à la nuit du 30 au 31 du même mois 1778 que les Americains ont fait leur retraites, 1778, Library of Congress.
effective at ranges of less than 1,000 yards. The Americans would need to get closer to do any real damage but this meant losing the altitude advantage. Any closer batteries they built would also be in the range of the British, who would be able to engage the new, closer gun emplacements.

Figure 1.4 Positions of combatants during the Siege.

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75 A military installation consisting of a prepared position for siting a weapon.
76 Capitaine Michel du Chesnoy, *Plan de Rhode Islande, les differentes operations de la flotte francoise et des trouppes Americaines commandees par le major general Sullivan contre les forces de terre et de mer des Anglois depuis le 9 Aout jusqu’a la nuit du 30 au 31 du meme mois que les Americains ont fait leur retraite 1778. 1778.* Library of Congress.
1.1.3 American Observations of the British Lines

The battlefield from the American viewpoint, which was on average about 83 feet higher than the British positions, showed Card’s Redoubt (74 feet high as the closest British fort) at the edge of the first rise above the pond at a range of 1,500 yards. The second feature was the line of redoubt fronted by an abbatis at 1,700 yards, and at its southern end, a 10-gun battery (113 feet high) at a range of 1,800 yards. The terrain between them, normally passable where Bailey’s Brook meets Easton’s Pond, was now overflowing with runoff from the storm.

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77 *DMF*, 2: 372-373.
78 *DFM*, 2; Based on calculations as measured in Google Earth.
79 *DFM*, 2; Based on calculations as measured in Google Earth.
1.2 Terrain Related Obstacles

1.2.1 Effects of the Storm on the Terrain

A number of obstacles thwarted the Americans’ pursuit of the British. Between the positions on Bliss and Honeyman Hill, runoff from the hurricane had created two major barriers. The storm-swollen Easton’s Pond (stretching from Easton’s Beach to the crossing at Green End) was now wider and deeper, and Bailey’s Brook had been transformed into a marshy wetland. Before the storm, which lasted August 11 – 13, the pond and brook were low and would have been easily passable (Figures 1.6, 1.7). After the rains, the valley was full beyond capacity, making it a serious obstacle (Figure 1.8).

Figure 1.6 Easton’s Pond and Bailey’s Brook under normal conditions, from a map by C. Blaskowitz, 1770.  

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80 Charles Blaskowitz, *A topographic chart of the bay of Narragansett in the province of New England, with all the isles contained therein, among which Rhode Island and Connomicut have been particularly surveyed, shewing the true positions & bearings of the banks, shoals, rocks &c. as likewise the soundings, to which have been added the several works & batteries raised by the Americans: Taken by order of the principal farmers on Rhode Island.* (London: Wm. Faden, Caring Cross, 1777). William L. Clements Library, University of Michigan.
1.2.2 Other Approaches

There were two alternate routes as well but they were well defended and would not be feasible. The west side of the approach to Newport, from Middletown, included a large expanse of open space to the north of the British defense line. The position from Tonomy Hill (152 feet

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high) commanded this relatively flat terrain, where large formations could be engaged out to 2,000 yards, making an attack from this side nearly impossible. The Americans also controlled the eastern end of Easton’s Beach but the west side proved formidable with a 1,300-yard stretch of sand in front of a British redoubt with cannon and abattis. These alternate routes were far too dangerous, and so the swamped valley, although not ideal, would be their only option.

1.2.3 Decisive Terrain

The decisive terrains in this conflict were:

a. Howland’s Ferry and associated land in Portsmouth: This area was needed by the Americans as a supply line and evacuation route. It was protected by the redoubts on the north end of the island and French frigates in the Sakonnet River.

b. The road across the north end of Easton’s Pond: This path was needed by the Americans as an avenue to attack if they were to go after the south end of the British defense line. The British needed to control it and the area north along Bailey’s Brook to stop the Americans from getting across the valley and attacking the defense line.

c. Easton’s Beach: The Americans held the east end of Easton’s Beach but if they could control the west side, they could attack the south end of the inner British defense line.

d. The lower slope of Honeyman Hill: The Americans needed this area to get closer to the British lines. Both so that their cannon could be in effective range, and to get American troops in striking distance, should they disable the British artillery.

1.3 Cover and Concealment

1.3.1 American Position
As a position, Honeyman Hill was a double-edged sword, providing cover for the back end of the operation but nothing else. The west side, facing the British lines, had very little cover. Only a few trees remained from the hill’s pre-war use as an orchard and the British had burned twenty houses to eliminate all other shelter. The area around Easton’s Pond and Bailey’s Brook was worse; it had been open farmland and had little to no cover. To remedy this shortcoming, most of the movements, scouting and repairs, were done under cover of darkness. Cannon, and the supplies needed for them, were moved in and out of their emplacements at night. During the day, trenches and batteries being dug doubled as cover for those doing the work. When there was a flash of British artillery the Americans dropped to the bottom of the trench until the sound of the cannonball reached them and when all was clear, they returned to their work.

Although their position on Honeyman Hill was not ideal, it is likely a decision made based on French involvement. Historian Christian McBurney explains, “Sullivan probably positioned his army as he did in order to accommodate d’Estaing’s troops, on whose return and participation he still counted. He may have further expected the more experienced French to make the initial assault on Pigot’s left, thereby eliminating the necessity of a more risky American attack to the east.” Given that Sullivan began the Siege under the assumption that the French would defeat Howe’s fleet and rejoin them in time, McBurney’s theory makes sense. It also may help explain Sullivan’s frustration later when things did not go as planned.

What the Americans lacked in cover and concealment on the front lines, they made up for on the north and east sides of the hill, which they used to their advantage. These areas were out of sight of the British and out of range of their artillery, making it a strategically safe location for

82 McBurney, 110.
83 McBurney, 141.
camp. The supply lines on East Main Road were also beyond the sight of the British, allowing the Americans to move troops, cannon, and supplies in and out of camp without risking observation.

1.3.2 British Position

Earlier, when the Americans were consolidating their forces at the north end of the island, the British (already in Middletown) had built a revetment\textsuperscript{84} and a ditch that extended the entirety of their outer line. This provided cover for cannon and small arms fire. The wall was made of compacted dirt four feet high and six feet thick, and provided protection and concealment for troop movements along the top of the hill to and from the various redoubts and batteries.

1.3.3 Evaluation of Potential Dead Spaces

There were no dead spaces on the American side of the valley but this was not the case for the British. Positioned high atop a steep bank, there were several areas the British cannon could not fire on (Figure 1.9). If American troops could move across the top of the pond after dark to muster in the dead zone, they theoretically could have captured the 10-gun battery and Card’s Redoubt. The cannon in the 10-gun battery could then have been turned to enfilade\textsuperscript{85} the British line. This would open the line for a general attack. The Americans would have needed a regiment of grenadiers or other specialized assault troops to carry out this type of mission, but there is no indication they had any of these. This makes it less likely that such a maneuver would have been successful and could be the reason one was not attempted.

\textsuperscript{84} A barricade of earth or sandbags set up to provide protection from blast, protecting a rampart, wall, etc.

\textsuperscript{85} A volley of gunfire directed along a line from end to end.
Figure 1.9 The 1778 Fage map has had topographic lines laid over it to show the hills and valley involved. To demonstrate where the potential dead spaces would have been on the battlefield, the straight red lines show the direction the cannons would have fired from each of the redoubts.\textsuperscript{86}

\textsuperscript{86} Fage, \textit{Plan of the works}, 1778. William L. Clements Library, University of Michigan.
Chapter 2 Evolution of the Siege & Cannon Analysis

2.1 Evolution of the Siege

2.1.1 American and British Objectives

Success for both sides was completely dependent on artillery as the battle unfolded. The British had guns spread throughout their outer line but the Americans needed to specifically disable those at Card’s Redoubt and the 7 and 10-gun batteries (Figure 2.1), which protected the south end of the battlefield (Figure 2.2, left side). If this could be accomplished, they could safely cross the swamped valley and turn the guns of the British southern flank against the rest of the line. The British firing back needed to do everything in their power to prevent this. Despite cannonading the enemy for days, the Americans failed to disable their three main targets.

Figure 2.1 The 7- and 10-gun batteries at Green End, as seen on the 1778 Fage map.87

Figure 2.2 Location and elevation of British (left) and American (right) batteries and connecting trenches are seen marked in red on this topographic map. British positions at Card’s Redoubt (70 ft.), the 10-gun battery (90 ft.), and the 7-gun battery (102 ft.) are the works to the left (west) of Easton’s Pond. The American batteries, #1 (178 feet), #2 (160 ft.), #3 (126 ft.), and #4 (108 ft.) and the trench works connecting them on Honeyman Hill are to the right (east) of the pond.88

2.1.2 Establishment of American Gun Batteries

Unlike the British, who were afforded the time to fortify in advance, the Americans developed their fortifications over the course of a week while conducting the Siege (Figure 2.2). Batteries 1 and 2 (Figure 2.3 A and C) were constructed on August 17 and 18, just before their operations in Middletown had been detected. By the 19th, both of these batteries were in working order and firing 18 pound guns at the British. Despite their altitude advantage, the Americans were still out of effective range (roughly 2,000 yards out) and needed to work their way closer to the enemy lines. Over the following days, while ducking in and out of the trenches to avoid cannon fire, a series of new batteries and trench works were built, creeping down the western slope of Honeyman Hill (Figure 2.3). Batteries 3 and 4 (Figure 2.3, E and F) were constructed within 1,000 yards of the British front lines and were firing by August 23. Even at this closer range, the 18-pound cannon still failed to penetrate the six-foot-thick British revetment (Figure 2.4). Simulations and analytical models were assessed to understand why the British retained their revetment, and the details of these analyses are listed later in this chapter.

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89 *DFM*, 2: 361
Figure 2.3 American approach (top) down Honeyman Hill, toward British lines (bottom). The letters along the American trenches show various works. Batteries A and C were constructed first, soon followed by E and F.  

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2.1.3 British Fields of Fire

The British had at least 44 cannon set up across the outer line, from the 10-gun battery to Tonomy Hill. Figure 2.5 shows the distribution of this artillery, which included two 6-pound, two 8-pound, 28 12-pound, seven 18-pound, five 24-pound guns. These cannon were arranged in interlocking fields of fire that would have been effective against an attack by the American infantry across Bailey’s Brook. Figure 2.6 illustrates this coverage and the field of fire the Americans would have faced if they had tried to storm across the swamped valley. The British guns had an effective range of 1,000 yards and a maximum range of roughly 2,000. Since the American batteries #3 and #4 were within 1,000 yards of the British line, Bailey’s Brook was well within range, so the British interlocking fields of fire would have annihilated any force that tried to storm across.
Figure 2.5 Cannons throughout the British front lines labeled on the 1778 Fage map.\textsuperscript{91}

Figure 2.6 British interlocking fields of fire. The cannon were effective at a range of roughly 1,000 yards.\(^2\)

To provide the coverage, the British redoubts were constructed with gun ports facing left, center, and right. Card’s Redoubt was the one exception. Perched east of the connected batteries and redoubts that made up the British outer line, on the steep Green End area of Bliss Hill, its gun ports faced left and right only (north and south) (Figures 2.7). If the Americans did manage to get across the valley and attempt to scale Green End, the cannon at Card’s Redoubt would have a clear shot to stop these assailants. Further, Card’s right (southeast) port (Figure 2.6, green), covered the blind spot at the base of Green End Avenue.

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\text{Figure 2.7 Card’s Redoubt wooden gun decks and gun ports were about +/-30 degrees.}^{93}
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2.1.4 Elevation Considerations

The British were using 12-pound field guns mounted on carriages so that they would move smoothly back with the recoil. Both the British and American gun positions had wooden decks to allow the guns to move easily and to be aimed roughly +/- 30 degrees from the direction.

\footnote{Fage, \textit{Plan of the works}, 1778. William L. Clements Library, University of Michigan.}
of the axis of their gun port. The British had to elevate the cannon muzzle to 6 degrees to reach the American batteries at #1 and #2 but could not deliver accurate fire (elevation shown in Figure 2.2). A lower elevation was used against #3 and #4. In all cases the British cannons were ineffective against the American gun batteries. Likewise, the American 18-pound cannon (Figure 2.8, Figure 2.9 shows a 6-pound gun) continued firing on the British to no avail. The technical supplement provided in Appendix G asserts that properly adjusting the angle at which the cannon is fired for the desired position downfield is crucial for hitting a target. Inexperienced artillerymen or platform damage could cause a change in angle when firing, leading to improper angle adjustment. Analytical models were used to simulate the cannon fire for the geography at Honeyman Hill to reveal the exact nature of the inaccuracy caused by inexperience and damage, discussed in detail in the technical supplement located in Appendix G.

\[\text{Figure 2.8 British 18-pound field guns.}^{94}\]

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\(^{94}\) Peterson, 44.
2.2 Cannon Analysis

The technical data used in this chapter pulls from a study and analysis on the artillery used by the Americans, including its range, trajectory, power, accuracy, and the ability to penetrate (or not) earthen fortifications. A full detailed technical report, including the MATLAB\textsuperscript{96} simulation code and results, is available in Appendix G.

2.2.1 Analysis of Smooth Bore Cannon

Information pertaining to the performance of 18th century smooth bore cannons is very limited and mostly anecdotal. The first works on cannon ballistics were completed by Benjamin

\textsuperscript{95} Peterson, 39.

\textsuperscript{96} Engineering software produced by MathWorks in Cambridge, MA, used to solve engineering and scientific problems. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.
Robins, an Engineer General to the East India Company.\textsuperscript{97} Robins’ work was revised and published by Dr. A.R. Collins.\textsuperscript{98} This work, with minor corrections and adjustments, was used as the principal reference for MATLAB programming thus used to generate the figures for this report. A verification of the software came from the recovery of a 12-pound British cannonball (Figures 2.10 and 2.11) recovered from a garden on Turner Road in Middletown, RI.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{cannonball}
\caption{A Middletown resident holds the cannonball he recovered from his Turner Road property (right). He has verified the location where it was found and has since donated the artifact to the Middletown Historical Society. It has since been identified as a 12-pound British cannonball that was likely fired at the American’s positioned on Honeyman Hill (left). Photo by author.}
\end{figure}

\textsuperscript{97} Benjamin Robins, \textit{New Principles of Gunnery containing The determination of the Difference in the Force of Gunpowder and The resisting power of air to swift and slow motions.} 1750, Republished in 1805 with corrections by F. Wingrave in the Strand, London.

This outcome provided confidence that the simulation, based on Robins and Collins, could be used to analyze the performance of other cannons used in the battle. Results of the simulation were also paired with a recovered cannonball fired from Bannister’s Redoubt mentioned in the diary. Figure 2.12 shows a recovery distance of 1,890 yards. The simulation shows that firing at about 5.5 degrees would result in a travel distance of about that length (Figure 2.13).
Figure 2.12 The distance from Banister’s Redoubt to the recovery location is 1,890 yards.\footnote{As measured by Google Maps (Yellow line)}
Figure 2.1 shows tabulated results from the MATLAB simulation beyond just the angle of attack. These results were used to assess variability in ballistics for cannonballs of varying mass and initial parameters, such as gunpowder quality and firing angle, as well as penetration of the cannonball into fortifications.
Figure 2.1

Tabulated results from MATLAB simulation for a 12-pound cannonball. Results shown include mass, diameter, area, soil index, % tangent ogives nose performance, % soft soil for weight < 60 pounds, velocity, range, total kinetic energy, penetration of soil in feet, and penetration of soil in inches.

Figures 2.15 through 2.17 show the MACH number, velocity, and Reynolds number\(^{100}\) versus distance for the 12-pound cannonball.

\(^{100}\) A dimensionless number that gives a measure of the ratio of inertial forces to viscous forces for given flow conditions. The Reynolds number is an important parameter that describes whether flow conditions lead to laminar or turbulent flow.
Figure 2.15 MACH number of a 12-pound cannonball versus distance traveled post firing. The cannonball exits the muzzle at a velocity of 1,359 feet per second. That is a speed of MACH 1.26.

Figure 2.16 Velocity of a 12-pound cannonball versus distance traveled. The terminal velocity was about 560 ft./sec.
2.2.2 Penetration and Range

The American cannons had to be able to disable the British artillery that were riveted on the west side of the valley. To do this, the cannons would have to send a ball with enough energy to penetrate six feet of dirt and have enough energy left to damage the British guns and crews beyond the revetment. Figure 2.18 shows a cannonball penetrating into a revetment with insufficient energy to break through the fortification. Alternatively, cannon fire would have to repeatedly target the same area on the revetment\(^{101}\) as to cumulatively administer enough damage to break through the defenses.

\(^{101}\text{A barricade of earth or sandbags set up to provide protection from blast, protecting a rampart, wall, etc.}\)
Penetration data for field guns of various sizes can be seen in figure 2.19, while common cannonball sizes can be seen in figure 2.20.

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103 As referenced in Dictionary of Fortification: Penetration, Solid Shot.

Note that the shot sizes in the penetration table do not match the British standard sizes. In fact, the data was generated by the French. There was initial doubt as to the accuracy of the data in Figure 2.19 and some way needed to be found to verify it.

In 1997 Sandia National Laboratories funded a study to define the equations necessary to determine the best way to penetrate the various forms of bunkers. The equations were used by Dr. Aaron Bradshaw to check the data in Figure 2.19. He produced a MATLAB script to predict the penetration capability of the American cannon. Results from the simulation found in his script can be seen in figures 2.21 and 2.22. “S” in these figures refers the penetrability of the soil. Dr. Aaron Bradshaw denotes an index between 8 and 10 as being soil fill material. The degree to which the soil is compacted causes the index to range between 8 and 10.

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106 C. W. Young *Penetration Equations* SAND97-2426, October 1997.
Figure 2.21 Penetration as a function of range for various degrees of soil compaction, S. Note that the historic data is also plotted in the figure for comparison.

Figure 2.22 Penetrations as a function of impact velocity for various degrees of soil compaction, S. Note that the historic data is also plotted in this figure for comparison.
The historic data falls between the soil conditions shown in figures 2.21 and 2.22, indicating agreement between the empirical data from 1750 and the empirical data from Sandia Laboratory in 1997. Figure 2.22 displays a proportional relationship between impact velocity and depth of penetration; a roughly linear relationship. Therefore, a higher impact velocity is needed to penetrate farther into the revetment.

Table 2.1 shows the range between the different batteries and the British positions for reference when approximating penetration.

<table>
<thead>
<tr>
<th>Battery</th>
<th>Card's Redoubt</th>
<th>7-Gun Battery</th>
<th>10-Gun Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1.29</td>
<td>1.6</td>
<td>1.526</td>
</tr>
<tr>
<td>#2</td>
<td>1.23</td>
<td>1.375</td>
<td>1.305</td>
</tr>
<tr>
<td>#3</td>
<td>0.92</td>
<td>1.03</td>
<td>0.97</td>
</tr>
<tr>
<td>#4</td>
<td>0.7625</td>
<td>0.95</td>
<td>0.92</td>
</tr>
</tbody>
</table>

From Figure 2.19, the range at which an eighteen-pound cannonball would penetrate six feet of dirt (72 inches) would be 50 yards for a soil compaction index of 8, and 300 yards for a soil compaction index of 10. The American cannon, even when fired from the most forward batteries (#4 to Cards Redoubt, #3 to Cards Redoubt, and #4 to 10 Gun Battery) are not close enough to the enemy revetments to achieve the necessary penetration of six feet to break through to the artillery.

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107 Fage, Plan of the works, 1778. William L. Clements Library, University of Michigan.; Based the map and its distance scales.
The French fleet abided by a 1732 ordinance, which standardized French cannons as 24-, 16-, 12-, 8-, and 4-pounders. The 24-pounder had a 5-2/3 inch bore, a 9-foot 6-inch long barrel, and weighed 5,400 pounds. Admiral d’Estaing’s warships carried 24-pound and 36-pound cannon. Table 2.2 below shows the quantity of guns Admiral d’Estaing carried on his warships.

Table 2.2 Guns aboard d’Estaing’s Languedoc, Tonnant and Cesar.\textsuperscript{108}

<table>
<thead>
<tr>
<th>Ship</th>
<th>Guns</th>
<th>Draft</th>
<th>Number and Type of Gun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languedoc</td>
<td>80</td>
<td>25</td>
<td>30 x 36-pound, 32 x 24-pound, 18 x 8-pound</td>
</tr>
<tr>
<td>Tonnant</td>
<td>80</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Cesar</td>
<td>74</td>
<td>22</td>
<td>28 x 30-pound, 30 x 18-pound, 18 x 8-pound</td>
</tr>
</tbody>
</table>

If the French 36-pound or 24-pound cannon could have been made available from the Languedoc and used from Honeyman Hill positions #3 and #4, the damage to the British artillery would have been increased. For the most compact soil (8) a:

- 36-pound cannon in Battery #4 would penetrate Card’s Redoubt to 92.95 inches
- 36-pound cannon in Battery #4 would penetrate 7-gun Battery to 83.8 inches.
- 24-pound in Battery #4 would penetrate Cards redoubt to 62 inches
- 24-pound gun in Battery #4 would penetrate 7-gun Battery to 60.9 inches

From this analysis, it can be concluded that the 24-pound gun would have been effective at penetrating the defenses. The British hauled water to their earthworks to wet them down and maintain their stopping power. To be effective against the British defenses that were 72 inches thick, the Americans would need 36-pound cannon in the advanced gun batteries (#3, #4).

\textsuperscript{108} Hattendorf, 5-8
Table 2.3 below shows the various altitudes and effective ranges for the different batteries, forts and guns in the battles.

Table 2.3 Range of the American batteries to their British targets, with the altitude of each position listed in parenthesis following its name.\textsuperscript{109}

<table>
<thead>
<tr>
<th>Batteries</th>
<th>Card's Redoubt (70 ft.)</th>
<th>7-Gun Battery (112 ft.)</th>
<th>10-Gun Battery (88 ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 (176 ft.)</td>
<td>1.288 kyd.</td>
<td>1.527 kyd.</td>
<td>1.583 kyd.</td>
</tr>
<tr>
<td>#2 (158 ft.)</td>
<td>1.778 kyd.</td>
<td>1.381 kyd.</td>
<td>1.381 kyd. (1.350)</td>
</tr>
<tr>
<td>#3 (132 ft.)</td>
<td>0.891 kyd. (980)\textsuperscript{110}</td>
<td>1.094 kyd.</td>
<td>1.091 kyd. (960)</td>
</tr>
<tr>
<td>#4 (124 ft.)</td>
<td>0.760 kyd. (780)</td>
<td>1.005 kyd.</td>
<td>1.032 kyd (1150)</td>
</tr>
<tr>
<td>#5 (120 ft.)</td>
<td>0.847 kyd.</td>
<td>1.111 kyd.</td>
<td>1.15 kyd.</td>
</tr>
</tbody>
</table>

\textbf{2.2.3 Cannon Ball Placement Errors}

There are a number of considerations that will influence the deviation of the cannonball in flight, preventing it from accurately hitting a target. The cannons were mounted on a gun carriage above the center of gravity of the combined structure, causing the firing of the cannon to impart a torque on the cannon and carriage. The wheels of the gun carriage may not have the same starting torque when the cannon is fired and it may change with time, causing the cannon or structure to move after the resultant impulse from firing. Furthermore, this torque and impulse may damage the carriage over time, leading to sway of the muzzle when firing, which would lead to inaccurate aiming of the cannon. The gunner sighting the cannon may also introduce both

\textsuperscript{109} Fage, \textit{Plan of the works}, 1778. William L. Clements Library, University of Michigan; \textit{Elevation Map of Middletown, Rhode Island}; Calculated distances as measured in Google Earth.

\textsuperscript{110} Based on \textit{DFM 2}: 385, values for Batteries 3 and 4 were interchanged. See red text.
azimuth\textsuperscript{111} and elevation errors (Figure 2.23). Additionally, variations in gunpowder quality due to moisture, manufacturing or other sources would cause variations in landing positions which could lead to inaccuracy. Finally, if the ball makes contact with the barrel, there may be a spin introduced that will cause the ball to take a curved trajectory. At low angles the effect is minimum. A sensitivity analysis was completed and recorded in the technical supplement found in Appendix G for each case mentioned above, as well as other parameters such as the presence of a cross-wind. This analysis was used to determine which elements of firing a cannon when varied would result in the most significant changes in ballistics.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{deviation.png}
\caption{Deviation as a function of elevation angle.\textsuperscript{112}}
\end{figure}

\textsuperscript{111} The angle of horizontal deviation, measured clockwise, of a bearing from a standard direction, as from north or south.

\textsuperscript{112} Stephen A. Jordon, \textit{Trajectory of a Cannonball}, located in Appendix G.
Below are various analytically-derived errors for the geometry of Cards Redoubt (Figure 2.24), as well as results from the MATLAB sensitivity analysis.

Sighting errors are:

\[
\begin{align*}
0.5 \text{ deg.} &= 8.73 \text{ yards at 1000 yards} & 0.79 \text{ inch off center at muzzle} \\
1 \text{ deg.} &= 17.45 \text{ yards} & 1.58 \text{ inch off center at muzzle} \\
2 \text{ deg.} &= 35.00 \text{ yards} & 3.17 \text{ inch off center at muzzle}
\end{align*}
\]

Elevation angle errors produce the largest range errors:

\[
\begin{align*}
0.8 \text{ deg} &= 904 \text{ yards (Delta of -95 yards)} \\
0.9 \text{ deg} &= 936 \text{ yards (Delta of -63 yards)} \\
1.0 \text{ deg} &= 967 \text{ yards (Delta of -32 yards)} \\
1.1 \text{ deg} &= 999.23 \text{ yards (Delta = 0)} \\
1.2 \text{ deg} &= 1030 \text{ yards (Delta of 31 yards)} \\
1.3 \text{ deg} &= 1061 \text{ yards (Delta of 62 yards)} \\
1.4 \text{ deg} &= 1092 \text{ yards (Delta of 93 yards)}
\end{align*}
\]
If one standard deviation (SD) of the aiming error is 0.5 degrees then the redoubt would subtend +/- 4 SD of the cross range error. If the standard deviation of the vertical angle is 1.26 degrees there will be 10% hits on the redoubt, which is what Mackenzie noted in his diary.

### 2.2.4 Technical Conclusions

Given their position, distance from and depth of the British earthen works, artillery available, and aiming errors, the Americans’ 18-pound cannon were not powerful enough to penetrate the enemy fortifications, and also likely to miss due to the number of impactful parameters (elevation, gunpowder quality, carriage damage, etc. More detail in the technical supplement) on cannonball trajectory, as well as the sensitivity of that trajectory to those parameters. If they had more substantial artillery, such as the 24-pound or preferably the 36-pound guns on d’Estaing’s *Languedoc*, the Americans could possibly have disabled Card’s Redoubt and the 7 and 10 gun batteries and changed the outcome of the battle.

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Chapter 3 The Disengagement

3.1 Lead up to the Withdrawal

3.1.1 D’Estaing Returns

On August 20, sails were spotted approaching the bay and word soon arrived that it was d’Estaing’s beleaguered fleet. Much to the Americans’ dismay, the French had returned to Rhode Island only as a courtesy and to communicate their plans. With severe damage throughout the fleet, d’Estaing felt they were in no condition to fight and intended to retreat to Boston for repairs.

Sullivan was horrified. The entire plan for retaking Newport, had been based on a joint effort of American and French forces. Now with that prospect behind them and British reinforcements en route, the outcome looked bleak. Additionally, d’Estaing wanted to withdraw his frigates stationed in the Sakonnet River, evacuate the American troops and end the Siege entirely. “To evacuate the island is death; to stay may be ruin” noted General Nathaniel Greene in a letter to a friend. Sullivan refused to end the Siege and in a last ditch effort to salvage what was left of the joint campaign, sent Greene, Lafayette, and Colonel John Langdon to the Languedoc to convince d’Estaing to stay or at the very least to provide additional troops. D’Estaing seemed to sympathize and was considering providing assistance but ultimately decided against it. Although the fleet was in his command, his fellow officers (captains of the individual ships) were adamant and at their urging d’Estaing made the decision

114 Abbass 1: 394.
115 Abbass 1: 395.
117 Abbass, 1: 395; McBurney, 151.
to sail on to Boston, leaving no aid to Sullivan’s army. In the end it seems d’Estaing couldn’t help but agree with his men. The French felt it was their first duty to preserve the fleet to fight another day.\(^\text{118}\) They also felt victory was not a mere few days away as Sullivan insisted.\(^\text{119}\)

The Americans’ high hopes had grown higher at the sight of the French, only to be dashed. This abandonment hit the troops’ morale exceedingly hard. The French had “…left us in a most Rascally manner…” wrote Colonel Israel Angell of the Continental Army.\(^\text{120}\) Several days later, in a letter to Washington, Greene recounted “…it struck such a panic among the Militia and Volunteers that they began to desert by shoals. The fleet no sooner set sail than they began to be alarm’d for their safety. This misfortune damp’d the hopes of our Army and gave new Spirits to that of the Enemy.”\(^\text{121}\) Additionally, d’Estaing’s decision revived old prejudices against their former enemy turned ally.\(^\text{122}\) The anti-French sentiments went all the way to the top. Sullivan was furious and insinuated the French were traitors, nearly coming to blows with Lafayette, who bore the brunt of the army’s bitterness.\(^\text{123}\) Sullivan went on to write a strongly worded letter of protest to d’Estaing detailing why he should not quit the campaign, which further fueled tensions between the allies.\(^\text{124}\) America’s new alliance was now turning into a diplomatic disaster.

Under the circumstances at hand, and after calming down, Sullivan did his best to assure the army to put their trust in him. An August 24 entry in the orders book shows that he attempted to address the concerns of his men, acknowledging and sharing in their disappointment.

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\(^\text{118}\) McBurney, 150.
\(^\text{119}\) McBurney, 151.
\(^\text{120}\) Israel Angell, *Diary of Colonel Israel Angell, 1778-1781*, ed. Edward Field (Providence: Preston and Rounds, 1899).
\(^\text{121}\) Greene, 2: 500, Greene to Washington, 28-31 August 1778.
\(^\text{122}\) During the previous decade, many colonists had fought under the British crown against the French during the French and Indian War.
\(^\text{123}\) McBurney, 153.
\(^\text{124}\) Abbass 1: 397.
but also reminding them not to be discouraged and to stay the course. “The Superiority we Shall maintain so long as the Spirit and desire of the Americans continues to be the Same that it was at the Commencement of the Enterprise.” The orders went on to explain that the arrival of British reinforcements was the only situation that would cause them to abandon the Siege, and that in the event of this unfortunate circumstance they would still have plenty of time to execute a safe retreat. It also emphasized that “…no Rash Steps should make a Sacrifice of them” and that “he [Sullivan] wishes them to place a proper confidence in him as their Commander-In-Chief whose business it is to attend to their Safety.” Finally, Sullivan addressed the desertions and ongoing plans, “it is with great grief and Astonishment the General finds a great number of Volunteers are about to leave the Island at this time and to give to America lasting proof of their wanting a firmness and bravery.”

A few days later, thinking better of his intemperate remarks and the importance of the alliance, Sullivan attempted to calm his troops’ animosity toward the French, by reminding them not to forget the significance and value of their aid. D’Estaing appreciated the retraction and even offered troops, to join the Americans by land but the damage was done. While the British were thrilled with the infighting, the episode had shaken the Americans. Although it would still go on for several more days, this spelled the end for the Siege. Now instead of trying to reclaim Newport, which Sullivan still held out hope for, the American sought to damage Pigot’s forces as best they could before making a safe retreat.

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125 Fletcher, 54, 24 August 1778.
126 Fletcher, 54, 24 August 1778.
127 Fletcher, 54, 24 August 1778.
128 Fletcher, 54, 24 August 1778.
129 McBurney, 154.
### 3.1.2 Preparations for the Retreat

Before the battle even began, the Continental Army had laid the groundwork in Portsmouth for a secure supply line and avenue of withdrawal. Although most of the French fleet had left in pursuit of Admiral Howe, three French frigates had been stationed in the Sakonnet River to protect this route, by way of Howland’s Ferry. They also adapted the former British defense works at Fort Butts in Portsmouth, to oversee and protect these lines (Figure 3.1).

![Figure 3.1](image_url)

*Figure 3.1 The Americans' defensive fallback position in Portsmouth, put in place at the beginning of the Siege to ensure a safe retreat, if needed.*

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130 Plan de Rhode Island et les differentes operations de la flotte-françoises et des troupes americaines commandées par le Major General Sullivan contre les forces de terre et de mer des Anglois depuis le 9 aoust jusqu'à la nuit du 30 au 31 du meme mois 1778 que les Americains ont fait leur retraite, 1778. Library of Congress.
By August 23, the Siege was already winding down and Sullivan began making preparations for a safe retreat, sending all useless and heavy baggage to the north end of the Island.\textsuperscript{131} Four batteries (16 cannon) had fired all day with no serious damage to the British artillery. Two days later, shells for their mortars were found to be too short and therefore defective, so the mortars had to be sent back to Tiverton as well.\textsuperscript{132} On August 27, all the militia and non-essential troops were ordered to the north end of the island (Figure 3.2, dark blue).\textsuperscript{133} The Americans waited until nightfall to remove the cannon from batteries #3 and #4, which were taken over Honeyman Hill to Portsmouth, via Green End Avenue and East Main Road.

### 3.2 The Withdrawal

#### 3.2.1 Action in Portsmouth

On August 28, fearing that British reinforcements could be nearing Rhode Island waters, the decision was made to pull back to the north end of the island. There they could await whichever would come first, assistance from the French or the need to retreat. After dark, the campfires were kept burning all night. The remaining troops on Honeyman Hill left camp in the early morning and departed for Portsmouth (Figure 3.2). Later that morning as the mist dissipated, the British observed an empty Honeyman Hill. General Pigot dispatched troops to assess the situation and pursue the Americans. General Richard Prescott led the 38th and 54th Regiments to Honeyman Hill via Easton’s Beach and found that it had indeed been completely deserted.\textsuperscript{134}

\textsuperscript{131} Fletcher, 53.
\textsuperscript{132} Fletcher, 57.
\textsuperscript{133} Fletcher, 58.
\textsuperscript{134} DFM, 2: 381.
With the abandonment of Honeyman Hill, the British snapped into action, immediately sending men up the island in pursuit of Sullivan’s army. The British troops marched up East Main Road and the Hessians up West Main, where they were ambushed *en route*, ultimately engaging in fierce fighting with American forces in prepared positions throughout the north end of the island.\(^{135}\) Colonel Angell recounted the day’s events in his diary,

…the enemy finding that we had left our ground pursued with all possible speed Come up with our piquet about sunrise and a smart firing begun, the piquet repulsed the British troops 2 or 3 times but was finily obliged to retreat as the Enemy brought a number of field pieces against them[.] the Enemy was soon check’t by our Cannon in coming up to our main body and they formed on Quaker Hill and we took possession of Buttses Hill the left wing of the british army was Compossed of hessians who Attackt our right wing and a Sevear engagement Ensued in which the hessians was put to flight and beat of the ground with a Considerable loss[,] our loss was not very great but I cannot ascertain the number.\(^{136}\)

As the two sides continued firing on and eventually cannonading one another, Lafayette set out for Boston on horseback to secure French aid. He made the trip in seven hours, and returned in six-and-a-half (a distance of 70 miles) with news that d’Estaing would send troops by land.\(^{137}\) Unfortunately it was too late. Earlier that morning word had come from Washington that the British fleet was on the move.\(^{138}\) It was time to retreat.

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\(^{135}\) Abbass, 1: 10-11.

\(^{136}\) Angell, 8.

\(^{137}\) Abbass, 1, 418.

\(^{138}\) Abbass, 1: 417.
Figure 3.2 Routes taken by the Americans up the island to Portsmouth and eventually across the Sakonnet River to Tiverton during their evacuation of the island. Note that the path to the north end cannot be observed from the British lines.\footnote{Plan de Rhode Island et les differentes operations de la flotte-fran\c{c}aises et des troupes americaines command\e es par le Major General Sullivan contre les forces de terre et de mer des Anglois depuis le 9 aoust jusqu\a la nuit du 30 au 31 du meme mois 1778 que les Americains ont fait leur retraites, 1778. Library of Congress.}
3.2.2 The Evacuation and Deception Methods

Similar to their withdrawal from Honeyman Hill, deception methods were used to safely move Sullivan’s force off the island. With tents pitched to mislead the enemy, all non-essential material and militia personnel were transported first. Meanwhile, in Portsmouth, Continentals were positioned to provide a rear guard for the remaining militia as it departed via the boatlift at Howland’s Ferry. The mobility corridor consisted of the same 100 rowboats that had transported them to Portsmouth in the first place. The final withdrawal happened under cover of darkness, when the remaining rear guard left camp for Tiverton by the boatlift. Initially, when the British heard the boats crossing at Howland’s Ferry, they worried the Americans were going down river to attack from the rear and trap them at the north end of the island, but General Pigot determined they were actually retreating to Tiverton. By the early morning on August 31, all American troops and equipment were off the island; the battle was over.

3.2.3 Aftermath

As it turns out, the retreat was just in time. Early the following morning, General Clinton arrived off Narragansett Bay with a fleet of seventy ships to reinforce the British. Meanwhile, at his headquarters in Tiverton, Sullivan wrote a lengthy report to the President of Congress, detailing the events of the last week and explaining his actions. “Upon the Count d’Estaing’s finding himself under a necessity of going to Boston to repair the loss he sustained in the late gale of wind, I thought it best to carry on my approaches with as much vigor as possible against Newport…” he explained. He went on to describe the army’s movements and intentions.

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140 McBurney, 203.
141 General John Sullivan to the President of Congress, August 31, 1778, printed in the Providence Gazette, September 26, 1778; See Appendix C to read additional articles on the Battle of Rhode Island from historic newspapers.
throughout the days of the Siege, their retreat up the island, and the battle that followed. “I have the pleasure to inform Congress, that no troops could possibly show more spirit than those of ours which were engaged,” he wrote of his men.\textsuperscript{142} He also sought to justify the retreat by explaining how it was so thoughtfully planned and carefully executed.

To make a retreat in the face of an enemy, equal, if not superior in number, and cross a river without loss, I knew was an arduous task, and seldom accomplished, if attempted; As our [sentries] were within 200 yards of each other, I knew it would require the greatest care and attention. To cover my design from the enemy, I ordered a number of tents to be brought forward and pitched in sight of the enemy, and almost the whole army to employ themselves in fortifying the camp. The heavy baggage and stores were falling back and crossing through the day; at dark, the tents were struck, the light baggage and troops passed dawn, and before twelve o’clock the main army had crossed with the stores and baggage….not a man was left behind not the smallest article lost.\textsuperscript{143}

Despite Sullivan’s successful retreat, it was clear that his earlier outburst had endangered America’s new alliance, as many blamed the French for the outcome. D’Estaing too thought Sullivan and the Continental Army were an unprofessional lot and complained to Congress of his treatment. On September 1, seeking to calm lingering tensions and salvage the relationship, Washington wrote to the commanding officers involved. A diplomatic voice of reason, in three separate letters, Washington reminded his generals of the greater cause. He encouraged Greene to promote good relations with the French, sympathized with and lifted up the rightfully miffed Lafayette, and reminded Sullivan of the high stakes, impact of his words, and importance of the alliance. In a fourth letter he smoothed things over with d’Estaing, focusing on the the unfortunate and unforeseen circumstances caused by the storm.\textsuperscript{144} Although Washington was

\textsuperscript{142} General John Sullivan to the President of Congress, August 31, 1778, printed in the \textit{Providence Gazette}, September 26, 1778.

\textsuperscript{143} General John Sullivan to the President of Congress, August 31, 1778, printed in the \textit{Providence Gazette}, September 26, 1778.

\textsuperscript{144} McBurney, 154; See Appendix D for more on Washington’s correspondence during the campaign.
privately disappointed in the outcome (and alarmed by the strain it put on the alliance) he joined Congress in publicly commending Sullivan and his army for a valiant effort. Any errors made by d’Estaing were downplayed and blamed on the weather. The British, expecting praise from the newly arrived Clinton, were instead berated. Frustrated by the missed opportunity for glory, he took his anger out on Pigot and Prescott, nit picking their actions. Ultimately, a campaign where neither side had been overwhelmingly successful, ended in both parties pointing fingers and claiming victory.
Chapter 4: Actions that Impacted the Battlefield

The Battlefield saw much activity in the two years immediately following the Siege. British forces destroyed the American trench works, and repaired and expanded their own outer line only to destroy all defenses before evacuating in 1779. The French, who arrived in 1780, then rebuilt the ruined fortifications and added their own. Since the defenses saw no action under the French, they were in excellent condition at war’s end. These activities by both sides ultimately determined what would be left for posterity.

4.1 Actions by the British

4.1.1 Destruction of the American Fortifications

When the battle ended, on August 31, the British wasted no time in dismantling the American fortifications at Honeyman Hill. Mackenzie noted on September 3 that Brown’s Regiment of Provincials had marched to the area “where the Rebels first broke ground” and that they were to be “employed in levelling the Rebel Batteries, and filling up the Trenches there.”145 By early October, the task was complete and Brown’s Regiment moved on to another project.146 A British soldier, Thomas Hughes, also observed this work in his diary when he wrote on October 6, “…[T]heir works though now fill’d up are still visible and were carried on with great regularity.”147

4.1.2 Expansion and Repairs of British Fortifications

145 *DFM*, 2: 391.
146 *DFM*, 2: 403.
147 Hughes, 45-46, quoted in Abbass 1: 434.
With the American trenches leveled, the British turned their attention to altering and expanding their own defenses, including the construction of a massive centrally located fort, large enough for 200 men and eight cannon.\footnote{DFM, 2; 403.} Built by Colonel Fanning’s Regiment of Provincials, the construction took over two months according to Mackenzie, from early October to its completion in mid-December.\footnote{DFM, 2: 403, 406.} Fort Fanning, as it was called, was located along West Main Road about half way between One Mile Corner and Two Mile Corner\footnote{One Mile Corner is an intersection at the town line, where Broadway in Newport becomes West Main Road in Middletown. Two Mile Corner is the intersection where West Main Road and East Main Road meet.} and is visible in several maps from the period, including the one by Lt. Edward Fage produced in the months following the battle (Figure 4.1).\footnote{Fage, Plan of the Works, 1778. William L. Clements Library, University of Michigan.} Once the project was done, attention turned to strengthening the remaining redoubts as well as the trenches and abbattis along the outer line.\footnote{DFM, 2: 431.}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fort_fanning_map}
\caption{Fort Fanning as seen on the 1778 Fage map, which depicted both the defenses in use during the Siege and those built or planned afterwards.\footnote{Fage, Plan of the Works, 1778. William L. Clements Library, University of Michigan.}}
\end{figure}
4.1.3 The Withdrawal Approaches

Mackenzie’s diary shows the British remained on edge in the months immediately following the battle. Although trenches were filled and redoubts strengthened, much of the British forces’ time was spent keeping an eye on the Americans’ activities in Tiverton and positioning themselves appropriately to defend the island if another attack should occur. It was within this anxious atmosphere that Fort Fanning was built. As the months went by and colder weather approached, Mackenzie’s entries show less interest in enemy activities and repairing of lines, and instead reflect an increasing concern for the state of their supplies and barracks.

This Garrison is at present very ill supplied with Fuel, Candle and Provisions. There not being more than for 14 days wood, Candles for about 7 days, and about 3 weeks flour. The troops have for a Considerable time past received Rice two days in the week instead of flour. A fleet is now out for wood, but they will not bring above 600 Cord, which is little more than two weeks consumption. Every step is taking to supply fuel: all the timber trees on the Island are cutting down, and the old wharfs will soon be broken up. Oil is to be delivered to the troops in lieu of Candles. Provisions can only be furnished from New York.

Very little attention has been paid at headquarters, New York, to the supplying this Garrison, with any of the above necessaries. 154

By mid-December the wharves had indeed been ripped up for firewood.155 The weather had turned so cold by Christmas Eve that liquor froze indoors, “poultry died,” and soldiers were found dead from exposure.156 Stephan Popp, a Hessian soldier, recorded similar circumstances.

It began to snow on Christmas night and continued until the 27th, the snow lay 3 to 4 feet deep, the cold was very severe, night men of one of our regiments were frozen to death, twenty-three men had their hands and feet badly frost bitten, --a woman with two little children was frozen to death in her house. Even the supply of drinking water was frozen.157

154 DFM, 2: 429.
155 DFM, 2: 431.
156 DFM, 2: 435.
From their fears over further American attacks in September to their worries over dwindling supplies and frigid temperatures in December, it was clear that the British felt uneasy and vulnerable in Newport by the end of 1778. The New Year was not much better. Supplies of food eventually arrived from New York but it was too little, too late. Both Popp and another Hessian soldier, Johann Conrad Döhla, record a fatal outbreak of scurvy in March 1779, the result of so many months of so little sustenance. This was not a winter the British wished to repeat.

They had survived the battle and the harsh winter but by spring there were signs the British priorities were shifting further south. Twice in 1779, the size of the garrison at Newport was diminished, first in March when the 26th Infantry Regiment left port and again in June when the Landgrave Regiment, British 54th Regiment, and Fanning’s Corps of Provincials were transferred. Counting on support of loyal Southerners, the British hoped to gain a strong foothold in the South and eventually work their way up the coast. The need for reinforcements in the South, coupled with the deteriorating state of Newport’s resources and the manpower needed to defend it, meant that it was time to move on. Newport as a garrison was becoming obsolete and too hard to maintain, and the British and Hessian forces occupying it were of better use in the Southern theater.

4.1.4 British Abandon Newport

160 Rockwell Stenrud. Newport: A Lively Experiment. (Newport, RI: Redwood Library and Athenaeum and Rockwell Stenrud, 2006), 222.
161 Stenrud, 222.
The British occupied, and in turn decimated, Newport over the course of their three-year stay. They had bled the island dry of all its resources and now their troops were needed elsewhere. Orders arrived in October 1779 to evacuate the island. This meant all fortifications on the island had to be destroyed before they embarked. “I went on work detail to destroy the defenses. These were all destroyed,” Döhla recorded on October 21. A few days later on October 25, they packed up, set fire to their barracks and sailed away. Döhla described the evacuation as follows,

On our march out of Newport all the houses were locked, and it was on the strictest orders of General Prescott that no inhabitants, and especially no females, permitted themselves to be seen at any window or on the street, and should anyone show themselves, those who were on patrol were ordered to fire at them immediately. Therefore, in Newport it appeared as if the entire city had died.

Early the next morning the Americans arrived, including Providence native Colonel Israel Angell, who had fought in the Battle of Rhode Island and kept a detailed account of his time in the Continental Army. On October 27 he noted, “I Spent this Day in Reconitering the Town, and works which was destroyed by the Enemy.” And a day later, “I road with the General Round all the Enemy Lines where I Saw Some of the Beautifullest works’ that I Ever Saw in my life….” Although the Continental Army had a short stay in Newport, it seems they repaired at least some of the fortifications before moving on. Soldier and native Newporter, Jeremiah Greenman, was among those who came to town after the British withdrawal. In late October, he recorded, “[C]ontinuing in Newport fixing the North battery on the point which the enemy had layed almost level – ordered to hold our Selves in Readyness to march for the Grand army.”

162 Döhla, 113.
163 Angell, 86.
164 Döhla, 113.
165 Angell, 87; See Appendix E to learn more about Col. Israel Angell’s diary and other sources used.
166 Angell, 87-88.
4.2 Actions by the French

4.2.1 Arrival of Rochambeau

Jean-Baptiste Donatien de Vimeur, comte de Rochambeau was an experienced fifty-five-year-old commander and French noblemen who had spent decades in the army. In the spring of 1780 he was given orders to take command of a French expeditionary force of 4,000 men (later increased to 6,000 at Rochambeau’s request) to America. In March, his fleet set sail from Brest bound for Newport, carrying the Bourbonnais, Saintonge, Soissonnais, and the Royal Deux-Ponts regiments and the Lauzun Legion (a “proprietary” corps), with more to follow.

On July 11, 1780, Rochambeau and the French Army arrived off Newport Harbor. “War weary” and suspicious of outsiders, Newporters did not come out to greet the general. A day later, when the French came ashore they received a rather cold reception. Luckily, this soon changed. In a letter dated July 16, Rochambeau recounted their arrival and first impressions.

There was no one about in the streets; only a few sad and frightened faces in the windows. I talked to some of the principal citizens, informing them that this was but the vanguard of a much larger force on the way and that the King had decided to uphold them with all his power and strength….this excellent news traveled fast, and on the evening of the following day all the houses were illuminated. The bells rang out, and there were fireworks.

Once their initial greeting and impressions were smoothed over, the French set to work taking care of their sick. A large portion of the men had become ill with scurvy during the crossing and hospitals were set up to treat them, with some soldiers being sent as far away as Bristol,

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168 Stensrud, 225
170 Whitridge, 76
Providence, and even Boston.\textsuperscript{173} With a very limited number of able bodies, the French set to work repairing what coastal fortifications they could.\textsuperscript{174} Word soon arrived that the British were planning to attack, hoping to catch the French off guard before they could get settled. An attack under such conditions would have proved disastrous, so Washington authorized Rochambeau “to call up the militia of Boston and Rhode Island to aid his army build the works for the defense of the island.”\textsuperscript{175}

A large British fleet was soon spotted off Newport. At this time the French were still in the process of disembarking their artillery.\textsuperscript{176} Sub lieutenant Jean-Baptiste-Antoine de Verger, an officer of the Royal Deux-Ponts Regiment, recorded the episode in his journal,

On the 21\textsuperscript{st}, 22 sails were sighted; they were all large ships, and we learned that Clinton was embarked in them with 6,000 men. Our situation was such that we had great cause to fear that we should be taken by storm. With no fort, with not a gun unloaded, after the grenadiers and chasseurs of our brigade had been detached to march to the Neck [Brenton’s Point], we had left only 400 men in condition to face the enemy. The rest were absolutely tent bound, or else unable to stand up for an hour. The brigade of the Soissonnais Regiment had fared better and still had 1,000 men fit for service; but the artillery and Lauzun’s Legion were very weak. Our sailors as well had suffered terribly from scurvy. The \textit{Conquérant} alone had 400 sick.

Had Clinton been more resolved to attack us it is certain he would have met with but feeble resistance with three landing-points to guard, we owed our safety to his irresolution alone.\textsuperscript{177}

Much like the American hesitation during the Battle of Rhode Island, inaction by the British deprived them of an opportunity as well. Verger goes on to explain that by July 25, the French

\textsuperscript{173} Forbes, 108.  
\textsuperscript{174} Forbes, 110.  
\textsuperscript{175} Quoted in Thomas Balch, \textit{The French in America During the War of Independence of the United States, 1777-1783}, ed. by Thomas Willing Balch, (Philadelphia: Porter and Coates, 1891), 115.  
had all their artillery unloaded and ready, and “a fine battery set up for firing hot shot.” The British observed the French for several days but never took action and ultimately left. Years later General Clinton would lament that their failure to destroy the French before they had time to settle in at Newport, gave the Americans the morale boost they had needed.

4.2.2 Repairs and Additions to the Battlefield Defenses

The French, relieved by Clinton’s departure, now had plenty of time to rebuild the defenses at their own pace. General William Heath and 4,000 militiamen had answered Rochambeau’s call for assistance but with the crisis averted, half were sent home to bring in their harvests. The remaining men were put to work under the command of Lafayette building and repairing a series of redoubts throughout Newport and Middletown. They worked on numerous forts along the coast, in defense of the harbor but also made major additions to the outer line in Middletown, used by the British during the Siege. According to several French maps, including the 1780 *Plan de la position de l’armée française autour de Newport et du mouillage de l’escadre dans la rade de cette ville*, Card’s Redoubt, Dudley’s Redoubt, Bannister’s Redoubt, and Irish’s Redoubt, along with the Tonomy Hill Fort, and Fort Fanning were all repaired, strengthened and renamed (Figure 4.2, 4.3 red circles). Six additional forts were added to this area (most named for the French regiments occupying them) including

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178 Rice, 1: 120.
179 Allen, 3.
180 Balch, 115.
181 Translation: Map of the Position of French Army around Newport and the Squadron Moored in the Harbor of this City.
Lunette de Soissonnois, Lunette des Americains, Queue d’hyrondle des chasseurs, Lunette de Bourbonnois, Redoute de Saintonge, Redoute de la Queue des’ting (Figure 4.3, blue circles).\(^{182}\)

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{A list of defensive works, built by the British but repaired and renamed by the French, from a 1780 French map.}\(^{183}\)
\end{figure}

\(^{182}\) Plan de la position de l’armée française autour de Newport et du mouillage de l’escadre dans la rade de cette ville (Map of the Position of French Army around Newport and the Squadron Moored in the Harbor of this City), 1780, Rochambeau Map Collection, Library of Congress.

\(^{183}\) Rochambeau Map Collection, 1780, Library of Congress.
Among those listed as new works was a fort on “Little Tonomy” (also known as Sunset Hill) a smaller summit just north of Tonomy Hill. Although this was a new fort, there had been a British presence at the site previously. It had been used as a “fleche,” a very minor defensive work built to assist the larger fort on Tonomy Hill. It was such a minor work however, that the drastic enlargement was considered a new addition to the lines rather than a restoration. The difference in shape and size of this work, from a fleche to a full redoubt, can be seen in Figure 4.4. Tonomy Hill Fort can also be seen here (to the right of Little Tonomy), and is a good example of the difference in shape and style of the French forts verses the English.

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184 Rochambeau Map Collection, 1780, Library of Congress.
185 A projecting, arrow or V-shaped outwork in a fortification.
186 Abbass 3: 405
Figure 4.4 Top: The “fleche” on Little Tonomy (top left) and Tonomy Hill Fort (top right) as they appeared during the Siege.\textsuperscript{187} Bottom: The same hills in 1780. Little Tonomy (bottom left) and Tonomy Hill Fort (bottom right) with their newly built and restored works carried out by the French.\textsuperscript{188}

Work on the defenses would continue until the French moved into their winter quarters at the end of September.\textsuperscript{189}

\textsuperscript{187} Fage, \textit{Plan of the works}, 1778, William L. Clements Library, University of Michigan.

\textsuperscript{188} Edouard Charles Victurnien Colbert, comte de Maulevrier, \textit{Plan de la ville, rade, et environs de Newport en Rode Island, avec le campement de l’armée Françoise près de cette place en 1780. la disposition des ouvrages qu’elle a excuté et le mouillage de l’escadre}. 1783. William L. Clements Library, University of Michigan.

\textsuperscript{189} Abbass 1: 456
4.2.3 Impact of the French on the Battlefield and Beyond

Although the island was now properly fortified, the French never had to put their defenses to the test, ultimately enjoying a rather peaceful stay from July 1780 to July 1781. The threat of a British attack was always a real concern but they were prepared for it and with the southern theater now the focus of the war, the British never attempted to retake Aquidneck Island. Instead, Rochambeau and the French Army spent their time and money in the city until they were needed elsewhere. During their stay, the French not only fortified the area, let their sick troops rest and their healthy men drill but Rochambeau was also able to plan with and eventually meet Washington. This would prove crucial to the final phase of the war.

The French also helped the city to recover. Unlike the British, the French paid for their lodgings and other needs. Rochambeau even paid (with gold and silver coins) to repair existing dwellings throughout the city to house his troops for winter, spending the modern day equivalent of $80,000. This was the kind of aid that Newport’s devastated economy so desperately needed.

Over the course of their year-long stay, Newport society had fallen in love with the French, hosting balls and dinners in their honor, and even allowing a Roman Catholic funeral mass and burial (for the recently deceased Admiral Charles-Louis d’Arsac, chevalier de Ternay) to be held at the Anglican Trinity Church. To the inhabitants of Newport, the French were charming and polite, making them welcome guests of the city, compared to the British who were now seen more as the occupiers they truly were.

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190 Stensrud, 227.
191 Commander of the French Navy who came to Newport with Rochambeau, he attended the first conference with Washington in September 1780 but died in Newport of malignant fever the following December.
By summer 1781, it was finally time to act. Rochambeau had met with Washington three times over the previous year (twice in Connecticut and once in Newport) and now the General would lead his troops to join Washington in an effort to lay siege to the British in New York.193 Plans soon changed however when an additional French fleet, promised by the King and commanded by Admiral Francois-Joseph-Paul, comte de Grasse, joined the war. De Grasse was headed for the Chesapeake Bay, and so all French forces set off for Virginia, where they would ultimately play an indispensable role in the surrender of British forces at Yorktown.194 Having left Aquidneck Island with its newly repaired defenses intact, the battlefield in Middletown was now in far better shape because of the French than it had been at the end of the Siege. This impact on the landscape meant that the works used during the Siege, and repaired under Rochambeau, could survive for posterity should the inhabitants not intervene.

193 Stensrud, 228, 230, 233
194 Stensrud, 233, 234
Chapter 5. Location and Condition of Battlefield

The Siege of Newport played out over approximately 1,351 acres on opposing hills in Middletown, Rhode Island, not far from the Newport border.¹⁹⁵ The battlefield was comprised of the British outer line, in the Bliss Hill and Tonomy Hill areas, the American works on Honeyman Hill, and the valley between them. Although the hills and valleys remain, few of the defensive works still stand.

5.1 - Location of the Battlefield

The American defenses at Honeyman Hill were located around today’s intersections of Green End Avenue, Aquidneck Avenue and Turner Road.¹⁹⁶ The British outer line ran northeast from a 10-gun battery at the intersection of Green End Avenue and Bliss Machine Road, and up the crest of Bliss Hill, passing Card’s Redoubt, and including Bannister’s and Dudley’s Redoubts. From Bliss Hill the line continued north, where it crossed West Main Road (just south of Two Mile Corner), at Irish’s Redoubt, and then turned westward to Tonomy Hill.¹⁹⁷

Largely developed today, the area was farmland and orchards when the British arrived in 1776. By the time of the Siege, the landscape had changed dramatically. “The country within a mile of the works has the most desolate appearance that possibly can be imagin’d”, Thomas Hughes noted in his diary. “The houses are all burnt for fear they should afford shelter to the enemy, their fences are destroy’d, and their orchards cut to the stumps either for opening the

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¹⁹⁵ Based on calculations from measurements taken using Google Earth.
country or making the abbattis. In short this island, formerly the Garden of America, is now the picture of war and rapine.”

5.2 Surface Condition

5.2.1 Battlefield at the Turn of the Century

After the Revolution, Middletown remained a rural farming community and by the turn of the 20\textsuperscript{th} century, had become a mix of farmland and modest cottages on country estates. This is reflected in the 1907 Atlas of Newport, Middletown and Portsmouth. Honeyman Hill and the east side of Easton’s Pond appears to be comprised of working farms. In contrast, the west side of the pond still had plenty of open space but also included a growing number of estates with elegant names and landscaped paths. These appear mainly along the Newport border with Middletown, in the Bliss Hill area, and are likely sprawl from rapidly growing Newport.

The landscape seen in the 1907 Atlas is backed up by historic photographs from the Middletown Historical Society archives, dating from the late 19\textsuperscript{th} and early 20\textsuperscript{th} centuries. Images of Honeyman Hill (Figure 5.1) and the top of Easton’s Pond show a rural landscape of farmhouses and fields ascending up the hill along Green End Avenue. A winding road along the top of Easton’s Pond’s west bank also shows little development (Figure 5.2). The heavily agricultural setting that was Middletown at the turn of the century made it likely that many of the defenses could have survived.

\begin{itemize}
  \item [198] Hughes, Thomas, 45-46, as quoted in Abbass 1: 434.
  \item [200] Historic Photographs PV-56, PV-56-2, Middletown Historical Society.
  \item [201] Historic Photograph PV-8, Middletown Historical Society.
\end{itemize}
Figure 5.1 Green End Avenue sloping down Honeyman Hill, to the crossing at the top of Easton’s Pond, c. 1900. Courtesy of the Collections of the Middletown Historical Society, Middletown, RI.

Figure 5.2 Green End Avenue on the west side of Easton’s Pond, at the base of Bliss Hill and the Green End area, late 19th century. Courtesy of the Collections of the Middletown Historical Society, Middletown, RI.

202 Historic Photograph PV-56-2, Middletown Historical Society.
203 Historic Photograph PV-8, Middletown Historical Society.
The first major interest in sites from the Siege in Middletown came in 1894, when a group of partners came together to purchase and preserve the fort on Vernon Avenue. Thought to be the remains of Card’s Redoubt because of its proximity to Green End, it was eventually donated to the Newport Historical Society (who owns it to this day). Two years later, in 1896, a new book *Revolutionary Defenses of Rhode Island* was published. Written by historian Edward Field, the book references several fortifications that still existed at the time and even includes a map of Rhode Island noting the locations of known fortifications (Figure 5.3). According to Field, although filled decades earlier, some remnants of the works on Honeyman Hill were still visible as late as the 1890s. Two forts, “Honeyman’s Hill Fort” and “Barkers Hill Fort” were listed on his map of the state and may be all that remained in the late 19th century of the ruined American defenses on Honeyman Hill.

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Figure 5.3 The 1896 map of existing fortifications on Aquidneck Island, seen in Field’s *Revolutionary Defenses in Rhode Island*.206

204 Field, 132.
205 Field, Map # 28.
206 Field, Map # 28.
Many of the works were also still visible in Field’s time. He reported, “…the line of intrenchments ran northerly towards Coddington’s Point. Within the past dozen years all have disappeared; portions of it in 1884 could be seen at [redacted], Collin’s place, and Bailey’s farm.”

According to the 1907 Atlas, a [redacted] was the owner of the property where Card’s Redoubt was located. The existence of some lingering defenses on this property were noted again in 1923, when H. W. H. Powel wrote an article for the *Newport History Bulletin*, in which he referred to the visible works at “Old Fort Farm,” a common local nickname for the property where Card’s Redoubt sits.

Photographs taken from multiple positions on Honeyman Hill, looking west, toward Card’s Redoubt and West Main Road, depict rolling hills of farmland, along with a lush stretch of trees on Bliss Hill (likely the neighborhood of cottages) (Figure 5.4). This same wooded area is visible from the other side of Bliss Hill in photos taken looking south, back into Newport, from One Mile Corner, and likely provided privacy for this more exclusive area (Figure 5.5). The scene, looking north from the same spot and up West Main Road into Middletown, is one of open fields and few structures (Figure 5.6). It is possible the remnants of Dudley’s, Bannister’s and Irish’s Redoubts could have still existed in this type of agricultural setting.

207 Field, 132.
208 Newport-Middletown-Portsmouth 1907 Atlas.
210 Historic Photograph PV-87, PV-123, Middletown Historical Society
211 Historic Photograph PV-81, Middletown Historical Society.
212 Historic Photograph PV-83, Middletown Historical Society.
Figure 5.4 The turn-of-the-century view from Green End Avenue (in foreground) on Honeyman Hill, looking west toward the tree-lined Bliss Hill. The Witherbee School (which stands today in the same location at the corner of Green End Ave. and Valley Road and is owned by the Middletown Historical Society) can be seen in the lower left corner, serving as a point of reference. Behind it, Miantonomi Avenue winds up Bliss Hill toward the area where Card’s Redoubt is located.\textsuperscript{213}

Figure 5.5 The view from One Mile Corner at the town line, looking south into Newport. Bliss Hill is within the treed area on the left.\textsuperscript{214}

\textsuperscript{213} Historic Photograph PV-87, PV-123, Middletown Historical Society.

\textsuperscript{214} Historic Photograph PV-81, Middletown Historical Society.
The remains of the fort at Tonomy Hill were also still visible in Field’s time. As the highest spot in Newport and one of the highest on the island, Tonomy Hill had been a significant landmark and lookout point for centuries. “In the centre of Tonomy Hill Fort there is an observatory which replaces an old one blown down many years ago, from which an extensive view of Newport and its harbor can be seen.” Field even includes a photograph labeled “Tonomy Hill Fort and Observatory, Newport” where one can see what it looked like at the time he was writing. In 1922 the City of Newport purchased a parcel of land that included Tonomy Hill. Once the seat of power for the Narragansett sachem Miantonomi, the hill was incorporated into a new public park created by the city and named for this historic figure. Later in 1929, the city replaced the old observatory at the top of the hill with a stone lookout tower, built as a World War I memorial. With sweeping views of Newport and Middletown, it is clear why it was

\footnotesize
\begin{itemize}
  \item \textsuperscript{215} Historic Photograph PV-83, Middletown Historical Society.
  \item \textsuperscript{216} Field, 133.
  \item \textsuperscript{217} Abbass 3: 408.
\end{itemize}
chosen as the site of a lookout and a fortification. Built high atop a rocky outcropping, from here the British could have safely observed their forces at work during the Siege and kept an eye on West Main Road and the bay at the same time.\textsuperscript{218} While other defenses around the island could have been disturbed by agriculture or development, Tonomy Hill Fort and the defense on Little Tonomy, survived into the 20\textsuperscript{th} century, more or less untouched, due to their elevation and rocky terrain. This topography made the sites less useful for practical purposes and better suited for a picturesque lookout and picnic area.\textsuperscript{219}

In the early 1920s, the Newport Historical Society became interested in British forts from the American Revolution. A map was drawn up showing what forts were visible on the farmland in Middletown, on what had been the battlefield (Figure 5.7). When compared to contemporary maps of the battlefield, it appears that the NHS map documented the 10-gun battery, Redoute de Saintonge, Card’s Redoubt, Irish’s Redoubt, Tonomy Hill Fort, and several others defenses constructed by the French near Coddington Point; but at the time, little documentation was available to sort out British from French forts.\textsuperscript{220} It was assumed that all defenses were British at their beginning, including the well preserved fort on Vernon Avenue. So in 1924, the Newport Historical Society and its president, Roderick Terry, chose this location as a dedication site to represent the British forts. A ceremony was held and a marker placed that read “Green End Fort built 1777 by the English for the Defense of Newport.” The very detailed \textit{Diary of Frederick Mackenzie} had not yet been published (that would happen in 1930), leaving no reason at the time to doubt the fort’s assumed origins.

\begin{footnotes}
\footnote{218}{Field, 102.}
\footnote{219}{Abbass 3: 407, 408.}
\footnote{220}{Terry, 15.}
\end{footnotes}
5.2.2 Battlefield Pre-WWII

A 1939 aerial map of Middletown shows the impact of time to the battlefield. Although little has changed on the farm fields of Honeyman Hill, new neighborhoods cropped up across Bliss Hill (Figure 5.8). The area is a mix of new, tightly laid out streets, older cottages and a few remaining agricultural fields. Card’s Redoubt, still in existence, sat in the backyard vegetation of

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Figure 5.7 Images from Rockerick Terry’s 1924 article about the fort on Vernon Avenue. The fort is seen as it looked in the 1870s (upper left, caption on photograph reads: “Green End Fort 1876”) and shortly after its 1924 dedication (lower left). The map produced by the Newport Historical Society (right) was also included in Terry’s article.  

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Terry, 2, 15.
a large residence at the corner of [REDACTED] and [REDACTED]. Trees in the shape of the redoubt can be seen in the aerial map (Figure 5.9). In 1778, the British line stretched northwest from Bliss Hill towards Irish’s Redoubt, just south of Two Mile Corner. Following this route in 1939 would take one out of the developing Bliss Hill and back into farm fields south of East Main Road. Although no written documentation has been found asserting the ruins of Bannister’s, Dudley’s or Irish’s Redoubts existed into the late 1930s, the aerial photos suggest Irish’s Redoubt may have survived. There is a suspicious shape visible in a farm field where it would have been (Figure 5.9), a shape similar to the image of the same redoubt depicted in one of the 1780 French maps.222

Having been purchased by the City of Newport in the 1920s and made the site of a park and World War I memorial, little changed at Tonomy Hill in the intervening years. Aerial photos from the late 1930s show the stone tower and paths peeking through trees and brush (Figure 5.9). The park and Little Tonomy, surrounded mainly by farm fields but with residential developments to its south, remained largely undisturbed.223

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222 Rochambeau Map Collection, Library of Congress.
Figure 5.8 Aerial photo from 1939 shows the use of land pre-WWII. The Honeyman Hill area (east of the pond) is comprised of wide open farm fields, while the Bliss Hill area (west of the pond and closer to Newport) is much more developed. All works that were visible at the time, including Card’s Redoubt, Redoute de Saintonge, Irish’s Redoubt, Tonomy Hill Fort and Little Tonomy have been marked in red. No evidence has been found to suggest the works on Honeyman Hill survived into the WWII era.  

224 Historic Aerial Photographs, ProvPlan.
Figure 5.9 Close up aerial photographs taken in 1939 showing the remains of Card’s Redoubt (top left), possibly Irish’s Redoubt (bottom left) and the defenses at Tonomy Hill (right), Tonomy Hill Fort and “Little Tonomy.”

Historic Aerial Photographs, ProvPlan.
5.2.3 Battlefield Today

In the post-World War II era, America experienced a building boom as rural communities became suburbs. Middletown was no different. As a result, the battlefield today is largely developed. It is currently comprised of 58% private space, 28% public and 13% non-profit owned land. Only 527 of its 1,351 acres remain unchanged. Much of the developed land is residential but stretches of commercial properties can be found in the valley (on today’s Valley Road), along Aquidneck Avenue, and on West Main Road. What little open land that remains is mostly located within the valley and along Bailey’s Brook, leading toward Easton’s Pond, the area that had been impassable in 1778 due to flooding from the hurricane (the Middletown Historical Society owns a 1.15 acre undeveloped parcel in this area). At least 300 acres of the battlefield are threatened due to the ongoing trend of developing open land into residential property.

Although Field reported that remnants of the American works at Honeyman Hill were still visible in the 1890s, it is highly unlikely they could still be seen today. The post war suburban developments off of Green End Avenue and commercial landscape of Aquidneck Avenue have left little if any terrain untouched. However, a Middletown resident recently donated to the Middletown Historical Society a 12-pound cannonball that had been buried in his yard on Turner Road. The artifact has since been identified (based on its weight) as a British cannonball that was fired at American defenses during the Siege. Based on where it landed and Mackenzie’s accounts, it is likely that the Turner Road cannonball was fired from the British gun

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226 Based on calculations from measurements taken using Google Earth.
227 Based on calculations from measurements taken using Google Earth.
228 Today, Easton’s Pond is actually broken into two portions. Separated by an earthen embankment, the northern section is now called Green End Pond and the southern remains Easton’s Pond. Since it was all one body of water during the 18th century, this landmark will continue to be called Easton’s Pond and referred to as one body of water throughout this report.
229 Based on calculations from measurements taken using Google Earth.
battery #1. Figure 5.10 shows the location of this gun battery on a contemporary map, where the blue and yellow lines intersect. The blue line represents the location of the British defense line and the yellow indicates the path of the cannonball towards Honeyman Hill, which landed south of and a little beyond the American battery #1 (see Figure 5.11). The area is now built up but there is space to look for the remains of the American trenches and gun batteries.

This image has been left intentionally blank to protect archaeological resources.

Figure 5.10 North end of the battlefield, as seen on a Google earth map. The blue line shows where the British defense line was and the yellow indicates the path of the cannonball that was found on Turner Road. Note the wide open land in the Bailey’s Brook valley.²³⁰

²³⁰ Location calculated using Fage, Plan of the works, 1778. William L. Clements Library, University of Michigan.
The Bliss Hill area is also heavily residential today. Several of the cottages still stand, but the areas between them have been further filled in. The 10-gun battery, where the British outer line began, was located at the top of Green End Avenue, near its intersection with Boulevard andMine Road but no remains exist (see Figure 5.12). The ruins of Card’s Redoubt, still visible, sits in a pine grove behind Boulevard, at the corner of Avenue, at Green End (see Figure 5.13). Although not part of the Siege, the fort on Vernon Avenue is nestled into this same neighborhood and sits in excellent condition among modest suburban homes, a block away from Card’s Redoubt (see Figure 5.14).

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Figure 5.12 The location of the 10-Gun Battery, where the British outer line began, at the top of Green End Ave.\textsuperscript{232}

Figure 5.13 The present day location of Card’s Redoubt in a pine grove behind 218 Boulevard.\textsuperscript{233}

\textsuperscript{232} Location on Google Map determined using Fage, \textit{Plan of the works}, 1778. William L. Clements Library, University of Michigan.
\textsuperscript{233} Google Maps.
Studies conducted by Ken Walsh, a member of the Newport Historical Society and founding member of the Middletown Historical Society, in the 1970s indicated that Green End Fort was actually the Redoute de Saintonge, built by the French (with help from the American militia) in 1780, when Rochambeau’s forces were stationed here (Figures 5.15 and 5.16, bottom, circled in blue).  

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234 Google Maps.
235 Walsh, Memo on Location of “Green End Fort”, *Newport History*, 1976
Figure 5.15 List of forts built new for the French, including the Redoute de Saintonge (see #6, abbreviated as Redoute St. Onge). 236

Figure 5.16 The outer line on Bliss Hill, built by the British in 1778 (top) and repaired and expanded by the French in 1780 (bottom). Redoute de Saintonge is not visible on this or any 1778 map but can be seen as #6 (circled in blue), south of Card’s Redoubt (#28, circled in red) on the 1780 French map. On both maps Card’s is located north of Green End Avenue’s crossing of Easton’s Pond, while Saintonge is in line with it, which was an early indicator that they were not the same fort.\footnote{Fage, \textit{Plan of the Works}, 1778 (top); Colbert, 1783 (bottom). William L. Clements Library, University of Michigan.}
The crest of Bliss Hill running north is now home to a large postwar residential
development looking down on High Street and the valley below. Any remains of Dudley’s or
Bannister’s Redoubts were likely leveled during the neighborhood’s construction. There is also
nothing left of Irish’s Redoubt, since the area where it was located has also long since been
paved over and used as commercial space and parking.

The site of the Tonomy Hill Fort holds the distinct honor of being the least developed site
of all the defenses in use during the Siege, thanks in part to the continued existence of
Miantonomi Park (Figure 5.17). Its paths and World War I memorial tower are also still there.
Other than this monument, which is only open to the public a few days a year, Tonomy Hill Fort
sits empty and forgotten. The trees that have grown up around it now block the once spectacular
view, leaving little reason for the public to visit it. Some of this overgrowth is eroding away at
what had been the edges of the fort and there is no signage or marker indicating its former use.
Today, Little Tonomy is completely overgrown. For years, it had been owned by the Newport
Housing Authority and had survived perhaps due to its proximity to the Miantonomi Park but it
was not officially part of it and thus was in danger without the city’s protection.238 In 2006 the
Aquidneck Land Trust became involved and it was soon incorporated into the park. Today, both
hills are protected thanks to both their own topography and their inclusion in this public space.

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238 Abbass 3: 405, 408.
5.2.4 Preservation Recommendations for Existing Sites

With the exception of Card’s Redoubt and Tonomy Hill Fort, most of the defenses present during the battle have been leveled or covered with newer construction, though the cannonball discovered on Turner Road is a good sign that evidence of the Siege may still exist beneath the surface. Currently the only defensive work within the boundaries of the original battlefield in excellent condition is the Redoute de Saintonge, which didn’t exist in 1778. Clear of brush and looking as if it were built yesterday, it is carefully maintained by the Rhode Island chapter of the Society of the Sons of the American Revolution. The “ruins” of Card’s Redoubt and Tonomy Hill Fort, although still in existence, suffer from neglect with their integrity threatened by the increasing growth of vegetation along their earthen walls. Care and routine
upkeep preserved the Redoute de Saintonge, the same maintenance is lacking but essential for the long-term preservation of Card’s Redoubt and Tonomy Hill Fort. Further still, since Tonomy Hill Fort is accessible to the public, it would benefit from signage, placing the area into historical context. Such signage would also benefit the Redoute de Saintonge. Today, the stone marker that incorrectly states “Green End Fort built 1777 by the British for the defense of Newport” remains the only information available at the site. A sign, detailing its history and addressing this confusion, would provide a more accurate context for the casual visitor and prevent the perpetuation of this misnomer.

### 5.3 Archaeological Evidence

The existence of modern day archeological equipment, such as Ground Penetrating Radar (GPR),\(^{239}\) has allowed the search for the battlefield to go below the surface (Figure 5.18, 5.19). Three sites associated with the Siege of Newport were selected for GPR surveys based on the historical record and available access to the properties (Figure 5.20). The Redoubt de Saintonge, located on Vernon Avenue, although not in existence during the Siege has been wrongly identified as Green End Fort (a nickname for Card’s Redoubt) over the years. It is hoped that evidence uncovered using GPR will further support the true, French, origins of the redoubt. The Aaron Lopez Farm was the location of an outpost used by the British to monitor Patriot activities in Tiverton and the Sakonnet River, in the lead up to the engagement. When the French entered the bay, causing all British forces to pull back to Newport, the post was abandoned. Fort Fanning was a centrally located fort constructed along the outer line (October – December 1778), following the battle, as the British sought to strengthen their defense lines.

\(^{239}\) A device that uses radar pulses to image the subsurface without disturbing the soil.
Measurement Procedure

The Sweep Markers place their poles on the tape at each end of a sweep. The GPR operator moves between them. When the sweep is finished, the markers are moved 0.5 meters and the next sweep is performed.

Figure 5.18. Procedure used to conduct a GPR study.

GPR Receive Patterns

Figure 5.19 GPR Receive Pattern.
Figure 20 The locations on Aquidneck Island of the three sites where GPR surveys were conducted, the Aaron Lopez Farm, Redoute de Saintonge (abbreviated as St. Onge) and Fort Fanning.
Dr. Jon Bernard Marcoux of Salve Regina University performed these GPR surveys between July 16, 2015 and November 19, 2015, and was assisted by Dr. Kenneth Walsh and Mersina Christopher of the Middletown Historical Society Research Team and students from Salve Regina University’s Cultural and Historic Preservation program (Figure 5.21). The results of the surveys were processed by Dr. Marcoux. His findings are discussed in the below paragraphs but his full report can be seen in Appendix F.
Figure 5.21 The GPR survey team at work. Top: Sweep markers, Mersina Christopher (MHS) and Eleni Soares (volunteer from St. Micheal’s School,) acted as guides for the GPR survey. Bottom: A Salve Regina University student and Dr. Marcoux scan the survey area at Linden Park, in search of Fort Fanning.
5.3.1 Aaron Lopez Farm

During the British occupation of Aquidneck Island, a number of farm houses along the Island’s east coast were seized and fortified. One of these farms was the country estate of Aaron Lopez, who in 1775 was Newport’s wealthiest man and was among the 2,000 people who fled the Island at the outbreak of war. When the British fortified the island the Lopez Farm became an outpost and barracks.\footnote{DFM, 1: 180; “200 at Lopez’s house on the east side.”} Located in Portsmouth, the Lopez farmhouse was 1,203 feet south of the junction of Wapping Road and Bramans Lane and can be found in a number of contemporary sources. The farm is visible in two Revolutionary War era maps, \textit{A Plan of Rhode Island}, by Charles Blaskowitz, 1770 and \textit{A Plan of Rhode Island, by Edward Fage, Captain Of Artillery, 1777-1779}. It is also detailed in the Town of Portsmouth land records. An indicator of British presence at the Lopez site is the changing footprint of Wapping Road on various historic maps. When a modern map of the area (Figure 5.22) is overlaid on the 1770 Blaskowitz map (Figure 5.23), the path of the Wapping Loop (created by Wapping Road, Michells Lane and Bramans Lane) is a good fit.\footnote{Charles Blaskowitz, \textit{A Plan of Rhode Island with the country and islands adjacent including a plan of the Town of Newport}. 1770. Heritage Charts (heritagecharts.com).} When the Google Map overlay is placed on the Fage map, which was created during the British occupation, it appears the British moved Wapping Road in Two places (Figures 5.24 – 5.26).\footnote{Fage, \textit{Plan of Rhode Island}, 1779, William L. Clements Library, University of Michigan.}
The Lopez Farm and the “Wapping Loop”

Aaron Lopez listed among the other landowners in the area.

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243 Google Maps.
244 Blaskowitz, *A Plan of Rhode Island with the country and islands adjacent including a plan of the Town of Newport*. 1770.
Figure 5.24 The British rerouted Wapping Road to the east of the Lopez house.  


Figure 5.25 There appears to be a path from the corners of Bramans Lane and Wapping Road through the stone walls and to the rear of the house that follows the British modifications.
Today the site of the Lopez Farm is part of Greenvale Vineyards, leaving much of the landscape open and accessible for study. To find further evidence of the British outpost, two GPR surveys were conducted in an attempt to locate intact remains of 18th century outbuildings associated with the farm. Survey areas were identified and set up with a 25m-x-12m grid and a 23m-x-27m grid (Figure 5.27). In the first area (Figure 5.28), multiple linear anomalies intersecting to create a square-shaped feature is believed to be the possible remnants of a long-filled stone foundation. This is likely an outbuilding from the farm. The second area (Figure 5.29) revealed two filled pits, features common in surveys of 18th century archaeological sites. Together, the existence of these features and their context within the site are promising. They suggest that remnants of the Lopez Farm still exist, and thus evidence of the Revolutionary War era outpost could too.
This image has been left intentionally blank to protect archaeological resources.

Figure 5.27 The site of the Lopez Farm with the two survey grids labeled in red.
Figure 5.28 GPR results from grid 1 of the Aaron Lopez site.
Figure 5.29 Results from grid 2 of the Aaron Lopez site.
5.3.2 Fort Fanning

In October 1778 the British began construction of Fort Fanning, along West Main Road between One and Two Mile Corner, just south of Irish’s Redoubt (Figure 5.30). Based on a comparison of Revolutionary War era and contemporary maps, an area was identified where remnants of the southernmost point of the fort was suspected to exist. Once the site of a public school, today the area is part of Linden Park, a public park featuring athletic fields and a playground, owned by the Town of Middletown. Within this area, an 80m-x-20m grid was established for a GPR survey, which was then scanned by Dr. Marcoux and a team of students (Figure 5.31).

Figure 5.30 Fort Fanning, started October 1778, as it appears on the Fage map.246

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246 Fage, Plan of the Works, 1778, William L. Clements Library, University of Michigan.
The GPR results returned several anomalies, but specifically a diamond shaped feature reminiscent of what would be expected for Fort Fanning (Figure 5.32). However, it was too small and its profile too uniform. Upon further analysis and research, including the study of a 1962 aerial photograph, it was determined that this feature was not the 18th century fort but instead a 20th century baseball diamond from the time the school was in use (Figure 5.33). In the end, no evidence of Fort Fanning was detected through this survey but further GPR testing to the east and west of the survey grid should be conducted before ruling out the fort’s presence.
Figure 3 GPR results from the Fort Fanning survey.
Figure 5.33 The 1962 aerial photograph (bottom and center) showing the existence of a baseball diamond in the same location as the feature (top).
5.3.3 Redoute de Saintonge

Less than a year after the British abandoned Aquidneck Island in October 1779, the French arrived and set to work restoring and expanding on Newport’s ruined defense lines, including the addition of Redoute de Saintonge (see Figure 5.34). Dr. Marcoux and his students established a 45m-x-19m grid within the current fortification for a GPR survey (Figure 5.35).

This image has been left intentionally blank to protect archaeological resources.

Figure 5.34 The GPR survey area of the Redoute de Saintonge on Vernon Avenue in Middletown.
The features detected during the survey provide evidence of the redoubt’s construction. It indicated the original ground surface of the slope from which the redoubt was built, the rammed earth used to level and extend the redoubt away from the natural slope of the land, and the construction of the embankment that protected the soldiers within the redoubt (Figure 5.36). The survey at Saintonge has also shown no evidence of cannonballs beneath the surface. This suggests that it saw no action, further supporting that it was not in existence during the Siege.
Figure 5.36 GPR results from the Redoute de Saintonge survey.
Chapter 6 Conclusions and Recommendations

6.1 Summary

There are a host of reasons the Siege failed. The lack of deception, bad timing, a rocky collaboration with the French, the unexpected hurricane, the geography, and the available technology, led to a “perfect storm” of events. These, combined with the impending arrival of British reinforcements, made for an insurmountable task and Sullivan knew it. Had some of these circumstances been different, the Americans could have possibly won and ended the Revolutionary War in Newport.

There was a distinct lack of deception in the American approach to the attack. In the beginning, American generals wrote a letter to the General Pigot saying that they were coming to get him. This might have had some psychological impact on an unseasoned commander but in this case, with a 6,000-man regular army including veteran officers, it only provided warning. When the French arrived off Newport, the British had no trouble observing their position in Narragansett Bay or the American camp in Tiverton. The result of this openness was that the British were able to strategize and put a plan in place to avoid a pincer movement by the Americans and French. Sullivan and d’Estaing had planned to attack Aquidneck Island from two sides (east from Fogland and west from Dyer Island) to trap the British stationed in Portsmouth. When the French fleet entered the bay, exchanging cannon fire with the shore batteries, their plan was easily discernible and the British immediately withdrew from the north end and east side of the island into Newport, leaving no one to trap.

The Americans also did not act fast enough. In the time that it took them to plan their advance, the British had more than enough time to dig in and better fortify the outer line. Sullivan himself had wanted to act quickly and take the British by storm but his colleagues
wanted a more methodical approach. Unlike the British, whose typical foot soldier was used as cannon fodder, the Continental Army tended to err on the side of caution and avoided conflicts that racked up too many casualties. This mentality and the urging of the other generals resulted in wasted time and opportunity. If the Americans had made their way down the island before the hurricane hit, they could have crossed the top of Easton’s Pond before it became flooded and before the British had time to dig in. The rains soaked gunpowder and other supplies, further delaying the Americans’ advance. By the time they reached Honeyman Hill, the valley was nearly impenetrable, due to the overflowing brook, the defenses that looked down on it, and the absence of specialized troops in the American ranks to handle such a situation.

Despite any planning that happened prior to the operation, the lack of proper coordination and cooperation between the French and the Americans during it made the entire engagement a messy affair. Although both were fighting for the same cause, they did not operate as a team, which greatly weakened their strategies. Sullivan who initially wanted to act quickly, listened to his officers rather than d’Estaing, and chose to take more time. D’Estaing, fearful of being trapped by Admiral Howe’s fleet, abandoned any plan to blockade Newport harbor and instead left to pursue the British on the open sea. Later when d’Estaing returned, battered from the storm, he almost agreed to lend troops and artillery to the Americans but decided against it at the behest of his adamant officers. For the Americans, this was cause for alarm. They were not only counting on the French but had based all their plans on a joint operation and soon American militiamen deserted in droves at the prospect of facing the British alone. This led to weakened morale in the American camp. It seems both Sullivan and d’Estaing were more easily swayed by their own officers than by each other. Despite all of the bad coordination between the two sides, it was d’Estaing’s unavoidable abandonment of the operation, already in progress, that made the
biggest difference. Once the French were out of commission, it was no longer a question of how to win but of inflicting what damage they could and withdrawing unscathed.

Although the French often get the bulk of the blame for the campaign’s failure, perhaps the single greatest hindrance the Americans faced on Rhode Island (whether they knew it or not) was the technology available to them and the role geography played in this. Newport’s location on an island meant that all equipment had to be transported by boat. Cannons over a certain weight were too heavy to make the trip across the Sakonnet River (the eastern passage of Narragansett Bay) in the army’s small boats. The cannons that did make the crossing (18 pounders) were not substantial enough to penetrate the earthen defenses of the British on Bliss Hill. When the French returned, badly damaged by the storm, Greene had hoped to secure cannons and men, at the very least but was turned down. Had the French agreed and delivered larger artillery by frigate, the outcome could have been different; 24-pound cannon would have been more useful and 36-pound cannon could have destroyed the British forts altogether.

The British were too dug in and fortified by the time the Americans arrived in Middletown. Without more substantial firepower and with a swamp between them and the enemy, the Americans did not stand a chance. They could not disarm the cannons because theirs were inadequate. They also could not storm the lines because the swampy terrain would slow them down too much, a deadly chance Sullivan was not willing to take. The French and their artillery were the Americans’ only hope to turn things around but the hurricane and d’Estaing’s choices forced a set of unforeseen circumstances on the operation that could not be avoided. With the Americans’ morale shaken by French actions and with no hope of things changing, their only option was to damage the British as they could before safely retreating. The following
June, while reflecting on the battle, Major General Charles Grey of the British Army summed it all up perfectly,

The Americans showed us they were soldiers and not just farmers. They built redoubts all around us, except for the side facing the water, dug trenches, drove us out of our camps with their cannon fire and had the will to storm our lines. But, this was the one thing their volunteers wanted to avoid, and just as well, for they would have lost many men without a fleet to support them. Their retreat was well planned and executed orderly.\footnote{Grey, Bayreuther Zietungen, 1779, as quoted in Schroder, 166.}

6.2 Preservation Recommendations

By studying the battlefield, it has become clear that a number of features of the historic landscape still exist and are worth preserving. Of the earthen fortifications, only Card’s Redoubt and Tonomy Hill Fort still have visible remnants. Traces of the defenses on Little Tonomy may also exist but the area is too overgrown to assess its condition properly. Card’s Redoubt rests in a Middletown resident’s backyard and thus is not accessible to the public, but the removal of brush and other overgrowth from its walls would greatly increase the chances of the fort’s survival. Tonomy Hill Fort is part of a public park maintained in part by the Aquidneck Land Trust. Although the park is well cared for, the walls of the fort are overgrown. Continued maintenance at this site to reduce overgrowth is key. Additionally, the installation of appropriate signage detailing the hill’s history and former use is highly recommended. This would place the area into historical context and provide visitors with an appreciation for the site’s significance. Further still, archaeological evidence may also remain at Card’s Redoubt and Tonomy Hill Fort and the use of non-invasive testing (such as GPR surveys), would be worth conducting.
The Elder John Bliss House, which was used as the British field headquarters during the Siege, is not currently on the National Register of Historic Places (NRHP). It is located off Bliss Road in Newport, set back between the British 1st and 2nd lines of defense. The house, which is generally regarded as the oldest in Newport, was used by the British during the Siege, and is one of few remaining examples of a uniquely-Rhode Island architectural style – the stone ender. The Bliss House would easily be eligible for the NRHP as it meets both criteria A (associated with events significant to the broad patterns of our history) and C (embodies distinctive characteristics of a method of style, period or construction). No plans currently exist for this property to be added to the NRHP but it is something the Middletown Historical Society Research Team highly recommends and hopes will happen in the future.

At the center of the battlefield, the area encompassing Bliss Hill, Honeyman Hill, and the valley and bodies of water between them is largely recognizable today. The hills are now developed into suburban neighborhoods with some commercial buildings, and the road crossing the top of Easton’s Pond experiences a high volume of traffic, but the overall topography and geography is the same. Enough of the relevant features (both natural and man-made) exist, to maintain the area’s historical integrity. Based on its condition and the significant events that occurred there, the heart of the battlefield is eligible for the NRHP. Additionally, the remaining features can be used to interpret the events of August 1778. The following section addresses this area and the plans the Middletown Historical Society has to preserve and interpret a small portion of the battlefield.
6.3 Future Plans

This project has paired historical research with scientific analysis to better understand the location, resources and outcome of the Battle of Rhode Island. It focused on the Siege of Newport in Middletown, where days of cannonading took place across the valley between Bliss Hill and Honeyman Hill, and where the Americans failed to penetrate the British lines. Through this process the Middletown Historical Society Research Team has gained a better understanding of the engagement, its setbacks, the sites associated with it, and the landscape of the battlefield. It was through this understanding, commitment to the topic and certain other circumstances, that a new project emerged.

Located at the heart of the battlefield between Bliss Hill and Honeyman Hill, and along the banks of Easton’s Pond, sits an undeveloped parcel of land owned by the MHS. Bequeathed to the organization in 2008, a plan had not yet been fully realized for the site. Now, with the completion of this study, it is clear the site can be put to use to recover this forgotten history. The installation of a small museum, signage and programming on these grounds would be an opportunity to commemorate the past and educate the public while preserving a portion of the battlefield. The site’s location, within the valley between the British and American lines and along the pond, would give visitors a more complete understanding of the geography that so greatly affected the operation. Visitors would learn of the importance of the French involvement in the war effort, both this unsuccessful attempt and Rochambeau’s later presence on the island and victories in the war. It would provide greater context as well for the many historic sites tourists see on their visits to Newport. Most importantly, this project would preserve a portion of the battlefield from further development and protect it for future generations.
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Glossary

Military & Technological Terms, People & Places

Military Terminology

**Abbatis:** A barrier of cut tries with sharpened branches toward the enemy.

**Enfilade:** A volley of gunfire directed along a line from end to end.

**Fascine:** Bundles of branches used to fill ditches and swamps.

**Fleche:** A projecting, arrow or V-shaped outwork in a fortification.

**Gabions:** Wicker Baskets filled with dirt and rock used to build forts.

**Gun Emplacement:** A military installation consisting of a prepared position for sitting a weapon.

**Parapet:** A protective wall or earth defense along the top of a trench or other place of concealment for troops.

**Rampart:** A tall, thick stone or dirt wall that is built around a castle, town, etc., to protect it from attacks.

**Redoubt:** A temporary or supplementary fortification, typically square or polygonal, without flanking defenses.

**Revetment:** A barricade of earth or sandbags set up to provide protection from blast, protecting a rampart, wall, etc.

Technological Terms

**Ground Penetrating Radar (GPR):** A geophysical technique used to collect and record information about the earth’s subsurface, by using radar pulses to map underlying archaeological features without disturbing the soil.

**MATLAB:** Engineering software produced by MathWorks in Cambridge, MA, used to solve engineering and scientific problems. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

**Reynolds number:** A dimensionless number that gives a measure of the ratio of inertial forces to viscous forces for given flow conditions. The Reynolds number is an important parameter that describes whether flow conditions lead to laminar or turbulent flow.
**Major Players**

**General Henry Clinton:** British army officer whose forces first captured Newport in 1776. In 1778 Clinton became commander in chief of British forces in America, following General Howe’s retirement. Although his second in command, Lord Cornwallis, was responsible for the loss at Yorktown, it was Clinton and not Cornwallis who received much of the blame upon returning to England, after the war.

**Admiral Comte d'Estaing:** A nobleman with many years in the French military, first in the army, then in the navy, d’Estaing was commander of the Toulon fleet ordered by King Louis XVI to aid the American colonies in 1778. Years later, he was guillotined in Paris during the Reign of Terror.

**Major General Nathaniel Greene:** Hailing from Rhode Island, Greene was manager of his family’s iron foundry before the war and became commander of the State army in 1775. After joining the Continental Army, he was quickly promoted to Major General and became one of Washington’s most skilled and trusted officers. He was assigned to help Sullivan retake Newport, in the hope that his local knowledge could be of use. Greene is largely remembered for his strategic mind and for his part in the war’s Southern theater. His actions proved crucial in the lead up to Yorktown, luring and exhausting Lord Cornwallis’ army throughout the South. After the war, he settled in Georgia, where he died in 1786.

**Admiral Richard Howe:** Commander of naval forces during the American Revolution and brother to General William Howe, who commanded the land forces.

**General William Howe:** A very successfully and decorated officer, Howe became Commander-in-Chief of British forces in America in April 1776, and remained in this position until his retirement in 1778.

**Major General Marquis de Lafayette:** French aristocrat and army officer who volunteered for the American Continental Army prior to French involvement in the war. Lafayette became a close friend and aide to Washington and participated in numerous engagements throughout the war, most notably helping to blockade Lord Cornwallis in the lead up to the Siege of Yorktown. He was also vital in America’s dealings with France, both during the Rhode Island Campaign and later helping Benjamin Franklin to secure 6,000 French soldiers under the command of Rochambeau. Lafayette went on to be a key figure in the French Revolution of 1789 and in the July Revolution of 1830.

**Lieutenant Frederick Mackenzie:** British officer in the Royal Welch Fusiliers, who kept a detailed diary during the American Revolution, recording his time stationed in Boston, Newport and New York. His diary provides enormous insight and is widely quoted and cited throughout this report.
Major General Robert Pigot: British officer and aristocrat, Pigot distinguished himself early in the war at the Battle of Bunker Hill. In 1777 he became 2nd baronet after the death of his brother George. That same year, he took command of the British forces stationed at Newport and successfully maintained hold of the city during the Siege and Battle of Rhode Island. Pigot remained in command of Newport until 1779 and was succeeded by General Prescott. He died in England in 1796.

Major General Richard Prescott: A twice-captured British officer known for being “insolent, ill-tempered and supercilious.” Prescott was freed the first time in a prisoner exchange for John Sullivan (who would later lead the campaign on Rhode Island). He came to Newport in November 1776 and eventually became its commander. He was captured for the second time, in an embarrassing incident in July 1777, by Major William Barton and a party of 40 Americans. Eventually returning to Newport, he took part in the Siege and Battle of Rhode Island and succeeded Pigot to command the city in 1779 until its abandonment. He died in England in 1788.

Lieutenant General Comte de Rochambeau: A French nobleman and the general in command of French forces in the later years of the American Revolution. Rochambeau was stationed at Newport from July 1780-1781. He led the French Army to aid Washington in the defeat of British forces under Lord Cornwallis at Yorktown, VA, virtually ending the war. During the French Revolution he was nearly guillotined but ultimately evaded execution and was later pensioned by Napoleon.

Major General John Sullivan: An attorney from New Hampshire, Sullivan joined the Continental Army as an officer in 1775 and took part in the Siege of Boston the following March. After being promoted to major general, he was captured during the Battle of Long Island in 1776 but was exchanged in time to lead Washington’s right column at the Battle of Trenton. After commanding the Rhode Island campaign at the age of thirty-eight, he found success on the battlefield defeating the Iroquois Indians in western New York, but ultimately resigned before the war’s end due to illness. He went on to become a delegate to the Continental Congress, presided over his state’s ratification of the Constitution and later in life became governor of New Hampshire.

Locations

See reference maps at end of glossary for a visual aid.

Aquidneck Island / Rhode Island: Comprised of the towns of Portsmouth (to the north), Middletown (in the center) and Newport (to the south) it is the largest island in Narragansett Bay in the State of Rhode Island. Originally called “Aquidneck” by the Narragansett tribe, it was later renamed “Rhode Island” by early English settlers. Both the State of Rhode Island and the Battle of Rhode Island are named for this geographic feature. Today it is widely referred to as

248 Boatner, 886.
Aquidneck Island, although its official name remains Rhode Island. Throughout this report it is called Aquidneck Island to avoid confusion with the state.

**Bailey’s Brook:** A brook on Aquidneck Island that runs into Easton’s Pond and was a major obstacle to the Americans during the Siege of Newport.

**Bliss Hill:** A hill in Middletown, Rhode Island overlooking Easton’s Pond (to the east). It was the site of the British Position during the Siege of Newport.

**Bliss House:** A house on the outskirts of Newport, used as the British field headquarters during the Siege. Today it is called the Elder John Bliss House and is considered the oldest house in Newport.

**Conanicut Island:** The second largest island in Narragansett Bay in the State of Rhode Island. It is comprised of the town of Jamestown and is located between Aquidneck Island to the east and the mainland to the west. Newport harbor faces this island.

**Easton’s Beach:** A beach located on the Newport - Middletown border on Aquidneck Island. It is south of Easton’s Pond and during the Siege of Newport was held by the British on the west end and the Americans on the east. It was another major obstacle for the Americans during the Siege.

**Easton’s Pond:** A pond on Aquidneck Island, north of Easton’s Beach that is fed by Bailey’s Brook, in Middletown, Rhode Island. It was a major obstacle to the Americans during the Siege.

**Green End:** The eastern most portion of Bliss Hill in Middletown, Rhode Island, which overlooked Bailey’s Brook, Easton’s Pond and faced the American position at Honeyman Hill. The British position at Card’s Redoubt and the French Redoute de Saintonge were both located in this area.

**Honeyman Hill:** The hill, located to the east of Bailey’s Brook and Easton’s Pond in Middletown, Rhode Island, where the American forces entrenched during the Siege.

**Middletown:** A town in the State of Rhode Island, located at the center of Aquidneck Island, between Portsmouth to the north and Newport to the south. It was the location of the Siege of Newport cannonading, at Bliss and Honeyman Hills, during the Battle of Rhode Island.

**Narragansett Bay:** A large bay in the state of Rhode Island, fed by the Providence, Taunton, and Sakonnet Rivers. Its islands include, Rhode (Aquidneck), Connnicut, and Prudence Islands.

**Newport:** A port city in the State of Rhode Island, located at the southern end of Aquidneck Island. It was one of the leading colonial ports before the Revolution, until it became occupied by British forces from 1776 to 1779. Although the Siege took place mainly in Middletown, main objective was to drive the British out and retake Newport.
**Newport Harbor:** The harbor of the mercantile port city Newport, Rhode Island, located on the southwest side of Aquidneck Island, facing Connanicut Island (Jamestown).

**One Mile Corner:** A local term for an intersection on Aquidneck Island at one of the town lines. It is where Broadway in Newport becomes West Main Road in Middletown and is roughly one mile from the seat of government in Newport.

**Point Judith:** A small cape on the southwestern side of Narragansett Bay, where it opens out onto Rhode Island Sound.

**Portsmouth:** A town in the State of Rhode Island located on the northern end of Aquidneck Island. It is where the American army both landed on the island when arriving from Tiverton and retreated to after the ending the Siege in Middletown. It is also where major fighting took place during the retreat.

**Providence:** The capital city of the State of Rhode Island, located at the mouth of the Providence River and head of Narragansett Bay. While the British occupied Newport, Providence was a Patriot stronghold and served as General John Sullivan’s headquarters prior to the Siege and Battle of Rhode Island.

**Sakonnet River:** The name for the east passage of Narragansett Bay in Rhode Island, between Tiverton and Little Compton to the east, and Aquidneck Island to the west.

**Sandy Hook:** A barrier spit in northern New Jersey, protruding into and sheltering part of Lower New York Bay. Located just south of New York City, ships headed for this port had to pass by Sandy Point en route. The British Navy stationed at New York used the strategic geography and location of Sandy Hook to their advantage to protect both the city and their fleet.

**Tiverton:** A town in the State of Rhode Island located across the Sakonnet River from Portsmouth on Aquidneck Island.

**Tonomy Hill:** Also part of the British outer line. It is the highest point on Aquidneck Island and the location of Tonomy Hill Fort.

**Two Mile Corner:** A local term for the intersection on Aquidneck Island, where East Main Road and West Main Road in Middletown, Rhode Island meet. It is one-mile north, up West Main Road, from One Mile Corner and two miles from the seat of government in Newport.
Reference Maps

The following maps visually show the location of the many places and landmarks listed in the above glossary.

Figure R.1 Narragansett Bay in the State of Rhode Island, including many landmarks referenced throughout the report.
Figure R.2 Aquidneck (aka Rhode) Island, along with towns involved in the campaign, the Sakonnet River and the area the Siege took place in.
Figure R.3 The above map indicates the relation of the three major hills involved in the Siege and their locations in context to one another.
Figure R.5 The above map shows the locations of major roads that existed during the Siege, still exist and are referenced thought out the report.
Appendix A

Order of the Battle

Table A.1 Ships of the French Squadron under Admiral d’Estaing\(^{249}\)

<table>
<thead>
<tr>
<th>SHIP</th>
<th>GUNS</th>
<th>DRAFT (FT.)</th>
<th>GUN TYPES / ASSIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languedoc</td>
<td>80</td>
<td>25</td>
<td>30 x 30 lb., 32 x 24 lb, 18 x 8 lb</td>
</tr>
<tr>
<td>Tonnant</td>
<td>80</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Cesar</td>
<td>74</td>
<td>22</td>
<td>28 x 30 lb, 30 x 18 lb, 18 x 8 lb</td>
</tr>
<tr>
<td>Zele</td>
<td>74</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Hector</td>
<td>74</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Guerrier</td>
<td>74</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Marseillais</td>
<td>74</td>
<td>22.4</td>
<td></td>
</tr>
<tr>
<td>Protecteur</td>
<td>74</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Vaillant</td>
<td>64</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>Provence</td>
<td>64</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>Fantasque</td>
<td>64</td>
<td>21.6</td>
<td>Assigned to West Passage</td>
</tr>
<tr>
<td>Sagittaire</td>
<td>50</td>
<td>20</td>
<td>Assigned to West Passage</td>
</tr>
<tr>
<td>Chimere</td>
<td>26</td>
<td>15</td>
<td>26 x 8 lb</td>
</tr>
<tr>
<td>Engageante</td>
<td>26</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Flore</td>
<td>26</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Aimable</td>
<td>26</td>
<td>15</td>
<td>Assigned to Sakonnet River</td>
</tr>
<tr>
<td>Alcmené</td>
<td>26</td>
<td>15</td>
<td>Assigned to Sakonnet River</td>
</tr>
</tbody>
</table>

\(^{249}\) Hattendorf, 5-8
Table A.2 Head of Divisions in General Sullivan’s Army of 10,112+ men.\textsuperscript{250}

<table>
<thead>
<tr>
<th>RANK</th>
<th>HEADS OF DIVISION</th>
<th>DIVISION</th>
<th>MEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maj. Gen.</td>
<td>Nathaniel Greene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>John Hancock</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marquis de La Fayette</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brigadiers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brig. Gen.</td>
<td>John Glover</td>
<td>(Line)</td>
<td>1,131</td>
</tr>
<tr>
<td></td>
<td>James M. Varnum</td>
<td>(Line)</td>
<td>1,037</td>
</tr>
<tr>
<td></td>
<td>Ezekiel Cornell</td>
<td>(RI Mil)</td>
<td>1,719</td>
</tr>
<tr>
<td></td>
<td>Solomon Lovell</td>
<td>(Mass Mil)</td>
<td>1,158</td>
</tr>
<tr>
<td></td>
<td>Jonathan Titcob</td>
<td>(Mass Mil)</td>
<td>959</td>
</tr>
<tr>
<td></td>
<td>Whipple</td>
<td>(NH Mil)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>John Tyler</td>
<td>(Conn. Mil)</td>
<td></td>
</tr>
<tr>
<td>Col. Cmdt</td>
<td>Christopher Greene</td>
<td>(RI Line)</td>
<td>1,626</td>
</tr>
<tr>
<td>Col.</td>
<td>William West</td>
<td>(RI Mil)</td>
<td>1,025</td>
</tr>
<tr>
<td>Aides</td>
<td>Col. John Trumbull</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H. Sherburne</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maj. Russell</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eben Sullivan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morris Lyman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Daniel Lyman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Rufus King</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Corps</td>
<td>Dr. Tillotson</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{250} Erich A. O’D. Taylor, \textit{Campaign on Rhode Island}, (Newport, 1928) 15.
Table A.3 Regimental Commanders in General Sullivan's Army of 10,124+ men.\textsuperscript{251}

<table>
<thead>
<tr>
<th>RANK</th>
<th>REGIMENTAL COMMANDERS</th>
<th>REG.</th>
<th>MEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Col.</td>
<td>H.B. Livingstone</td>
<td>4th NY</td>
<td>659</td>
</tr>
<tr>
<td></td>
<td>John Topham</td>
<td>1st RI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thorndyke &amp; Lt. Col. Wadsworth</td>
<td>(Mil)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joseph Noyes</td>
<td>1st King's County</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Charles Dyer</td>
<td>2nd King's County</td>
<td></td>
</tr>
<tr>
<td></td>
<td>John Langdon</td>
<td>with dragoons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stock</td>
<td>with N.H. light horse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gower &amp; Richard Gridley</td>
<td>with artillery</td>
<td>810</td>
</tr>
<tr>
<td></td>
<td>John Crane</td>
<td>3rd Continental Artillery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. Burbanks</td>
<td>(Mass) bombs</td>
<td></td>
</tr>
<tr>
<td>Maj.</td>
<td>Nathaniel Eyres</td>
<td>(Pa) carpenters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whitworth</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Christopher Lippitt</td>
<td>2nd RI (Mil)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W.R. Lee</td>
<td>boats</td>
<td></td>
</tr>
<tr>
<td></td>
<td>John Doggett</td>
<td>Mass (Mil)</td>
<td></td>
</tr>
<tr>
<td>Lt. Col.</td>
<td>Olney</td>
<td>RI line</td>
<td></td>
</tr>
<tr>
<td>Col.</td>
<td>Henry Jackson</td>
<td>line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edward Wigglesworth</td>
<td>13th Mass line</td>
<td></td>
</tr>
<tr>
<td>Col.</td>
<td>Israel Angell</td>
<td>2nd RI line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nathaniel Wade</td>
<td>Mass</td>
<td></td>
</tr>
<tr>
<td>Lt. Col.</td>
<td>Francois Fleury</td>
<td>engineer</td>
<td></td>
</tr>
<tr>
<td>Maj.</td>
<td>Silas Talbot</td>
<td>1st RI</td>
<td></td>
</tr>
<tr>
<td>Col.</td>
<td>John Laurens</td>
<td>(aide to Washington)</td>
<td></td>
</tr>
<tr>
<td>Col.</td>
<td>John Jacobs</td>
<td>Mass Mil</td>
<td></td>
</tr>
<tr>
<td>Lt. Col.</td>
<td>Ebenezer Sprout</td>
<td>4th Mass</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M. de Touched</td>
<td>artillery</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{251} Taylor, 15
Table A.4 British, Hessian, and Provincial (loyalist) Forces at Newport under the Command of General Pigot

<table>
<thead>
<tr>
<th>CORPS</th>
<th>MEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Artillery</td>
<td>592</td>
</tr>
<tr>
<td>16th Light Dragoons</td>
<td>121</td>
</tr>
<tr>
<td>17th Light Dragoons</td>
<td>143</td>
</tr>
<tr>
<td>1st Light Infantry</td>
<td>334</td>
</tr>
<tr>
<td>2ed D</td>
<td>386</td>
</tr>
<tr>
<td>1st Grenadiers</td>
<td>346</td>
</tr>
<tr>
<td>2ed D</td>
<td>300</td>
</tr>
<tr>
<td>Fort Guards</td>
<td>755</td>
</tr>
<tr>
<td>7th Regiment</td>
<td>260</td>
</tr>
<tr>
<td>17th Regiment</td>
<td>259</td>
</tr>
<tr>
<td>23rd Regiment</td>
<td>259</td>
</tr>
<tr>
<td>26th Regiment</td>
<td>239</td>
</tr>
<tr>
<td>33rd Regiment</td>
<td>334</td>
</tr>
<tr>
<td>37th Regiment</td>
<td>284</td>
</tr>
<tr>
<td>42nd Regiment</td>
<td>536</td>
</tr>
<tr>
<td>44th Regiment</td>
<td>261</td>
</tr>
<tr>
<td>47th Regiment</td>
<td>387</td>
</tr>
<tr>
<td>63rd Regiment</td>
<td>262</td>
</tr>
<tr>
<td>64th Regiment</td>
<td>301</td>
</tr>
<tr>
<td>2 Co. Garrison Battalion</td>
<td>179</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CORPS</th>
<th>MEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jager</td>
<td>532</td>
</tr>
<tr>
<td>Linsing</td>
<td>306</td>
</tr>
<tr>
<td>Lingercke</td>
<td>336</td>
</tr>
<tr>
<td>Landgrave</td>
<td>301</td>
</tr>
<tr>
<td>Kochler</td>
<td>314</td>
</tr>
<tr>
<td>Ditforth</td>
<td>421</td>
</tr>
<tr>
<td>Prince Carl</td>
<td>463</td>
</tr>
<tr>
<td>Trumbach</td>
<td>455</td>
</tr>
<tr>
<td>Prince Hereditaire</td>
<td>408</td>
</tr>
<tr>
<td>Donch</td>
<td>423</td>
</tr>
<tr>
<td>Mirbach</td>
<td>400</td>
</tr>
<tr>
<td>Losberg</td>
<td>279</td>
</tr>
<tr>
<td>Knynhauwen</td>
<td>303</td>
</tr>
<tr>
<td>Artillery</td>
<td>350</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Provincials</th>
<th>1,769</th>
</tr>
</thead>
<tbody>
<tr>
<td>British</td>
<td>6,601</td>
</tr>
<tr>
<td>German</td>
<td>5,291</td>
</tr>
<tr>
<td>Provincials</td>
<td>1,769</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>13,661</strong></td>
</tr>
</tbody>
</table>

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*DFM, Vol. 1, 2*
Table A.5 Admiral Howe’s British fleet of warships that left Sandy Hook, NJ for Newport to engage the French fleet.253

<table>
<thead>
<tr>
<th>SHIPS OF THE LINE</th>
<th>GUNS ON BOARD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornwall</td>
<td>74 guns (1 x 74 guns)</td>
<td>Cornwallis</td>
</tr>
<tr>
<td>Raisonnable</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>Eagle</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>Trident</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>Nonsuch</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>Sumerset</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>St. Albans</td>
<td>64 guns</td>
<td></td>
</tr>
<tr>
<td>Ardent</td>
<td>64 guns (7 x 64 guns)</td>
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</tr>
<tr>
<td>Preston</td>
<td>50 guns</td>
<td></td>
</tr>
<tr>
<td>Centurion</td>
<td>50 guns</td>
<td></td>
</tr>
<tr>
<td>Renown</td>
<td>50 guns</td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>50 guns</td>
<td></td>
</tr>
<tr>
<td>Isis</td>
<td>50 guns (5 x 50 guns)</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>FRIGATES</th>
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</thead>
<tbody>
<tr>
<td>Phoenix</td>
<td>44 guns</td>
<td></td>
</tr>
<tr>
<td>Roebuck</td>
<td>44 guns (2 x 44 guns)</td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>36 guns (1 x 36 guns)</td>
<td></td>
</tr>
<tr>
<td>Richmond</td>
<td>32 guns</td>
<td></td>
</tr>
<tr>
<td>Pearl</td>
<td>32 guns</td>
<td></td>
</tr>
<tr>
<td>Apollo</td>
<td>36 guns (1 x 32 guns)</td>
<td></td>
</tr>
<tr>
<td>Sphynx</td>
<td>20 guns</td>
<td>Sent to NY</td>
</tr>
<tr>
<td>Vigilant</td>
<td>20 guns (2 x 20 guns)</td>
<td></td>
</tr>
<tr>
<td>Nautilus</td>
<td>16 guns (1 x 16 guns)</td>
<td></td>
</tr>
</tbody>
</table>

253 *DFM, 2: 332; Hattendorf, 5-7.*
<table>
<thead>
<tr>
<th>Type of Ship</th>
<th>Number</th>
</tr>
</thead>
<tbody>
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<td>50 gun ships</td>
<td>3</td>
</tr>
<tr>
<td>44 gun ships</td>
<td>2</td>
</tr>
<tr>
<td>Small frigates</td>
<td>8 (L 108 ft., B 30 ft., D 9'7&quot;, guns 20 x 9 lb (Sphinx sent to NY))</td>
</tr>
<tr>
<td>Fire Ships</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13 ships of the line, 13 small ships and frigates, 3 fire ships = 29 warships</strong></td>
</tr>
<tr>
<td>Bomb vessels</td>
<td>3 (sent to NY)</td>
</tr>
<tr>
<td>Galleys</td>
<td>4 (sent to NY)</td>
</tr>
<tr>
<td>Bomb tender</td>
<td>2 (sent to NY)</td>
</tr>
</tbody>
</table>
Appendix B

The following text was prepared by Ralph C. Weiss. All maps shown are in the collections of the William L. Clements Library at the University of Michigan.

Maps of the Battle of Rhode Island, by Ralph C. Weiss

There are at least three dozen maps that show information concerning the Battle for Rhode Island. The Middletown Historical Society Research Team was able to obtain a number of maps, sketches and charts to identify the 1778 battlefield in Middletown from the William L Clements Library at the University of Michigan, Ann Arbor. Only 12 maps identify the Middletown fortifications or shed significant detail surrounding the events that took place in August of 1778. All maps shown in this presentation are the courtesy of William L Clements Library.

The “Plan of the Town and Environs of Newport Rhode Island” (Figure 1) signed by the British chief engineer Abraham D’Aubant, provides a graphic illustration of the Middletown battlefield. Dated 1779, this map shows the British fortifications in the first and second line of defense to the north and east of Newport. The map is signed but it is extremely doubtful that it was drawn by D’Aubunt. When looking at the upper right-hand quadrant of this map, the 1778 Edward Fage map of the same area (Figure 3) should be reviewed.

This map provides information concerning the British defenses and the American forces’ covered works that may have been in place at the time of the Siege in August 1778. However, after studying Figure 3, even this information is in doubt. There are two folio sheets that must be put together to provide the picture of the battlefield in Middletown as it developed from August 8th to August 25th. The two sheets are fitted together one over-the-top of the other with the legend sheet on the bottom.
Figure 1 Map drawn in 1779 by British commanding engineer Abraham D’Aubant, depicting the works built August 8 – 29th for the Siege and proposed defenses yet to be built.
When put together the map measures 41 ¾ by 50 ½ inches and is drawn to scale of 1 inch to 500 feet. All soundings are in fathoms. This is a highly accurate, detailed, finished colored topographical map. The shoreline coloring is not traditional blue but a very light green. This is the obvious giveaway that these pieces belong together. The upper half shows the area of Valley Road, Easton’s Pond upper and lower, and all the land, to the west, including Newport Harbor and Goat Island (Figure 1).

In March 1777, D’Aubant sent a report to Gen. Howe in New York which describes the work undertaken from December 8, 1776 to March 31, 1777. It includes an activity report that describes the project plans being developed for the fortifications. In the correspondence, he gives a picture of the engineering department activity in Newport. This map shows the disposition of British and Hessian troops for the defense of Newport. D’Aubant laid out this plan in a written document in August 1777 and received direction from Gen. Clinton to proceed. On November 21, 1777, he sent a letter to New York concerning the fortifications. This letter was approved by General Pigot. He made the endorsement and gave directions of things that he wanted accomplished. In the endorsement the first fortification of the outer defense line to the northwest of Newport he describes the area as being “Shefield to Tomini.” This is the only time this description is ever used on any of the British maps examined. It may be that this part of the outer line was moved further south to provide a defensive line between the North Battery and Tomini(sic) Hill. The chain of fortifications that compose the outer line were to be manned by a total of 840 men.  

This map exhibits the defenses prior to August 8, 1778. It also shows the French fleet as they entered the harbor and engaged the British batteries and the works that were

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raised that day until the Siege was lifted on August 29th. It includes the proposed work to be accomplished in 1779 for the defense Newport and the rebel batteries that were erected along with the number of canon or armament and the date on which these fortifications started firing. This is an extremely comprehensive map and is the key to the Siege of Newport and the Middletown battlefield. This is the only map that shows the location of the British headquarters on Spring Street at the head or east end of what appears to be Green Street. The information contained in the legend is so important that it has been enlarged and displayed here (Figure 2).
Figure 2 The legend for the 1779 D’Aubant map (Figure 1). Listing both completed and proposed defenses.\footnote{D’Aubant, 1779. William L. Clements Library, University of Michigan.}
The “Plan of the Works Which Form the Exterior Line of Defence, for the Town of Newport in Rhode Island…” (Figure 3) is signed by Edward Fage, November 1778, and is drawn to the scale of 1 inch to 500 feet. All soundings are in fathoms, and it shows the outer line (first line) of defense that the British used during the siege of Newport. This finished, colored, topographical map shows a very small part of the northeast corner of the inner line (second line of defense) that was set up. It shows the American covered trench works that came down the west side of Honeyman Hill across what is today Aquidneck Avenue and down to the southwest and across Green End Avenue. The map is 26 by 17 ½ inches and shows topographical detail of the defensive works, batteries, bastions and entrenchments. This map is unique because it shows the dates when the defenses were changed and even though the map is dated November 8, 1778. There is a plan named, “Plan of and Entrenchment with Redoubts, ordered by Maj. Gen. Pigot to be thrown up, for the Defense of the Town of Newport, begun the September Quarter, No.16,” that was probably never accomplished based on the information contained on this map. It shows fortifications built from August to October 1778, which makes it more important than the map shown in Figure 1.
Figure 3 Map of the British and American works used during the Siege and drawn by Fage in November 1778. Defenses like Fort Fanning, that were in the process of being built when the map was drawn are also included.
The “Plan of Rhode Island surveyed and drawn by Edward Fage in the years 1777 78 and 79” (Figure 4) is a map of the entire island of Rhode Island (Aquidneck Island), and is drawn to scale of 1 inch to 2000 feet. This map was made on two sheets of paper and its title is in a note on the lower right-hand corner of the main sheet. The larger piece measures 21 ¼ by 37 ½”, and is attached at the lower left side (west) to another sheet that measures 4 ½ by 23 ¾ inches. The map is a finished, colored, topographical map showing Rhode Island and part of Conanticut Island, along with soundings and distances. There is a large amount of detail on this map. It shows clearly the Rebel trench works coming down the west side of Honeyman Hill. Most importantly it shows which houses were destroyed throughout the island during the British occupation. It also shows where ships were scuttled in the harbor, distances between various points, major fortifications, soundings, and a list of all the major landholders throughout the island. The information was important because the British knew they were going to have to house their troops. This map was certainly used by D’Aubant to draw up the defenses for Newport. It is the only map found thus far that shows the Headley House just southwest of Turkey Hill.

257 Fage, Plan of the works, 1778. William L. Clements Library, University of Michigan.
Figure 4 The full "Plan of Rhode-Island" surveyed and drawn by Fage in 1777, 1778 and 1779. 

“Plan of the Town of Newport in the adjacent Country with a Project for its Defense” (Figure 5), is a finished colored topographical map of the town and the surrounding country side for approximately two miles. This map has a border, a title block and is the third most significant map of the Middletown battlefield. Edward Fage, who was an artillery officer, was primarily interested in the distance for artillery fire. Hence all of his drawings include distances. The scale of the map is 1 inch equals 1000 feet and measures 10 ½ by 20 inches. There is no legend or index that corresponds to the survey for the angles for point A through L. Points M through P no doubt anticipate landing points for a possible amphibious invasion.
Figure 5 The map by Edward Fage displaying the plans for Newport’s defenses.  

The below, incomplete, map (Figure 6) is by Edward Fage according to the Clements Library catalog. It is a colored topographical map drawn to scale of 1 inch to 2000 feet. It also has a scale for feet, yards, and miles in the lower left corner. The soundings are important because the French flag ship drew 34 feet of water which made her passage extremely vulnerable. The map is significant as it shows the French fleet arriving in Newport and penetrating the west passage, which is titled “Narragansett passage.” It shows the first rate ship of the line entering Newport harbor and firing on the British positions on Goat Island.

Figure 6 The unfinished map of lower Narragansett Bay, attributed to Fage.260

260 Fage, Edward, Newport County, Ca., 1779. William L. Clements Library, University of Michigan.
“A Chart of The Harbour of Rhode Island and Narragansett Bay….” (Figure 7), was printed by J.F.W. Des Barres in 1778. It shows the disposition of the British fleet and approximately where the various British ships were sunk when the French fleet entered the Narragansett Bay, Newport Harbor and the Sakonnet River. This is a beautiful map that has at least seven different states. While the map is highly accurate and is based on a survey made by Blaskowitz, who reported to Samuel Holland, there are a few things that are misplaced. The covered trench works shown in Middletown have no explanation and are not properly placed. Des Barres had returned to England in 1774 and convinced the British government to give him access to all the information coming in from the colonies so he could print maps. The information for this map came through the Colonial Office. Therefore, he had no firsthand knowledge of exactly where the covered works were dug or where the ships were sunk from the written description of the events that he was receiving. This map of Narragansett Bay is of such high accuracy that it was a standard for the next 75 years. Map makers use others surveys for information and incorporate it into their work. Even today the USGS survey maps still show a British unit marked on the north end of the island with no explanation.
Figure 7 Chart of the Harbor of Rhode Island and Narragansett Bay printed by J.F.W. Des Barres in 1778.\textsuperscript{261}

\textsuperscript{261} Des Barres, Joseph F.W., \textit{A Chart of the harbor of Rhode Island and Narragansett Bay surveyed in pursuance of directions from the Lords of Trade to his majesty’s surveyor general for the northern district of North America:}
The Charles Frederick William Mielatez map titled “MAP of the MILITARY
OPRRATIONS in 1777 – 78, Rhode Island” (Figure 8) was published as Plate II in Major
General George W. Cullum’s book, Historical Sketches of the Fortifications in Defense of
Narragansett Bay, Washington, 1884. This map was copied from a map in the collections of the
Massachusetts Historical Society in Boston, Massachusetts and it was actually drawn by J.
Denison. It was drawn to a scale of 1 inch equals 1 miles and has a black and white border. The
original, which has discolored with age, shows the various units of the opposing forces. There is
a legend in the lower left corner. Another original of this map exists in the Rhode Island
Secretary of State Office in Providence, Rhode Island. Therefore, there are two known original
maps by J. Denison showing the retreat of the American forces from the Siege of Newport from
August 24 through August 31, 1778. Edward Field stated a third copy may have been sent to the
State of Connecticut, however, a search was made some years ago and it was determined that
there were no records of such a map.

This map shows the disposition of the American troops at the north end of the island, and
it shows them leaving the island and taking up positions on the Tiverton Heights. It also shows
the French fleet as it departs Newport Harbor. This shows clearly that without naval support and
the support of the French army, which was to attack from the west, the battle was lost. If this
battle had been won in August 1778, there would have been no Yorktown and a great number of
American and British lives would have been saved. It would have been the second major British
Army defeat in North America, the first being at the Battle of Saratoga in 1777. The sentiment

Published at the request of the right honourable Lord Viscount Howe / by J.F.W. Des Barres esq. London: J.F.W.
in England would not have allowed the American Revolution to continue. Most American historians concede this fact.

The “Plan of the Position of His Majesty’s Troops at Rhode Island, after the defeat of the Rebels the 29th of August 1778” (Figure 9) may have been drawn by a Hessian soldier. It is a colored map (done in red, blue and black) showing the disposition of British ships and military units throughout the island. This map has stylized trees casting their shadow in the east-west direction. The map is drawn to scale of 1 inch equals approximately 1 mile. It measures 11 ½ by 18 ½ inches. There is an unusual compass rose showing west as the direction arrow. This map is not entirely accurate. It does show some of the fortifications in their correct position but they are not correctly drawn. Further still, several landmarks are labeled with alternative names or spellings. Coaster Harbor Island is called Smallpox Island\textsuperscript{263}, Tomini Hill is called Domini

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{map.jpg}
\caption{The map of the battlefield of the Siege and Battle of Rhode Island.\textsuperscript{262}}
\end{figure}

\textsuperscript{262} Mielatz, Charles Frederick William. Map of the military operations in 1777-78 on Rhode Island. 1883. William L. Clements Library, University of Michigan.

\textsuperscript{263} In the 18\textsuperscript{th} and 19\textsuperscript{th} centuries this island was used to contain outbreaks of small pox and other epidemics. A portion of a small pox cemetery still remains on the island today. Due to this use Coasters Harbor Island was frequently referred to in past centuries as “Pest Island” or “Small Pox Island.”
Hill, and Honeyman Hill is called Haman Hill. The use and spelling of “Domini Hill” and “Haman Hill” further suggest that a Hessian may have been involved in the creation of this map.

Figure 9 The likely hessian-drawn map of the island showing the defenses.\(^{264}\)

\(^{264}\) Plan of the position of his majesty’s troops at Rhode Island, after the defeat of the rebels the 29th of August 1778. 1778. William L. Clements Library, University of Michigan.
The Newport Harbor map draft (Figure 10) has no title or border. It was surveyed by Charles Blaskowitz with a 17-man survey party in late October 1774. Ezra Stiles, the Congregational minister and prominent Newport resident, referenced it on October 25, 1774, in his diary. One of the interesting things about this map is as a survey map it would have typically been destroyed. The map shows a penciled-in fort on Goat Island and this configuration of the outer walls lasted well into the 19th century. The North Battery which was built by the British when they occupied Newport is not shown. However, the fields of fire for such a fortification are clearly penciled in to protect Rose Island and to provide a clear field of fire to the Newport Harbor entrance, clearly missing the fort on Goat Island. The North Battery was the west end of the British inner line during the Siege of Newport, drawn on a plane table and the grid used can clearly be seen. The map measures 17 by 15 inches and although there is no scale shown, it appears to be made to the scale of 1 inch equals 500 feet. The inshore measurements of the water depth are given in feet whereas further out it is given in fathoms.

The Newport Harbor draft map (Figure 10) was the basis for the one commonly seen today titled, “A Plan of the town of Newport in Rhode Island” surveyed by Charles Blaskowitz and engraved and published by William Faden, September 15, 1777 (Figure 11). In this map, the main survey line used is just north of Spring Street. The final version (Figure 11) has numbers on it that correspond to a list containing the street names. Trinity Church is listed as well as the first Congregational Church and their locations are shown. The list of the street names is not provided on the earlier draft version (Figure 10).

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265 It was also the basis for “A Plan of the Town of Newport” published by F.B. W. Des Barres in 1776.
Figure 10 The draft map of Newport Harbor surveyed by Blaskowitz in 1774.\textsuperscript{266}

The French map, “Plan De La Ville, Rade, et Environs de Newport…” (Figure 12) of 1780 shows the 35 fortifications of the French army, the 13 rebuilt British fortifications, the six British forts left in ruin, the seven campsites of the French army, and the nine major ships of the

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line of the French Navy. It also shows the positions of the sunken British ships used to protect the North Battery in 1778. The map is a finished colored topographical map drawn to scale of 1 inch to 100 toise. The actual dimensions of the map are unknown.

268 1 Toise = 6 old French feet or 6.4 English feet.
Figure 12 The 1780 French map detailing additions and alterations to the battlefield.\textsuperscript{269}

\textsuperscript{269} Colbert, Edouard Charles Victurnien, Comte de Maulevrier. \textit{Plan de la ville, rade, et environs de Newport en Rode Island, avec le campement de l'armée Françoise près de cette place en 1780. la disposition des ouvrages qu'elle a exécuté et le mouillage de l'escadre.} 1783 [ca. 1783]. William L. Clements Library, University of Michigan.
Appendix C

The following text covers excerpts from historical newspapers including, the Providence Gazette (Providence, RI), Massachusetts Spy (Worcester, MA) and the Royal Gazette (New York, NY). All articles included pertain to the Battle of Rhode Island, its lead up and aftermath, and are displayed chronologically. They were selected, studied and transcribed by James Rehill.

Battle of Rhode Island in Historical Newspapers

Transcribed Articles

20 June 1778

Providence Gazette: Letter from General John Sullivan to General Pigot

“Sir, the repeated application of the discussed Families of those Persons who were captured by your Troops on the 25th…induce me to write you upon the Subject. As those Men were not in…Service, or found in Arms, I cannot conceive what were the Motives for taking them, or guess the Terms upon which their Release may be obtained… the War, on the Part of Britain, been founded in Justice; and had your Troops, in their [Excellence], completed the Destruction of the Boats, and our military Preparations in that Quarter, without wantonly destroying defenceless Towns, burning Houses...to the Deity, plundering and abusing innocent Inhabitants, and dragging from their peaceful [Habitations] unarmed and offending Men, such an Expedition might have shone with splendor. - It is now darkened with savage Cruelty, and stained with [undeniable] Disgrace.

“In your last Letter to me, you gave it as your Opinion, that the Inhabitants of America, at large, would entertain more favourable Sentiments of the Views and Intentions of Great-Britain, than I seemed inclined [to have]. If, Sir, the unprecedented Cruelty of your Troops, displayed upon ever petty Advantage, since the Commencement of this Conflict; the inhuman and unexampled Treatment of Prisoners, who by the Fortune of War, have fallen into your Power, had not sufficiently convinced the Inhabitants of the United States, that they had nothing to

expect from that Nation, but a Continuance of those tyrannical and cruel Measures which drove them to a separation; the Conduct of your Party…late Excursion, must have stamped it with Infallible Certainty.

“The Law of Retaliation has not as yet been exerted by the Americans. Humanity has marked the line of their Conduct thus far, even though they knew that their Tenderness was attributed to…; but if a Departure from the Laws of Humanity can in any Instance be justified, it must be when such relentless Destroyers are entrapped by the Vigilance of the Party invaded. Perhaps….Period, the Americans, fired with Relentless… accumulated Injuries; wearied with the long… or a humane Conduct, which has only been regarded with… and Insult… despairing to mitigate the Honors of War, by… in the Practice of a Virtue, which their Enemies seem to have banished from their Minds; may, by suddenly executing the Law of Retaliation, convince Britons, that they have mistaken the Motives of American Clemency, and is… too long with undeserved… should such an Event take Place, the unhappy Sufferers may charge their Misfortune to the Commanding Officers of the British Army in this Country, whose mistaken Conduct has weaned the Afflictions of Americans from your Nation, driven them to disavow Allegiance to your Sovereign, and at length routed them to Acts of Retaliation.

“I should not have wrote you so particularly upon this subject, had I not observed, in the Newport Gazette, that the Conduct of your Troops, employed on the late Expedition, had receive your Approbation, and warmest Thanks.

“Your favoring me with a Line, informing upon what Terms a Release of those unfortunate Persons may be obtained, will much oblige, Sir,

Your most obedient and very humble Servant,

JOHN SULLIVAN”

_Philadelphia Gazette: Letter from General Pigot to General Sullivan_271

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“Sir, I received your very extraordinary Letter, and as you request nothing more than the Favour of a Line to inform you upon what Terms the Prisoners taken on the 25th of last Month can be obtained, it is unnecessary to trouble you with a Reply to any other Part of your Letter.

“You are pleased to say, you cannot conjecture upon what Terms their Release may be obtained; You certainly must know, that by the Laws of this Country every Man above sixteen, and under sixty, is...to serve as a Soldier, under very severe Penalties; and have Generals and Field Officers appointed to lead them, whenever called forth; and I have no Doubt but many of those very Persons, whom you call peaceable Inhabitants of this Island, by General Spencer. This being the case, I do not see there can be any Objection made to their being exchanged for Soldiers or Seamen. Any one who does not come under the above Description, of being between sixteen and sixty, shall, upon your pointing him out, be immediately set at Liberty, without any Exchange, Should this Proposal be agreeable to you. I am ready to make the Exchange as soon as you please; but in case it does not meet with your Approbation, I am sorry to acquaint you, that not having it in my Power to accommodate the Prisoner so conveniently and well as I could wish to do, must be under the Necessity, when an Opportunity offers, of sending them to New York, where they will be better attended to, and more at large, and I wish I could say their Exchange more easily effected.

“I am, Sir,

Your most obedient humble Servant,

ROBERT PIGOT.”

Providence Gazette: Letter to General Sullivan from a General Officer in the American Army

“The Enemy have every Thing in Readiness to [make] their Departure from Philadelphia. It is reduced to a moral Certainty that they mean to march through Jersey. They were under Orders to proceed this Morning, but were prevented by the Commissioners arriving last Evening from England. They are, the Earl of [Carlisle], Governor Johnstone, and Mr. Eden, Brother to the late

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Governor of Maryland. Lord Cornwallis is with them, but in what Capacity I am not able to say - I do not imagine this will prevent them from leaving the City; It may possibly delay them a few Days.

“One County in England rose in Rebellion, in Consequence of the Attempt to raise a new Regiment upon Subscription. The Master went to a great Length; but I am not fully ascertained of the Particulars.”

Last Week several Transports arrived at Rhode Island from New York, and bought a Reinforcement of what are called the new Levies, alias Tories; their Numbers not known.

Thursday last Brigadier General Varnum arrived here from the Grand Army in Pennsylvania.

We Learn, from good Authority, that the British Commissioners are arrived at Philadelphia from England; and that some Dispatches, relative to the Negotiation proposed by them, have been forwarded by Express to Congress.

We hear that a Cartel is settled, and that a general Exchange of Prisoners will speedily take Place.

The Privateer Ship Blaze-Castle, Capt. James Munro, of this Port, has taken a small Cruiser, of two 6 Pounders, and 4 Swivels, fitted out at Antigua. She had taken several Prizes before Capt. Munro met with her. The Blaze-Castle has also taken a Vessel with dry Goods, and a Brig of 130 Tons, laden with Wine, and a Schooner with slaves. The three former are safe arrived, but the Schooner has been re-taken.

18 July 1778

_Providence Gazette: Letter to General Sullivan (USA) from an Officer at Bristol_273

““The Enemy landed last Night on Hog-Island, and with their usual Spirit attacked and burnt an empty House and barn, together with some Hay which had been cut by the Inhabitants and through Neglect was left on the island.”

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273 “Letter to General Sullivan from an Officer at Bristol.” _Providence Gazette_ 18 July 1778: 3. _America’s Historical Newspapers_. Web.
Monday last a Number of the Enemy’s Ships and smaller Vessels went up the Western Sound from Newport, bound to New York or Long Island. The next Day 21 Sail were observed coming down Sound; one of them, a Sloop, ran on a Reef of Rocks, but was got off; her Boat, on board which was a Captain in the British Land Service, three or four Seamen, and several American Prisoners, was brought on Shore by the latter, who inform that the last mentioned Fleet had on board 2000 Invalids bound to Rhode Island.

Wednesday last General Sullivan reviewed the Troops stationed at Bristol, Swansey and Tiverton, when Salutes were fired from the Batteries in those Towns. The Men made an excellent Appearance and performed the Manoeuvres and Firings with great Alertness and military Order.

Captain George Allen, who lately sailed from this Port in a small Privateer, has taken a Vessel laden with Coal, and carried her into New London.

22 July 1778

Royal Gazette: New York, July 22 274

The following is a list of the Toulon fleet off Sandy Hook, under the command of the Compte D’Estaing;

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<th>Men</th>
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<td>1160</td>
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</tr>
<tr>
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<td>64</td>
<td>700</td>
</tr>
<tr>
<td>Le Sagittaire</td>
<td>54</td>
<td>500</td>
</tr>
<tr>
<td>L’Engageant</td>
<td>26</td>
<td>300</td>
</tr>
<tr>
<td>La Chimere</td>
<td>26</td>
<td>300</td>
</tr>
<tr>
<td>Le Clement</td>
<td>26</td>
<td>300</td>
</tr>
</tbody>
</table>

Three ships [were] sent by Le Compte D’Estaing (names unknown) to the river Delaware.

….Yesterday it was reported that an engagement had happened between a French frigate of 28 guns, and his Majesty’s ship Greyhound, Captain Dixon, and that after a fierce battle the Frenchman yielded and was carried into Rhode Island.

25 July 1778

_Providence Gazette: Newport, July 16_⁷⁷⁵

Last evening a fleet from New York, in which came his Excellency Major General Prescott, with his Majesty’s 38th regiment, two regiments of [Anspach], Col. Fanning’s new raised corps, and a detachment of royal artillery.

30 July 1778

_Massachusetts Spy: Hartford, July 28_⁷⁷⁶

….The Brigades of Generals Glover and Varnum are on their march to the Eastward.

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⁷⁷⁵ “Newport, July 16.” _Providence Gazette_ 25 July 1778: 3. _America's Historical Newspapers_. Web.

We have an account of the arrival of another Squadron of the French fleet; 'tis supposed to be at Newport.

We learn that a number of the best pilots are gone on board the French fleet likewise several gentlemen well acquainted with the coasts and harbours.

As the Count de Estaing will doubtless be eager to improve the present favourable moment, we every hour expect accounts of the most important and interesting events.

**Massachusetts Spy: New London, July 24.**

On Saturday a flag from hence sailed for Newport, with a number of British Prisoners and returned again on Tuesday night with one American and seven Frenchmen; by these we learn that the fleet mentioned in our last to have gone down the Sound, from New York to Newport, had upwards of 3000 Hessian Troops on board, whom they landed on Conanicut Island - that the enemy are fortifying Brenton’s Point. Conanicut, and Beavertail, at the Lighthouse that they had received intelligence of the French fleet’s arrival on this coast, by a brig which fell in with them, but made her escape and afterwards got into Newport; that this account put them in great consternation; since which the American prisoners had received much better treatment; but that they are still very sickly. Among the prisoners who came in this... is a Frenchman, who has been but 24 days from Martinico; he informs, that a fleet of 18 sail of Spanish men of war was shortly to sail from the Havannah, to join the French Squadron on the coast.

1 August 1778

**Providence Gazette: Providence, August 1**

Wednesday… the great... of every good Subject, the Fleet of his Most Christian Majesty, the great and wise Ally of these States, commanded by Admiral Count d’Estaing… Point of Judith,

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278 “Providence, August 1.” *Providence Gazette* 01 August 1778: 3. *America's Historical Newspapers*. Web.
when a Number of [Persons] belonging to this Town went immediately on board, and brought them safe to Anchor off the Harbour of Newport, whereby our savage Enemies are in their….blockaded. On Thursday two French Ships of the Line came up the West Side of Conanicut, and took their Stations above the North End of that Island; several Shot were fired at them as they passed, and a few returned; the Enemy’s Ship which lay there got under Sail on the near Approach of our Friends, and entered Newport Harbour by the West Side of Conanicut. Their Troops soon after evacuated Conanicut, and fled to Rhode Island, having previously...up the Magazine, spiked their Cannon, destroyed the… and set Fire to the Barracks. The [Kingfisher], of 16 Guns with two Gallies, were blown up by the Enemy in Sakonnet River, on the Approach of two other French Ships. The Britons, with their friends the... are in great Consternation; and a few… will probably produce Events of the utmost Importance.

The French have brought in 15 Sail of Prizes, one of them a ship bound to New York, laden with… among which are six large Mortars, and a Quantity of Shells.

The Honorable Major General Sullivan, with his [Suite], went on board the French Admiral’s ship on Thursday last, and yesterday returned to…

On Thursday Major General Greene arrived at… Seat in East Greenwich, from the American Army; and yesterday came to town Brigadier-General Glover.

Yesterday two Boats landed on Conanicut, and brought off some Beds, a Number of Hogs, and two Hessians.

The Navigation in this Port is now open by Way of [Sakonnet] and the West Passage.

On Thursday a vessel arrived here from Stonington.

Since our last several Deserters have arrived here from Rhode Island, who inform that the Enemy’s Troops Consist of between 5 and 6000 men; more than one Half of them Hessians; The latter were greatly dissatisfied on hearing of a French fleet being on the Coast; the Britons endeavoured to pacify them by suggesting that the French Admiral intended nothing more than to… with the Rebels. The Harbour being now blocked up, the Hessians will have an Opportunity of judging what Kind of Trade is proposed, and were then on the Main; would doubtless desert in great Numbers.

The Deserters likewise inform that the Enemy intend to destroy all their Ships, if they find it impracticable to defend them.
Providence Gazette: Navy-Board, Boston, July 18

All Officers and Seamen, belonging to any Continental Ship or Vessel of War, within the Eastern Department, now absent on the recruiting service, or otherwise, are hereby required immediately to repair on board their several Ships; and all Seamen now in America, who regard the Liberty of Mankind, or the Honor of the United States of America, as well as their own Advantage, are now earnestly entreated to enter immediately on board some of the Continental Vessels, in order to afford all possible Aid and Assistance to His Most Christian Majesty’s Fleet, under the Command of the Count de Estaing, the Vice-Admiral of France, now in the American seas, for the Purpose of assisting these American States in vanquishing a haughty and cruel Enemy, too long triumphant on these Seas, now is the Time to secure to yourselves Safety in your future Voyages, and to avoid the Cruelties which all those experience who have the Misfortune to be captured by the Britons; and now is the Time to make your Fortunes.

6 August 1778

Massachusetts Spy: Worcester, August 6

A considerable body of men, are by this time assembled at Rhode Island, as the militia of this state, who were ordered thither, are chiefly arrived, also two brigades of continental troops, so that we may soon expect interesting intelligence from that quarter.

We hear the State of New Hampshire are raising men very fast for the expedition.

A list of line of battle ships, etc. under the command of Lord Howe, at Sandy Hook, 21st July, 1778.

<table>
<thead>
<tr>
<th>Ship</th>
<th>Guns</th>
<th>Pounders</th>
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<tbody>
<tr>
<td>Leviathan</td>
<td>70</td>
<td>24</td>
</tr>
<tr>
<td>Somerset</td>
<td>64</td>
<td>32</td>
</tr>
<tr>
<td>Ardent</td>
<td>64</td>
<td>24</td>
</tr>
<tr>
<td>Trident</td>
<td>64</td>
<td>24</td>
</tr>
</tbody>
</table>

Besides several 32 gun frigates, 20 gun ships, a sloop of 16 guns.. and 1 fire-ship.

Extract of a letter from an American naval officer dated Philadelphia July 12, 1778:

“I came over in the French fleet, and send you an account of the same which you’ll show our friends. The ships under command of Vice Admiral Count D’Estaing are:

<table>
<thead>
<tr>
<th>Ship</th>
<th>Guns</th>
<th>Ship</th>
<th>Guns</th>
<th>Frigates</th>
<th>Guns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languedoc</td>
<td>90</td>
<td>Guerrier</td>
<td>74</td>
<td>Chimere</td>
<td>36</td>
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<tr>
<td>[Tonanne]</td>
<td>80</td>
<td>[Fantasque]</td>
<td>64</td>
<td>[L’Engageant]</td>
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<tr>
<td>Cesar</td>
<td>74</td>
<td>Provence</td>
<td>64</td>
<td>[Clement]</td>
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<td>Zele</td>
<td>74</td>
<td>[Vaillant]</td>
<td>64</td>
<td>[L’Arimable]</td>
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<tr>
<td>[Hector]</td>
<td>74</td>
<td>[Sagitaire]</td>
<td>50</td>
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<tr>
<td>Marseillels</td>
<td>74</td>
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<tr>
<td>Protecteur</td>
<td>74</td>
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</table>

Besides the fleet that sailed with Count D’Estaing, there are five French ships of forte, gone to Virginia with supplies of various kinds for the States, and designing to return to France loaded with tobacco, etc. …one of 50 guns; two of 40, and two of 32 guns. These ships were put under the direction of Beaumarchais, one of the French ministers, noted for his affection to the American cause, and though they belong to the King, came out under the appearance of
merchantmen. This fleet, it is said, is soon expected to join the Count D’Estaing, and act for a season under his orders.”

Gen. Prescott is the Commander in chief of the enemy’s forces at Rhode-Island.

8 August 1778

*Providence Gazette: Providence, August 8* 281

Sunday last the Marquis de la Fayette arrived here from the grand American Army, and on Thursday set out for the Camp at Tiverton.

On Monday Generals Varnum and Glover’s Brigades, with two Companies of the Train of Artillery, arrived here from White Plains, and have since marched to the Southward.

Thursday last a Company of Volunteers arrived here from Salem, to serve in the intended Expedition against the Enemy on Rhode Island. A great Number of Volunteers are likewise expected from Newburyport, Boston, and several Towns in Connecticut.

Yesterday the Honorable Major-General Sullivan left this Place, to take upon him the Command of the Army destined for the [Redaction] of Rhode Island.

Monday last seven Prizes, taken by His Most Christian Majesty’s Squadron, arrived safe at this Port; one of them a Sloop of War, called the York; the others laden with Sugar, Rum, Coffee, etc.

The Fleet have also taken a sloop laden with [Pines]...Limes, Turtle, etc.

Two Hundred and Forty-five Prisoners, taken in the above Prizes, have been since conducted here by Land from Point Judith, and sent on board a Guard-Ship prepared for their Reception.

Wednesday last, on the appearance of two French Men of War on the East Side of Conanicut, the Enemy ran four of their Frigates and a Galley ashore on Rhode Island, and soon after burnt them with their Stores, Provisions, etc. We since learned that the Vessels destroyed are the Lark, Orpheus, and Juno, of 32 Guns each, the Cerberus of 28, and the Pigot Galley.

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A small Privateer landed a Number of Men the same day on Rhode Island, and brought off four...belonging to the above mentioned Frigates, having on board small Arms, clothing, etc.

The Flora, of 32 Guns, and the Grand Duke of Russia, a Storeship, are all the Vessels of Force the Enemy have now remaining in this State.

On Wednesday three Persons made their escape from Newport; they inform that the Enemy have sunk 11 Transports between Goats and Rose Islands, and that they have destroyed all the Farming Utensils on Rhode Island.

Nine of the new Levies deserted from Rhode Island on Wednesday last.

12 August 1778

Royal Gazette: Extract of a Letter from Newport (Rhode Island) dated August 3, 1778

We are now blocked up by the French fleet, 12 ships of the line, 3 frigates, and an incredible number of American privateers, which ply backward and forward to supply them and obstruct the passage of small craft or intelligence. Five days ago they made their appearance. Two ships went down Conannicut and fired at a small battery we had at the Light House, which, when they had passed, we blew up; two more went on the other side of the Island, which caused us to blow up the King Fisher sloop of war and two galleons, stationed to defend the island. Two of the French ships cruise, two lay on the back of the Conanicut, and 12 are at the mouth of the harbor, near the Light-House.

...A person who left Rhode Island last Thursday declares, that the general attack of the British lines had been deferred until last Sunday, as a large body of the Connecticut militia had not yet arrived, and that General Green was to command the enterprize.

...By a gentleman from the Eastward we are informed, that last Friday night three whale boats came over from Connecticut to Southhold, on the east end of Long Island, and informed their friends there, that a 74 gun ship, belonging to Count D’Estaing’s squadron, in attempting to go through a narrow passage near Newport, run aground, and was so severely cannonaded from

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the batteries there, that the crew were obliged to abandon and set her on fire, and that an unarmed Vessel, which was sent to her assistance, suffered the same fate.

...Last night an account was brought to town that the rebels had abandoned their enterprise against Rhode Island, Mons. D’Estaing having suddenly left that place, and two of his ships behind him. We hope soon to give authentic particulars of the events that may have lately occurred in that quarter.

*The following anecdote we believe may be depended on:*

While the Count D’Estaing’s squadron lay off Sandy Hook, a marine officer belonging to one of the ships, a Scotchman by birth, went on shore at Shrewsbury, the inhabitants finding he spoke good English, crowded to converse with him, and told him how happy they were made by the arrival of the French fleet, as they did not doubt their Independence would be established by their co-operation. Whereas the Scotch officer with a significant shake of his head answered them, “he believed they were mistaken, that he looked upon their Independence only as a dream, for that France or Britain must have this country.”

### 13 August 1778

**Massachusetts Spy: Fresh Intelligence from Rhode Island**

By a gentleman belonging to this town, (whose veracity we will vouch for) who went on Rhode Island with our troops last Sunday, and left them in high spirits last Tuesday evening, and arrived here late last night, we have the following particulars, with a confirmation of these preceding:

Last Sunday evening a Fleet of British Ships, (he counted twenty five sail) appeared off Rhode Island; immediately after Count d’Estaing, who lay with 8 sail of the line, between Prudence Island and Newport, properly arranged for an attack on Rhode Island and sent a message onshore to Gen. Sullivan, requesting him to be under no...with regards to the English fleet, for as soon as the wind and tide would permit he determined to go out and attack them. The next morning the English fleet lay off Newport and about 9 o’clock the French admiral weighed

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anchor with 10 ships of the line, passed the enemy forts on his way, which he saluted with some of his heavy metal, and silenced two of their batteries which had begun to play on his shipping, and made fast for the British fleet, which seeing the movement of the French squadron formed for battle; but as the French approached, the English, perceiving their force, did not wait till the Count could come up with them, but made all the sail they could to get out of the reach of his cannon. The count pursued them, and had not returned last Tuesday night. Two sail were seen standing in about sun-down that evening, supposed to be two prizes which the French had taken, as a gentleman, who was observing the motions of the shipping after our informant (the place of observation being on an eminence where they could discover great way at sea) said he perceived, by help of his glass, the ship the French Admiral was in, to come up with some of the British, and concluded that two of them had stuck to the French flag.

The British fleet before mentioned are believed to be under the command of Lord Howe, who has been very assiduous in collecting his force together, to attack Count d’Estaing ever since the Count’s arrival on this coast.

As soon as the Count d’Estaing returns, which without doubt will be soon, a general attack is intended to be made on the enemy on the island.

The French Admiral left several of his ships at anchor near Newport, and we are told, there is not an English ship of force in sight of the island. The Marquis La Fayette is to have the command of the French troops, which are to be landed immediately after the return of the Count d’Estaing.

The American force now against Rhode Island is supposed to be above 10,000 men. The arrival of the English fleet, from St. Helen’s on this coast, has been reported for two or three days. The Tories tell the story with great glee, one asserts this fleet was lately seen off the Banks of Newfoundland, another says she was parted with off the Western Islands, while others do not scruple to say it is actually arrived before Newport; Alas poor souls… let them enjoy it. We have search the various reports to the bottom, and if we are not mistaken, they all spring from one fountain. The New London Gazette, of last Friday, has the following paragraph:

“A British ship of 64 guns arrived at New York last week, supposed to be from Halifax, though it is given out in New York that she belonged to Admiral Byron’s squadron from England, and that she parted with it in a gale of wind a few days before her arrival.”
Another account, from Boston, says, “A commander of a privateer belonging to this state, not long since captured by the enemy, and since made his escape from New York the… says, A British man of war of 64 guns had lately arrived there, which came out as was reported in that city, with a British fleet consisting of eleven sail of the line, bound for America, and every moment expected at New York. Our informant had this account from the Doctor of the captured privateer, who attended a hospital in the city. He received this account from a midshipman of the 64 gun ship, who was sent there as an invalid.” This undoubtedly is the same ship mentioned under the New-London [article]. A third account, also from Boston, says, “A vessel arrived from the West Indies, in a neighbouring port, on her passage was brought to by a British man of war said to be from England bound to New York, who informed that a fleet of British men of war of 20 sail was at Portsmouth, when she left it, and was expected to come out for American in about 12 days.” It Is highly probable this is the ship mentioned in the other two accounts, and that she was from Halifax.

Two of the Cork provision fleet, one of them a ship of 300 tons, the other a large brig, are taken by a French man of war, and sent into Bedford. Another ship belonging to the British fleet was captured by one of our….

When the enemy evacuated the Island of Conanicut, they left a large number of sheep there, which they… from the neighbouring island….

15 August 1778

Providence Gazette: Providence, August 15

Saturday last Count D’Estaing, with 12 Ships of the Line, entered the Harbour of Newport, to cooperate with our Army destined for the [Redaction] of Rhode Island. The Ships were briefly fired on as they passed the Enemy’s Batteries, but received very little Damage; the Fire was gallantly returned, and we since learn, by a Deserter, that several of the Enemy were killed in the North Battery.

On Sunday a British Fleet, supposed to be Lord Howe’s, consisting of about 30 Sail, arrived off Point Judith, with Intention, as is conjectured, of throwing [Succours] on Rhode Island. The Wind being southerly, His Most Christian Majesty’s Fleet could not get out of the Harbour till next morning, when a Breeze springing from the Northward, the brave Count D’Estaing, with the 12 Ships above mentioned, came to sail. They were again briefly cannonaded from the Enemy’s Batteries as they passed, and the Fire was returned with great Spirit. The dastardly Britons, on perceiving the French Ships under Way to engage them, immediately weighed their Anchors, and crowded all Sail towards the South-East. At Two o’Clock, P.M. the southernmost of the French Ships were supposed to be within four Miles of the British, and in our next we hope to give our Readers a good Account of them.

A person from New London informs, that a Fishing Boat is arrived there, the Master of which says that he was between Block Island and [Monsock] on Monday last, and saw some of the French Ships towards Evening, come up with Part of the British Fleet, when a heavy Firing commenced, but does not know the Event.

On Wednesday and Thursday we had severe Storm of Wind and Rain, which has prevented the Return of Count D’Estaing.

On Sunday and Monday last the Honorable General Sullivan, with the Army under his Command, landed upon Rhode Island without Opposition. The Enemy abandoned all their Works and Barracks at the North End, leaving them in good Order, and retreated within their Lines, which are about three Quarters of a Mile from the Town of Newport. Our Troops have Possession of Quaker, Wind-Mill, and Butts’s Hills, and a strong Detachment is advanced within a Mile and a Half of the Enemy’s Lines, near which, on Saturday, the Enemy burnt several Houses.

Our Army, consisting of about 12,000 Men are in fine spirits. The Advance, composed of the light Troops, Independent Companies, and 50 Men from each Brigade, under the Command of Col. Levingston; the right Wing is commanded by General Greene, the Left by the Marquis de la Fayette, the second Line by General Hancock, and the Reserve by Col. West.

Forty-seven Deserters have come over to our Army since their landing on Rhode Island.

In the Storm on Wednesday and Thursday last a Sloop, a Schooner, and several Boats, were drove ashore near the South Ferry.
20 August 1778

Massachusetts Spy: Extract of a Letter from an officer on Rhode Island, to an officer in this town, dated August 10, 1778

“The cannonade, which continued very brisk about two hours was occasioned by the French fleet’s passing the enemy’s batteries as they were going out to sea after the fleet which lay at the mouth… more than eight ships of the line, besides a large number of frigates. The Admiral sent to General Sullivan, that he should attack them in the morning, which obliged the land army to lay upon the oars until the event is known….

“The advance of the army is composed of the light troops, independent companies, and fifty men from each brigade, commanded by Col. Livingston, the right wing of the army by Gen. Green, the left by the Marquis de La Fayette, the second line by General Hancock, and the reserve by Col. West.

“The army are in fine spirits, and are determined to return victorious.”

A letter from a gentleman in the army on Rhode Island, to a General officer in this town, dated August 11, says, “I embrace this first moment since our landing to inform you, that at 9 o’clock yesterday, I landed with the [first] line of the army, the artillery of which I command, with the enemy having left their works there the evening before. We have not yet go to [Logger-beads]. The heavy artillery is mostly over; it is probable we shall move forward this afternoon; our distance from the enemy is seven miles. An English fleet of 8 ships of the line, and 25 sail of other vessels, appeared yesterday, near the evening, to the mouth of the harbor of Newport. The French fleet sailed out this morning to meet them. The cannonade from the enemy’s forts as they passed them, and from the ships was beyond description. We are in anxious expectation for the event, as our further proceeding depends much upon it.”

The late violent storm, and the Count d'Estaing’s going out after Lord Howe’s fleet, which in all probability were bringing large succours of men, etc. to the British army on Rhode Island, have retarded a closer advancement of our troops to the enemy; many of them were sheltered from the severity of the weather in houses… and huts which they made for themselves by putting sails and such like materials upon the stone walls, and covering them with hay and straw, etc. Those who had tents suffered the most, as the violence of the wind blew them down.

“The French fleet have not returned; we shall wait no longer for them; to-morrow morning the whole army advances.

“The enemy’s principal fortification is on Domini Hill - They keep entirely within their lines - few deserters, no prisoners. The enemy have six British and six German regiments, about six thousand - strong.

“We may soon expect some favourable accounts from the French fleet. The General has this moment returned from reviewing the army, they are a fine body of men, from whose exertions we may expect the most happy decision. - Affairs wear the most promising aspect.”

“We are now encamped within about 4 miles of the enemy. Yesterday we were alarmed by the enemy’s advancing, [Estimated] to be a party of about 600, that came out to [reconnaissance].

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They took a few stacks of hay and returned. We were immediately under… and advanced within about one mile of their works, but they had retired before we got up with them. We should have advanced with the whole army this morning but the weather has been stormy all night and still continues. We shall march as soon as it is cleared up; Gen. Sullivan says he has 12,000 men today, and expects to make up 14,000 tomorrow.”

Massachusetts Spy: Extract of a letter brought by the last express from Rhode Island, dated August 15

“At six o’clock this morning the army were paraded, and at seven the signal for marching was given, when the whole began to advance, we arrived without opposition, within two miles of the enemy’s lines in the afternoon. Where the army now remain encamped on the hill.” - The French fleet had not arrived when the express came…

It is said that the Count d’Estaing, when he was coming into the harbour of Newport, put onshore a number of American gentlemen, that had been on board his fleet, saying that though he should be proud of their joint services upon many occasions, he would have none of the exposed in attacks that were proper to his own ships. When he went out to met Lord Howe’s fleet he left two 64 gun ships and a brig to guard that harbour.

Massachusetts Spy: Extract of a letter from an Officer of distinction dated Rhode Island, August 14

“You have doubtless hear before this of our being in possession of the North-end of the island, and may perhaps soon expect to hear of our being in Newport. The situation of the enemy is such that it is almost impossible to make any impression upon their works - They are strongly fortified across the whole island - Their works consist of a chain of redoubts seven in number, within half musket shot of each other; which is what they call the front line. They have in the rear of these five other redoubts at about the same distance from each other connected by a breast work seven

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feet high, with a ditch ten feet wide, and a battery in front, and a strong line of pickets in the rear of the ditch. Their numbers are about 6000 - Provision they are not in want of - Desertion prevails much among them; we had 43 come out to us yesterday. As soon as the weather permits we shall move close down to their lines. We are not at the distance of five miles from them. The late storm was very unseasonable for us. The Count d’Estaing is not in sight. By deserters from them we hear, that he took four and sunk two of Howe’s fleet; but nothing certain is yet arrived.

_massachusetts spy: worcester, August 20^291_

From our correspondents in the army on Rhode Island, we have the following intelligence, as late as the morning of Tuesday last, our army were then in high spirits, and well provided with necessaries, as appear by the following letters to the printer hereof.

_massachusetts spy: extract of a letter from an officer of distinction, dated, camp near newport, August 17th, 1778^292_

“We landed on this island Sunday the 9th...and took possession of the enemy’s works on the north part which they had evacuated without damaging them in the least, those on Quaker Hill were considerable, with commodious barracks. The army was immediately formed in three lines across the island: first and second line of battle, with a Corps de reserve; the first line composed mostly of Continental troops. Exclusive of the aforesaid arrangement, we had a very considerable body of light troops advance. In this situation we remained until Saturday the 15th, in consequence of the most severe storm I ever knew; the army suffered much, for it was impossible to keep the tents standing, the wind was so exceeding strong.

“The morning of the 15th, we advanced towards Newport, each line in three columns; during our march, as we passed over some eminence, I could almost take the whole in at one view; the heavy columns, with the artillery, together with the advance corps and flanking divisions, all moving in the most regular manner, with standard displayed, was a sight truly

animating. We advanced within about one mile and a half of the enemy’s lines, where we have secured our camp by throwing up some redoubts. We are now employed in raising batteries the distance of about 100 [rods] from the enemy’s redoubts; they are very frequently saluting of us from their works.

“The French fleet, that you was informed failed out to attack the English, has not yet returned The wind is now fair, we expect they will soon appear in sight; after which we hope soon to render a good account of the British army in Newport.

“Gen. Pigot, (who commands the British army) was heard to say, that if the French fleet returned, they must all be prisoners. Between fifty and sixty have deserted from the British since we came on the island…”

Massachusetts Spy: Extract of another letter, dated Rhode Island, four miles from Newport, August 17

“Last night we began to throw up some works not above a hundred rods from the enemy’s redoubts; in which we were favoured this morning by the fog; it has now cleared off, since which the enemy have saluted us with a few cannonballs. We expect the French fleet in today, and are all ready for an attack.”

Massachusetts Spy: Extract of a letter from an officer in camp dated Rhode Island, four miles from Newport, August 16

“We marched from Portsmouth yesterday morning, headed by Major-General Green and the Marquis de la Fayette, and the reserve commanded by Col. West, and arrived here about noon. The enemy gave us no manner of interruption. We are in plain view of their works. Our troops last night lay on their arms, and without any covering; The Marquis to encourage them, had a marquee pitched, and lodged just in the rear of our brigade among his guard, which the corporal

was about to remove, but the Marquis ordered them to lie still, adding, ‘We are all soldiers alike now.’

“August 17th. A party went last right on fatigue near the enemy’s lines; it was very foggy and so continues, which favours the design…

“P.S. Since writing the above the fog is cleared off, and a small cannonade has begun.”

22 August 1778

_Providence Gazette: Providence, August 22_295

Early on Saturday Morning last the Honorable Major General Sullivan, with the Army under his Command, advanced towards Newport, and the same Evening encamped on an Eminence two Miles from the Enemy’s Lines, without Opposition, where the main Body of the Army now lies. The same Night a Detachment took Possession of a Height on the Enemy’s Right, about Half a Mile from their front Line of Works, which it commands. On Sunday Morning, the 16th, the Enemy began a brisk Cannonade, though without Effect, and in the Evening a Battery was opened on the Right, which they cannonaded next Day; but the Fire was not returned. Tuesday and Wednesday, two other Batteries being opened, there was much Firing on both Sides, and the Enemy were driven from a Work on the Right. On Thursday Afternoon a brisk Cannonade again commenced, but nothing decisive has yet taken Place. Our Troops are in high Spirits, and eager for Action. Deserters from the Enemy continue to come in daily, and on Sunday three Prisoners were taken.

Thursday last his Excellency Count D’Estaing, with 11 Ships of the Line, returned from Pursuing the British Fleet, and came to Anchor off Point Judith. The [Caesar], of 74 Guns, parted with the Fleet in the late Storm, and is hourly expected.

The British Fleet consisted of 22 Sail, among which were [8] Ships of the Line. The French Fleet came up with them the Day after they left Newport, when Preparations were made for engaging; but the Storm coming on, they were compelled to separate, which favoured the

295 “Providence, August 22.” Providence Gazette 22 August 1778: 3. America's Historical Newspapers. Web.
Escape of the Britons. Two only were taken… the Senegal Sloop of War, commanded by a Captain Gambier, and the Carcass Bomb Ketch.

The Languedoc, and one other Ship, received some Damage in the Storm, which came on at a most critical Time, as a fair Prospect had otherwise presented of capturing a great Part of the Enemy’s Fleet.

A small Privateer fell in with Part of the British Fleet after the Storm, the Master of which informs, that he observed a 74 Gun Ship and a frigate to be dismasted.

Certain accounts are received, that the Spithead Fleet, of which so much Parade has been made in the English Prints...at Anchor in that Harbour the 9th of June last. The [Brest] Fleet, which is much superior in Force, continued to wait their Motions.

Since the destruction of the Enemy’s Shipping in the Bay, upwards of 30 pieces of Cannon, (chiefly 12 pounders) 4 Anchors, a large Quantity of Rigging, several Boats, etc. have been taken from the wrecks, and brought to this Town.

Royal Gazette: Some Particulars of the British and French fleets

On Tuesday the 11th Instant, a most violent tempest arose, which continuing until Friday following, dispersed both the fleets. On Sunday the French Rear Admiral, supposed to be Mons. Bosse of the Le Zele (the Zealous), a ship of seventy four guns and rated to have nine hundred men, bore down on his Majesty’s ship Isis, commanded by Capt. John Raynor, of fifty guns, and rated to have three hundred and fifty men; who permitted not a gun to be fired until the enemy approached very near the Isis, when a fierce engagement ensued, and continued, it is said, about an hour and an half. The Rear Admiral’s fire being very much directed against the Isis’s rigging, rendered her utterly incapable of pursuing the Zele, who wore round, and being one of the best sailing ships of the Comte D’Estaing’s squadron; escaped from capture merely by … during the action a quantity of papers were observed to be thrown out of the cabin windows of the Zele.

On Saturday afternoon his Majesty’s ship Renown, of 50 guns, commanded by Captain George Dawson, fell in with the Languedoc, of 94 guns, and rated to have eleven hundred men, about 30 leagues southeast of Sandy Hook; this capital ship had been distanced in the storm on

the 11th instant. The Renown attacked her on the quarter, and kept up a steady fire against her from 4 o’clock till dark, intending to renew the engagement in the morning, but the French Admiral, availing himself of the darkness of the night, brought his ship to an anchor, by which means the Renown became separated three or four miles from him. At daybreak, Captain Dawson observed the Count D’Estaing, attended with several other ships of his own squadrons, which occasioned the fifty gun ship to bear away, and thereby escaped from a superiority, to himself, invincible.

His Majesty’s ship Preston, commanded by Commodore Hotham, of 60 guns, and rated for three hundred and fifty men, fell in with the Le Tonane, of 84 guns, and rated for eleven hundred men, said to be commanded by Mons. Bougainville, a gentleman who in the last war, had the honour of serving his sovereign in Canada; and is allowed to be an officer of distinguished abilities. This ship had lost her [port-sprit?] and fore-mast, on the 11th instant. The Preston raked her fore and aft a considerable time, and would certainly have made a prize of Her but for the intervention of several other ships of the Toulon fleet, which occasioned the Preston to leave her to their protection.

27 August 1778

*Massachusetts Spy: By Boston Friday’s Post - Boston, August 20* 297

Authentic Intelligence from our army on Rhode Island:

“On the 15th instant, at six o’clock, P.M. a detachment of our troops, with a covering party, paraded in the front of our army, where the ...intrenching tools... etc were ordered, and as soon as it was dark, took possession of a height on the enemy’s right, which commands their front line of works, at the distance of about half a mile. - The enemy did not discover our taking possession of this post until the morning of the 16th, when they began and continued a brisk cannonade without effect. During the time our detachment were at work, they opened a covered way, and about half completed a battery on the right, which was to be finished, and another on the left

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erected, the next night that our batteries would opened on the 19th. Our troops were in high spirits, and that great regularity ha been conspicuous in all their manoeuvres. The French fleet not returned on the morning of the 18th.”

By the last night’s express from Rhode Island, we are informed, that on the night of the 17th instant the covered way and two batteries of 4 guns each, were almost completed. That a fatigue party of 1000 men, were employed on the works on the 18th, which so much provoked the enemy, that they fired three or four hundred shot at our people, but to very little purpose, two men only being slightly wounded, and the party continued at work.

Massachusetts Spy: Extract of a letter from Major General Hancock, to the Hon. J. Powell, Esq; dated Tuesday evening, Aug. 18

“Nothing material has happened since my letter of this morning except a constant cannonade from the enemy, without any other damage then slightly wounding one man. A firing has been heard a sea, which we think denotes the approach of the French fleet, and expect to see them in the morning, after which we shall proceed with great vigour and dispatch. Our men being fully employed in completing the works near the enemy’s lines. Desertion prevails among them, notwithstanding their circumscribed situation and double guards, this night being very dark we expect many, in one day 41 have come in.

“Wednesday morning, five o’clock. Everything quiet, and very heavy fog and small rains. No account of the French fleet; indeed it is impossible they should set in, as it is exceeding thick.”

Massachusetts Spy: By Boston Tuesday’s Post - Boston, August 24
On the night of the 20th instant, our army erected another battery on Rhode Island, advanced 40 or 50 rods in front of these at first...on the hill, which have been already mentioned: This battery is not only nearer, but better situated to annoy the enemy. We had one more killed and two wounded. On the afternoon of the 20th, the Count d’Estaing returned with his squadron having taken an English frigate of 28 guns... Two of the French ships suffered some little damage in their masts in the late severe storms. The spirit of desertion greatly prevails among the enemy.

Massachusetts Spy: Extract of a letter from an officer on Rhode Island, dated Aug. 21.300

“We thought it very unlucky for us, that the French fleet [left us], but it was unavoidable. Lord Howe had 3000 men on board his fleet...which he would have landed... The Wednesday after… The Languedoc lost some of her topmasts, and a 74 lost some masts. They are now off Point Judith, and have brought up the Senegal.... We have some batteries of eight guns each playing upon the enemy today, tomorrow we shall open the mouths of fourteen guns more, and [some of our] mortars will begin playing in the morning. We have had, I imagine, near 2000 shot fired on us, which has killed one man wounded [some]...”

29 August 1778

Providence Gazette: Providence, August 29301

On Wednesday next the Honorable General Assembly of this State will meet at East Greenwich.

The Caesar, a French Ship of 74 Guns, mentioned in our last to be missing, is arrived at Boston Soon after the Violence of the late Storm had abated, in which she was separated from the Fleet, she fell in at 10 o’Clock at Night with a British Ship of 64 Guns; about Three in the Morning a sharp Engagement commenced, which continued 3 hours, when two other British Men of War heaving in Sight, the Caesar quitted her. The British Ship was greatly damaged,
several of her Ports being beat into one, and her Pumps going, when the Caesar made Sail. We learn that 13 Men were killed and 19 wounded on board the Caesar. The Captain had his right Arm badly wounded, which has been since amputated, and one of the Lieutenants lost a leg.

Two of His Most Christian Majesty’s Ships having been disabled in the last severe Storm on Saturday last, they sailed from Point Judith to refit, convoyed by the Remainder of the Fleet.

The Operations against Rhode Island continue to be carried on with Vigour, and if the Enemy should not receive large Reinforcements in the Absence of Count D’Estaing; whose Return is daily expected, there is the fairest Prospect that the Expedition will be crowned with Success. A brisk Fire has been kept up several Days this Week, with very little Effect on the Part of the Enemy. Deserters continue to come out daily.

Last Monday Night a Party of the Enemy from Rhode Island landed on the Narragansett Shore, and with their usual Spirit dragged an inoffensive Farmer from his House (Mr. Rowse Potter) whom they carried off, with one of his Negroes.

Capt. Tredwell, in the Privateer Sloop Hero, of this Place, in Company with the Privateer Barton, of Dartmouth, has taken a Schooner from Jamaica, laden with Molasses, Rum, etc. and brought her into Port.

The above mentioned Schooner, previous to her being captured, took up Cat. John Bell and his Crew, late of the Brig Ruby; also Capt. John Daggers, and three of his Men, late of the Ship Nancy, the Remainder of her Crew, 15 in Number, being drowned. They were Part of a Fleet from Jamaica, bound to England, and were, with nine others, wrecked on the [Bahamas] Banks, in the late violent Storm.

The Privateer Sloop General Stark, of Warren, in this State, has taken a Brig with 100 bags of Cotton Wool, and a Quantity of Redwood, and sent her into Boston.

3 September 1778

*Massachusetts Spy: By The Rhode Island post - Worcester, September 3. Extract of a letter from an officer of distinction, dated camp at Rhode Island, August 30*302

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“The night before last we adjourned from our camp before Newport, leaving behind us neither ten, equipage, stores, or even an old shoe, and retired in very good order to this place, called Butt’s Hill. At 7 o’clock yesterday morning the advance of the enemy attacked our light troops who were posted in advance of the enemy on the east and west roads. After a severe action, in which the enemy had vastly the superiority in numbers, we retired in excellent order to the main body. I was sent with this order in the east road. The fire was very hot, both of cannon and musketry, and rather disobliging for a few minutes to my nerves.

“The enemy advancing rapidly, were received warmly by a number of heavy cannon, which induced them to halt. After lying quiet for an hour a strong party advanced Hessian and British light infantry, with an intention to gain our right flank, under cover of two ships which were then opposite to us; they were soon drove out of the way by the cannon from Bristol, and two 18 pounders, which we took down on the open beach; the Hessian and British light infantry mean-time, advanced briskly through a hollow way covered by small brush in front of a redoubt. They were opposed, but at first ineffectually by a few brave fellows, whom they pushed in on our quarter, a hundred yards behind the redoubt. Two continental regiments were now ordered to attack their right, while a brigade of your militia, under General Lovell, and led on by your friend, were to attempt their left and rear. The enemy soon gave way to this manoeuvre… I pushed on almost too far with the militia, quite under the brow of a hill on which was a small redoubt with artillery, and in its rear the whole left wing of the enemy. I was conscious of being near them, but as I could not know their exact position, from the hollow in which we were, I rode up the hill to reconnoitre them, and found myself instantly within musket shot of their whole line; I retreated you may well believe, to my men with full speed. Our troops soon after retired, and the enemy were happy to remain quiet, after retiring some distance from where they first formed their line- in retiring from our right, they plundered and ruined all the houses which were in their way in a scandalous manner.

“In the whole day we have lost about 50 or 60 killed, and 180 wounded, as near as we can hitherto guess. The enemy’s loss must be much greater, as they received most furious and effectual fires after they broke and ceased to return it.

“Had our troops been excessively fatigued by the retreat, we should P.M. have attacked the enemy, and forced them to a general action. If it does not storm that will probably happen today. Some fine lads have slept in death already. Jackson’s regiment was in all the actions, and
behaved to admiration, as did everyone else, whether officer or soldier. Better I assure you than British or Hessians.”

**Massachusetts Spy: Extract of a letter from an officer of distinction, dated Camp at Portsmouth, Rhode Island, August 30**

“It is with the greatest mortification I have to inform you, that we have retreated from the enemy’s lines at Newport, after erecting works, covered ways, batteries, etc. to such an amazing extent in the space of ten or twelve days, as must I think surprise the British army to view. We did not retreat in consequence of having anything to fear from the army that is at present on the island, but by being informed by General Washington that Lord Howe’s fleet had arrived at New York, and that there was the greatest possibility of their reinforcing Rhode Island, immediately. The General in his letter has nearly the following words, that he hopes this will arrive before the fleet, so that you may take every precaution in order to secure a safe retreat. We began our retreat from the lines on Friday evening, at 8 o’clock the pickets and advanced parties, left their posts at twelve, we come off without being discovered by the enemy; they came on in the morning and we had a severe contest with them. I have not time to give you the particulars as the post is now obliged to cross the ferry.”

**Massachusetts Spy: Extract of another letter from the same gentlemen, dated Tiverton, August 30, 1778**

“We evacuated our lines on the South end of the Island on Friday at nine o’clock in the evening and retired to the north end, which was about 5 miles, it was discovered by the enemy by daybreak next morning, and by 8 o’clock they came in sight, moving in two solid columns toward us, our army was immediately formed for order of battle and detachments sent to engage them, they seeing our army in a position for action, halted upon an eminence opposite to us a short time, then their left wing advanced and attacked our right but were soon repulsed and drove

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back with considerable loss. We finally held our ground and obliged the enemy to retire.

Yesterday both parties were busy in intrenching; but the General finding himself and army liable to be surrounded by an English fleet, which could cut off a possibility of retreating, he ordered all the baggage to be carried off the Island and last night the whole army crossed unmolested and I believe unobserved. I think the retreat has done the General great honor, to get off an Island with so large an army and such a quantity of baggage without loss."

We are well informed that the succours sent into the enemy, at Newport, by Gen. Howe, were very considerable. It is supposed they consisted of 6000 men, and their whole number on the island of 14000, besides the advantage of their shipping. Their loss in the action of the 29th was very great...We hear the French fleet will soon be ready for sea.

5 September 1778

_Providence Gazette: Boston, August 31_395

Friday last the fleet of His Most Christian Majesty, commanded by his Excellency the Count D’Estaing, arrived in Nantucket… and the day following his Excellency and part of the fleet, came up to town. He was saluted by the shipping and forts on his landing……

Sept. 3. A fleet of ships, supposed to be Lord Howe’s… has been discovered standing off this harbour for several days past, but disappears this day. The fleet, it is conjectured, consisted of upwards of 20 sails, some very...ships.

The Count D’Estaing has erected very formidable… on George’s Island, in which we hear he has mounted 100 cannon of heavy metal, which he took from his fleet with a determination to defend himself against any invasion from our enemies, while his fleet are repairing the damage they sustained in the late storm.
The Fleet of His Most Christian Majesty having sailed to Boston to repair the Damages sustained in the late violent Storm, the Operations by Land against the Enemy’s… Holds on R. Island were continued to be carried on with vigour till the Evening of the 28th, at which Time our… by a Field return, consisting of only 5400 Men...unanimously determined by the General Officers, in... to change to Position of the Army from the Advanced Batteries before the Enemy’s Lines, and to take Post on Butts’s Hill, at the North End of the Island, till the Return of the Fleet. This was effected before Two o’Clock the next Morning with the greatest Order, the Picket, commanded by Col. Wigglesworth, remaining on Quaker Hill, a Mile in Front of the main Body, and Livingston’s and Laurens’s Corps advanced on the East and West Roads, a Mile beyond the Picket. At Seven o’Clock the advanced Corps were attacked by the Enemy, and after returning the fire briskly,...to the Picket on Quaker Hill. Here the [army] made a stand, and were reinforced on the Left by a Regiment from Glover’s Brigade, commanded by Lieut. Col… and on the Right by a Regiment from Varnum’s Brigade commanded by Lieut. Col. Livingston. The Actions became severe; our Men were well posted, and twice pulsed the Enemy on the Left; but they being strongly reinforced, and a general Action not intended on this... the advanced Corps were ordered to retire, which they did with the greatest Order and Regularity, having 5 killed and 16 wounded on the Left, and bringing off a Lieut. and... Prisoners. The Enemy about Nine in the Morning began a cannonade, which was returned with great Spirit, and Skirmishing continued between the advanced Parties until near Ten, when their two Ships of War and... small armed Vessels having got up the River on our right flank, the Enemy send most of their Force that Way, and endeavoured to turn our Right, under Cover of the Ships fire; they were twice Driven back in much Confusion, when a third effort was made with greater Numbers; General Sullivan now ordered the Right to be reinforced, and a sharp Conflict of near an Hour succeeded, in which also the Artillery of both Armies played briskly from the Hills. The Enemy were at length routed, and fled in great confusion to a Hill, where they had Cannon and works to cover them, leaving their dead and wounded on the Field; we took about 60 prisoners. The… must have ended in the Ruin of the British Army, had not the Redoubts on the Hill covered them from a close [Pursuit]. Immediately after the Repulse of the Enemy on the Right, they appeared advancing on our Left,

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Providence Gazette: Providence, September 5

in Consequence of which Glover’s Brigade, were ordered in advance, and form in a cross Road within Half a Mile of the Enemy; They accordingly took Post, and a Cannonade, with Skirmishing, ensued, and continued till dark. It was not judged adviseable to attack them in their Works, as our Troops, inferior in Number to the Enemy, were much fatigued, and had been without Provision or Refreshment of any Kind for 36 Hours. Too much… cannot be given to the Officers and Soldiers in general for their exemplary Bravery. On the Morning of the 30th our Army pitched their Tents on the Front of Butts’s Hill, and a heavy Cannonade commenced and continued through the whole Day. At Seven in the Evening our Picket was posted in advance of the…Line, and a Chain of [Sentinels] formed from the East to the West River. In Consequence of authentic Intelligence received that Lord Howe, with his Fleet, had sailed from Sandy Hook, and that from the best Information 150 Sail of Transports were in the Western Sound, with 5000 Troops, bound to Newport, a Council was called, who were unanimously of Opinion, considering the Situation of the Army, the Absence of the French Fleet, and the momentary Expectation of the Enemy’s receiving a strong Reinforcement of Troops, with a Number of Ships, that the Island should be evacuated, which was accordingly [completed] by 12 o’Clock the same Night, in perfect Order and Safety, not leaving behind the smallest Article of Provision, Camp Equipage, or military Stores. The Enemy’s Fleet, with the Reinforcement, arrived off Point Judith at Seven o’Clock next Morning.

The Number of the Enemy left dead on the Field of Action, according to the best Accounts, was 180, exclusive of those killed in the Engagements with the light Troops, Picket, and skirmishing Parties, and exclusive of those killed by the firing of our heavy Artillery, which played upon their Line through the Day, with apparent great Success. The whole Loss, in Killed Wounded and Prisoners, is supposed to be upwards of 700.

Return of the Killed, Wounded and Missing, of the American Troops, in the Action of the 29th of August.

Col. Laurens advanced Corps, 2 noncommissioned Officers, 8 Privates, killed; 7 NCOs, 24 Privates, wounded; 1 NCO , 3 Privates missing. - Col Livingston’s light Corps, 2 [Subaltern], 1 NCO, 5 privates killed; 4 [Subaltern], 5 NCOs, 16 Privates wounded; 9 Privates missing. - General Varnum’s Brigade, 3 Privates killed; 1 Field Officer, 2 [Subaltern], 19 Privates wounded; 1 Private missing. - General Glover’s, 1 [Subaltern], 2 Privates killed; 1 [Subaltern], 16 Privates, wounded; 4 Privates missing. - Col. Commandant Green’s, 1 [Subaltern], 2 Privates,
killed; 9 Privates wounded; 11 Privates missing. - General Lovel’s, 2 Privates killed; 1 Field Officer, 1 Captain, 1 NCO, 13 Privates wounded; 1 NCO, 4 Privates missing. - General Tyler’s, 1 [Subaltern], 4 Privates, wounded. - Col. Commandant Brown’s 1 Private wounded.

Total, 4 [Subaltern], 3 NCOs, 23 Privates killed; 2 Field Officers, 1 Captain, 8 Subalterns, 13 NCOs, 113 Privates, wounded; 2 NCOs, 27 Privates, Missing. Total, of Killed, Wounded and Missing, 211.

Lieut. Col. William Livingston received two slight Wounds; Major Sherburne of New Hampshire, wounded Lieut. Lowell, of Jackson’s, killed; Lieut. Barber, of Lee’s, and Lieut.s. Henley and Phelon, of Henley’s, wounded.

On Thursday last a large Fleet was seen in the Western Sound, near New London, supposed to be the same that brought reinforcements to Newport.

16 September 1778

Royal Gazette: Newport, September 3

Last Saturday morning it being discovered that the rebels had dismantled their redoubts opposite to our lines, Sir Robert Pigot gave orders for the grenadiers and light infantry, with the Hessian [chaffeurs], to advance, which they did with their usual alacrity, being supported by the 22nd, 43rd, Brown’s and Fanning’s regiments, with the Regiment De Hayne, and two regiments of Anspach. It was discovered as they advanced, that the rebels had been for several days removing their stores and heavy cannon to the north end of the island. The troops met with little opposition until they had advanced some miles, when they were fired upon behind stone walls by large parties of the rebels posted to annoy them. But these obstacles were soon removed by the ardour of the troops, who rushed on with such [impervosity], that the rebels were soon obliged to betake themselves to their last post, which was upon Windmill Hill, so strongly fortified, and so commanding a spot, that Brigadier General Smith thought it was prudent to check the progress of the troops (who had been already fatigued by so long a march) and to take post on Quaker Hill.

The troops remained in this situation all the next day, in hopes the rebels would feel bold enough to renew the attack, which they however declined, and took themselves off on Sunday night, leaving their barracks in good order.

The loss of the rebels on this occasion is supposed to be between three and four hundred killed and wounded.

Thus ended the THIRD expedition of Rhode Island, so greatly to the honour of Mr. Sullivan, that there is no doubt he will be enrolled among the heroes of New England.

Such was the bravery of the troops engaged, British, Hessians, and Anspach, that they deserved to vie with each other in their exertions against the enemy.

26 September 1778

_Providence Gazette: Letter from General Sullivan to the President of Congress, August 31_

“Upon the Count D’Estaing’s finding himself under a necessity of going to Boston, to repair the loss he sustained in the late gale of wind, I thought it best to carry on my approaches with as much vigour as possible against Newport, that no time… be lost in making the attack upon the return of the fleet, or any part of it, to cooperate with us. I had sent expresses to the Count to hasten his return, which I had no doubt would at least bring part of his fleet to us in a few days. Our batteries played upon the enemy’s works for several days with [apparent] good success, as the enemy’s fire from the…visibly grew weaker, and they began to abandon some of those next…and on the 27th we learned they had removed their cannon from all the outworks except one. The town of Newport is defended by two lines, supported by several… connected with the lines. The first of these lines extends from a large pond called Easton’s pond, near to Tomminy hill, and then turns…to the water, on the north of Windmill hill; this line was defended by five redoubts in front. The second line is more than a quarter of a mile within this, and extends from the sea to the north side of the island, terminating at the north battery; On the south, at the entrance by Easton’s beach, where this line terminates, is a redoubt which commands the pass, and has another redoubt about twenty [rods] on the north. There a number of small works

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interspersed between the lines, which render an attack extremely hazardous on the land side, without a naval force to cooperate with it. I however should have attempted carrying the works by storm, as soon as I found they had withdrawn their cannon from their outworks, had I not found, to my great surprise, that the volunteers, which composed a great part of my army, had returned and reduced my numbers to little more than that of the enemy; between two and three thousand return in the course of twenty-four hours, and other were still going off, upon a supposition that nothing could be done before the return of the French Fleet. Under those circumstances, and the apprehension of the arrival of an English Fleet with reinforcements to relieve the Garrison, I sent away all the heavy articles that could be spared from the [army] to the main; also a large party was detached to get the works in repair on the north end of the island to throw up some additional ones, and put in good repair the batteries at Tiverton and Bristol, to secure a retreat in case of necessity. On the 28th a council was called in which it was unanimously determined to remove to the North end of the island, fortify our camp, secure our communication with the main, and hold our ground on the...till we could know whether the French fleet would return in our assistance. On the evening of the 28th we moved with our stores and baggage, which had not been previously sent forward, and about two in the morning encamped upon Butts’s hill, with our right extending to the west road, and left to the east road; the flanking and covering parties still further towards the… on the right and left. One regiment was posted in a redoubt advanced of the right of the East line; Colonel Henry B. Livingston with a light corps, consisting of Colonel Jackson’s detachments, and a detachment from the army, was stationed in the...Another light corps, under the command of Colonel Laurens, Col. Fleury, and...was posted on the west road. These corps were posted near three miles in front; In the rear of those was the picquet of the army, commanded by Col. Wade. The enemy having received intelligence of our movement, came out early in the morning with nearly their whole force, in two columns, advanced in the two roads, and attacked our light corps; they made a brave resistance, and were supported for some time by the picquet. I ordered a regiment to support Col. Livingston, another to Col. Laurens, and at the same time sent them order to..the main army in the best...they could. They kept up a retreating fire up on the enemy and retired in excellent order to the main army. The enemy advanced on our left very [front] but were repulsed by General Glover; They then [moved] to Quaker hill. The Hessian columns [moved to] a chain of hills running northward from Quaker hill. Our army was drawn up, the first line in front of the works
on Butts’s hill, the second in rear of the hill, and the reserve near a creek, and near half a mile in the rear of the first line. The distance between these hills is about one mile. The ground between the hills is meadow land, interspersed with… The enemy began a cannonade upon us about nine in the morning, which was returned with double force. Skirmishing commenced between the advanced parties till near ten o clock, when the Enemy’s two ships of war and some small armed vessels having gained our right flank, and began a fire, the enemy bent their [force] that way, and endeavoured to turn our right under cover of the ships fire, and to take the advanced redoubt on the right. They were twice driven back in great confusions, but a...made with greater numbers and much more resistance when, had it not been for the timely aid sent forward would have succeeded. A sharp conflict of nearly an hour ensued, in which the cannon from both armies placed on the hills, played briskly in support of their own party. The enemy were at length routed, and fled in great confusion to the hill where they last formed, and where they had artillery and...works to cover them, leaving their dead and wounded in considerable numbers behind them. It was impossible to ascertain the number of dead on the field, as it could not be approached by either party without being exposed to the cannon of the other army. Our party recovered about twenty of their wounded, and took near sixty prisoners, according to the best accounts I have been able to collect; amongst the prisoners is a Lieutenant of Grenadiers. The number of their dead I have not been able to ascertain but know them to be very considerable. An officer informs me that in one place he counted sixty of their dead. Col. Campbell came out the next day, to gain permission to view the field of action, to search for his nephew, who was killed by his side, whose body he could not get off, as they were closely pursued. The firing of artillery continued through the day, and the...with intermission six hours. The heat of the action continued near an hour, which must have ended in the ruin of the British army, had not their redoubts on the hill covered them from further pursuit. We were about to attack them in their lines, but the men’s having no rest the night before, and nothing to eat either that night or the day of the action, and having been in constant action through most of the day, it was not thought adviseable, especially as their position was exceedingly strong, and their numbers fully equal, if not superior to ours. Not more than fifteen hundred of my troops had ever been in action before. I should before have taken possession of the hill they occupied, and fortified it, but it is no defence against an enemy coming from the south part of the island, though exceedingly good against an
enemy advancing from the north end towards the town, and had been fortified by the enemy for that purpose.

“I have the pleasure to inform Congress, that no troops could possibly show more spirit than those of ours which were engaged. Col. Livingston, and all the officers of the light troops, behaved with remarkable spirit; Colonels Laurens, Fleury, and Major Talbot, with the officers of that corps, behaved with great gallantry. The brigades of the first line, Varnum’s, Glover’s, Cornell’s, and Greene’s, behaved with great firmness. Major General Greene, who commanded in the attack on the right, did himself the highest honor, by the judgment, and bravery exhibited in the action. One brigade only of the second line was brought to action, commanded by Brigadier General Lovell; he, and his brigade of militia, behaved with great resolution. Col. Crane and the officers of artillery deserve the highest praise. I enclose Congress a return of the killed, wounded and missing on our side, and beg leave to assure them, that, from my own observation, the enemy’s loss must be much greater. Our army retired to camp after the action; the enemy employed themselves in fortifying their camp through the night. In the morning of the 30th I received a letter from his Excellency George Washington, giving me notice that Lord Howe had again failed with the fleet, and receiving intelligence at the same time that a fleet was off Block Island, and also a letter from Boston, informing me that the Count D’Estaing could not come around so soon as I expected, a council was called, and as we could have no prospect of operating against Newport with success without the assistance of a fleet, it was unanimously agreed to quit the island until the return of the French Squadron. To make a retreat in the face of an enemy, equal, if not superior in number, and cross a river without loss, I knew was an arduous task, and seldom accomplished, if attempted; As out [sentries] were within 200 yards of each other, I knew it would require the greatest care and attention. To cover my design from the enemy, I ordered a number of tents to be brought forward and pitched in fight of the enemy, and almost the whole army to employ themselves in fortifying the camp. The heavy baggage and stores were falling back and crossing through the day; at dark, the tents were struck, the light baggage and troops passed dawn, and before twelve o’clock the main army had crossed with the stores and baggage. The Marquis de la Fayette arrived about 11 in the evening from Boston, where he had been by request of the general officers, to solicit the speedy return of the fleet. He was sensibly mortified that he was out of action; and that he might not be out of the way in case of action, he had rode from hence to Boston in seven hours, and returned in six and a half, the
distance near seventy miles. He returned time enough to bring off the pickets, and other parties which covered the retreat of the army, which he did in excellent order, not a man was left behind not the smallest article lost. I hope my conduct through this expedition may merit the approbation of Congress. Major Morris, one of my...will have the honor of delivering this to your Excellency; I must beg leave to recommend him to Congress as in the officer who in the last, as well as several other actions, has behaved with great spirit and good conduct, and doubt not Congress will take such notice of him, as his long service and spirited conduct deserves. I have the honor to be, dear Sir, with most esteem, Your Excellency’s most obedient

And very humble servant,

JOHN SULLIVAN

P.S. The Event has proved how timely our retreat took place, as one hundred sail of the enemy’s ships arrived in the harbour the morning after the retreat. I should do the highest injustice, if I neglected to mention that Brigadier-General Cornell’s indefatigable industry in preparing for the expedition, and his good conduct through the whole, merits particular notice. Major Talbot, who assisted in preparing the boats, and afterwards served in Col. Laurens’s corps, deserves great praise.

[Since the foregoing letter was forwarded to Congress, it has been since ascertained that the enemy’s loss, in the action of the 29th of August, amounts to a thousand and twenty-three killed, wounded and missing]
folks throughout the provinces, and thereby answer the purposes for which they are calculated. It would therefore be of use if any officer would upon such occasions employ an idle hour in furnishing some illustrations to the very sublime and heroic [stories] of their rebel excellencies.

Mr. Sullivan informs Congress that, upon the departure of the French fleet, he resolved to carry on his approaches against Newport with all possible vigor, that he silenced most of the batteries, and drove us from all our out-works, except one, that as soon as that was also silenced, he should have attempted to carry our lines by storm, notwithstanding their great strength, had not the Volunteers (magnanimous fellows) abandoned him by thousands a day.

Now, Sir, during the 26 days that the General remained before our camp, or rather in sight of it, his vigorous resolutions went executed, in so desperate a manner, as to kill one very unfortunate soldier, and wounded another, by a random cannon shot, all his batteries being erected at a useless distance from our lines, except one, which they attempted to bring within point blank, on the 17th of August, and which they abandoned for ever and ever, as soon as some guns were pointed against it.

Those who know our troops, will readily agree with Mr. Sullivan, that the y are as unlikely to abandon a post before their enemies have come near enough to be distinguished without glasses, because in the course of a month’s cannonade, they had left one man, without ever having had a gun damaged. Indeed the parapets still remain standing witnesses the innocence of his Excellency’s experiments upon gunnery. In fact, as General Sullivan had, with great prudence encamped with a...between his camp and ours, and had, further to facilitate his approaches (although the idea was rather new), rut up and abetted the only practicable passage to us, it became unnecessary to fatigue our men, and expose some other unlucky fellow wantonly to the chance of having his bones broke, by keeping them in the lines and our cannon, as the General observes, were indeed silenced, after a very thorough experience, that the rebel batteries were at such a distance, as to render it extremely absurd to expend ammunition against them. Had General Sullivan been pleased to advance his batteries within execution distance, and to have removed those obstacles of his own constructing that prevented the approaches of his troops to our camp, the guns would have, I will not say to his astonishment, again broken silence, and the lines have been again manned.

As our garrison considered themselves as the besieged, not as the besiegers, although the rebel army seems to have held a different opinion, we did not think it incumbent upon us to
interfere with those obstacles which Mr. Sullivan threw between us to prevent all communication and ill blood; not whilst the French fleet threatened us in the rear, did it appear to our commander necessary to break the truce which the rebel general had effectually established by means of this precaution. But how General Pigot can justify himself, after this very civil and inoffensive manner in which his antagonists have behaved themselves during their visit, for the rude way in which he wished them a good journey, I cannot see. I know those who attempted to defend him say, that without some little skirmish, a share of the ridicule which his visitors have drawn upon themselves would have remained with him and that it was rather creditable with a part of a besieged garrison unreinforced, to drive the enemy, who had come there with a certain confidence of making him a prisoner, for six miles before them, into lines, from the nature of the ground and works much stronger than those which he himself had occupied and still more creditable to remain afterwards with this detachments, (which did not consist of one half of his garrison) in front of the rebel lines, fully as near as they had ever adventured to approach to his camp, and without any [merafs] or abettee between them, until the rebel army thought it prudent to abandon them silently in the night, and steal over to the continent, singing in whispers, *Is Triumphe!* And with reason says the General, for was it not glorious to withdraw in the face of this garrison, which had by enchantment became a superior army. What, General, do you forget that you served out daily nearly twenty thousand rations to your army and that General Pigot’s garrison never consisted of 5000 men, the latter half of which (the other remained many miles off at the opposite extremity of the Island) were then boarding your army, ready to give you another parting blow, as soon as you quitted your stronghold, had you not yet stolen off in the dark.

Apprehensions of so small a detachment could not proceed from nature. In spite of appearances I will do more honour to the nerves of our antagonists. The council of war, I am convinced, are men of reading, and must have received their precautionary ideas from Falstaff, “what if they should rob us” or perhaps they were aware of the mishaps of the adventurous Scotsman, who essay’d to catch a Tartar. This warlike Caledonian entered a wood in quest of his enemy, and soon after hallowed out to his commander, “I have caught a Tartar,” “Bring him then” “He won’t come,” “come yourself”, “he won’t let me”.

Out of the respect I bear for Congress, who certainly are an ingenious body, I will take the liberty of giving them a little advice which cannot be disagreeable, as it accords so well with
their grand object of saving appearances. It is to have some sober man at hand, to revise the letters from their different commanders, upon the accomplishment of such great events as the retreat from Rhode Island, to prevent all palpable contradictions, to give the accounts, in some degree, an air of truth and consistency, and above all to avoid those libels, which their Generals, without any bad intentions, I sincerely believe, have been in the custom lately of writing against their own conduct, and the behaviour of the good people under them. Whether the reviser understands anything of military matters, is immaterial, as I apprehend it is since hoped that those pieces of a composition, however glossed over, can mislead men versed in war, however, they may mislead the mob.

Had this precaution been taken, General Sullivan would not have written the paragraph that he remained master of the field of battle, and in others, that his troops retired three miles before those assailants when attacked, and did not stop till they [reached] the lines which the General, with a prophetic eye, had been preparing for their safety several days before. That this field of battle, by which his Excellency must mean the ground immediately in front of his lines, was so commanded by our cannon that he does not send people to count the dead. That General Pigot sent out nearly his whole force, when it is known to every old woman in Rhode Island, that eight regiments remained in the lines. Neither would he have wrote that he had been shamefully abandoned by the greatest part of his army, so as only to have a number equal to the detachment of two thousand men that attacked him, and remained at his [back] until he withdrew. Nor would he have spoke of the strength of the lines before Newport, when he must know, that those we occupied, were crafted in days and after he had landed on the island.

From what I have said, I mean not to infer that Americans are deficient in natural courage. The idea is illiberal, and I disavow it. Although the stubborn climate of England may produce more course and steady nerves, than either the sunshine of the continent of Europe or of America, yet I am persuaded that the breed of Englishmen, wherever transplanted, feeling as they retain a real love of freedom and independence, will display that superior [vigor] which we inherit for a series of centuries from our SACRED ANCESTORS. In a just cause, Americans have shown what blood they are sprung from with us, fighting for the constitution of Freedom, Justice, and of their Fathers, that have reportedly proved their gallantry.

ESCARMOUCHE
Appendix D

The following text covers written correspondence, orders and reports relating to the Battle of Rhode Island, found in the George Washington Papers. The relevant writings have been studied and compiled below by Jessica Analoro. Section I lists and summarizes these writings, while Section II displays images of some of the more significant documents and those not fully described in Section I.

George Washington Papers

Section I: Papers Relevant to the Battle of Rhode Island

<table>
<thead>
<tr>
<th>Entry by Alphabetical Order</th>
<th>Brief of Transcription (Extracting Information of Rhode Island relevance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Rhode Island Regiment, 1778, List of Officers</td>
<td>See Section II</td>
</tr>
<tr>
<td>American Intelligence, August 1778, British Navy Off Rhode Island</td>
<td>See Section II</td>
</tr>
<tr>
<td>Continental Army Officers to Charles Hector, Comte d’Estaing, August 22, 1778</td>
<td>See a Section II</td>
</tr>
<tr>
<td>George Washington, January 1, 1778, Plan for Arrangement of the Army of the Campaign of 1778</td>
<td>See Section II</td>
</tr>
<tr>
<td>George Washington, July 12, 1778, General Orders</td>
<td>(Note 21 of the entry highlighted), Liet. Ebenezer West of Second RI Regiment; Ordering the sick to be brought to King’s Ferry; wagons provided.</td>
</tr>
<tr>
<td>George Washington to Caleb Brewster, August 8, 1778,</td>
<td>George Washington asks Caleb Brewster (member of Culper spy ring; carried messages from Setauket NY, NYC and Long Island) to gain intelligence of movement of enemy ships sailing from “the hook” as it is pertinent to the troops at Rhode Island.</td>
</tr>
<tr>
<td>George Washington to Charles Hector, Comte d’Estaing, July 14, 1778</td>
<td>George Washington receiving news of d’Estaing’s arrival on the coast. Informing him to discuss means of communication with his camp, with Col. Laurens; establishing “conventional signals” and such.</td>
</tr>
<tr>
<td>George Washington to Charles Hector, Comte d’Estaing, July 15, 1778</td>
<td>George Washington providing d’Estaing with livestock, and informs him that any other supplies needed will be provided accordingly.</td>
</tr>
<tr>
<td>George Washington to Charles Hector, Comte d’Estaing, July 17, 1778</td>
<td>Camp at Haverstraw Bay (New York)</td>
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<tr>
<td>Responding to previous letters received by d’Estaing. Provides d’Estaing with his full confidence in his duties. Informing him of Lt. Col. Hamilton to better explain plans and such, in person, rather through letter. Also sends to him Lt. Col. Fleury, who is to provide knowledge of the coast/harbors.</td>
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<thead>
<tr>
<th>George Washington to Charles Hector, Comte d’Estaing, July 18, 1778</th>
<th>From Camp Haverstraw</th>
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<tbody>
<tr>
<td>George Washington sending Captain William Dobbs, to assist in knowledge of coast/harbors, in particular that of New York.</td>
<td></td>
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</tbody>
</table>

| George Washington to Charles Hector, Comte d’Estaing, July 22, 1778 | Commenting on sending reinforcements to General Sullivan. (On Aug. 26, d’Estaing sent a letter to Congress stating that as a result of poor information, sailors and row boats were lost in the effort of going through the Shewsbury River) |

| George Washington to Charles Hector, Comte d’Estaing, July 26, 1778 | Informing D’Estaing that General Greene will be delivering the letter; ensures him of his abilities and his knowledge of his home state of Rhode Island, in the assistance with the engagement. |

<table>
<thead>
<tr>
<th>George Washington to Charles Hector, Comte d’Estaing, August 8, 1778</th>
<th>Information regarding the possibility of Lord Howe attacking the Rhode Island regiments. In the letter GW does not seem to think it probable Howe would do so.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Note 31 states that the original draft contained information of Lord Howe’s sailing from Sandy Hook. Actual extracts of the letter are quotes in Washington’s letter to John Laurens on Aug. 8 and subsequent letter to Congress on August 9.</td>
<td></td>
</tr>
</tbody>
</table>

| George Washington to Charles Hector, Comte d’Estaing, August 12, 1778 | See Section II |

<table>
<thead>
<tr>
<th>George Washington to Continental Congress, July 12, 1778,</th>
<th>Note 25, it is noted that on July 11, John Laurens wrote, “Congress have directed me to propose for your Excellency’s consideration an attack by Vice Admiral Count d’Estaing upon the British ships of War and Transports in the Harbor of Rhode Island, by which possession of a safe port may be gained, and the retreat of the British forces in the Island be cut off, as an alternative to a hazardous or ineligible attempt upon the British squadron within Sandy Hook.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laurens asking GW permission for d’Estaing to attack British ships in Newport Harbor.</td>
<td></td>
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<tr>
<td>Date</td>
<td>Recipient</td>
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<tr>
<td>August 7, 1778</td>
<td>Continental Congress</td>
</tr>
<tr>
<td>August 9, 1778</td>
<td>Continental Congress</td>
</tr>
<tr>
<td>August 19, 1778</td>
<td>Continental Congress</td>
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<tr>
<td>August 24, 1778</td>
<td>Continental Congress</td>
</tr>
<tr>
<td>August 25, 1778</td>
<td>Continental Congress</td>
</tr>
<tr>
<td>September 4, 1778</td>
<td>Continental Congress</td>
</tr>
<tr>
<td>August 31, 1778</td>
<td>Ezekiel Cheever</td>
</tr>
<tr>
<td><strong>George Washington to Horatio Gates, July 3, 1778</strong></td>
<td>GW reports 245 casualties against the enemy in the action on June 28 (Monmouth Courthouse at Monmouth New Jersey); reports a gathering of 100 prisoners.</td>
</tr>
<tr>
<td><strong>George Washington to James Clinton, July 31, 1778</strong></td>
<td></td>
</tr>
<tr>
<td><strong>George Washington to James M. Varnum, July 21, 1778</strong></td>
<td>Orders James M. Varnum (brigadier general) to command Col. Livingston/Sherburne’s and Webb’s regiment. Provides a list of places, including several in Rhode Island (Coventry, Providence) *special note towards providence, instructs him on his arrival to be under the command of general Sullivan.</td>
</tr>
<tr>
<td><strong>George Washington to Jeremiah Olney, July 21, 1778</strong></td>
<td>Ordering Jeremiah Olney (Rhode Island regiment) to march with Col. Angells to Providence (route provided).</td>
</tr>
<tr>
<td><strong>George Washington to Jeremiah Powell, August 2, 1778</strong></td>
<td>Letter to Jeremiah Powell (Massachusetts Senate), saying General Glover’s brigade was detached to Rhode Island (with an intended attack on the enemy) George Washington requests recruits from the state.</td>
</tr>
<tr>
<td><strong>George Washington to John Glover, July 23, 1778</strong></td>
<td>Asks John Glover (Brigadier General—from Marblehead, Mass.) to march to Providence. A hurried note, asking his immediate assistance.</td>
</tr>
<tr>
<td><strong>George Washington to John Laurens, July 22, 17781-1799</strong></td>
<td>Asking Laurens to assist d’Estaing in safely getting his ship through British forces, preventing the landing of the French forces; suggests men being sent to Long Island to destroy enemy resources (cattle, horses, etc.); cutting off communication between British forces In regards to Rhode Island, deciding whether to attack the enemy fleet as it departs from ‘the hook’ Suggests an attempt upon Halifax following Rhode Island</td>
</tr>
<tr>
<td><strong>George Washington to John Laurens, August 8, 1778</strong></td>
<td>Informs Laurens that Howe had left ‘the hook’ and departed to Rhode Island on August 7. Said, “no troops nor transports were thought to be with them” GW advises that if d’Estaing had not already done so, to employ light cruisers off Rhode Island to meet enemy forces before they arrive at Rhode Island.</td>
</tr>
<tr>
<td><strong>George Washington to John Sullivan, July 17, 1778</strong></td>
<td>Informing Sullivan of D’Estaing’s arrival on the coast off Sandy Hook (fleet of 12 ships of the line and 4 frigates). Expects at this point an attack on either New York or Rhode Island; states they are prepared for an attack at New York, but need more preparations for one at Rhode Island; Requests Sullivan to immediately begin applying for recruits in Rhode Island, Massachusetts and Connecticut- 5000 men total- in order to at least be superior by land, to counter the British sea strength -requesting Sullivan to engage pilots informed of Newport harbor, to be knowledgeable of certain signals in order for Sullivan to be aware of the French Admiral’s arrival</td>
</tr>
<tr>
<td>Date</td>
<td>Recipient</td>
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<td>--------------------</td>
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</tr>
<tr>
<td>July 22, 1778</td>
<td>John Sullivan</td>
</tr>
<tr>
<td>July 27, 1778</td>
<td>John Sullivan</td>
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<tr>
<td>July 28, 1778</td>
<td>John Sullivan</td>
</tr>
<tr>
<td>July 31, 1778</td>
<td>John Sullivan</td>
</tr>
<tr>
<td>August 4, 1778</td>
<td>John Sullivan</td>
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<tr>
<td>August 16, 1778</td>
<td>John Sullivan</td>
</tr>
<tr>
<td>July 18, 1778</td>
<td>Jonathan Trumbull</td>
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<tr>
<td>July 28, 1778</td>
<td>Jonathan Trumbull</td>
</tr>
<tr>
<td>July 22, 1778</td>
<td>Marquis de Lafayette</td>
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<tr>
<td>Date</td>
<td>Recipient</td>
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</tr>
<tr>
<td>July 27, 1778</td>
<td>George Washington to Marquis de Lafayette</td>
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<tr>
<td>July 31, 1778</td>
<td>George Washington to Marquis de Lafayette</td>
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<tr>
<td>July 31, 1778</td>
<td>George Washington to Marquis de Lafayette</td>
</tr>
<tr>
<td>August 10, 1778</td>
<td>George Washington to Marquis de Lafayette</td>
</tr>
<tr>
<td>August 25, 1778</td>
<td>George Washington to Marquis de Lafayette</td>
</tr>
<tr>
<td>August 8, 1778</td>
<td>George Washington to Nathanael Greene</td>
</tr>
<tr>
<td>September 1, 1778</td>
<td>George Washington to Nathanael Greene</td>
</tr>
<tr>
<td>August 4, 1778</td>
<td>George Washington to Peter Muhlenberg</td>
</tr>
<tr>
<td>September 2, 1778</td>
<td>George Washington to Silas Deane</td>
</tr>
<tr>
<td>July 26, 1778</td>
<td>George Washington to Thomas Tillotson</td>
</tr>
<tr>
<td>August 4, 1778</td>
<td>George Washington to William Maxwell</td>
</tr>
<tr>
<td>Source</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>George Washington to William Maxwell, August 31, 1778.</td>
<td>Staten Island- whether the British seem to be gathering on ships or moving towards NY. Asking for immediate intelligence about the certainty of the enemy sailing to Newport- whose command their under, number of ships, artillery, etc.</td>
</tr>
<tr>
<td>John Sullivan, August 24, 1778, <em>Rhode Island Campaign General Orders</em></td>
<td>See Section II</td>
</tr>
<tr>
<td>John Sullivan, August 26, 1778, <em>Rhode Island Campaign</em></td>
<td>See Section II</td>
</tr>
<tr>
<td>John Sullivan, August 31, 1778, <em>Casualty Report</em></td>
<td>See Section II</td>
</tr>
<tr>
<td>John Sullivan to Charles Hector, Comte d’Estaing, July 25, 1778.</td>
<td>See Section II</td>
</tr>
<tr>
<td>Nathanael Greene to Charles Hector, Comte d’Estaing, August 21, 1778</td>
<td>See Section II</td>
</tr>
<tr>
<td>Rhode Island War Council to George Washington, <em>Proceedings at Providence Rhode Island</em>, January 15, 1778</td>
<td>See Section II</td>
</tr>
<tr>
<td>Solomon Southwick to George Washington, <em>Report on Commissary Assistants in Rhode Island</em>, May 26, 1778.</td>
<td>See Section II</td>
</tr>
</tbody>
</table>
Section II: Document Images


<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Station</th>
<th>Place of Residence</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 1778</td>
<td>James Wallace</td>
<td>Providence</td>
<td>Providence</td>
</tr>
<tr>
<td>April 1778</td>
<td>Jeromiah Clark</td>
<td>Easton</td>
<td>Little Compton</td>
</tr>
<tr>
<td>Ditto</td>
<td>Stephen Smith</td>
<td>Bristol</td>
<td>Bristol</td>
</tr>
<tr>
<td>Ditto</td>
<td>Charles Lippitt</td>
<td>Warren</td>
<td>Warren</td>
</tr>
<tr>
<td>Ditto</td>
<td>Stephen Mumford</td>
<td>East Greenwich</td>
<td>East Greenwich</td>
</tr>
<tr>
<td>May 1778</td>
<td>Joseph G. Taylor</td>
<td>North Kingston</td>
<td>North Kingston</td>
</tr>
</tbody>
</table>

For Excellence,

George Washington, Esq.

Commissioner in Chief over the Forces of the United States of America.

[Image of the letter from Solomon Southwick to George Washington]
Appendix E

*The following text covers relevant sources on the Battle of Rhode Island, both primary and secondary. The sources were studied and summarized below by Allyson Boucher.*

**Bibliographic Essay**

**Primary Sources**

Primary sources are the root of historical research in that they offer a firsthand account of the experience. There are several documents, journals, and first-hand accounts from the Battle of Rhode Island in 1778 that still survive. Below are listed a select few sources and information from each respective source.


Background on Angell:

Israel Angell was a fifth generation descendant of Thomas Angell, who had come to Providence with Roger Williams. He was born in North Providence on August 24, 1740, the son of Oliver and Naomi (Smith) Angell. Colonel Angell participated in battles of the Brandywine and Red Bank, and was with the army during winter of 1777-78 at Valley Forge. After the Battle of Monmouth, his regiment sent to RI to unite with General Sullivan in operations in Newport RI. He retired from the army on January 1, 1781.

Angell’s diary begins August 20, 1778 – his regiment had been encamped at Tiverton RI, forming part of the force under General John Sullivan, engaging in operations against British—and ends September 23, 1778, when he left due to sickness.

Events noted in diary related to the Battle of Rhode Island:
On August 20, Angell marched with detachment of 500 men as a covering party at 5pm; French fleet not yet heard of “spread great consternation in the army.” The next day there was heavy fire between the armies. News on August 22 that the French Admiral Comte D’Estaing arrived off Beavertail, but after fog and storm they “left us in a most Rascally manner and will be the Event God only knows,” as Angell said. On August 24 and 25, the British and American armies continued exchange of cannonade and bombing. Colonel Livingston, Major Huntingdon and their teams proceeded to lower works to get off cannon and mortar as they decided on retreat. On August 27, one ensign, John Viol, and fourteen men were taken prisoner by the British troops. At eight o’clock at night on August 28, Angell was ordered to strike tents and march to north end of island by the commander of the Continental Army, General John Sullivan; orders countermanded and were then ordered to tarry on the ground until further orders. On retreat, repulsed enemy troops two or three troops. American troops took control of Butts Hill; Hessian troops had severe attack on Americans, but they suffered more casualties. Sullivan received word from Washington that British ships were on their way from New York to Newport. Angell and his troops completed their retreat around three in the morning on August 31 from Aquidneck Island to Howland’s Ferry and then on to Warren.


Mrs. Mary Almy was an innkeeper who had British Loyalist sympathies. In her journal, she describes her experience during the battle to her husband.

On July 29, Mrs. Almy hears news of the French fleet of eleven ships in the harbor. The next few days she describes not much happening in harbor, but hears news of French ships going up Conanicut passage on August 2. All the businesses in town are closed as talk of preparations to sink French ships is spread. Confusion among people in Newport as to when battle will start, and Mrs. Almy send her six children to be with her relatives away from inn. Mrs. Almy notes her distress and anxiety at the approaching confrontation between ships. She says that “everybody [in the town] turns politician forming and planning schemes for Lord [British
General William] Howe, to make this naughty French Count [Comte D’Estaing] repent his having joined the subject to rebel against the true and lawful Sovereign.” British and French fleets engage in sea fight. There is a violent storm from August 11-12. Mrs. Almy speaks of her loneliness and the quiet around town. On August 20, she learns that the French fleet was in bad condition and had left. According to news from Mrs. Almy, British General Robert Pigot gave orders to British and Hessian troops to follow American troops by day. She learns on August 24 that American troops had retreated; British troops began to decamp in the morning.

**Secondary Sources**

Secondary Sources are just as important in research, providing context and various interpretations from historians. Below are select secondary sources and summary of information on each (in alphabetical order).

Abbass, D.K., PhD. *Rhode Island in the Revolution: Big Happenings in the Smallest Colony.*


Part I: A Chronology of the War in Rhode Island

I-H: Siege of Newport – August 14-18, 1778

Aug 14- Two American battalions encamped south of Quaker Hill—200 Americans seen on East Road, but British fire drove them off. RI Governor William Greene gave more supplies of powder.

August 15 – Americans began move south toward Newport: General Sullivan at head with 200 troops; John Laurens and Silas Talbot in command of next light infantry units; followed by main, Nathanael Greene with Varnum’s brigade and Gen. Whipple’s NH militia. Americans headquartered at Oakland Farm, to north of East Main Road, and took note of British positions from Honeyman’s Hill.

August 16- American encampment began to build fortifications on Honeyman’s Hill and one on hill near Redwood’s. Americans efforts focused on creating earthworks and trenches
along Honeyman’s Hill to east of Newport. Nathaniel Greene wrote to wife on August 16 that they were within two miles of Newport and would begin approach that night. Americans opened 6 batteries with connected trenches down the slope of the hill.

Aug 17- British fired 2 shots at new works – they continued to build defenses.

Aug 18- British troops fired cannons at American batteries (no. 2 and 3) but did little damage.

Aug 19- British captured American sentry who gave information; after weather cleared, British fired on American gallery; Americans were advanced far enough that their cannon fire could reach any part of British line, so British drew back their positions.

Pigot had sent word to Clinton in NY that they might not be able to hold off Americans; had asked for transports to evacuate Newport and might have to surrender. There were criticisms of Americans of position in marshy ground on eastern side of Newport. French had planned to take position north of the city. British responded by reinforcing defenses; continuous cannonade between British and American troops.

The majority of American militiamen had only enlisted in July for three weeks. American troops had trouble keeping men as well as maintaining supplies in Rhode Island. American troops had decreased from 10,000 to 5,000 members.

After storm in mid-August, rest of British fleet under Howe had returned to NY for repairs. French fleet returned to RI area at the top of Narragansett Bay on Aug 20. Comte D’Estaing knew his damaged ships would not be able to defend against rest of British ships arriving from New York.

On August 20, General Sullivan sent Lafayette and Greene to French ship Languedoc to protest D’Estaing’s departure, in which they gave full written argument of reasons for French to stay in Rhode Island. They argued that it was essential to alliance to defend island, however Lafayette refused to sign because of French loyalties. Lafayette later protested Sullivan’s behavior in letters to Washington. Greene and Sullivan wrote letters to Washington—aware of potential damage of friction between French and American officers. By September 3, Sullivan wrote to Washington that tensions were resolved.

The French left Narragansett Bay on August 22, heading towards Sakonnet River, the same day, Howe and Brits left NY.
On August 23, American troops fired from all batteries against enemy. The next morning, British attack on Potter’s Chimney, but one killed and two captured; also crossed Easton’s Beach and burned Easton’s house.

On August 24 and 25, Americans and British continued to build batteries and exchange fire. Americans ceased construction of trenches/batteries on August 26. Sullivan called another council, decided to hold American position until reinforcements because of their decrease in army numbers. At that point, the number of troops had diminished from 7000 to 4000 men. Rhode Island Governor Greene said that the state was not able to send any more troops.

Battle of RI – Aug 29-31, 1778

The heaviest fighting in Rhode Island occurred as Americans were retreating to the northern end of Aquidneck Island. American General Greene commanded right wing on West main road, and General Glover commanded left wing on East main road. Americans had pitched tents early in morning on August 29 on Butts hill. Greene’s regiment with Major Samuel Ward Jr., including 100 black soldiers held redoubt near shore on right wing.

As British advanced on land, their ships (the Sphnyx, the Vigilant, and the Spitfire) took up position between Prudence Island and American right. Captain von Malsberg saw Laurens advanced party and engaged in first confrontation of battle on West Main Road. Laurens retreated, taking up position near Turkey Hill. Von Lossberg and his troops joined and drove Americans from Turkey Hill. Retreating Americans ambushed Noltenius’ Chasseurs and continued push until they reached the edges of General Greene’s troops. Smith pursued American Livingston’s troops, but the British had not sent an advanced party; Americans at Union Street ambushed them.

Sullivan sent reinforcements down East Main Road. The fighting continued as they moved further north of the island. American troops, with reinforcements, engaged British and Hessian troops at Quaker Hill. British ships bombed from Bristol. American Major Ward in command of “Colored Regiment”; they engaged with General Von Lossberg and his Hessian troops. Hessian troops could not withstand the number of Americans and withdrew to top of Turkey Hill. Cannonade and fighting continued into the night.
The number of fatalities in that part of the battle was low. Sullivan’s troops: 30 killed, 137 wounded, and 44 missing. British and Hessian troops: 38 killed, 210 wounded, and 44 missing. British and American armies remained in positions on August 30 and continued exchange of artillery.

Sullivan received letter from Washington that British ships were on their way from New York to Rhode Island. He called council of war, and decided to retreat to the forts at Tiverton. On the night of August 30, the main part of the American army reached Tiverton, and three hours later the rest of army had left Aquidneck Island. British returned to original positions (from July) on Conanicut and Aquidneck Islands. On August 31, Sullivan wrote complete report of Battle of Rhode Island for Washington.


Source on background of Battle of Rhode Island:

General William Howe – head of old Boston garrison—began operations in the lower Hudson River Valley of New York. The town of Newport, Rhode Island seized at end of 1776 by British. The July 1776 Declaration of Independence made it more likely for Americans to receive foreign aid. The war became from 1778 on – a global conflict – French and other allies for Americans. D’Estaing unable to force a decisive action to maintain blockade of New York. The following month, D’Estaing won Newport, and came close to compelling surrender of British garrison with cooperation of French fleet, Continental troops and local New England militia. British believed that French and Americans were unnatural allies (Catholic monarchs and Protestant republicans). Conclusion: entry of France changed course of American war, especially because of naval forces.

On August 11, General Sullivan’s army numbered 10,122 men (not including 500-600 NH volunteers). Sullivan believed his army was strong enough without the French troops so gave orders to march the next morning, August 12. However, a storm ravaged Aquidneck Island and forced the American troops to stop advance. Both the British and American armies became sick from weather and some died from exposure.

After a few days, Sullivan gave orders to move on the morning of August 15. On August 15 at two in the afternoon the American troops reached Honeyman’s Hill; they pitched tents and began to station advanced posts. Their position on hill and area (which had been selected by the Continental Congress on July 25) was poor because it gave the British a height advantage; there were also marshy conditions on the ground.

British General Pigot had opened bombardment from August 16-17 on Sullivan’s troops. Sullivan had many men desert throughout the Battle of Rhode Island. He had to ask for more troops from the other New England militias; RI sent remaining half of its militiamen to Aquidneck Island. From date of August 18, Americans began construction work of five-gun battery at their position at Honeyman’s Hill. Pigot continued work of strengthening the British line; starting August 10, troops cut down trees and set down across Green End line to Tomini Hill. They continued to build defense line from Easton’s Beach to pond. On August 16, Hessian General Von Lossberg stationed in front of little Tomini with seamen troops and 2 six pounders. On August 19, Sullivan’s troops launched cannonade on British line, which forced them to move back their encampment; Americans had also been hit, with two wounded and one dead.

On August 20, Comte D’Estaing returned to waters close to Newport, but gave word to American troops that he would continue to Boston for repairs. The Americans Generals on Aquidneck Island were upset at D’Estaing’s departure. Sullivan, Greene, and Hancock met and wrote document that stated they had only agreed to battle in RI because of promise of French aid, and without their aid the Americans would be abandoned and likely have to retreat. The generals’ protest of French actions was given to General Heath to give to D’Estaing and French troops when they arrived in Boston. Lafayette upset by American proclamations against French.

On August 23, Americans has two more batteries, engaged British all day; Sullivan’s troops: 8,174 men, which kept dwindling each day.

Hancock left army to go to Boston. American soldiers at scene wrote in diaries about how French had betrayed them by leaving for Boston.
On Aug 20, Lieutenant Stanhope sent word to troops of RI of D’Estaing’s return to Boston area.

British General Howe led his ships for Newport on August 25. On his way to RI, Howe was met by *Galatea* (a British ship), which informed him D’Estaing had left Newport area, so Howe set off for Boston. Howe arrived in Boston on August 30, two days behind arrival of French.

General Sullivan asked commanders (Washington) for course of action for American troops. General John Glover suggested move to the northern end of the island so ferries to mainland could be secured; other generals agreed. Nathanael Greene disagreed, thought a force of 300 men in small boats led by John Laurens should land on the right flank of the British lines and carry through to guards on Easton’s Beach.

On August 24, Sullivan received word from Washington that Howe was assembling a hundred ships on Long Island, so it was decided that the colonials would be more secure at northern tip where they could await the return of D’Estaing’s fleet. Sullivan again asked for reinforcements from other New England regiments. According to letters from Governor William Greene, 60 men left on mainland to guard Providence.

On August 25, British bombarded Sullivan’s troops for an hour and a half; colonial troops fired only a few shots with little guns. Pigot suspected that Americans expected to retreat; he sent out reconnaissance patrols on August 26.

On August 27 at 2pm, Howe’s ships *Sphinx, Vigilant*, and *Nautilus* anchored in Newport. Pigot expected reinforcement from British commander Clinton. Clinton arrived with 4000 troops, hoping to cut off Sullivan and move against Providence. On night of August 27, Lafayette left for Boston.

Greene and American troops formed right wing and took West Road, and Glover and left wing moved towards East Road. Advanced troops were drawn off Pigot’s line and reached Butts Hill.

Sullivan’s works of around 5-6000 formed defensive line facing Newport. Pigot’s informant Captain MacKenzie told of American withdrawal (realignment).

Smith marched against Quaker Hill and West Road; Captain von Malsberg and Captain Noltenius with Hessian troops marched against Laurens on East Road. Germans forced Americans back in skirmishes near Laurens’ main flank. Pigot sent troops to aid Smith. Laurens
and his men fell back after push from von Lossberg, which was able to storm from three sides. Laurens was then forced to retreat to Turkey Hill and fall back to the main army near Sullivan.

Concealed Americans in cornfield sent volley on Brit. Nolt’s line. British and Hessian troops came for both sides and attempted to cut through middle as Laurens troops retiring back against walls. Smith faded; Hessians restocked; Liviningston received recruits from Sullivan.

Major Tousard, member of Lafayette’s military family, had horse blown from him and his right arm severed against British artillery.


The French ships arrived the afternoon of August 20 in Narragansett Bay. The American camp rejoiced at their arrival. However, winds kept them from entering Newport harbor that day.

French commander of their ship Senegal, Ensign Joseph Comte de Cambis, gave news to the Americans on Aquidneck Island that the French fleet will go up to Boston to repair its damages after the storm of August 11-13. Several American officers, including Nathanael Greene, Marquis de Lafayette, and Colonel John Langdon, were sent to the French fleet to ask the Admiral D’Estaing to change his decision to leave. D’Estaing replied to their request that the French were leaving for reasons of self-preservation.

On August 21, the French fleet left Rhode Island waters. Americans were still upset by their departure. Sullivan wrote letter in objection, “Protest of the General Officers on Rhode Island,” listing nine arguments for the French to stay, which was also signed by Nathanael Greene and several officers. The American protest slightly soured the French-American relations, as the French felt insulted by the American reaction.

On the island, Americans continued to extend trenches and new batteries. General Pigot’s British troops fired on American troops at work. American commanders had considered retreat, but decided to dig in until the British reinforcements arrived. Sullivan issued plans for quick withdrawal if necessary, especially because they were losing large number of troops. Sullivan noted large decrease in American troops numbers, mostly due to desertion, from 11,000 to 8,800 between August 15 and August 24. Major Eyre and carpenters were instructed to put up gun platforms on the northern end of island. Colonel John Crane’s cannon was also moved to north
to Butts Hill. Volunteers from Salem, Massachusetts were given orders to have boats ready at Howland’s and Bristol Ferries. Also, as a cautionary step all unnecessary baggage was to be transported off of island.

The night of August 26, there was exchange of fire; however, the next day Americans began to move their front line cannon.

Three ships of British navy spotted; they were a 20 gun frigate *Sphnyyx*, 14 gun sloop *Nautilus*, and 20 gun armed vessel *Vigilant*. The arrival of the ships brought the news that Clinton was gathering about 4,300 reinforcements at Long Island to bring to Rhode Island.

Greene created plan to attack British lines with 5,000 soldiers, including 300 men led by John Laurens to surprise British redoubt. Sullivan also discussed moving to top of Butts Hill. Lafayette went up to Boston to ask for repaired French ships to return to RI. On August 28, Sullivan ultimately decided that all units should all fall back to defensive positions around Butts Hill.

Sullivan’s army next goal, along with defense and retreat, was to protect Howland’s Ferry to be able to leave island. Sullivan split troops in valley below Butts Hill, so that their front line of defense stretched across island. The 1st RI regiment held position on right wing commanded by Nathanael Greene, from Butts Hill to Durfee’s Hill. West Road blocked by Laurens and Major Silas Talbot and Lieutenant Colonel Louis de Fleury, and East Road blocked by Colonel Henry Beekman Livingston, with a detachment of 250 men of army’s picket under Colonel Nathaniel Wade.

On August 29, British Major Frederich Mackenzie spotted withdrawal of Sullivan’s troops, and Pigot gave orders to attack. Pigot assembled British, Hessian, and Loyalist troops (about 5,700 soldiers and artillerymen), and then ordered 3 columns to go after Sullivan mid-retreat. Major General Friedrich Wilhelm von Lossberg led 1,000 men up West Road. Brigadier General Francis Smith led central column of 1,100 men. Major General Richard Prescott, Pigot’s right hand man, led troops up East Road. Hessian commander von Lossberg attacked Laurens from 3 sides; Americans were outnumbered and withdrew with Hessian after them. Von der Malsburg came to Hessian assistance. Laurens advance troops fell to below Turkey Hill as Hessians continued to move forward towards them. Sullivan ordered Laurens back to main lines; Von Lossburg assaulted again, and Laurens retreated again and eventually led to ground west of Butts Hill. Pigot ordered Prescott’s troops to reinforce General Smith on East Road.
There were 3,700 Brit regiments facing 3,900 American front line and advance troops. Livingston’s troops headed north to Quaker Hill after seeing British Captain Thomas Coore’s companies. British troops led by Smith and Campbell did not send out advance troops and were ambushed by American Colonel Nathaniel Wade at Middle Road. Once they recovered, they followed after Wade and Livingston’s troops on East Road. Americans troops were able to check the advance of the British troops.

Sullivan sent Colonel John Trumball to order Wigglesworth’s Regiment back to main line. Hessian von Huyn regiment had been approaching towards them. Smith’s senior commanders on East Road prepared their troops (1100 men) for attack on Americans (900 men) on that end. Major Mackenzie was given information that morning that troops withdrew from Quaker’s Hill.

According to American accounts, their retreat went smoothly and orderly. British troops continued to advance within range of American cannon. From Quaker’s hilltop British General Smith could see positions from Butts Hill to American right wing that showed that they had not caught up with army. They obeyed Pigot’s orders not to bring on general engagement, especially because British troops guarding Newport were not available. Smith withdrew his infantry to Quaker Hill and bombard Glover’s troops from above, but it had no effect.

At 10am, von Lossberg’s troops just arriving at Turkey Hill with main American positions at Durfee and Butts Hill. Nathanael Greene and his troops were on that end; they held key position of Artillery Redoubt (1/2 mile southwest of Butts Hill); the walls could be used for use for protection held by Major Samuel Ward’s 1st RI regimen. Von der Malsburg charged redoubt but regiment repelled them. Then under orders from von Lossberg tried assault again on American right wing. Small squadron of British ships assisted on assault by shelling rear. British Captain Alexander Graeme abandoned efforts after receiving cannonballs from Bristol battery. After his firing from Brit ships lessened, Von Lossberg directed another assault on Americans – 2nd RI regiment was sent in to help 1st RI regiment and able to help fight.

American cannon fire continued to hurt Hessian troops. They still pressed forward against Americans with 1200 men forcing American retreat. Fighting for Greene’s troops included 1600 men although many fired long range still effective because of number and coming from downhill (Butts hill to Durfee hill). The Hessians therefore became cut off with Americans on all sides. Greene called for MA militia to attack Hessian troops’ rear. By 3:30 pm, fighting
on that side had ended – German troops retreated to Turkey Hill. Sullivan decided against
general attack – sought to get army of island. British had gained land, but Americans had
responded well to attacks and inflicted more casualties – British/Hessian/Loyalist 260: 38 killed,
210 wounded, and 12 missing; American 211 casualties: 30/137/44.


As with the rest of the Revolutionary War, spies played a role in Rhode Island campaign.
Sullivan reversed sentence of whipping given by court martial panel against Mansfield Allen.
American spies on Aquidneck Island did not use real names. General Sullivan received one
fairly accurate report of British troop defense positions from an American spy. In September
1778, Marquis de Lafayette attempted to set up an American spy network that would infiltrate
the British in Newport; also, sent fake deserter and other disguised American officer. Efforts by
colonials to root out Tories may have hampered British spy efforts.

Murray, Thomas Hamilton. “John Sullivan and the Battle of Rhode Island: a Sketch of the
Former and a Description of the Latter.” *American-Irish Historical Society*. 1902.

According to Murray, Americans had withstood and repelled successive attacks. They
made an effect on British forces, in which they had lost one-fifth their entire force in action. The
British had taken possession of Newport, Rhode Island in December 1776. It was General
George Washington’s plan to have Americans take hold of island. General John Sullivan was
appointed to succeed Major General Spencer by Congress.

On June 19, Congress based on the request of Sullivan and Governor Greene, returned
Rhode Island troops to the state for defense, and the navy to prepare three ships for defense of
Providence, Warren, and Taunton rivers; meanwhile the British interrupted preparations and
burned several houses in Bristol.

The arrival of the French fleet in New York caused the British prepare for attack. On
July 29, 1778, the French fleet under Comte D’Estaing arrived, including twelve ships of the
line, four frigates and a corvette with 4,000 troops. He had meeting with Sullivan that decided
two ships of the frigate were to take position and cut off retreat of enemy’s vessels in bay.
British realized plan and ran four ships aground to burn them, and later destroyed smaller vessels to prevent being taken by French. D’Estaing changed mind, embarked troops forgoing arrangements with Sullivan and went to give battle to Howe’s fleet; Sullivan and Lafayette were shocked. Storm the night of August 12 scattered fleets; French had engaged some smaller British ships but because of ships’ damages went to Boston for repairs.

Sullivan then sent away all materials not needed at main lines. On August 28, he held council that they would move to north end of island and fortify camps. Enemy and American troops would fire back and forth throughout the day. According to Sullivan the troops showed great spirit when engages and “the brigades of the first line, Varnum's, Glover's, Cornell's, and Greene's, behaved with great firmness. Major-General Greene who commanded in the attack on the right, did himself the highest honor by the judgment and bravery exhibited in the action.”

Losses – Americans: 211 (killed, wounded, missing); British: 1023

Stevens, John Austin. An Address delivered in Newport: The French in Rhode Island, Newport in the Revolutionary Period, 1778-1782.

Comte D’Estaing had sought to engage British with his fleet at New York, but they had already left, so his French fleet then sailed for Newport.

Washington directed Sullivan to apply for five thousand men from New England militias, and then said to divide the troops into divisions in Rhode Island under command of Marquis de Lafayette and General Greene.

On July 29, they appeared off Brenton’s Ledge- detached frigates to East and West Passages, also cut off British retreat because of shallow waters. On August 5, French frigates holding western passage anchored in middle channel. Four British frigates were run ashore on RI and burned as they neared Tonomy Hill. Eight vessels sunk and thirteen burned, and at same time, British scattered over island burning houses and destroying land.

General Sullivan and D’Estaing met to discuss plan of action. On August 8, Sullivan said he planned to cross from mainland to island with troops. D’Estaing then forced his troops in middle passage; they had heavy fire from British, then British destroyed two remaining vessels. D’Estaing and troops began landing after fog lifted the next day, and then began their organization and drills.
British troops led by General Pigot came from north of island and posted on Bannister’s Hill and across Tonomy Hill.

Joint attack of Americans and French was scheduled to take place on August 10, with D’Estaing landing about 4,000 troops; Sullivan’s troops began crossing at Fogland Ferry at north end of island (with around 10,000 troops). Sullivan occupied deserted British post and then pushed down island with Colonel Livingston to within a mile of Pigot’s line of defense.

British commander General Howe sailed towards Newport and engaged with D’Estaing. That night, August 11, there was a great storm that damaged the ships. On August 13, French fleet separated and Languedoc badly damaged; also, attacked at sunset by one of British ships. Both fleets suffered great damages.

Lafayette informed D’Estaing that British Admiral Byron was on way to support British troops in RI, so therefore French would be significantly outnumbered. The French fleet set sail the next day as it was decided that French should go up to Boston where repairs to ships could be made.

Schroder, Walter K. *The Hessian Occupation of Newport and Rhode Island: 1776-1779.*


General John Sullivan ordered the troops to move to the northern tip of island after the unexpected withdrawal of the French fleet to Boston.

Lieutenant Freidrich McKenzie observed American movements on morning of August 29 and gave information to General Pigot. Hessian troops ordered to move forward to Irish’s Redoubt with 2,000 men including light infantry. Major General Von Lossberg was in overall command of the Hessian troops; he led advance troops along West Road to attack at any opportunity. The British 38th and 54th Regiments, along with 22nd and 43rd Regiments as flanking companies, under Major General Prescott, pursued along East Road.

Hessian Captain Von der Malsberg spotted American Colonel John Laurens at rear of Sullivan’s army. Hessians engaged American troops, back and forth, with a few wounded on each side; Americans withdrew.

There was also a skirmish between Colonel Campbell’s 22nd Regiment and American troops, under Colonel Henry Beekman Livingston, near Union Street and East Road. There were
many dead and wounded, especially due to ambush from behind stonewalls by the Americans; then Americans quickly withdrew.

The Ansbach-Bayreuth troops, which were other German troops, continued push to north of island. Sullivan’s troops withdrew to artillery redoubt and Windmill Hill (or Butts Hill). However, the Hessians were able to advance more swiftly than the American commanders thought. There were several smaller engagements along Turkey Hill. There was a shortage of ammunition on the British side, which slowed Hessian advance and gave the Americans a chance to strengthen defensive positions and fire muskets.

During the night of August 29 and 30, troops maintained positions while some American troops moved to Howland’s Ferry. Pigot then decided to wait out American movements, but American evacuation of island had been completed by morning and his search parties in area found nothing.


The Rhode Island General Assembly voted that every able-bodied negro, mulatto and Indian slave could enlist for duration of Revolutionary war with the same wages as free men. Christopher Greene led the 1st Rhode Island Regiment, and Varnum led the 2nd Rhode Island Regiment. On August 1, the Rhode Island called its militia, which was composed of six regiments of 3,000 soldiers. General Washington sent his most trusted generals to work with General John Sullivan, Lafayette and Nathanael Greene. The French Admiral D’Estaing and Sullivan made plans for Rhode Island. On August 8, French would enter Narragansett Bay; on August 9-10, they would ferry Sullivan’s ships to east shore of Aquidneck Island, and French soldiers and marines would, at the same time, land on west shore and then their combined forces would attack British. The American troops were able to successfully land, but the British ships on horizon upset D’Estaing plan. A severe storm struck Aug 11-12, that led the French fleet to leave on August 20 for Boston for repairs.

The American troops’ strength declined after departure of French. After word that British troops were expecting reinforcements from New York for their 7,000 men, American
commanders decided to withdraw. The night of August 28-29, Americans withdrew to north of island.

Sullivan positioned troops to cover island as they withdrew to north. British General Pigot ordered his forces to pursue the Americans, but to avoid a general engagement. Brigadier General Smith marched along east road with regiments, and Major Lossberg with Hessian troops moved along western road towards Turkey Hill.

American troops led by Laurens fired on advanced British troops, and the British suffered casualties and stopped; Laurens continued uphill. British on East Road came under fire from American troops led by Livingston, who were also able to move to higher ground. General Sullivan on hearing firing, he ordered a regiment forward and for advanced troops to return to mainline. British troops had swept before them, but held to order of no general engagement. The men on both sides were tired from heat exhaustion.

General Nathanael Greene and Varnum were on Butts Hill. They saw Hessian advance in valley and sent the 2nd Rhode Island Regiment for reinforcements of the artillery redoubt. Hessian General Lossberg urged troops forward from his view on Turkey Hill, at one point they had more than one thousand troops to attack redoubt. Greene and Varnum committed troops to saving redoubt. Cannon fire came from both sides of hill; however, most of firing was at long range. Sullivan reported for army: 211 soldier killed, wounded, or missing; Pigot reported: 260 British, Hessian and Tory casualties. Greene, Laurens and other commanders recommended assault on enemy on hills, but Sullivan rejected. The night of August 29-30, the two sides remained in place and shot long range artillery fire. The night of August 30-31, Sullivan quietly removed troops from island via boats to Tiverton and Bristol; many of regiments returned to their homes around New England.

More sources for information on the Revolutionary War in Rhode Island:


Schumacher, Alan T. and Diana Macarthur-Stanham. *The Siege of Newport: July-August, 1778*.


Neimeyer, Charles P. *Rhode Island Goes to War: The Battle of Rhode Island, 1776-1778*. Digital Commons @ Salve Regina 2003-10-01T07:00:00Z; Computer file. http://digitalcommons.salve.edu/newporthistory/vol72/iss249/8/.


Billias, George N. “General Glover’s Role in the Battle of Rhode Island (August 1778).” *RI Historical Society*, 36 (1959), 33-42


Summary: "Orderly" book kept by or for Major Gibbs (1778 August 8-28). Orders from headquarters at Tiverton (R.I.) and Newport (R.I.) concern securing provisions, shelter, and ammunition. Included in the volume is information about courts martial, and the organization of troops and detachments.

Notes: George C. Mason produced six known unique "Extra Illustrated" editions of his published book, *Reminiscences of Newport*. There are original manuscripts and engravings carefully interspersed and bound in with the text, sometimes illustrative of the text they accompany, sometimes seemingly unrelated to the text but relevant to the history of Newport, R.I. The Redwood Library holds three editions of one volume each and one set in two volumes. Institutions known to hold other versions are the Rhode Island Historical Society, in six volumes, and the New York Public Library. https://archive.org/details/reminiscencesofn01mason

“Frederick Mackenzie papers, 1760-1783.”

Abstract: The Frederick Mackenzie papers contain military documents and several bound volumes relating to numerous aspects of British army administration during the American Revolutionary War. These include returns of casualties, provisions, vacancies, and ordnance for various regiments, as well as scattered orders and memoranda on army policies.


Notes: All inquiries regarding this collection should be directed to Norris Foundation Curator of American Historical Manuscripts.

Notes: Originally from the London Gazette Extraordinary, Oct. 15, 1778.


Appendix F

The following report was prepared by Dr. Jon Bernard Marcoux. It provides more detailed results of the Ground Penetrating Radar surveys conducted for this project.

Ground Penetrating Radar Survey at Three Sites
Associated with the Battle of Rhode Island
Middletown and Portsmouth, RI

Submitted by: Jon Bernard Marcoux, Ph.D. (Salve Regina University)
Submitted to: Dr. Kenneth Walsh (Middletown Historical Society)

August 2016
**Introduction**

This report summarizes the results of a ground penetrating radar (GPR) survey conducted between July 16, 2014 and November 19, 2015 for Dr. Kenneth Walsh of the Middletown Historical Society. The survey was performed by Dr. Jon Bernard Marcoux of Salve Regina University, primarily assisted by Dr. Kenneth Walsh and Mersina Christopher. Areas included in the survey were distributed across three sites – the Redoubt de St. Onge, the Aaron Lopez Farm, and the suspected site of Fort Fanning (Figure 1). All of these sites are associated with the Revolutionary War landscape on Aquidneck Island during the Battle of Rhode Island. The goal of the survey was to determine whether the study sites contained any intact archaeological deposits that might be associated with the Revolutionary War period. The results of the survey demonstrate the following: 1) the Redoubt de St. Onge is quite intact, with construction layers still visible in the GPR profiles; 2) one of the areas investigated at the Aaron Lopez farm (Grid 1) contains an anomaly that may related to a structure or stone wall foundation; 3) the surveyed area at the suspected site of Fort Fanning did not show evidence of a military feature; instead the primary anomaly was a mid-20th century baseball diamond.
Figure 1 Map depicting three survey areas in current study.
Survey Methods

The survey employed techniques and methods that fall under the subfield of archaeological geophysics (AG). Archaeological geophysics is a field of study that utilizes precise measurements of certain physical properties of soil in order to identify and define buried archaeological features (e.g., storage pits, trash-filled pits, burials, house posts). The most obvious benefit of AG is that it provides the archaeologist with a "picture" of sorts of what lies beneath the surface of the ground. This image can be used as map to direct excavations to specific features within an archaeological site - greatly reducing the amount of time spent searching for these features using traditional field methods. Archaeological geophysics has been in existence since the 1940s; however, only within the last decade have major advances in computing power and increases in the sensitivity of measuring instruments made AG a practical and cost-effective research tool (Ernenwein and Hargrave 2009; Gaffney and Gater 2003; Johnson 2006). While still at a nascent stage, AG is growing in popularity among archaeologists in the southeastern U.S.. Recently, AG techniques were used to define the size and structure of manmade "shell rings" along the coast of Georgia (Thompson et al. 2004) and to identify buried trash-filled pits and house structures at the Crystal River Mound site in western Florida (Pluckhahn et al. 2009). Despite this recent growth, however, AG remains largely limited to projects conducted by researchers at large universities (Johnson 2006).

Archaeological geophysics includes a number of different techniques, each of which focuses on a different physical property of soil. Ground penetrating radar (GPR) is the most popular technique because it is cost effective and time efficient (Conyers 2006; Aspinall et al. 2008; Kvamme 2006) GPR accurately maps objects (like metal pipes) and archaeological features by sending radar wave pulses through the soil and measuring the time it takes for each
wave to be reflected back to an antenna at the surface. Differences in soil, such as would be expected between the subsoil and a filled-in pit or the presence of subsurface objects are detected as changes in the velocity of the radar wave. The benefit of GPR is that it results in a three-dimensional picture of subsurface features, where the analyst can record the horizontal positions of features as well as their depths.

For the GPR survey, we established a 45m-x-19m grid at the Redoubt de St. Onge site, a 25m-x-12m grid and a 23m-x-27m grid at the Aaron Lopez Farm site, and an 80m-x-20m grid at the Fort Fanning site. The geophysical survey instrument parameters were set to collect the maximum amount of data within reasonable time and data storage limits. The GPR instrument is capable of relatively dense data point collection. The GPR instrument was set to record 50 scans per meter with 512 individual radar pulses per scan on transects spaced 50 cm apart. This resulted in 25,600 radar pulses per meter, which for example would equate to 20,992,000 individual pulses for a 20 m-x-20m area. Pin flags were used to mark transects for Dr. Marcoux, who covered each grid by pacing in a zigzag pattern. The data recovered from the GPR survey were processed by Dr. Marcoux using RADAN software by GSSI, Inc.

**Survey Results**

*Redoubt de St. Onge*

Figure 2 shows the location of the survey area at the site of Redoubt de St. Onge in Middletown, RI. This site is owned by the Newport Historical Society, who graciously gave us permission to perform the survey. The upper-right portion of Figure 3 depicts the survey results at a depth of 50 centimeters below surface (cmbs). This plan view map, and those associated with the other two sites in the survey are oriented with North facing the top of the page. The
plan view map depicts the amplitude of radar reflections recorded by the GPR instrument. The amplitude, or strength, of the reflection is color-coded from dark low (gray) to high (white). As stated above, one of the benefits of GPR is the ability to explore subsurface features in three dimensions. Each transect in the survey captures a vertical profile of the soil to a depth of approximately two meters. The bottom of Figure 3 shows a single representative profile from the survey. The location of this profile is shown as a dashed line in the plan view. The features shown as high amplitude reflections (light colored) represent significant differences in the soil encountered by the radar waves. Hyperbolas - the upside-down, U-shaped reflections - suggest a round object like rocks, which there are plenty of, roots, and perhaps even ordinance. Flat or undulating planar reflections represent flat objects or surfaces, such as what would be expected in rammed earth fortifications. The profiles of features with multiple high amplitude point-source reflection hyperbolas and planar reflections typically indicate a fill. The profiles from each survey block are combined to create a three-dimensional subsurface model. All of the plan-view map figures in this report represent horizontal “slices” taken at a particular depth below surface.

The plan view map in the upper right portion of Figure 3 shows two North-South oriented linear anomalies at approximately 50 cmbs. One anomaly is located in the center of the survey area and the other along the eastern margin. When the GPR profiles are consulted, it is clear that these are high-amplitude planar reflections that increase in depth as they move east. Such reflections represent sloped surfaces that descend from West to East across survey area. In the lower portion of Figure 3, the GPR profile shows three such planar surfaces. The first surface (on the left) likely represents the original ground surface of the slope from which the redoubt was constructed. The second surface (in the center of the profile) represents tamped or rammed earth that was used to level and extend the redoubt away from the natural slope. The last surface (on
the right) is associated with a final extension and construction of the embankment that protected
the soldiers within the redoubt. The upper left portion of Figure 3 shows a photograph of the
redoubt taken in the late 19th century.
This image has been left intentionally blank to protect archaeological resources.

*Figure 2 Map depicting GPR survey grid at Redoubt de St. Onge.*
Figure 3 Top Left: 1896 Photograph of Redoubt de St. Onge. Top Right: Plan view of GPR survey at 50 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.
Aaron Lopez Farm

The Aaron Lopez Farm site is located in Portsmouth, RI. We surveyed two areas searching for possible intact remains of outbuildings associated with this merchant’s 18th century farm (Figure 4). The results of the GPR survey in Grid 1 are presented in Figure 5. The upper portion of the figure depicts a horizontal “slice” of the survey area at 100 cmbs. There are a number of small bright “spots” in the survey area. These are high amplitude point anomalies that likely represent large rocks, as the soil at this site contained many large pieces of glacial till. In addition to these, there appear to be a number of lower amplitude linear anomalies trending Southeast to Northwest. In the eastern portion of the survey area, two of these linear anomalies intersect with two other perpendicular linear anomalies to form a square-shaped feature (outlined in Figure 5). A GPR profile cutting through this feature (Figure 5: bottom) shows two areas of multiple high amplitude reflections at a depth of 100 cm (approximately at 18m and 26m along the transect measured along the top of the profile). In between these two areas are multiple moderate amplitude reflections. Taken together, this data suggests the possible remnants of a stone foundation that has been filled in.

The results of the survey in Grid 2 are presented in Figures 6 and 7. Figure 6 includes a plan view “slice” of the survey area at a depth of 40 cmbs (top), as well as a representative profile (bottom) whose position in the survey area is marked by the dotted line. The profile contains a high amount of reflectivity. This “noisy” appearance is doubtless caused by the dense glacial till observed in the soil. The eastern margin of the survey area contains a high amplitude linear anomaly that appears as a distinct hyperbola in the profile. It is the anomaly at the very eastern edge of the profile highlighted at the bottom of Figure 6. This feature, which runs North-Northeast to South-Southwest, is a metal or ceramic pipe. Two other anomalies identified at this
depth may be associated with the Aaron Lopez occupation. In the plan view (Figure 6: top), these anomalies appear as two rectangular areas of high reflectivity along the northern margin of the survey grid. In profile, they are two distinct areas of high amplitude point (hyperbolic) and planar (flat) reflections (Figure 6: bottom). These types of reflections are often associated with filled-in features like pits. The western feature extends to a depth of approximately 100 cmbs and the eastern feature to a depth of 50 cmbs. These features may be associated with the stone wall that forms the northern boundary of the survey grid. However, given that the features extend approximately two meters south of the wall and that they are 50 cm and 100 cm deep, it seems more likely that another interpretation is warranted.

Figure 7 shows a plan view “slice” of the survey Grid 2 at a depth of 100 cmbs (top) and a representative profile (bottom) whose position in the survey area is marked by the dotted line. The prominent feature at this depth is a high amplitude linear anomaly along the eastern margin of the survey area. In profile, this anomaly presents as a high amplitude hyperbola similar to that identified as a pipe in Figure 6. Indeed, it is clear in the profile that this anomaly is another ceramic or metal pipe laid at a greater depth than that described in Figure 6. At a depth of 100 cm, the soil in the western half of the survey area is more highly reflective. The profile in the western portion of Grid 2 shows a series of high amplitude reflective surfaces at this depth (Figure 7: bottom). The likely cause of these reflections is a stratigraphic change in soil composition, as soils in this portion of Aquidneck Island are characterized by a change from silty loam to sandy loam at this depth.
This image has been left intentionally blank to protect archaeological resources.
Figure 5 Top: Plan view of GPR survey Grid 1 at 100 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.
Figure 6 Plan view of GPR survey Grid 2 at 40 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.
Figure 7 Plan view of GPR survey Grid 2 at 100 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.
**Fort Fanning**

The suspected site of Fort Fanning includes a portion of a public park (Linden Park) in Middletown, RI (Figure 8). This wooden fort was one a complex of British military features commanding the heights of Aquidneck Island. The site was used for a school for a number of decades in the 20th century and is currently a public park featuring athletic fields and a playground. The survey grid at this site was established in an area where we believed a remnant of the fort might still exist based on comparisons to Revolutionary War-era maps.

The results of the survey are shown in Figure 9. The top of the figure is a plan view “slice” of the survey area at a depth of 40 cmbs, and the bottom of the figure is a representative profile whose position in the survey area is marked by the dotted line. The high-amplitude linear anomaly located in the eastern portion of the survey area is a cement sidewalk that is visible on the surface. Three other anomalies are visible in the central and western portions of the survey area. In the center of the survey area, there is a roughly diamond-shaped area containing patches of highly reflective soil. Indeed, a profile cutting through the center of the anomaly shows a single, somewhat dissected, high amplitude planar reflection at a depth of 40cmbs (Figure 9: bottom). This suggests that the diamond-shaped feature forms a single surface. The same type of high-amplitude planar reflection defines the profiles of the ovoid area along the south-central portion of the survey area and the “bent” linear anomaly to the west and north of the ovoid anomaly.

The diamond shape and orientation of the first anomaly is reminiscent of what would be expected for Fort Fanning based on its depiction on 18th century maps; however, the anomaly is much too small and its profile is much too uniform to suggest a match. Furthermore, the other two anomalies do not match any expectations generated by the maps. The probable interpretation
for all three anomalies is depicted in Figure 10. An aerial photograph of the area taken in 1962 (when the school was in use) clearly shows a baseball diamond in the same area as the anomalies detected in our survey. The use of clay to build the diamond and the pitcher’s mound explains the high amplitude planar reflections recorded in the profiles.
This image has been left intentionally blank to protect archaeological resources.

Figure 8 Map depicting GPR survey grid at the Fort Fanning site.
Figure 9 Top: Plan view of GPR survey at 40 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.
Figure 10 Comparison of GPR survey results with a 1962 aerial photograph of the Fort Fanning site.
Conclusions

The results of the survey suggest that GPR can contribute useful information to the search for remnants of the Revolutionary War landscape on Aquidneck Island. The survey provided new information addressing the construction history of the Redoubt de St. Onge. At the Aaron Lopez Farm site, the GPR survey identified a potential buried structure foundation and two filled pits. Based on comparisons to 18th century maps, the structure foundation likely served as the base for an outbuilding. Finally, the survey did not find any evidence for remains of Fort Fanning. Given that the survey area at this site only included a small portion of the park, these results should not be seen as definitive evidence of the fort’s absence. Indeed, more GPR survey should be conducted to the east and west of the current survey grid. While the anomalies identified in this survey must also be “ground truthed” though archaeological testing, in all, the results of this survey are encouraging that portions of Aquidneck Island’s Revolutionary War landscape are still intact.
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Appendix G

The following technical supplement was prepared by Drew Canfield to provide a detailed explanation of the scientific analysis in Chapter 2 of this report.

Technical Supplement for the Analysis of the Battle of Rhode Island in August 1778

Drew Canfield, Roger Williams University

Summary of the Battle at Valley Road

The British held Newport in 1778 during the Revolutionary War, which was a seaport capable of providing the British with units and needed supplies. In the same year, a treaty with France aligned the French with the Colonials in the war. Admiral d’Estaing commanded a fleet of twelve ships to aid the Colonials in the war. At the request of General Washington, Admiral d’Estaing was reassigned to aid General Sullivan in the removal of the British in Newport. General Pigot, in charge of the British Forces, sought to defend Newport due to its value as a seaport. Armed with reports of the French’s aid and marching orders for General Sullivan on Newport, General Pigot called his units to pull back and fortify Newport. Defensive fortifications, including the structures redoubt and abbatiss, were constructed by the British to hold the seaport. The abbatiss ran from Green End to Tonomy Hill, defense working 4 feet high and 6 feet deep, about 40 feet behind the abbatiss. The Colonial troops stationed themselves in Portsmouth, and intended on marching to Honeyman Hill to combat Card’s Redoubt on Valley Road. A map of the battlefield can be seen in Figure 4.
Figure 4: Map of battlefield at Valley Road. Positions of Combatants noted.

The colonials held smooth bore cannons, which featured a maximum range of 2000 yards, yet were most effective at ranges less than 1000 yards. While their elevated position at Honeyman Hill provided an advantage due to elevation (176 feet), the distance between the emplacements and the British’ Card’s Redoubt was 1700 yards, elevated 74 feet high. There was also a 10 Gun battery at a range of 1800 yards and a height of 113 feet. Gail winds and rain caused Eastons Pond, which bordered the British encampments, to increase and size, and turned surrounding terrain into a marsh; therefore, Colonial maneuverability was decreased.
Records by Captain Mackenzie of the British in his diary reveal that cannon fire did not result in irreparable damage to British artillery and defenses. General Washington ordered the Colonials to retreat on August 28, 1778 due to the lack of progress. While the failure of the battle can be partially attributed to the lack of an element of surprise due to the lack of cover for arriving French Naval ships, and the delivery of a letter from Colonial Generals telling General Pigot of their incoming attack, a question remains: why were the cannons fired by the Colonials incapable of destroying British artillery and defenses? This technical report aimed to analyze the ballistics of cannon fire during the era of the Revolutionary War through simulation in order to uncover potential explanations for the loss.

For a more thorough analysis of the battle, including tactics, details of the terrain, and other details including references, please refer to the historical evaluation which this supplement accompanies.

**Cannon fire Simulation Theory**

*Internal Ballistics Theory*

Cannon fire and associated ballistics is a relatively understudied field when compared to other weapon ballistics studies, such as rifles, missiles, etc. Benjamin Robins, a military engineer and mathematician, developed an analytical model for internal ballistics for cannon fire in 1742 (Robins 1805). Robins claimed that the force exerted on the cannonball traveling down the muzzle can be approximated using the following equation:

\[
F(x) = \frac{R P_{atm} A c}{x}
\]

*Equation 1: Force exerted on cannonball due to expansion of gas from gunpowder ignition in a cannon muzzle from Robins 1805.*
where:

\( F(x) \): force exerted on the cannonball

\( R \): initial ratio of hot gas pressure to atmospheric pressure

\( P_{atm} \): atmospheric pressure

\( A \): cross-sectional area of the cannon-ball

\( C \): length of the barrel occupied by the powder charge prior to ignition

The Australian Research Council (ARC), specifically Dr. Collins, reviewed Robin’s work, as well as work done by others, to derive models for analyzing smooth bore cannon ballistics (Collins n.d.). Robin’s research also discussed the air resistance experienced by the cannonball as it accelerates, as well as models for approximating the velocity of the cannonball. As the ARC states, Newton’s second law (Equation 2) can be utilized to derive an expression for the velocity of the ball (Equation 3).

\[
F = ma
\]

*Equation 2: Newton's Second Law*

where:

\( F \): Force

\( m \): mass of the body

\( a \): acceleration of the body

\[
\frac{1}{2}mv^2 = \int_c^LF(x)dx
\]

*Equation 3: Kinetic energy of the cannonball in terms of the work done on the ball derived from Newton's Second Law*
where:

- \( m \): mass of the cannonball
- \( v \): muzzle velocity of the cannonball at a distance \( L \) down the barrel
- \( L \): full length of the barrel

The left-hand term is the kinetic energy of the cannonball, while the right-hand integral is the work done on the ball. Substituting Equation 1 into Equation 3 and solving the integral results in Equation 4.

\[
\frac{1}{2} mv^2 = R P_{\text{atm}} A c \ln \left( \frac{L}{c} \right)
\]

*Equation 4: Solution to the integral shown in Equation 3.*

The cross-sectional area of a cannonball can be modeled as a circle, and the length of barrel occupied by powder charge can be approximated using the density of gunpowder, as shown by ARC in Equation 5.

\[
P = \frac{\pi d^2 c}{4} \eta
\]

*Equation 5: Mass of the powder charge in terms of density*

where:

- \( P \): Powder Charge
- \( \eta \): Gunpowder density
- \( d \): diameter of cannonball

Rearranging Equation 5 and substituting into Equation 4 yields Equation 6.

\[
\frac{1}{2} mv^2 = R P_{\text{atm}} \left( \frac{\pi d^2}{4} \right) \left( \frac{4P}{\pi \eta d^2} \right) \ln \left( \frac{L}{c} \right)
\]
Equation 6: Full expression for kinetic energy as a function of work done on a cannonball in the muzzle of a cannon

Again, rearranging and simplifying Equation 6 in terms of muzzle velocity results in an expression capable of approximating muzzle velocity (Equation 7).

\[
v = \sqrt{\frac{2RP_{atm} \left( \frac{P}{\eta} \right) \ln \left( \frac{L}{c} \right)}{m}}
\]

Equation 7: Muzzle velocity of a cannonball exiting a cannon

External Ballistics Theory

Dr. Collins also outlines the ballistics acting upon a cannonball external to the cannon. The main force acting to decelerate the cannonball is aerodynamic drag acting on the surface of the cannonball (Equation 8).

\[
F_D = \frac{1}{2} C_D \rho A v^2
\]

Equation 8: Drag force acting on an objecting traveling through a fluid

where:

- \( F_D \): Force of drag acting on the cannonball
- \( C_D \): Coefficient of drag
- \( \rho \): Density of the fluid through which the body is traveling
- \( v \): velocity of the body

Note that this analytical model neglects viscous drag, which is an appropriate assumption for objects with high Reynolds numbers. Reynolds number is a non-dimensional parameter for
comparing the inertial forces, or similarly pressure drag, of the object moving through the fluid to the viscous forces impeding it (Equation 9). The higher the Reynolds number, the less viscous drag forces impact the object. Fluids with a Reynolds number below 2300 are considered laminar, transitional between 2300 and 4000, and turbulent above 4000.

$$Re = \frac{\rho v L}{\mu}$$

*Equation 9: Reynolds number*

where:

- **Re**: Reynolds Number
- **L**: Hydraulic diameter of the object
- **μ**: Kinematic viscosity of the fluid

Note that the hydraulic diameter of a circle is the diameter of that circle. The Reynolds number of the cannonballs in flight will be calculated in the simulation to verify this assumption. The drag coefficient of an object is dependent on the geometry of the object, the surface roughness, fluid properties, and the velocity of the fluid passing over the object. A model developed by Spearman and Braswell for the drag coefficient of a sphere for Mach numbers, or ratio of current velocity to the speed of sound (1125.33 feet/second), between 0.6 and 10.5 was utilized for approximating the drag coefficient on the cannonball (Spearman and Braswell 1993).

J. W. M. Bush in the department of mathematics at MIT impresses the importance of considering another phenomenon termed the drag crisis when modeling drag forces acting on an object in flight (Bush 2013). While the viscous effects are negligible and the pressure drag is the most influential force on the ball in flight when looking at the system as a whole, within the layer of fluid adjacent to the ball, titled the boundary layer, the viscous forces play a larger role. Below
is a figure taken from Bush’s report showing the progression of the boundary layer as the Reynolds number increases.

Figure 5: Figure 3 from Bush 2013. Caption reads as follows. Figure 3: Schematic illustration of the evolution of the flow past a smooth sphere with increasing Reynolds number, \( Re = \frac{Ua}{\nu} \).

a) For \( Re \leq 1 \), the streamlines are fore-aft symmetric and the drag is principally of viscous origins. b) For \( Re > 10 \), boundary layer separation downstream of the sphere induces a vortical wake and a significant pressure drag. c) For \( 100 < Re < 1000 \), the vortical wake becomes unstable, resulting in lateral forces on the sphere. d) For \( Re > 1000 \), the wake becomes turbulent, its extent being maximum for e) \( Re \approx 2 \times 10^5 \). f) For \( Re > 2 \times 10^5 \), the boundary layers become turbulent, delaying the boundary layer separation and decreasing the extent of the turbulent wake. Owing to the resulting dramatic reduction in drag on the sphere, the latter transition is called the drag crisis. Note that the precise Re-values at which flow transitions occurs depends strongly on the sphere’s surface roughness. Images from Daish (1972).

As shown in the transition from picture d to e to f in Figure 5, the boundary layer separates from the object with increasing Reynolds numbers and then conforms back to the surface geometry as Reynolds number continues to increase. A body experiencing fluid flow
with a Reynolds number between $2 \times 10^5$ and $2 \times 10^6$ experiences what is known as the drag crisis. In this range, the drag coefficient increases significantly before lowering again at higher Reynolds numbers. Again, the Reynolds number for the cannonball in flight needs to be calculated over the course of its flight to assess whether or not the cannonball experiences the drag crisis.

Zhang Lumin in the Foreign Technology Division report titled “Research on the Asymmetrical Aerodynamic Forces of Reentry Vehicles” states that asymmetric surface drag can impart a rotational acceleration upon a reentry vehicle (Lumin 1992). Asymmetric surface drag can be generated from asymmetric surface roughness. Rotational velocities of a body in flight within a fluid medium experience the Magnus effect, which can alter the trajectory of the ball depending on the axis about which the ball is rotating. J. W. M. Bush also enumerates the different effects the Magnus Effect can have on a ball’s trajectory (Bush 2013). In summary, the cannonball could experience an acceleration in any direction, causing the ball to potential spread horizontally, or fall short of the target, or pass over the target.

David Poche and Peter George detail in their paper titled “Solid Shot Essentials: A guide to the Authentic and Non-Authentic” the formation of a mold seam and mold vent sprue from a solid shot mold on a cannonball, which would create asymmetric surface roughness (Poche and George n.d.). Dr. Steve Jordan from the University of Rhode Island asserted that super-sonic bodies experience negligible accelerations resulting from surface roughness phenomena. Evaluation of the simulation would reveal the nature of the cannonball in flight and the necessity of including rotational acceleration into the simulation will be determined at that point. The Mach number can be used to determine this necessity.
**MATLAB Code Rationale**

Cannons with varying bores and associated gunpowder quantity and cannonball size were used in the simulation to observe the trajectory of the different cannons used in the 18th century. The first section of the code uses the equations for internal ballistics to approximate the velocity of the cannon at any point along the muzzle. The velocity and force acting on the cannonball are checked at one thousand positions within the muzzle.

The drag equations discussed in the external ballistics section were used to calculate the velocity at each point using Newton’s second law. The equation itself can be rewritten in a differential form in terms of velocity, for acceleration is the first derivative of velocity (Equation 10). Position can also be derived from this expression, for velocity is the first derivative of position.

\[
\frac{F}{m} = a = \frac{dv}{dt} = \frac{d}{dt} \left( \frac{dv}{dt} \right)
\]

*Equation 10: Differential form of Newton’s Second law*

The aerodynamic drag forces impart a deceleration on the ball; therefore, the velocity of the ball at any time can be approximated as the velocity of the point prior subtracted by the deceleration approximated by Equation 10, multiplied by the amount of time the object experienced that acceleration (Equation 11).

\[
v_x(t_n) = v_x(t_{n-1}) - \frac{F_x(t_n)}{m} \cdot dt
\]

*Equation 11: Approximation of the velocity of the cannonball heading downfield*

This equation can be modified to include any other decelerating effects needed for simulation, such as gravity in the y-direction (Equation 12).
Total velocity of the cannonball at any point can be calculated using vectors and the Pythagorean Theorem (Equation 13).

\[ V_{total}(t_n) = \sqrt{v_y(t_n)^2 + v_x(t_n)^2} \]

*Equation 13: Total velocity of the cannonball at any point in time.*

Given that the cannon is fired at an upward angle, the muzzle velocity must be separated into the vertical and downfield components based on the angle, \( \theta \), it was fired at (Equation 14).

\[ v_y(0) = V_{muzzle} \sin(\theta), \quad v_x(0) = V_{muzzle} \cos(\theta) \]

*Equation 14: Vertical and downfield components of the cannonball velocity at the first instant the cannonball leaves the muzzle*

The position of the ball over time after it leaves the muzzle will be approximated using the average of the velocity one point in the simulation prior to the current point and the current velocity (Equation 15). The position of the ball is checked for twelve thousand and 1 positions, at 0.001 second intervals.

\[ y(t_n) = y(t_{n-1}) + \left( \frac{v_y(t_n) + v_y(t_{n-1})}{2} \right) \times dt \]

*Equation 15: Position of the cannonball at any time. Written in terms of the y-direction*

This equation can be rewritten for the x or z-direction. The code also calculates the kinetic energy of the cannonball, as well as the Reynolds number of the fluid around the cannonball and the angle of attack of the cannonball. Angle of attack is defined as the arctangent
of the velocity in the y and x direction (Equation 16). The returned angle is the vertical angle at which the cannonball is ascending or descending.

$$\beta = \text{atan} \left( \frac{v_y(t_n)}{v_x(t_n)} \right)$$

Equation 16: Angle of attack of the cannonball

Once the simulation has run, the time and position downfield at which the cannonball lands can be determined. Note that the altitude would be set as -200 feet for the cannon is fired at an elevated position and fired at a 4 degree angle. Internal and external ballistics are plotted over position, including velocities, forces, Reynolds numbers, Mach numbers and kinetic energy. All code can be seen in the Appendix.

Results for Cannon Fire Simulation

Validation of Assumptions

The minimum Mach number for muzzle velocities of the different cannons fired was 1.164, meaning the ball is exiting the muzzle at supersonic speed; therefore, neglecting asymmetric surface roughness is a valid assumption. The minimum Reynolds number of the cannonballs during flight was $9.42 \times 10^5$; therefore, the drag crisis occurs within the muzzle and does not occur during flight. Additionally, the airflow around the cannonball is turbulent, meaning the viscous drag is negligible compared to the pressure drag.
Internal Ballistics Plots

Below are two plots, one showing the force exerted on the cannonball over the length of the cannon (Figure 6) and the other showing the Mach number of the cannonball over the length of the cannon (Figure 7).

Figure 6: Force exerted on the cannonball over the length of the cannon. Legend shows weight of cannonballs.
Figure 7: Mach number of the cannonball over the length of the cannon. Legend shows weight of cannonballs

**External Ballistics Results**

Below are the plots from the external ballistics simulation. Each of the following figures were plotted against the distance downfield the cannonball currently achieved at each point. Figure 8 shows the altitude of the cannonball. Figure 9 shows the angle of attack of the cannonball. Figure 10 shows the kinetic energy of the cannonball. Figure 11 shows the Reynolds number of the cannonball. Figure 12 shows the total velocity of the cannonball. Figure 13 shows the x-component velocity of the cannonball. Figure 14 shows the y-component of the cannonball. Finally, Figure 15 shows the coefficient of drag for a cannonball as a function of Mach number.
Figure 8: Altitude of the cannonball as a function of against the distance downfield
Figure 9: Angle of Attack (in degrees) of the cannonball as a function of against the distance downfield
Figure 10: Kinetic Energy of the cannonball as a function of against the distance downfield
Figure 11: Reynolds number of the airflow around the cannonball as a function of against the distance downfield.
Figure 12: Total velocity of the cannonball as a function of against the distance downfield
Figure 13: X-component velocity of the cannonball as a function of against the distance downfield
Figure 14: Y-component velocity of the cannonball as a function of against the distance downfield
Sensitivity Analysis for Cannonball Ballistics

Above results model the behavior of a cannonball in an idealized scenario: no wind, no rotation, no horizontal spread and a constant vertical angle. In order to answer the question “what lead to the inaccuracy of the cannon fire during the battle,” scenarios need to be evaluated with less than ideal conditions.
Four scenarios were considered for assessment: the presence of a horizontal angle away from the target when firing, a non-preferred vertical angle when firing, variation in gunpowder quality, and a cross wind. An 18-pound cannonball with associated cannon size and gunpowder quantity was used for each study, and the changes in total velocity, x-component velocity, y-component velocity, kinetic energy, Reynolds number, landing position, altitude, angle of attack, and horizontal spread were used to analyze the impact of each scenario.

*Horizontal Angle Modeling*

The vertical angle used for firing was kept at 4 degrees, while the horizontal angle was varied from 0.1 to 2 degrees in increments of 0.1 degrees. A new z-component was integrated into the simulation, which alters how the total velocity and other velocity components are calculated. In 3D kinetics, the 3D vector must be projected onto a plane through which the desired component passes (Equation 17). For example, to calculate the x-component, the vector must be projected into either the x-y plane, or the x-z plane. The total velocity simply involves another square term (Equation 18).

\[ V_z(0) = \cos(\alpha) \sin(\theta)V_{muzzle} \]
\[ V_y(0) = \sin(\alpha)\cos(\theta)V_{muzzle} \]
\[ V_x(0) = \cos(\alpha)\cos(\theta)V_{muzzle} \]

*Equation 17: Vertical, downfield and horizontal components of the cannonball velocity at the first instant the cannonball leaves the muzzle*

\[ V_{total}(t_n) = \sqrt{v_z(t_n)^2 + v_y(t_n)^2 + v_x(t_n)^2} \]

*Equation 18: Three-dimensional Total velocity of the cannonball at any point in time.*
Horizontal angle errors can be generated either from operator error or improper support from the wooden platform below. The impulse generated from the cannon fire could wear the platform and cause the cannon to either sink into the damaged platform or ground, or change angle during fire.

*Vertical Angle Modeling*

The vertical angle at which the cannon was fired was varied from 3 to 5 degrees in 0.1 degree increments to see the variation in multiple parameters resulting from a 1-degree variation. All other parameters and equations were kept constant. The vertical angle could vary either due to improper setup by the operator or wear in the wooden platform causing the cannon to sink into either the ground or the wood, or tilt.

*Gunpowder Quality Modeling*

Gunpowder quality was varied from 1500 to 1600, known values for gunpowder quality in the 18th and 19th century as stated by Robins 1805, in increments of 100 to simulate either poor gunpowder packing in the muzzle or moisture. All other parameters and equations were kept constant.

*Cross Wind Modeling*

Addition of a cross wind incorporates another direction of drag as well as movement. The average maximum wind speed in August in Middletown, RI was found by NOAA to be 15 miles per hour, and drag coefficients for that speed were found using the same model implemented in the original simulation. The drag force acting in the z-direction was considered using the relative
velocity of the cannonball to the cross wind. The same total velocity equation seen in Equation 18 was used to approximate the total velocity of the cannonball.
Results from Each Scenario

The standard deviations of the key parameters identified in the introduction to the sensitivity analysis can be seen in Table 1.

Standard deviations for velocity, energy, altitude and angle of attack are based on the maximum value found in each simulation.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Standard Deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Velocity (ft/s)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Horizontal Spread</td>
<td>0.001</td>
</tr>
<tr>
<td>Vertical Angle</td>
<td>0.000</td>
</tr>
<tr>
<td>Gunpowder Quality</td>
<td>14.112</td>
</tr>
</tbody>
</table>

Table 1: Standard deviation of key parameters for the various assessment scenarios.

Table 2 below shows the maximum and minimum Reynolds numbers within the simulations, as well as the maximum change in landing position downfield.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Max. Reynolds Number</th>
<th>Min. Reynolds Number</th>
<th>Max. Change in Landing Position (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Spread</td>
<td>3254892.615</td>
<td>1419526.945</td>
<td>0</td>
</tr>
<tr>
<td>Vertical Angle</td>
<td>3254892.615</td>
<td>1337555.231</td>
<td>1141.079</td>
</tr>
<tr>
<td>Gunpowder Quality</td>
<td>3330076.747</td>
<td>1357272.55</td>
<td>229.0123</td>
</tr>
</tbody>
</table>

Table 2: Values of Key Parameters for the various assessment scenarios

Additionally, firing the cannon at an angle causing horizontal spread lead to a maximum 500-foot difference a 0.1-degree angle to a 2 degree angle. Rather than only use the 18-pound cannonball for the cross wind, each cannon with their associated cannonball and gunpowder quantity was used in the simulation. For comparison, only the results from the 6-pound cannonball are listed in Table
3. Values shown in the table are the differences between the cross wind simulation and the original simulation rather than standard deviations, for the speed of the cross wind was kept constant at 15 miles per hour.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Reynolds Number</td>
<td>-169.984</td>
</tr>
<tr>
<td>Max. Reynolds Number</td>
<td>0</td>
</tr>
<tr>
<td>Landing Position (ft)</td>
<td>6</td>
</tr>
<tr>
<td>Horizontal Spread (ft)</td>
<td>13.102</td>
</tr>
<tr>
<td>Altitude (ft)</td>
<td>0.14</td>
</tr>
<tr>
<td>Angle of Attack (degrees)</td>
<td>0.000786</td>
</tr>
</tbody>
</table>

*Table 3: Values of the differences between the original cannon simulation for the 6-pound cannonball and the simulation including a cross wind.*
Analysis and Conclusions

The minimum Reynolds number for all simulations ensures the validity of the underlying assumptions made in this report. The cannonball avoids the drag crisis during external ballistic performance, and the pressure drag is the dominant force acting on the cannonball. Additionally, the standard deviations of the total velocity are very small in comparison to the speed of sound. The assumption that the projectile is moving at supersonic speed and, thus, rotational forces can be neglected is also verified since the original simulation found this assumption valid.

As expected, changing the vertical angle at which the cannon is fired causes the largest changes in key parameters. Properly adjusting the angle at which the cannon is fired for the desired landing position downfield is crucial for hitting a target. Insufficiently-trained militia men may have encountered misses from improper angle selection due to inexperience. Additionally, as stated previously, damage to the wooden platform beneath the cannon could cause changes in vertical angle.

Variations in gunpowder quality also caused significant variations in landing position: a difference of about 230 feet. Quality can change depending on manufacturing, as well as storage. Improperly storing the gunpowder such that moisture contaminates the powder could change the performance of the cannon, as seen by the results. Middletown, Rhode Island air is higher in moisture content due to coastal environment; therefore, there is an increased chance for moisture to contaminate the gunpowder if not stored properly.

While horizontal angle did not cause a change in downfield landing position in the x-direction by more than about a foot, there was a large window of error for landing position in the z-direction (left and right when facing downfield), specifically 500 feet when fired at a four-
degree vertical angle. Changes in horizontal angle can occur from the same sources as the vertical angle: inexperience and platform damage.

The presence of a cross wind perpendicular to the desired trajectory of the cannonball does produce some undesired flight trajectory elements. The cannonball did land 6 feet short of the target, as well as about 13 feet to the right of the center of the target. It is worth noting, though, that the speed of the wind was based on the average maximum wind speed in August for Middletown, Rhode Island. The wind speed was not likely at this maximum while every cannonball was fired. Wind speed could have also been higher than average at that time. Regardless of the exact speed of the cross wind, the presence of a cross wind causes the smallest changes in performance but could be just enough to miss a target.

In conclusion, the vertical angle at which the cannon is fired and gunpowder quality cause the largest changes in ballistic performance when firing a cannon.

References


   http://www.pochefamily.org/books/solidshotessentialsmod.html


Summary: The present report is an engineering analysis of cannonballs (shots) launched from a cannon barrel typical of the revolutionary war. First attempts assumed ideal conditions meaning that the shot was smooth with no rotary motion at launch. During ideal flight, an opposing aerodynamic drag and a vertical gravitational acceleration were the prime input parameters to a 2nd-order time-dependent numerical computation of the shot trajectory. The aerodynamic drag was calculated by a semi-empirical expression in terms of the instantaneous shot Mach and diameter-based Reynolds numbers. By adhering to the historical data, the ideal computations involved four combinations of a constant shot/charge weight ratio. Comparisons between the ideal trajectories and historical range data showed largest differences at the lowest launch angles (0° to 10°). But a consistent outcome revealed the surrounding flow as strictly supercritical (fully turbulent). Attempts to reduce the range-data disparity began with treating the shot’s rough surface. Knowing that the cannonballs were formed inside a sand/clay/water mixture mold, the aerodynamic drag coefficient was modified accordingly which produced an overall higher resistive force during shot flight. The differences in the range data comparisons reduced substantially where the highest launch angle (10°) was under 4%. A second improvement in the trajectory simulation involved the shot’s rotary motion. This added effect gave an initial angular velocity and acceleration at shot launch. Moreover, the computation extended to a three-dimensional spherical system to account for out-of-plane (2D) rotary motions. New comparisons between the numerical and historical range data revealed logical trends in the shot trajectory. The shot consistently missed the intended target with rise in launch angle until reaching a peak lateral distance (~ 50 yards) at 8°. Future efforts to improve predictions of the shot trajectory rest on the highly complex interaction between the shot’s rotary motion and the oncoming freestream flow.
aerodynamic drag force and a vertical gravitational acceleration. We will begin this study assuming ideal conditions with comparisons to experimental data in terms of distance traveled by the shot under varying parameters of shot weight, gun power weight and launch angle. Units of each material property and launch parameter will adhere to the Imperial (or US customary) system (lb., ft. and sec).

The launch dynamics of the cannon shot begin with the impulsive force \( F \). The initial velocity of the shot at time \( t = 0 \) is \( m_s v_0 = \sum F_{0,1} = m_s v_1 \) where \( m_s \) and \( v \) are the shot mass and shot velocity. Because the force is an impulse and the initial velocity \( v_0 \) is zero, the launch velocity is simply \( v_1 = F/m_s \). However, this ratio for estimating \( v_1 \) is not immediately useful because no experimental data exists for the impulsive force. Instead, an alternate expression was developed by Robins\(^1\) involving the impulsive force distributed over the total barrel length (L). Accordingly, this approach required a kinetic energy balance of the form \( m_s v_1^2 = 2 \int_0^L F(s) \, ds + m_s v_0^2 \) for determining the shot launch velocity with \( F(s) \) evaluated by the expression \( F(s) = R p A/ s \) where \( R, p, A, \ell \) and \( s \) are the ratio of hot gas pressure to atmospheric pressure, atmospheric pressure, barrel area (or bore) and gun power length within the barrel length (s); \( 0 \leq s \leq L \). After substituting this force definition into the energy balance equation, integrating along \( s \), then simplifying, the amplitude of the launch velocity becomes

\[
v_1 = \frac{2 R p}{m_s} \pi r^2 \ln \left( \frac{L}{\ell} \right)
\]

(Eq. 1)

where \( r \) is the bore (or shot) radius. The length \( \ell \) is given by \( \ell = m_p / (\pi^2 \rho_p) \) with \( m_p \) and \( \rho_p \) as the mass and density of the gun power. For the present calculations, \( p = (14.7)(144) \) lb/ft\(^2\) and \( \rho_p = 55 \) lb/ft\(^3\). Robins\(^1\) measurements provided \( R = 1000 \), but the later experiments by Hulton\(^1\) suggested \( 1500 < R < 1600 \). In the present calculations, we will use the latter value (\( R = 1600 \)). Lastly, we note that the position direction of the launch velocity (\( v_1 \)) is coincident with the longitudinal axis of the cannon barrel.

Given the launch velocity, the next step demands obtaining a useful expression for the aerodynamic drag force \( F_d \) acting on the spherical shot during flight. The position vector of this drag force aligns with the shot’s local trajectory, but opposes the corresponding direction of the flight velocity vector (\( v_s \)). According to our conventional definition, \( F_d = 1/2 C_D \rho_a A v_s^2 \) where \( C_D, \rho_a \) and \( A \) are the aerodynamic drag coefficient, air density and shot cross-sectional area. Herein, we emphasize that the drag coefficient \( C_D \) of a sphere is not a simple determination. This parameter is highly dependent on the trajectory Mach number (\( M_a \)) and the Reynolds number (\( Re_D \)) as illustrated in Fig. 1; \( M_a = v_s/a \) and \( Re_D = 2 v_s r/\nu \) where \( a \) and \( \nu \) are the speed of sound and the kinematic viscosity at local atmospheric conditions. Experimental measurements show that the effects of \( Re_D \) on \( C_D \) become negligible at high values of \( M_a \) and vice versa. Unfortunately, the trajectory of a cannon shot covers the full range of these coupled parameters. After many experimental and analytical studies,
resultant formulations and procedures for estimating the coupled effects of \( M_a \) and \( Re_D \) on the aerodynamic drag coefficient \( C_D \) have become reasonable reliable.

The procedure adopted herein for evaluating \( C_D \) adheres to the collected works of Miller and Bailey\(^2\) and Morrison\(^3\) as described by Collins\(^4\). According to Morrison\(^3\), \( C_D \) for a smooth sphere can be estimated in terms of only \( Re_D \) at low-\( Ma \) (\( M_a < 0.3 \rightarrow \) incompressible flow conditions) by the semi-empirical expression

\[
C_D(Re_D) = \frac{a}{Re_D} + \frac{b(Re_D/B)}{[1.0+(Re_D/B)^\alpha]} + \frac{c(Re_D/C)^\beta}{[1.0+(Re_D/C)^\lambda]} + Re_D^\delta/D \quad \text{(Eq. 2)}
\]

where \( a = 24, b = 2.6, B = 5.0, \alpha = 1.52, c = 0.411, C = 263,000, \beta = -7.94, \lambda = -8.0, \delta = 0.8 \) and \( D = 461,000 \). This expression is graphically illustrated in Fig. 2 for \( 10^4 \leq Re_D \leq 10^7 \) with the following limits;

\[
\begin{align*}
Re_D &\geq 2.0 \times 10^6 \quad \rightarrow \quad C_D = 0.15 \\
1.20 \times 10^6 \leq Re_D < 2.0 \times 10^6 \quad \rightarrow \quad C_D = 0.19 - 8 \times 10^4 / Re_D \\
4.77 \times 10^5 \leq Re_D < 1.2 \times 10^6 \quad \rightarrow \quad C_D = -0.485 - 0.1 \cdot \log(Re_D)
\end{align*}
\]

In view of Fig. 2, \( Re_D < 3.5 \times 10^5 \) identifies a subcritical state (laminar flow surrounding the shot), \( 3.5 \times 10^5 \leq Re_D \leq 4.2 \times 10^5 \) as critical (transitional flow) and \( Re_D > 4.2 \times 10^5 \) as supercritical (turbulent flow).

The impact of \( M_a \) as well as the coupled effects of \( M_a \) and \( Re_D \) are modeled using cubic Benzier functions. These functions appear as

\[
\begin{align*}
B_a(u) &= a_1 \cdot (1-u)^3 + 3a_2 \cdot u \cdot (1-u)^2 + 3a_3 \cdot u^2 \cdot (1-u) + a_4 \cdot u^3 \quad \text{(Eq. 3a)} \\
B_b(u) &= b_1 \cdot (1-u)^3 + 3b_2 \cdot u \cdot (1-u)^2 + 3b_3 \cdot u^2 \cdot (1-u) + b_4 \cdot u^3 \quad \text{(Eq. 3b)}
\end{align*}
\]

with the variable \( u \) ranging as \( 0 < u \leq 1 \). The coefficients \( a_i \) are four points that target \( M_a \) whereas the coefficients \( b_i \) target \( C_D \). An example at high \( M_a \) where the \( Re_D \) influence becomes negligible on \( C_D \) produces the coefficients \( a_i = (0.1, 0.95, 0.55, 1.5) \) and \( b_i = (0.0, 0.0, 0.95, 1.0) \). The last two coefficients denote \( C_D = 1.0 \) when \( M_a = 1.5 \) (\( u = 1 \)). Thus, the limit \( M_a = \min(1.5, Ma) \) is necessary to implement Eqs. 3. Likewise, the first two coefficients \( (0.1, 0.0) \) create the limit \( M_a = \max(0.1, Ma) \) where \( M_a \) no longer influences \( C_D \). For \( M_a = B_a = 0.1 \rightarrow 1.5 \), the variable \( u \) is determined iteratively under an error tolerance (~0.001) followed by \( C_D = B_b \) given \( u \). When \( M_a < 1.5 \), the impact of \( Re_D \) is introduced using the coefficients \( g_i = (0.0, 0.85, 0.57, 1.0) \) and \( h_i = (1.1, 1.1, 0.05, 0.0) \) for the Benzier functions \( B_g(u) \) and \( B_h(u) \). Again, \( u \) is iteratively evaluated for \( B_g = M_a \) followed by \( B_h \) knowing the variable \( u \). Combining these Benzier functions with Eq. 2 gives the relationship

\[
C_D = B_b(u) + B_h(u) \cdot C_D(Re_D) \quad \text{(Eq. 4)}
\]

Beside raising the drag coefficient, \( M_a > 0.1 \) shifts the \( C_D \) curve in Fig. 2 to the right along the \( Re_D \) axis (see Fig. 1). This shift is handled by the approximation
\[ S(M_a) = s_1 + s_2 \cdot \tan^{-1}\left[ s_3 (M_a - s_4) \right] \]  
(Eq. 5)

where \( s_i = (0.78, 0.22, -12.0, 0.23) \). Thus, the final expression for estimating \( C_D \) is

\[ C_D = B_b(u) + B_h(u) \cdot C_D[S(M_a) \cdot Re_D] \]  
(Eq. 6)

This relationship is graphically illustrated in Fig. 1 for \( 0.3 \leq M_a \leq 1.5 \) and \( 10^4 \leq Re_D \leq 10^7 \) (see Miller and Bailey for additional details).

Knowing the aerodynamic drag force \( (F_a) \) and the initial velocity \( (v_1) \), we can formulate the trajectory path of the shot during flight. According to Newton’s 2nd law \( F_a = m_a a_s \) where \( a_s \) is the shot acceleration during flight. Using the variable \( f_s = s_s \) where \( s_s \) is the shot arc distance, then \( ds_s/dt = f_s' = v_s \) and \( f_s'' = d^2 s_s/dt^2 = [a_s - g \cdot \sin(\theta)] \) such that Newton’s law becomes a 2nd-order ordinary differential equation (ODE) written as

\[ f_s'' + \Lambda f_s' v_s = 0 \]  
(Eq. 7a)

where \( \Lambda = 1/2C_D \rho_s A/m_s \), \( g \) is the vertical gravitational acceleration (32.2 ft/s\(^2\)) and \( \theta \) is the local angle of the trajectory path referenced to the horizontal axis (ground level). Equation 7a can be readily advanced temporally using a 4th-order Runge-Kutta method from time \( t = 0 \). The horizontal \((x)\) and vertical \((y)\) components of Eq. 7a are

\[ f_x'' + \Lambda f_x' f_x' = 0 \]  
(Eq. 7b)

\[ f_y'' + \Lambda f_y' f_y' = 0 \]  
(Eq. 7c)

with \( f_s' = (f_x'^2 + f_y'^2)^{1/2} \), \( \theta = \tan^{-1}(f_y'/f_x') \) and \( f_s'' = a_y - g \). The solution sequence for calculating the shot trajectory proceeds as Eq. 1 \( [f_s' (t=0) = v_1] \), Eqs. 3, 5 and 6 \( [C_D(t)] \) and Eqs. 7 \( [s_s(t), x_s(t), y_s(t), v_s(t), v_x(t) \text{ and } v_y(t)] \) with fixed time step \( dt = 0.01 \). The computation terminates when \( y_s \leq 0 \). The air density was \( \rho_s = 0.00234 \text{slugs/ft}^3 \) which was modified by the shot altitude according to \( H(y_s) = e^{-\kappa y_s} \) with \( \kappa = 3.158 \times 10^{-5} \).

Table 1 Historical Range Measurements Listed by Collins

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Collins extracted forty-nine trajectory measurements (see Table 1) from two 19th-century British experimental studies on the shot trajectory at four sets of shot ($W_s$) and charge ($W_c$) weights that were launched at eleven angles ($0^\circ < \theta_1 < 10^\circ$). The ratio $S_c = W_s/W_c \sim 3$ was the standard service charge ratio which produced a consistent launch velocity ($v_1 \sim 1685\text{ft/s}$). Figure 3 shows four shot paths for the same launch angle $\theta_1 = 6^\circ$. In that figure, the notations signify the shot and charge weights as $W_s - W_c$. Notice that the higher shot and charge weights generate longer trajectory ranges. Apparently, the elevated drag force due to the increased diameter of the larger shot is offset by the shot mass; that is $\Lambda = F_a/m_s$ decreased with consistent $S_c$ and $v_1$.

Listing comparisons between the historical experimental measurements and the present numerical predictions of the shot ranges under assumed ideal conditions is futile at this point. Instead, plotting their percent differences in terms of the required $F_a$ to reach agreement is more appropriate to better understand the contributing factors leading to realistic conditions. Inasmuch as $C_D$ is the only adjustable quantity, we will focus on that applied force parameter. Figure 4 shows a $C_D$ factor (in percent) against the shot launch angle ($\theta_1$) for the four sets of shots and charges. To be perfectly clear, the $C_D$ factor ($C_{DF}$) in the figure is the additional drag force coefficient (or percent drag $D_s$) that is necessary to reach agreement between the experimental range measurements and the present numerical predictions; $\Lambda(C_D) = \Lambda[C_D (\text{Eq. 6})] + \Lambda(C_{DF})$. Looking at Fig. 4, the only immediate observation is the reduction of $C_{DF}$ with higher $\theta_1$.

The first deviation from ideal conditions that is worth investigating is the shot’s assumed smooth surface. Reports of cannon balls recovered without several centuries of environmental degradation indicate a sand surface roughness. This discovery is certainly acceptable because the cannon ball molds were constructed of a coarse sand mixed with clay and water. Sand surface
roughness is sized $\varepsilon \sim 1\text{mm}$. Scaling this value by the various cannon ball diameters ($3\text{in} < D < 7\text{in}$) gives $5.0 \times 10^{-3} < \varepsilon / D < 1.3 \times 10^{-2}$. Figure 5 shows the resultant shift in the drag coefficient curve (Fig. 2) in the form of increasing $\varepsilon / D$ versus $\text{Re}_D$. According to the computations of the four sets of shot-charge weights and eleven launch angles under ideal conditions, minimum Reynolds numbers (at the target point $y_s = 0$) varied $1.5 \times 10^6 < \text{Re}_D < 5 \times 10^6$. Knowing that $\text{Re}_D > 10^6$, the shot flight is always in a supercritical state meaning that the surrounding flow condition is fully turbulent with a non-shedding vortical wake. Small surface imperfections such as the mold seam, filler hole sprue and mold vent sprue would most likely have little impact on the flight flow parameters. Moreover, $\varepsilon / D > 5 \times 10^{-3}$ suggests that $C_D' > 0.4$ regardless of the coupled conditions of $M_a$ and $\text{Re}_D$ during flight (see Fig. 5).

Upon applying the restriction $C_D' \geq 0.4$ in Eq. 6, Fig. 6 shows the modified $C_D$ factors for the shot-charge weights and launch angles in Table 1. The trend of a decreasing $C_D$ factor with increasing launch angle ($\theta_1$) that was previously observed in Fig. 4 is much more pronounced in this figure. At a launch angle $\theta_1 = 10^\circ$, direct comparisons between the field range measurements and numerical predictions are within 5%. Although one should expect cannon preparation subtleties that would affect the shot launch and resultant trajectories, their disparities would not discount the recognizable trend between the $C_D$ factor and the launch angle.

A second deviation from ideal conditions is circumferential spin of the spherical shot at launch. Circumferential spin would in fact be faster with lower launch angle under equivalent shot and charge weights due to the increased effect of wall friction while the shot transverses the cannon barrel. Unlike the longitudinal motion, the shot would experience both an angular velocity ($\omega_s$) and acceleration ($\alpha_s$) at launch. Assuming that the spherical shot is rolling and sliding while traversing the cannon barrel, we can readily approximate $\omega_s$ and $\alpha_s$ in the following manner. Looking at Fig. 7, the frictional force ($F_\theta$) is $F_\theta = \mu_k \cdot N = \mu_k \cdot W \cdot \cos(\theta)$ with $\mu_k$ as the kinetic (sliding) friction coefficient. By applying Newton’s 2nd law at the sphere center, the shot acceleration becomes $F_\theta \cdot r = I \cdot \alpha$ where $I$ is the sphere’s moment of inertia. Given that $I_{\text{sphere}} = 2/5 m_s r^2$ and $W_s = m_s \cdot g$, the shot’s angular acceleration ($\alpha_1$) at launch is

$$\alpha_1 = 5 \mu_k g \cdot \cos(\theta_1) / 2r \quad \text{(Eq. 8)}$$

with the angular velocity $\omega_1 = \alpha_1 \cdot t_1$. The variable $t_1$ is the time the shot traverses the cannon barrel. Again, by assuming an impulsive force at time $t_0 = 0$ and initial distance $s_0 = 0$ we can easily formulate $t_1$ as $s_1 = s_0 + v_1 t_1 + \frac{1}{2} a_1 t_1^2$. The acceleration $a_1$ at launch is $F_0 = m_s a_1$ (Newton’s 2nd law) or $a_1 = \mu_k g \cdot \cos(\theta_1)$. Knowing the launch velocity from Eq. 1, the time $t_1$ is calculated using
Engineering tables list $\mu_k \sim 0.2$ for dry sliding contact between two cast-iron surfaces. This parameter ranges between 0.48 and 0.55 for dry sandblasted surfaces. For the present calculations of the spherical shot traversing the cannon barrel, the sliding friction coefficient was set to 0.5.

An example calculation of $v_1 \sim 1683$ ft/s and $\theta_1 = 6^\circ$ for a 12-lb shot and 18-caliber cannon shows $t_1 = 0.0041$ sec with $\alpha_1 = 211$ sec$^{-2}$ and $\omega_1 = 0.86$ sec$^{-1}$. Thus, the rotation of a shot exiting the cannon barrel would be observable by the field team. This argument is supported by several historical reports on Naval gunnery where a particular report\(^6\) notes that the shot experiences a ‘peculiar rotary motion through the air’. One should expect that any surface discontinuities on the shot surface (such as the mold seam, filler hole sprue and mold vent sprue) would enhance the rotary motion while traversing the cannon barrel (material contact) as well as during flight (aerodynamic contact).

A rotating sphere with an oncoming freestream will experience a lift force called the Magnus effect. Although Heinrich Magnus\(^7\) reported this lift force in 1853, Walker (1671) noted much earlier the effect on a tennis ball as well as Robins (1742)\(^1\) as a British artillery scientist. The Magnus force ($F_M$) is perpendicular to the drag force ($F_D$) as illustrated in Fig. 8 for an oncoming freestream from the left and a counter-rotating sphere\(^8\). Due to the resultant interaction between the oncoming freestream flow and sphere rotation, a positive Magnus force is a negative lift force (negative y-direction) as shown in Fig. 8. In the case of the cannon shot where the freestream is oncoming from the right with a clockwise rotation at an angle $\theta_1$ from the ground level (x-axis), the positive Magnus force vector is directed $-90^\circ$ from the aerodynamic force vector (counter-clockwise is positive) or $\theta_1 - 90^\circ$ from the x-axis. Notably, the combined effects of the flow state and rotational speed will lead to either a positive or negative Magnus force. According a report by Muto et al.\(^9\), both the subcritical and supercritical states generate a positive Magnus force with minor dependence on the rotation rate. Conversely, the Magnus force becomes negative in the critical flow state with strong influence by the rotation rate. Knowing that the flow state of cannon shot is always supercritical, we can exploit the experimental measurements of Kray\(^8\) and the computational results of Muto et al.\(^9\) to access the Magnus effect on the shot trajectory.

According to Muto et al.\(^9\) the Magnus force is positive and monotonically proportional to the spin rate (SP) when the sphere flow state is supercritical. This variable is defined $SP = \omega r/v_s$, which is easily evaluated at shot launch. After launch, dynamic interaction between the rotating sphere and oncoming freestream is incredibly complex and exceedingly difficult to reliably quantify in terms of a time-varying Magnus force during shot flight. To date, both the experimental measurements and numerical computations have reported the Magnus effect for constant spin rates and freestreams. Even under those constant conditions, very little data is available for the supercritical state. One option for assessing the Magnus effect on the present cannonball study is to assume an average force (or coefficient, $C_{Mavg}$) during flight. This average Magnus force can be readily quantified by iterative adjustments to the $\Lambda$ variable in Eqs. 7 until close agreement is reached between $x_s(t)$ and the historical ranges listed in Table 1.

$$t_1 = -v_1/a_1 + [(v_1/a_1)^2 + 2s_1/a_1]^{1/2} \tag{Eq. 9}$$
The Magnus force coefficient \((C_M)\) holds a similar definition as the drag coefficient; \(C_M = 2F_M/(ρAV_s^2)\). Thus, the force variable becomes \(\Lambda(C_{D,M}) = \Lambda(C_D) + \Lambda(C_{Mavg})\) where (as before) \(C_D \geq 0.4\). Kray et al.\(^{10}\) measured a near-linear relationship between \(C_M\) and \(SP\) with \(SP \leq 0.3\) for a soccer ball spinning in the supercritical regime. For our initial exercise, we will assume \(C_{Mavg} = SP_{avg}\) with the sphere rotation being strictly 2D (along the \(x-y\) plane). Figure 9 plots the average spin rates necessary to reach agreement with the historical range measurements. The distribution of \(SP_{avg}\) data points indicate minimums when approaching the lowest and highest launch angles \((θ_1 → 0°\) and \(θ_1 → 10°\)). These results are quite reasonable because the smaller launch angles reach the target sooner (highest \(v_x\), lowest \(F_M\)) whereas the larger angles launch the shot at the lowest spin rates (again lowest \(F_M\)). Negative average spin rates were found for about 15\% of the test cases listed in Table 1. These opposite results are very reasonable when considering variabilities such as the shot surface roughness, cannon-shot-charge preparation, measurement error, etc.

To continue our analysis of the Magnus effect, we will consider only the positive spin rates. Assuming that the rotation vector coincides with the \(x-y\) plane is obviously not realistic, but certainly not improbable. If we assume that these maximum positive \(SP_{avg}\) values represent \(x-y\) rotations, then they also define the spin rate envelope associated with 2D \(→\) 3D rotations. This envelope is illustrated in Fig. 9 as a 2\(^{nd}\) -order polynomial with \(SP_{avg} = d_1θ_1^2 + d_2θ_1 + d_3\) with \(d_1 = -3.086x10^4\), \(d_2 = 2.128x10^3\) and \(d_3 = 1.556x10^2\). Positive spin rates within the envelope represent a rotation vector in 3D spherical space. In spherical space, a second angle (\(φ_1\)) is required to position the rotation vector from the \(x-y\) plane. Again using the historical range data, we can approximate \(φ_1\) from the four sets of shot-charge weights listed in Table 1. Evaluating \(φ_1\) completes the present investigation for understanding the potential major factors contributing to cannon shots missing their intended targets.

The solution sequence in Eqs. 7 require additions and adjustments to treat a spherical trajectory path. A new lateral \((z)\) coordinate is introduced of the form

\[
f_z'' + Ωf'_z'f_z = 0 \tag{Eq. 10}
\]

with the trajectory velocity \((f_z')\) and new angle \((φ_1)\) evaluated as \(f_z' = (f_x'^2 + f_y'^2 + f_z'^2)^{1/2}\) and \(φ_1 = \sin^{-1}(f_z'/f_z')\), respectively. In Eq. 10, \(f_z = z(t)\) and \(f'_z = v_z(t)\) which are the lateral distance and velocity of the shot trajectory path. The lateral acceleration component is \(f_z''\). The new forcing function \((Ω)\) is defined as \(Ω = 1/2C_Msin(φ_1)p_0A/m\) which becomes negligible \((Ω = 0)\) for a shot rotation vector coincident with the \(x-y\) plane. As before, we will assume \(C_M = SP_{avg}\) with \(SP_{avg}\) defined by the 2\(^{nd}\) -order polynomial. In Eqs. 7, the forcing function \((A)\) for the \(x-y\) components of the trajectory path requires an adjustment as \(\Lambda = 1/2C_Dcos(φ_1)p_0A/m\) which reduces to a 2D solution of the trajectory path when \(φ_1 = 0\). Although the variability of \(φ_1\) during shot flight is most likely a non-linear function, no trajectory data exists to support a representative expression.
Thus, the present assessment of $\phi_1$ assumes that this angle is constant (or average angle) during shot flight.

The estimated angles $[(\phi_1)_{avg}]$ to account for the out-of-plane Magnus force vector are plotted in Fig. 10 versus launch angle ($\theta_1$). Again, these angles arose from agreement between the trajectory predictions and historical range data listed in Table 1 that lie inside the Magnus force envelope. The condition $C_{D'} > 0.4$ was maintained throughout these determinations. The angles above $90^\circ$ denote a negative Magnus force ($S_{avg} < 0$ in Fig. 9) which may be possible when considering the complex interaction between the oncoming freestream and shot rotation. At first glance, the $\phi_1$ angles generally increase with launch angle ($\theta_1$) for each shot-charge combination. This result should be expected because the gravitational vector would induce the friction vector ($F_\theta$) that represents contact between the shot and inside barrel to cause a more $x$-$y$ planar rotation for the lowest launch angles. Notably, the $\phi_1$ angles in Fig. 10 reveal a very large scatter for each launch angle. In many cases, the rotation vector varies between the $x$-$y$ ($\phi_1 = 0^\circ$) and $x$-$z$ planes ($\phi_1 = 90^\circ$). This particular result may reflect the non-uniformity of the shot surface. Inasmuch as the cannon bore was not much larger than the shot itself (windage $< 0.25$ inches), surface imperfections such as the mold seam, filler hole sprue, mold vent sprue, rust and rough casting would play a contributing role in the initial direction of the shot’s rotation vector. Seemingly, the large variability in the historical range data (even at equivalent launch angles) is probably attributed to the orientation of the Magnus force during shot flight.

The lateral distances $(z)$ from the $x$-$y$ trajectory path that correspond to the $\phi_1$ angles in Fig. 10 are plotted in Fig. 11. Of the forty-nine shots listed in Table 1, only nine shots (18%) show close proximity to the presumed targets in Table 1 ($z < 1$yd) even under the present analysis. A higher variability in the shot surface would reduce this accuracy percentage even further. The clear trend towards missing the intended targets is illustrated in Fig. 11 for the higher launch angles where $8^\circ$ appears as the worst case. In the present analysis, a higher launch angle ($\theta_1 > 8^\circ$) reduces the lateral variability due simply to the lower impact of the gravitational force on the angular velocity ($\omega$).

Further improvements in the present prediction of the shot trajectory center on the complex interaction between the rotary motion and the high-speed freestream flow during flight to obtain a better quantitative understanding of resultant Magnus force. The available data used herein represents experimental measurements and numerical computations of the Magnus force at constant conditions of rotation rate and freestream velocity. But the Magnus force, rotation rate and oncoming freestream are all highly interactive and time-dependent. Fortunately, numerical strategies presently exist to quantify this time-dependent behavior. Building such a numerical strategy with an appropriate trajectory simulation matrix would require a couple of years to
finalize. But the final product would be ubiquitous meaning that one could accurately predict and clearly understand the shot’s trajectory behavior which responds to the applied forcing during aerodynamic flight.

References

2. Miller, D.G. and Bailey, A.B., 1979, ‘Sphere Drag at Mach Numbers from 0.3 to 2.0 at Reynolds Numbers Approaching 10^7,’ J. Fluid Mech., 93(3), 449.
Appendix: MATLAB Software used for Simulation

Drew Canfield’s Analysis of Various Cannons

clear;
clc;
hold off

%% Define Initial Parameters
g = 32.2; % ft/s^2
CB = zeros(6,5);
CB(:,1) = [6;12;18;24;32;36]; % Cannon Ball mass lbs
CB(:,2) = [3.49;4.40;5.04;5.55;6.10;6.34];% Cannon Ball Dia inches
CB(:,3) = CB(:,2)*25/24; % Cannon Bore inches
CB(:,4) = CB(:,3)/12; % Bore in ft.
CB(:,5) = (pi/4).*CB(:,4).^2; % Bore Area sq ft
CB(:,6) = CB(:,1)/g; % mass of CB in slugs
CB(:,7) = (pi/4).*(CB(:,2)/12)^2; % Ball cross section Area sq ft
CB(:,8) = CB(:,2)/12; % Cannon ball dia. feet
L_ft = CB(:,4)*18; % length of the bore in Feet
Patm = 14.7*144; % DC from Robin 1804
R = 1600; % DC based on 19th century, Collins
GPden = 55; % Gun powder density lbs/ft cu
C_ft = (CWt./GPden)./CB(:,5); % Length of charge in ft

F = zeros(1000,6);
FD = zeros(1000,6);
V = zeros(1000,6);
Vmach = zeros(1000,6);
X = zeros(1000,6);
dx = L_ft(:)/1000; % DC divides up the length of the cannon into 1000th's
CD = 5; % Coefficient of Drag
Fkn = zeros(1000,6);
Vkn = zeros(1000,6);

%% Estimation of Muzzle V including drag
K1 = zeros(6,1);
K2 = zeros(6,1);
K1(:) = R*Patm*CB(:,5).*C_ft(:);
K2(:) = -0.0871*.5*CD*CB(:,1)/g;

%% Simulation within the Cannon
for k=1:6
    for n=1:1000
        X(n,k) = n*dx(k); % DC defines 1000 positions in the cannon
        if(X(n,k)>C_ft(k))
            F(n,k) = R*(C_ft(k)/(n*dx(k)))*Patm*CB(k,5)-.5*.08071*V(n-1).*V(n-1)*CD*CB(k,5);
            % DC First term gunpowder force, second term drag
        end
    end
end
if(n>1) %DC allows velocity at bottom of cannon to be zero
V(n,k) =
1991*sqrt(((CWt(k)./((CB(k,1))+(CWt(k)/3)))*log(X(n,k)./C_ft(k))));
%  V(n,k) =
1991*sqrt(((CWt(k)./((CB(k,1))))*log(X(n,k)./C_ft(k))));

Vmach(n,k) = V(n,k)./1087.4;
%DC Current mach number of cannonball

end
end
end

MuzzleV = V(1000,:); %DC exit velocity of cannonball
Re(:,1) = ((CB(:,2).*MuzzleV(:)/(12*1.69))*10000)'; %DC Based on 80 F temp,
true

% Parameters for Air Simulation
ang = 4/57.3 ; % cannon elevation radians, where 4 is degree of cannon
MN(1:6,1) = 1;
MN(1:6,2) = 2;
x = zeros(12000,6);
y = zeros(12000,6);
Vx = zeros(12001,6);
Vy = zeros(12001,6);
Vt = zeros(12001,6);
Ret = zeros(12001,6);
Ret(1,:) = Re(:,1); %DC
AngA = zeros(12001,6);
CD = zeros(12001,6);
VxFps = Vx(1,:); %DC first entry in Vx for each cannonball
VyFps = Vy(1,:); %DC first entry in Yx for each cannonball
Table = MN(:,1);
CB_mass = CB(:,1)/g; %Mass of Cannonball in slugs
rho = .074; %density of air lbs/ft^3(1.225kg/m^3)
y0 = 10; % Height of cannon
nb = zeros(1,6);
dt = .001;
En = zeros(12000,6);
MACH = zeros(12000,6);
Mach = zeros(12000,6);
t = zeros(12000,1);

CannonAlt = 112; %Altitude of Cannon
TgtAltitude = 176; %Altitude of Target
TgtAltD = 176-112; %Altitude difference in feet
EOF = zeros(3,1);

% Drag Coef Model
%SphereCD
hold off
CDA = zeros(2500,2);
M = zeros(2500,1);
M = (1:1:2500)/1000;
n = 1:1:2500;
CDA(1:300,1) = .1;
CDA(301:500,1) = .1 + n(1:200)/6000;
for n=1:400
    CDA(500+n,1) = CDA(500,1) + n*.5/400 + .1*(1+(sin(-pi/2+n*(2*3.1416/400))));
end
for n=1:700
    CDA(900+n,1) = CDA(900,1) +.38*(1-exp(-.005*n));
end
CDA(1601:2500,1) = CDA(1600,1);
CDA(700:2500,2) = CDA(700:2500,1);
CDA(1:600,2) = .47;
for n=1:99
    CDA(600+n,2) = CDA(600,2) + (n*.001);
end
figure(15)
%Plot Drag Coef
semilogx(M(200:2500),CDA(200:2500,1),'k');
hold on;
semilogx(M(200:2500),CDA(200:2500,2),'--');
Limits = [.2,2.5,0,1.5];
axis(Limits);
grid on;
grid minor;
title('CD vs MACH ')
ylabel('CD');
xlabel('MACH');
legend('Re > Transition', 'RE < Transition');
hold off
%end Drag coef+++++++++++++++++++++++++++++++++++++++++++++++

%% In Air Simulation
for k=1:6
    x(1,k) = 0; % Range
    y(1,k) = y0; % altitude
    Vy(1,k) = sin(ang)*MuzzleV(k);
    Vx(1,k) = cos(ang)*MuzzleV(k);
    Vt(1,k) = sqrt(((Vx(1,k))^2)+((Vy(1,k))^2));
    MACH(1,k) = MuzzleV(k)/1125.33;
for n=2:12000
    t(n) = n*dt; %time in msec
    MACH(n,k) = Vt(n-1,k)/1125.33;
    Mach(n,k) = 1000*MACH(n,k); % used in drag cal.
    Icd = round(Mach(n,k)); % index for drag cal.
    if(Icd>2500)
        Icd = 2500; % Limit of CD
    end
    CD(n,k) = CDA(Icd,1); %Drag coef from function
    Fdrx = .5*rho*(Vx(n-1).^2)*CD(n,k)*CB(k,5); %Drag Force
dvx = (Fdrx/CB(k,1));
    Fdry = .5*rho*(Vy(n-1).^2)*CD(n,k)*CB(k,5); %Drag Force
dvy = (Fdry/CB(k,1));
\[ \begin{align*}
    V_y(n,k) &= V_y(n-1,k) - g \cdot dt - dV_y \cdot dt; \\
    V_x(n,k) &= V_x(n-1,k) - dV_x \cdot dt; \\
    E_n(n,k) &= 0.5 \cdot CB_mass(k) \cdot V_x(n,k) \cdot V_x(n,k); \quad \% DC neglects y energy \\
    V_t(n,k) &= \sqrt{(V_x(n,k))^2 + (V_y(n,k))^2}; \quad \% DC Based on 80 F temp, true \\
    AngA(n,k) &= \arctan(V_y(n,k)/V_x(n,k)); \\
    dy &= ((V_y(n-1,k) + V_y(n,k)) \cdot dt/2); \quad \% average velocity \cdot time \\
    dx &= ((V_x(n-1,k) + V_x(n,k)) \cdot dt/2); \\
    \% CD = .2; \quad \% Tupalent flow, Re \sim 10^6 \\
    x(n,k) &= x(n-1,k) + dx; \\
    y(n,k) &= y(n-1,k) + dy; \\
    \mbox{if} ((y(n,k) < -200) \mbox{ and } nb(k) < 1) \quad \% DC finds the location of when the altitude \\
    \quad \mbox{is less than -200 ft from the starting height} \\
    nb(k) &= n;
\end{align*} \]
table(Table, adeg, L_ft, C_ft, MuzzleV, VxFps, VyFps, Re)

figure(7)
for n=1:6
plot(X(:,n), F(:,n))
if n == 1;
    hold;
end
plot(X(:,n), F(:,n))
end

figure(8)
end

figure(9)
end

%% Figures/Table for Exterior Ballistics
figure(1)
for k=1:6
AngAp(k,:) = AngA(1:12000,k)'*57.3;
plot(xp(1:nbp), AngAp(k,1:nbp))
if k == 1;
    hold;
end
MaxAngA = max(AngA(1:12000,1))*57.3;
disp('Maximum Angle of Attack in 1');
disp(MaxAngA)

figure(2)
for k=1:6
Enp(k,:) = En(1:12000,k)';
plot(xp(1:nbp),Enp(k,1:nbp))
if k == 1;
    hold;
end
end
title('En vs Distance ')
ylabel('En ft-lb');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(3)
for k=1:6
Vxp(k,:) = Vx(1:12000,k)';
plot(xp(1:nbp),Vxp(k,1:nbp))
if k == 1;
    hold;
end
end
title('Vx vs Distance ')
ylabel('Vx ft/sec');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(4)
for k=1:6
Vyp = Vy(1:12000,k)';
plot(xp(1:nbp),Vyp(1:nbp))
if k == 1;
    hold;
end
end
title('Vy vs Distance ')
ylabel('Vy');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

Vtp = zeros(1,12001);
figure(5)
for k=1:6
Vtp(k,:) = Vx(l:12001,k)';
plot(xp(l:nbp),Vtp(k,(l:nbp)))
if k == 1;
  hold;
end
end
title('Velocity vs Distance ')
ylabel('Velocity ft/sec');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(6)
for k=1:6
  Atp(k,:) = y(l:12000,k)';
  plot(xp(l:nbp),Atp(k,(l:nbp)))
  if k == 1;
    hold;
  end
end
title('Altitude vs Distance ')
ylabel('Altitude Feet');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

maxAlt1 = max(y(l:12000,1));
disp('Maximum Altitude in 1 in ft')
disp(maxAlt1)

figure(10)
Ret = Ret';
for n=1:6
  plot(xp(l,:),Ret(n,:));
  if n == 1
    hold;
  end
end
title('Reynolds Number vs Distance ')
xlabel('Distance (ft)')
ylabel('Reynolds Number')
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

% Double Check Assumptions about fluid mechanics
% Reynolds Number Minima per Cannonball
MinRe = zeros(6,1);
for n = 1:6
  Min = find((Ret(n,:) == min(Ret(n,:))),1,'first');
  MinRe(n,1) = Ret(n,Min);
end
ReMIN = min(MinRe(:,1));
disp('Minimum Reynolds Number')
disp(ReMIN);

MaxRe = zeros(6,1);
for n = 1:6
    Max = find((Ret(n,:) == max(Ret(n,:))),1,'first');
    MaxRe(n,1) = Ret(n,Max);
end
ReMAX = max(MaxRe(:,1));
disp('Maximum Reynolds Number');
disp(ReMAX);

Drew Canfield's Sensitivity Analysis

Analysis of Cross Wind
% Evaluation of Cross Wind Impact on Cannonball Ballistics
clear;
clc;
hold off

%% Define Initial Parameters
CB = zeros(6,5);
CB(:,1) = [6;12;18;24;32;36]; %Cannon Ball mass lbs
CB(:,2) = [3.49;4.40;5.04;5.55;6.10;6.34];%Cannon Ball Dia inches
CB(:,3) = CB(:,2)*25/24;%Cannon Bore inches
CB(:,4) = CB(:,3)/12;%Bore in ft.
CB(:,5) = (pi/4).*CB(:,4).*2; %Bore Area sq ft
CWt = [1.25;1.87;2.5;6;8;9];%Charge Wt in lbs gunpowder
L_ft = CB(:,4)*18;%length of the bore in Feet
Patm = 14.7*144;%DC from Robin 1804
R = 1600;%DC based on 19th century, Collins
GPden = 55;%Gun powder density lbs/ft cu
C_ft = (CWt./GPden)/CB(:,5); %Length of charge in ft

F = zeros(1000,6);
FD = zeros(1000,6);
V = zeros(1000,6);
Vmach = zeros(1000,6);
X = zeros(1000,6);
dx = L_ft(:)/1000;% DC divides up the length of the cannon into 1000th's
g = 32.17;%ft/s^2
CD = 5;%Coefficient of Drag
Fkn = zeros(1000,6);
Vkn = zeros(1000,6);

%% Estimation of Muzzle V including drag
K1 = zeros(6,1);
K2 = zeros(6,1);
K1(:,1) = R*Patm*CB(:,5).*C_ft(:);
K2(:,1) = -0.0871*0.5*CD*CB(:,1)/g;

%% Simulation within the Cannon
for k=1:6
    for n=1:1000
        X(n,k) = n*dx(k); %DC defines 1000 positions in the cannon
        if(X(n,k)>C_ft(k))
\[
\begin{align*}
F(n,k) &= R^\times \left( \frac{C_{ft}(k)}{(n \times dx(k))} \right) \times Patm \times CB(k,5) - 0.5 \times 0.08071 \times V(n-1) \times V(n-1) \times CD \times CB(k,5); \\
\text{\%DC First term gunpowder force, second term drag} \\
\text{if}(n>1) \text{\%DC allows velocity at bottom of cannon to be zero} \\
V(n,k) &= 1991 \times \sqrt{\left( \frac{CWt(k)}{(CB(k,1) + (CWt(k)/3))} \times \log \left( \frac{X(n,k)}{C_{ft}(k)} \right) \right)}; \\
\text{\%DC changed 1928 to 1991 to align with use of } R = 1600, \text{ \%19th century values} \\
V_{mach}(n,k) &= \frac{V(n,k)}{1087.4}; \\
\text{\%DC Current mach number of cannonball} \\
\end{align*}
\]

end

end

drag

MuzzleV = V(1000,:); \text{\%DC exit velocity of cannonball} \\
MuzzleVdrag_2 = Vdrag_2(1000,:); \\
Re(:,1) = (CB(:,2).*MuzzleV(:)/(12*1.69))*10000; \text{\%DC Based on 80 F temp, true} \\

\% Parameters for Air Simulation \\
ang = 4/57.3; \text{\% cannon elevation radians, where 4 is degree of cannon} \\
N(1:6,1) = 1; \\
N(1:6,2) = 2; \\
x = zeros(12000,6); \\
y = zeros(12000,6); \\
Vx = zeros(12001,6); \\
Vy = zeros(12001,6); \\
Vt = zeros(12001,6); \\
Ret = zeros(12000,6); \\
Ret(1,:) = Re(:,1); \\
AngA = zeros(12001,6); \\
CD = zeros(12001,6); \\
VxFps = Vx(1,:); \text{\%DC first entry in Vx for each cannonball} \\
VyFps = Vy(1,:); \text{\%DC first entry in Yx for each cannonball} \\
Table = N(:,1); \\
CB_mass = CB(:,1)/g; \text{\%Mass of Cannonball in slugs} \\
rho = 0.074; \text{\%density of air lbs/ft^3(1.225kg/m^3) - based on pounds} \\
y0 = 10; \text{ \% Height of cannon} \\
b_0 = zeros(1,6); \\
dt = .001; \\
En = zeros(12000,6); \\
MACH = zeros(12000,6); \\
Mach = zeros(12000,6); \\
t = zeros(12000,1); \\

CannonAlt = 112; \text{\%Altitude of Cannon} \\
TgtAltitude = 176; \text{\%Altitude of Target} \\
TgtAltD = TgtAltitude - CannonAlt; \text{ \%Altitude difference in feet} \\
EOF = zeros(6,2); \\

\% Drag Coef Model
% SphereCD
hold off
CDA = zeros(2500, 2);
M = zeros(2500, 1);
M = (1:1:2500)/1000;
n = 1:1:2500;
CDA(1:300,1) = .1;
CDA(301:500,1) = .1 + n(1:200)./6000;
for n=1:400
CDA((500+n),1) = CDA(500,1)+ n*.5/400 + .1*(1+(sin(-pi/2+n*(2*3.1416/400))));
end
for n=1:700
CDA((900+n),1) = CDA(900,1) +.38*(1-exp(-.005*n));
end
CDA(1601:2500,1) = CDA(1600,1);
CDA(700:2500,2) = CDA(700:2500,1);
CDA(1:600,2) = .47;
for n=1:99
CDA(600+n,2) = CDA(600,2) + (n*.001);
end
figure(15)

figure(15)

% Plot Drag Coef
semilogx(M(200:2500),CDA(200:2500,1),'k');
hold on;
semilogx(M(200:2500),CDA(200:2500,2),'--');
Limits = [.2,2.5,0,1.5];
axis(Limits);
grid on;
grid minor;
title('CD vs MACH ')
ylabel('CD');
xlabel('MACH');
legend('Re > Transition', 'RE < Transition');
hold off

% In Air Simulation
for k=1:6
x(1,k) = 0;  % Range
y(1,k) = y0;  % altitude
z(1,k) = 0;  % Horizontal Spread
Vy(1,k) = sin(ang)*MuzzleV(k);
Vx(1,k) = cos(ang)*MuzzleV(k);
Vz(1,k) = 0;
Vt(1,k) = sqrt(((Vx(1,k))^2)+((Vy(1,k))^2)+Vz(1,k)^2);
MACH(1,k) = MuzzleV(k)/1125.33;

for n=2:12000
 t(n) = n*dt;  % time in msec
 MACH(n,k) = Vt(n-1,k)./1125.33;
 Mach(n,k) = 1000*MACH(n,k);  % used in drag cal.
 Icd = round(Mach(n,k));  % index for drag cal.
 if (Icd>2500)
  Icd = 2500;  % Limit of CD
 end
\[ CD(n,k) = CDA(Icd,1); \] % Drag coef from function

% Cross Wind Incorporation
% Average Max Wind Speed in August - 15mph
Ws = (15*5028)*(1/60)*(1/60); % ft/s
Ws_Icd = round(abs(Vz(n-1,k)-Ws)*1000);
if (Ws_Icd>2500)
    Ws_Icd = 2500;
end
CD_cw = CDA(Ws_Icd,1);
Fdrz = 0.5*rho*((Vz(n-1,k)-Ws)^2)*CD_cw*CB(k,5); % Cross Wind Drag
dvz = (Fdrz/(CB(k,1)));
Vz(n,k) = Vz(n-1,k)+dvz*dt;
dz = ((Vz(n-1,k)+Vz(n,k))*dt/2);
z(n,k)=z(n-1,k)+dz;

% 2D Ballistics
Fdxr = .5*rho*(Vx(n-1).^2)*CD(n,k)*CB(k,5); % Drag Force
dvx = (Fdxr/(CB(k,1)));
Fdry = .5*rho*(Vy(n-1).^2)*CD(n,k)*CB(k,5); % Drag Force
dvy = (Fdry/(CB(k,1)));
Vy(n,k) = Vy(n-1,k)-g*dt-dvy*dt;
Vx(n,k) = Vx(n-1,k)-dvx*dt;
En(n,k) = 0.5*CB_mass(k).*Vx(n,k).*Vx(n,k); % DC neglects y energy
Vt(n,k) = sqrt(Vx(n,k).^2+Vy(n,k).^2+Vz(n,k).^2);
Ret(n,k) = (((CB(k,2))*Vt(n,k))/(12*1.69))*10000'; % DC Based on 80 F
temp, true
AngA(n,k) = atan(Vy(n,k)/Vx(n,k));
dy = ((Vy(n-1,k)+ Vy(n,k))*dt/2); % average velocity *time
dx = ((Vx(n-1,k)+ Vx(n,k))*dt/2);
% CD = .2; % Tupbulent flow, Re ~10^6
x(n,k)= x(n-1,k)+dx;
y(n,k) = y(n-1,k)+dy;

if(y(n,k)>TgtAltD)
    EOF(k,1) = x(n,k);
    EOF(k,2) = n;
end
if((y(n,k)<-200)* nb(k)<1) %DC finds the location of when the altitude
    % is less than -200 ft from the starting height
    nb(k) = n;
end
end
end

nbp = 0;
for n=1:6
    if nbp<nb(n);
        nbp = nb(n); % finds the latest element position for when the altitude
        % of the cannonball is less than -200 ft from starting altitude
    end
    X_land(1,n)=nbp;
end
xp = zeros(1,length(x));
xp(:) = x(:,1)'/3;
Np = n;
Range = EOF./3; % Range yards
MaxRange = max(Range);

%% Figures/Tables from internal ballistics
Bore = CB(:,3);
CB_dia = CB(:,2);
adeg = [4,4,4,4,4,4]';
Table =N(:,1);
table(Table,CB_mass,Bore,CB_dia,CWt)
Table = N(:,2);
table(Table,adeg,L_ft,C_ft, MuzzleV,VxFps,VyFps, Re)

figure(7)
for n=1:6
    plot(X(:,n),F(:,n))
    if n == 1;
        hold;
    end
end
plot(X(:,n),F(:,n))
end
title('Force vs Length ')
xlabel('Distance ft')
ylabel('Force lbs')
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(8)
for n=1:6
    plot(X(:,n),V(:,n))
    if n == 1;
        hold;
    end
end
plot(X(:,n),V(:,n));
end
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity ft/sec')
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(9)
for n=1:6
    plot(X(:,n),Vmach(:,n))
    if n == 1;
        hold;
    end
end
plot(X(:,n),Vmach(:,n));
end
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity Mach')
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off
%% Figures/Tables for Exterior Ballistics
nbp = max(EOF(:,2))-1;

figure(1)
for k=1:6
    AngAp(k,:) = AngA(1:12000,k)'*57.3;
    plot(xp(1:nbp),AngAp(k,1:nbp))
if k == 1;
    hold;
end
end
title('AngA vs Distance ')
ylabel('AngA');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off;

figure(2)
for k=1:6
    Enp(k,:) = En(1:12000,k)';
    plot(xp(1:nbp),Enp(k,1:nbp))
if k == 1;
    hold;
end
end
title('En vs Distance ')
ylabel('En');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(3)
for k=1:6
    Vxp(k,:) = Vx(1:12000,k)';
    plot(xp(1:nbp),Vxp(k,1:nbp))
if k == 1;
    hold;
end
end
title('Vx vs Distance ')
ylabel('Vx ft/sec');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(4)
for k=1:6
    Vyp = Vy(1:12000,k)';
    plot(xp(1:nbp),Vyp(1:nbp))
if k == 1;
    hold;
end
end
title('Vy vs Distance ')
ylabel('Vy');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

Vtp = zeros(1,12001);
figure(5)
for k=1:6
    Vtp(k,:) = Vx(1:12001,k)'
    plot(xp(1:nbp),Vtp(k,(1:nbp)))
    if k == 1;
        hold;
    end
end
title('Velocity vs Distance ')
ylabel('Velocity ft/sec');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(6)
for k=1:6
    Atp(k,:) = y(1:12000,k)'
    plot(xp(1:nbp),Atp(k,(1:nbp)))
    if k == 1;
        hold;
    end
end
title('Altitude vs Distance ')
ylabel('Altitude Feet');
xlabel('Range Yds');
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(10)
Ret = Ret';
for n=1:6
    plot(xp(1,:),Ret(n,:))
    if n == 1
        hold;
    end
end
title('Reynolds Number vs Distance ')
xlabel('Distance (ft)')
ylabel('Reynolds Number')
legend('6lb','12lb','18lb','24lb','32lb','36lb');
hold off

figure(14)
for k=1:6
    plot(xp(1:nbp),z(1:nbp,k))
    if (k == 1)
        hold;
    end
end
title('Horizontal Spread vs Distance ')
ylabel('Horizontal Distance (ft)');
xlabel('Range (Yds)');
legend('6lb', '12lb', '18lb', '24lb', '32lb', '36lb');
hold off

%% Double Check Assumptions about fluid mechanics
% Reynolds Number Minima per Cannonball
MinRe = zeros(6,1);
for n = 1:6
    Min = find((Ret(n,:) == min(Ret(n,:))),1,'first');
    MinRe(n,1) = Ret(n,Min);
end
disp('Minimum Reynolds Numbers');
disp(MinRe);
ReMIN = min(MinRe(:,1));

MaxRe = zeros(6,1);
for n = 1:6
    Max = find((Ret(n,:) == max(Ret(n,:))),1,'first');
    MaxRe(n,1) = Ret(n,Max);
end
ReMAX = max(MaxRe(:,1));

%% Analysis of Impact

Hspread = z(end,1);
Land = (X_land(1));

disp('Horizontal Spread in ft');
disp(Hspread);
disp('Maximum Reynolds Number');
disp(ReMAX);
disp('Minimum Reynolds Number');
disp(ReMIN);
disp('Landing Position in ft');
disp(Land);

% Data from Original Simulation

% Minimum Reynolds Number
% 9.224075405632702e+05
%
% Maximum Reynolds Number
% 4.883343867833446e+06
% Range(1,1)
%
% ans =
% 7855
% Maximum Angle of Attack in 1
% 4.302281140389114
% Maximum Altitude in 1 in ft
% 1.671552540999079e+02
DiffReMIN = ReMIN - 9.224075405632702e+05;
DiffReMAX = ReMAX - 4.883343867833446e+06;
DiffLandPos = Land - 7855;
DiffAlt = max(y(1:12000,1)) - 1.6715525409999079e+02;
DiffAngA = max(AngA(1:12000,1))*57.3 - 4.302281140389114;

disp('Difference in Min. RE')
disp(DiffReMIN)
disp('Difference in Max. RE')
disp(DiffReMAX)
disp('Difference in Landing Position in ft')
disp(DiffLandPos)
disp('Difference in Altitude in ft')
disp(DiffAlt)
disp('Difference in Angle of Attack in degrees')
disp(DiffAngA)

Analysis of Vertical Angle
% Evaluation of change of Angle on ballistics of 18 lb Cannonball
clear;
clc;
hold off

%% Define Initial Parameters
CB = zeros(1,5);
CB(1,1) = 18;  %Cannon Ball mass lbs
CB(1,2) = 5.04;  %Cannon Ball Dia inches
CB(1,3) = CB(1,2)*25/24;  %Cannon Bore inches
CB(1,4) = CB(1,3)/12;  %Bore in ft.
CB(1,5) = (pi/4).*CB(1,4).^2;  %Bore Area sq ft
CWt = 2.5;  % Charge Wt in lbs gunpowder
L_ft = CB(1,4)*18;  %length of the bore in Feet
Patm = 14.7*144;  %DC from Robin 1804
R = 1600;  %DC based on 19th century, Collins
GPden = 55;  %Gun powder density lbs/ft cu
C_ft = (CWt./GPden)./(CB(1,5));  %Length of charge in ft

F = zeros(1000,1);
FD = zeros(1000,1);
V = zeros(1000,1);
Vmach = zeros(1000,1);
X = zeros(1000,1);
dx = L_ft(:)/1000;  % DC divides up the length of the cannon into 1000th's
g = 32.2;  %ft/s^2
CD = 5;  %Coefficient of Drag
Fkn = zeros(1000,1);
Vkn = zeros(1000,1);

%% Simulation within the Canon
for n=1:1000
    X(n) = n*dx;  % DC defines 1000 positions in the cannon
    if(X(n)>C_ft)
\[
F(n) = R\left(\frac{C_{ft}}{(n \times dx)}\right) \times \frac{Patm \times CB(1,5)}{0.08071 \times V(n-1) \times V(n-1)} \times CD \times CB(1,5);
\]

**First term: gunpowder force, second term: drag**

\[
\text{if} \ (n>1)
\]

\[
\text{allowing velocity at bottom of cannon to be zero}
\]

\[
V(n) = 1991 \times \sqrt{(\frac{CWt.}{(CB(1,1) + (CWt/3))} \times \log(X(n)/C_{ft}))};
\]

**19th century values**

\[
V_{mach}(n) = \frac{V(n)}{1087.4};
\]

**Current mach number of cannonball**

\[
\text{end}
\]

\[
\text{end}
\]

\[
MuzzleV = V(1000,1)';
\]

**Exit velocity of cannonball**

\[
Re(:,1) = \left(\frac{CB(:,2) \times MuzzleV(:)}{(12 \times 1.69)}\right) \times 10000';
\]

**Based on 80 F temp, true**

**Parameters for Air Simulation**

\[
\text{AngV = 3.1:0.1:5;} \quad \text{AngV = AngV./57.3;}
\]

\[
x = \text{zeros(12000,20);} \quad y = \text{zeros(12000,20);} \quad X_land = \text{zeros(1,20);} \quad Vx = \text{zeros(12001,20);} \quad Vy = \text{zeros(12001,20);} \quad Vt = \text{zeros(12001,20);} \quad Vx(1,:) = MuzzleV \times \cos(AngV(:)); \quad Vy(1,:) = MuzzleV \times \sin(AngV(:)); \quad Ret = \text{zeros(12000,20);} \quad Ret(1,:) = Ret(:,1); \quad AngA = \text{zeros(12001,20);} \quad CD = \text{zeros(12001,20);} \quad VxFps = Vx(1,:); \quad VyFps = Vy(1,:); \quad CB_mass = CB(1,1)/g; \quad \text{Mass of Cannonball in slugs} \quad \rho = 0.074; \quad \text{Density of air lbs/ft^3}(1.225kg/m^3) \quad y_0 = 10; \quad \text{Height of cannon} \quad nb = \text{zeros(20,1);} \quad dt = 0.001; \quad En = \text{zeros(12000,20);} \quad I = 0;
\]

**In Air Simulation for Varying Angles**

\[
\text{for } H = 1:20 \quad \text{ang} = \text{AngV}(H); \quad \text{x}(1,H) = 0; \quad \text{Range}\]

\[
y(1,H) = y_0; \quad \text{altitude}\]

\[
Vy(1,H) = \sin(\text{ang}) \times \text{MuzzleV}; \quad Vx(1,H) = \cos(\text{ang}) \times \text{MuzzleV}; \quad Vt(1,H) = \sqrt{Vx(1,H)^2 + Vy(1,H)^2});
\]

\[
\text{for } n=2:12001 \quad t = n \times dt; \quad \text{time in msec}\]

\[
\text{Mach} = \frac{Vt(n-1,H)}{1125.33}; \quad CD(n,H) = 0.580.58 \times \tanh(2 \times (\text{Mach} - 0.8))\% \text{Drag coef}
\]

\[
Fdxr = 0.5 \times \text{rho} \times (Vx(n-1,H)^2) \times CD(n,H) \times CB(1,5)\% \text{Drag Force}
\]

\[
dvx = Fdxr/CB(1,1)); \quad Fdry = 0.5 \times \text{rho} \times (Vy(n-1,H)^2) \times CD(n,H) \times CB(1,5)\% \text{Drag Force}
\[ dvy = (F_{dry}/CB(1,1)) \]
\[ Vy(n,H) = V_y(n-1,H) - g*dt - dv_y*dt \]
\[ Vx(n,H) = V_x(n-1,H) - dv_x*dt \]
\[ En(n,H) = 0.5*CB_{mass}.*Vx(n,H).*Vx(n,H); \% DC neglects y energy \]
\[ Vt(n,H) = sqrt(Vx(n,H)^2 + Vy(n,H)^2); \]
\[ Ret(n,H) = (((CB(1,2))*Vt(n,H))/(12*1.69))*10000'; \% DC Based on 80 F \]

\[ temp, true \]
\[ AngA(n,H) = atan(Vy(n,H)/Vx(n,H)); \]
\[ dy = ((Vy(n-1,H) + Vy(n,H))*dt/2); \% average velocity * time \]
\[ dx = ((Vx(n-1,H) + Vx(n,H))*dt/2); \]
\[ % CD = .2; \% Turbulent flow, Re ~10^6 \]
\[ x(n,H) = x(n-1,H) + dx; \]
\[ y(n,H) = y(n-1,H) + dy; \]
\[ if((y(n,H)<-200)*nb(H)<1); \% DC finds the location of when the altitude \]
\[ % is less than -200 ft from the starting height \]
\[ nb(H) = n; \]
\[ end \]
\[ if y(n,H)<-200 \]
\[ I = I+1; \]
\[ if I == 1 \]
\[ X_{land}(1,H)=x(n,H); \]
\[ end \]
\[ end \]
\[ I = 0; \]
\[ end \]

\[ nbp = 0; \]
\[ for n=1:6 \]
\[ if nbp<nb(n); \]
\[ nbp = nb(n); \% finds the latest element position for when the altitude \]
\[ % of the cannonball is less than -200 ft from starting altitude \]
\[ end \]
\[ end \]
\[ xp = zeros(1,length(x)); \]
\[ xp(:) = x(:,1)'/3; \]
\[ E_{land} = X_{land}(1,20) - X_{land}(1,1); \]

\[ \% Figures/Tables from internal ballistics \]

figure(1)
plot(X,F);
title('Force vs Length ')
xlabel('Distance ft')
ylabel('Force lbs')

figure(2)
plot(X,V);
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity ft/sec')

figure(3)
plot(X,Vmach);
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity Mach')

%% Figures/Tables for Exterior Ballistics

AngV = AngV.*57.3;
AngA = AngA.*57.3;
figure(4)
for k=1:20
    AngAp(k,:) = AngA(1:12000,k)'*57.3;
    plot(x(1:nbp),AngAp(k,1:nbp))
if k == 1;
    hold;
end
end

AngA vs Distance 

ylabel('AngA');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

figure(5)
for k=1:20
    Enp(k,:) = En(1:12000,k)';
    plot(x(1:nbp),Enp(k,1:nbp))
if k == 1;
    hold;
end
end

En vs Distance 

ylabel('En');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

figure(6)
for k=1:20
    Vxp(k,:) = Vx(1:12000,k)';
    plot(x(1:nbp),Vxp(k,1:nbp))
if k == 1;
    hold;
end
title('Vx vs Distance ')
ylabel('Vx ft/sec');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
   ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
   ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
   ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
   ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

figure(7)
for k=1:20
    Vyp = Vy(1:12000,k)';
    plot(xp(1:nbp),Vyp(1:nbp))
    if k == 1;
        hold;
    end
end
title('Vy vs Distance ')
ylabel('Vy');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
   ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
   ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
   ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
   ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

Vtp = zeros(12001,20);
figure(8)
for k=1:20
    Vtp(:,k) = Vx(:,k)';
    plot(xp(1:nbp),Vtp(1:nbp,:))
    if k == 1;
        hold;
    end
end
title('Velocity vs Distance ')
ylabel('Velocity ft/sec');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
   ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
   ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
   ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
figure(9)
for k=1:20
    Atp(k,:) = y(1:12000,k)';
    plot(xp(1:nbp),Atp(k,(1:nbp)))
    if k == 1;
        hold;
    end
end
figure(10)
for n=1:20
    plot(xp(1,:),Ret(n,:));
    if n == 1;
        hold;
    end
end
%% Double Check Assumptions about fluid mechanics
% Reynolds Number Minima per Cannonball
MinRe = zeros(20,1);
for n = 1:20
    Min = find((Ret(n,:) == min(Ret(n,:))),1,'first');
    MinRe(n,1) = Ret(n,Min);
end
ReMIN = min(MinRe(:,1));
MaxRe = zeros(20,1);
for n = 1:20
    Max = find((Ret(n,:) == max(Ret(n,:))),1,'first');
    MaxRe(n,1) = Ret(n,Max);
end
ReMAX = max(MaxRe(:,1));

%% Calculation of Standard Deviation of each measure by the end
Vtmax = max(Vt(:,:));
Vymax = max(Vy(:,:));
Vxmax = max(Vx(:,:));
Emax = max(En(:,:));
Atp = Atp';
Altmax = max(Altmax(:));
AngMax = max(AngMax(:));

Vstd = std(Vtmax(:));
Vystd = std(Vymax(:));
Vxstd = std(Vxmax(:));
Enstd = std(Emax(:));
altstd = std(Altmax(:));
Angstd = std(AngMax(:));
nbstd = std(nb(:));
Restd = std(MinRe(:,1));

X = java_array('java.lang.String', 6);
X(1) = java.lang.String('Velocity');
X(2) = java.lang.String('Y_Velocity');
X(3) = java.lang.String('X_Velocity');
X(4) = java.lang.String('Energy');
X(5) = java.lang.String('Reynolds_Number');
X(6) = java.lang.String('nbp');
D = cell(X);
X = java_array('java.lang.String',2);
X(1) = java.lang.String('Altitude');
X(2) = java.lang.String('Angle_Of_Attack');
D2 = cell(X);
StandardDeviations = table(Vstd,Vystd,Vxstd,Enstd,Restd,nbstd,'variablenames',D)
StandardDeviations2 = table(altstd,Angstd,'variablenames',D2)

disp('Max Re');
disp(ReMAX);
disp('Min Re');
disp(ReMIN);
disp('Max Change in Landing Position');
disp(E_land);

Analysis of Horizontal Spread
% Evaluation of change of Angle on ballistics of 18 lb Cannonball
clear;
clc;
hold off
%% Define Initial Parameters
CB = zeros(1,5);
CB(1,1) = 18; % Cannon Ball mass lbs
CB(1,2) = 5.04; % Cannon Ball Dia inches
CB(1,3) = CB(1,2) * 25/24; % Cannon Bore inches
CB(1,4) = CB(1,3) / 12; % Bore in ft.
CB(1,5) = (pi/4) .* CB(1,4).^2; % Bore Area sq ft
CWt = 2.5; % Charge Wt in lbs gunpowder
L_ft = CB(1,4) * 18; % length of the bore in Feet
Patm = 14.7 * 144; % DC from Robin 1804
R = 1600; % DC based on 19th century, Collins
GPden = 55; % Gun powder density lbs/ft cu
C_ft = (CWt ./ GPden) ./ CB(1,5); % Length of charge in ft

F = zeros(1000,1);
FD = zeros(1000,1);
V = zeros(1000,1);
Vmach = zeros(1000,1);
X = zeros(1000,1);
dx = L_ft(:) / 1000; % DC divides up the length of the cannon into 1000th's

for n=1:1000
    X(n) = n * dx; % DC defines 1000 positions in the cannon
    if (X(n) > C_ft)
        F(n) = R * (C_ft / (n * dx)) * Patm * CB(1,5) - .5 * .08071 * V(n-1) * V(n-1) * CD * CB(1,5);
        % DC First term gunpowder force, second term drag
        if (n > 1)
            % DC allows velocity at bottom of cannon to be zero
            V(n) = 1991 * sqrt(((CWt / ((CB(1,1) + (CWt/3))) * log(X(n) ./ C_ft)));
            % DC changed 1928 to 1991 to align with use of R = 1600,
            % 19th century values
            Vmach(n) = V(n) / 1087.4;
            % DC Current mach number of cannonball
        end
    end
end
MuzzleV = V(1000,1)'; % DC exit velocity of cannonball
Re(:,1) = ((CB(:,2) .* MuzzleV(:,1) / (12 * 1.69)) * 10000)'; % DC Based on 80 F temp, true

%% Parameters for Air Simulation
AngV = 0.1:0.1:2;
AngV = AngV ./ 57.3;
ang = 4/57.3;
x = zeros(12000,20);
y = zeros(12000,20);
z = zeros(12000,20);
Pdry= zeros(12000,20);
Pdx= zeros(12000,20);
Pdz= zeros(12000,20);
Pdry= zeros(12000,20);
dvy = zeros(12000,20);
dvx = zeros(12000,20);
dvz = zeros(12000,20);
dy = zeros(12000,20);
dx = zeros(12000,20);
dz = zeros(12000,20);
X_land = zeros(1,20);
Vx = zeros(12001,20);
Vy = zeros(12001,20);
Vz = zeros(12001,20);
Vt = zeros(12001,20);
Ret = zeros(12000,20);
t = zeros(12000,20);
Ret(1,:) = Ret(:,1);
AngA = zeros(12001,20);
CD = zeros(12001,20);
VxFps = Vx(1,:), % DC first entry in Vx for each cannonball
VyFps = Vy(1,:), % DC first entry in Yx for each cannonball
CB_mass = CB(1,1)/g; % Mass of Cannonball in slugs
rho = .074; % Density of air lbs/ft^3 (1.225 kg/m^3)
y0 = 10; % Height of cannon
nb = zeros(20,1);
dt = .001;
En = zeros(12000,20);

% Drag Coef Model
%SphereCD
hold off
CDA = zeros(2500,2);
M = zeros(2500,1);
M = (1:1:2500)/1000;
n = 1:1:2500;
CDA(1:300,1) = .1;
CDA(301:500,1) = .1 + n(1:200)/6000;
for n=1:400
    CDA((500+n),1) = CDA(500,1) + n*.5/400 + .1*(1+(sin(-pi/2+n*(2*3.1416/400))));
end
for n=1:700
    CDA((900+n),1) = CDA(900,1) + .38*(1-exp(-.005*n));
end
CDA(1601:2500,1) = CDA(1600,1);
CDA(700:2500,2) = CDA(700:2500,1);
CDA(1:600,2) = .47;
for n=1:99
    CDA(600+n,2) = CDA(600,2) + n*.001;
end

figure(15)
% Plot Drag Coef
semilogx(M(200:2500),CDA(200:2500,1),'k');
hold on;
semilogx(M(200:2500),CDA(200:2500,2),'--');
Limits = [.2,2.5,0,1.5];
axis(Limits);
grid on;
grid minor;
title('CD vs MACH ') ylable('CD'); xlabel('MACH'); legend('Re > Transition', 'RE < Transition'); hold off

%% In Air Simulation for Varying Angles
for H = 1:20
    ang2 = AngV(H);
    x(1,H) = 0;  % Range
    y(1,H) = y0;  % altitude
    z(1,H) = 0;  % Horizontal Spread
    Vy(1,H) = cos(ang2)*sin(ang)*MuzzleV;
    Vx(1,H) = cos(ang)*cos(ang2)*MuzzleV;
    Vz(1,H) = cos(ang)*sin(ang2)*MuzzleV;
    Vt(1,H) = sqrt(Vx(1,H).^2+Vy(1,H).^2+Vz(1,H).^2);
for n=2:12001
    t(n,H) = n*dt;  % time in msec
    MACH(n,H) = Vt(n-1,H)/1125.33;
    Mach(n,H) = 1000*MACH(n,H);  % used in drag cal.
    Icd = round(Mach(n,H));  % index for drag cal.
    if(Icd>2500)
        Icd = 2500;  % Limit of CD
    end
    CD(n,H) = CDA(Icd,1);  % Drag coef from function
    Fdrx(n,H) = .5*rho*(Vx(n-1,H).^2)*CD(n,H)*CB(1,5);  % Drag Force
    dvx(n,H) = (Fdrx(n,H)/CB(1,1));
    Fdry(n,H) = .5*rho*(Vy(n-1,H).^2)*CD(n,H)*CB(1,5);  % Drag Force
    dvy(n,H) = (Fdry(n,H)/CB(1,1));
    Fdrz(n,H) = .5*rho*(Vz(n-1,H).^2)*CD(n,H)*CB(1,5);  % Drag Force
    dvz(n,H) = (Fdrz(n,H)/CB(1,1));
    Vy(n,H) = Vy(n-1,H)-g*dt-dvy(n,H)*dt;
    Vx(n,H) = Vx(n-1,H)-dvx(n,H)*dt;
    Vz(n,H) = Vz(n-1,H)-dvz(n,H)*dt;
    dVx = .5*CB_mass.*Vx(n,H).*Vx(n,H);  % DC neglects y energy
    Vt(n,H) = sqrt(Vx(n,H).^2+Vy(n,H).^2+Vz(n,H).^2);
    Ret(n,H) = (((CB(1,2))*Vt(n,H))/(12*1.69))*10000';  % DC Based on 80 F
    if(temp, true)
        AngA(n,H) = atan(Vy(n,H)/Vx(n,H));
    end
    dy(n,H) = ((Vy(n-1,H)+ Vy(n,H))*dt/2);  % average velocity *time
    dx(n,H) = ((Vx(n-1,H)+ Vx(n,H))*dt/2);
    dz(n,H) = ((Vz(n-1,H)+ Vz(n,H)) *dt/2);
    x(n,H) = x(n-1,H)+dx(n,H);
    y(n,H) = y(n-1,H)+dy(n,H);
    z(n,H) = z(n-1,H)+dz(n,H);
    if((y(n,H)<-200)* nb(H)<1)  % DC finds the location of when the altitude
% is less than -200 ft from the starting height
nb(H) = n;
end
end
end

nbp = 0;
for n=1:20
    if nbp<nb(n);
        nbp = nb(n); % finds the latest element position for when the altitude
        % of the cannonball is less than -200 ft from starting altitude
    end
    X_land(1,n)=nbp;
end
xp = zeros(1,length(x));
xp(:) = x(:,1)'/3;

E_land = X_land(1,20)-X_land(1,1);

%% Figures/Tables from internal ballistics

figure(1)
plot(X,F);
title('Force vs Length ')
xlabel('Distance ft')
ylabel('Force lbs')

figure(2)
plot(X,V);
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity ft/sec')

figure(3)
plot(X,Vmach);
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity Mach')

%% Figures/Tables for Exterior Ballistics

AngV = AngV.*57.3;
AngA = AngA.*57.3;
figure(4)
for k=1:20
    AngAp(k,:) = AngA(1:12000,k)'*57.3;
    plot(xp(1:nbp),AngAp(k,1:nbp))
    if k == 1;
        hold;
    end
end
title('AngA vs Distance ')
ylabel('AngA');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20))); heads

figure(5)
for k=1:20
    Enp(k,:) = En(1:12000,k)';
    plot(xp(1:nbp),Enp(k,1:nbp))
    if k == 1;
        hold;
    end
end

figure(6)
for k=1:20
    Vxp(k,:) = Vx(1:12000,k)';
    plot(xp(1:nbp),Vxp(k,1:nbp))
    if k == 1;
        hold;
    end
end

figure(7)
for k=1:20
    Vyp = Vy(1:12000,k)';
    plot(xp(1:nbp),Vyp(1:nbp))
if k == 1;
    hold;
end
end
title('Vy vs Distance ')
ylabel('Vy');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

figure(21)
for k=1:20
    Vzp = Vz(1:12000,k)';
    plot(xp(1:nbp),Vzp(1:nbp))
    if k == 1;
        hold;
    end
end
title('Vz vs Distance ')
ylabel('Vz (ft/s)');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));
hold off

figure(22)
for k=1:20
    plot(t(:,k),Vz(:,k))
    if k == 1;
        hold;
    end
end
title('Vz vs Time ')
ylabel('Vz (ft/s)');
xlabel('Time (s)');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8))...
    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12))...
    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16))...
    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20)));

Vtp = zeros(12001,20);
figure(8)
for k=1:20
Vtp(:,k) = Vx(:,k)';
plot(xp(1:nbp),Vtp(1:nbp,:))
if k == 1;
    hold;
end
end
title('Velocity vs Distance ')
ylabel('Velocity ft/sec');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4)));
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8)));
\n    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12));
\n    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16)));
\n    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20));
end
hold off
\nfigure(9)
for k=1:20
Atp(k,:) = y(1:12000,k)';
plot(xp(1:nbp),Atp(k,(1:nbp)))
if k == 1;
    hold;
end
end
title('Altitude vs Distance ')
ylabel('Altitude Feet');
xlabel('Range Yds');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4)));
    ,num2str(AngV(5)),num2str(AngV(6)),num2str(AngV(7)),num2str(AngV(8)));
\n    ,num2str(AngV(9)),num2str(AngV(10)),num2str(AngV(11)),num2str(AngV(12));
\n    ,num2str(AngV(13)),num2str(AngV(14)),num2str(AngV(15)),num2str(AngV(16)));
\n    ,num2str(AngV(17)),num2str(AngV(18)),num2str(AngV(19)),num2str(AngV(20));
end
hold off
\nfigure(20)
for k=1:20
plot(t(1:nbp),z(1:nbp,k))
if k == 1;
    hold;
end
end
title('Horizontal Spread vs Time ')
ylabel('Horizontal Spread (ft)');
xlabel('Time (s)');
legend(num2str(AngV(1)),num2str(AngV(2)),num2str(AngV(3)),num2str(AngV(4))...
figure(10)
Ret = Ret';
for n = 1:20
plot(xp(1,:),Ret(n,:));
if n == 1;
    hold;
end
plot(xp(1,:),Ret(n,:));
end

%% Double Check Assumptions about fluid mechanics
% Reynolds Number Minima per Cannonball
MinRe = zeros(20,1);
for n = 1:20
Min = find((Ret(n,:) == min(Ret(n,:))),1,'first');
MinRe(n,1) = Ret(n,Min);
end
ReMIN = min(MinRe(:,1));

MaxRe = zeros(20,1);
for n = 1:20
Max = find((Ret(n,:) == max(Ret(n,:))),1,'first');
MaxRe(n,1) = Ret(n,Max);
end
ReMAX = max(MaxRe(:,1));

%% Calculation of Standard Deviation of each measure by the end
Vtmax = max(Vt(:,:));
Vymin = min(Vy(:,:));
Vxmax = max(Vx(:,:));
Emax = max(En(:,:));
Atp = Atp';
Altmax = max(Atp(:,:));
AngMax = max(AngA(:,:));
Vstd = std(Vtmax(:));
Vystd = std(Vymax(:));
Vxstd = std(Vxmax(:));
Enstd = std(Emax(:));
altstd = std(Altmax(:));
Angstd = std(AngMax(:));
nbstd = std(nb(:));
Restd = std(MinRe(:,1));

X = java_array(\'java.lang.String\', 6);
X(1) = java.lang.String(\'Velocity\');
X(2) = java.lang.String(\'Y_Velocity\');
X(3) = java.lang.String(\'X_Velocity\');
X(4) = java.lang.String(\'Energy\');
X(5) = java.lang.String(\'Reynolds_Number\');
X(6) = java.lang.String(\'nbp\');
D = cell(X);
X = java_array(\'java.lang.String\', 2);
X(1) = java.lang.String(\'Altitude\');
X(2) = java.lang.String(\'Angle_Of_Attack\');
D2 = cell(X);
StandardDeviations =
table(Vstd,Vystd,Vxstd,Enstd,Restd,nbstd,\'variablenames\',D)
StandardDeviations2 = table(altstd,Angstd,\'variablenames\',D2)

disp(\'Max Re\');
disp(ReMAX);
disp(\'Min Re\');
disp(ReMIN);
disp(\'Max Change in Landing Position in ft\');
disp(E_land);

HSpread = z(end,20)-z(end,1);
disp(\'Horizontal Spread in ft\');
disp(HSpread);

Analysis of Gunpowder Quality
% Evaluation of change of quality of gunpowder on ballistics of 18 lb Cannonball
clear;
c1c;
hold off

%% Define Initial Parameters
CB = zeros(1,5);
CB(1,1) = 18; %Cannon Ball mass lbs
CB(1,2) = 5.04;%Cannon Ball Dia inches
CB(1,3) = CB(1,2)*25/24; %Cannon Bore inches
CB(1,4) = CB(1,3)/12; %Bore in ft.
CB(1,5) = (pi/4).*CB(1,4).^2; %Bore Area sq ft
CWT = 2.5;% Charge Wt in lbs gunpowder
L_ft = CB(1,4)*18;%length of the bore in Feet
Patm = 14.7*144; %DC from Robin 1804
GPden = 55; %Gun powder density lbs/ft cu
C_ft = (CWT./GPden)./(CB(1,5)); %Length of charge in ft
F = zeros(1000,11);
FD = zeros(1000,11);
V = zeros(1000,11);
Vmach = zeros(1000,11);
X = zeros(1000,11);
dx = L_ft(:)/1000; % DC divides up the length of the cannon into 1000th's

g = 32.2; %ft/s^2
CD = 5; %Coefficient of Drag
Fkn = zeros(1000,11);
Vkn = zeros(1000,11);

R = 1500:10:1600; %Quality of Gunpowder Changes

%% Simulation within the Canon
for k = 1:11
    for n=1:1000
        X(n,k) = n*dx; %DC defines 1000 positions in the cannon
        if (X(n,k)>C_ft)
            F(n,k) = R(k)*(C_ft/(X(n,k)))*Patm*CB(1,5) -.5*.08071*V(n-1,k).*V(n-1,k)*CD*CB(1,5);
            if (n>1)
                V(n,k) = sqrt(2*g*R(k)*(Patm/GPde)n*(CWt/CB(1,1))*log(X(n,k)./C_ft));
                Vmach(n,k) = V(n,k)/1087.4;
                %DC Current mach number of cannonball
            end
        end
    end
end
MuzzleV = V(1000,:); %DC exit velocity of cannonball
Re(:,1) = ((CB(:,2).*MuzzleV(:)/(12*1.69))*10000); %DC Based on 80 F temp, true

%% Parameters for Air Simulation
AngV = 4;
AngV = AngV./57.3;
x = zeros(12000,11);
x_land = zeros(1,11);
y = zeros(12000,11);
Vx = zeros(12001,11);
Vy = zeros(12001,11);
Vt = zeros(12001,11);
Vx(1,:) = MuzzleV*cos(AngV(:));
Vy(1,:) = MuzzleV*sin(AngV(:));
Ret = zeros(12000,11);
Ret(1,:) = Re(:,1);
AngA = zeros(12001,1);
CD = zeros(12001,11);
VxFps = Vx(1,:); %DC first entry in Vx for each cannonball
VyFps = Vy(1,:); %DC first entry in Vy for each cannonball
CB_mass = CB(1,1)/g; %Mass of Cannonball in slugs
rho = .074; %density of air lbs/ft^3(1.225kg/m^3)
y0 = 10; % Height of cannon
nb = zeros(11,1);
dt = .001;
En = zeros(12000,11);
I = 0;

%% In Air Simulation for Varying Angles
for H = 1:11
    ang = AngV;
    x(1,H) = 0;  % Range
    y(1,H) = y0;  % altitude
    Vy(1,H) = sin(ang)*MuzzleV(H,1);
    Vx(1,H) = cos(ang)*MuzzleV(H,1);
    Vt(1,H) = sqrt(Vx(1,H).^2+Vy(1,H).^2);
    for n=2:12001
        t = n*dt; %time in msec
        Mach = Vt(n-1,H)/1125.33;
        CD(n,H) = .58+0.58*tanh(2*(Mach -.8)); %Drag coef
        Fdrx = .5*rho*(Vx(n-1).^2)*CD(n,H)*CB(1,5); %Drag Force
        dvx = (Fdrx/CB(1,1));
        Fdry = .5*rho*(Vy(n-1).^2)*CD(n,H)*CB(1,5); %Drag Force
        dvy = (Fdry/CB(1,1));
        Vy(n,H) = Vy(n-1,H) - g*dt - dvy*dt;
        Vx(n,H) = Vx(n-1,H) - dvx*dt;
        En(n,H) = 0.5*CB_mass.*Vx(n,H).*Vx(n,H); %DC neglects y energy
        Vt(n,H) = sqrt(Vx(n,H).^2+Vy(n,H).^2);
        Ret(n,H) = (((CB(1,2))*Vt(n,H))/(12*1.69))*10000'; %DC Based on 80 F temp, true
        AngA(n,H) = atan(Vy(n,H)/Vx(n,H));
        dy = ((Vy(n-1,H)+ Vy(n,H))*dt/2); %average velocity *time
        dx = ((Vx(n-1,H)+ Vx(n,H))*dt/2);
        if((y(n,H)<-200)* nb(H)<1) %DC finds the location of when the altitude
            %is less than -200 ft from the starting height
            nb(H) = n;
        end
        if n <12000
            if y(n,H)<-200
                I = I +1;
            if I == 1
                X_land(1,H)=x(n,H);
            end
        else
            X_land(1,H)=x(n,H);
        end
    end
    I = 0;
end

E_land = X_land(1,11)-X_land(1,1);

nbp = 0;
for n=1:6
    if nbp<nb(n);
        nbp = nb(n); %finds the latest element position for when the altitude
% of the cannonball is less than -200 ft from starting altitude
end
xp = zeros(1,length(x));
xp(:) = x(:,1)'/3;

%% Figures/Tables from internal ballistics
figure(1)
for n=1:11
plot(X(:,n),F(:,n))
if n == 1;
hold;
end
plot(X(:,n),F(:,n))
end
title('Force vs Length ')
xlabel('Distance ft')
ylabel('Force lbs')
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

figure(2)
for n=1:11
plot(X(:,n),V(:,n))
if n == 1;
hold;
end
plot(X(:,n),V(:,n));
end
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity ft/sec')
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

figure(3)
for n=1:11
plot(X(:,n),Vmach(:,n))
if n == 1;
hold;
end
plot(X(:,n),Vmach(:,n));
end
title('Velocity vs Length ')
xlabel('Distance ft')
ylabel('Velocity Mach')
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

%% Figures/Tables for Exterior Ballistics
AngV = AngV.*57.3;
AngA = AngA.*57.3;
figure(4)
for k=1:11
AngAp(k,:) = AngA(1:12001,k)'*57.3;
plot(xp(1,1:nbp),AngAp(k,1:nbp))
if k == 1;
    hold;
end
end
title('AngA vs Distance ')
ylabel('AngA');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off;

figure(5)
for k=1:11
Enp(k,:) = En(1:12001,k)';
plot(xp(1:nbp),Enp(k,1:nbp))
if k == 1;
    hold;
end
end
title('En vs Distance ')
ylabel('En');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off;

figure(6)
for k=1:11
Vxp(k,:) = Vx(1:12001,k)';
plot(xp(1:nbp),Vxp(k,1:nbp))
if k == 1;
    hold;
end
end
title('Vx vs Distance ')
ylabel('Vx ft/sec');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
      num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
      num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off;

figure(7)
for k=1:11
Vyp = Vy(1:12001,k)';
plot(xp(1:nbp),Vyp(1:nbp))
if k == 1;
    hold;
end
end
title('Vy vs Distance ')
ylabel('Vy');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
    num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
    num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

Vtp = zeros(12001,20);
figure(8)
for k=1:11
    Vtp(:,k) = Vx(:,k)';
    plot(xp(1:nbp),Vtp(1:nbp,:))
    if k == 1;
        hold;
    end
end
title('Velocity vs Distance ')
ylabel('Velocity ft/sec');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
    num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
    num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

figure(9)
for k=1:11
    Atp(k,:) = y(1:12001,k)';
    plot(xp(1:nbp),Atp(k,(1:nbp)))
    if k == 1;
        hold;
    end
end
title('Altitude vs Distance ')
ylabel('Altitude Feet');
xlabel('Range Yds');
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
    num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
    num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

figure(10)
Ret = Ret';
for n=1:11
    plot(xp(1,:),Ret(n,:));
    if n == 1;
        hold;
    end
plot(xp(1,:),Ret(n,:));
end
title('Reynolds Number vs Distance ')
xlabel('Distance (ft)')
ylabel('Reynolds Number')
legend(num2str(R(1)),num2str(R(2)),num2str(R(3)),num2str(R(4)),...
    num2str(R(5)),num2str(R(6)),num2str(R(7)),num2str(R(8)),...
    num2str(R(9)),num2str(R(10)),num2str(R(11)));
hold off

%% Double Check Assumptions about fluid mechanics
% Reynolds Number Minima per Cannonball
MinRe = zeros(11,1);
for n = 1:11
    Min = find((Ret(n,:) == min(Ret(n,:))),1,'first');
    MinRe(n,1) = Ret(n,Min);
end
ReMIN = min(MinRe(:,1));

MaxRe = zeros(11,1);
for n = 1:11
    Max = find((Ret(n,:) == max(Ret(n,:))),1,'first');
    MaxRe(n,1) = Ret(n,Max);
end
ReMAX = max(MaxRe(:,1));

%% Calculation of Standard Deviation of each measure by the end
Vtmax = max(Vt(:,:));
Vymax = max(Vy(:,:));
Vxmax = max(Vx(:,:));
Emax = max(En(:,:));
Atp = Atp';
Altmax = max(Atp(:,:));
AngMax = max(AngA(:,:));

Vstd = std(Vtmax(:));
Vystd = std(Vymax(:));
Vxstd = std(Vxmax(:));
Enstd = std(Emax(:));
altstd = std(Altmax(:));
Angstd = std(AngMax(:));
nbstd = std(nb(:));
Restd = std(MinRe(:,1));

X = java_array('java.lang.String', 6);
X(1) = java.lang.String('Velocity');
X(2) = java.lang.String('Y_Velocity');
X(3) = java.lang.String('X_Velocity');
X(4) = java.lang.String('Energy');
X(5) = java.lang.String('Reynolds_Number');
X(6) = java.lang.String('nbp');
D = cell(X);
X = java_array('java.lang.String',2);
X(1) = java.lang.String('Altitude');
X(2) = java.lang.String('Angle_Of_Attack');
D2 = cell(X);
StandardDeviations = table(Vstd,Vystd,Vxstd,Enstd,Restd,nbstd,'variablenames',D)
StandardDeviations2 = table(altstd,Angstd,'variablenames',D2)
Dr Aaron Bradshaw analysis of Soil Penetration

%AaronChk
hold off;
A = 20;%area sq in
D = zeros(9,2);
K = 0.65;%Compensation for light wt. penetrator and soft soil
N = 0.65;%dimentionless
S = [8;10]; %dimentionless
V = zeros(9,1);%feet/second
V = [1235;1202;1146;1051;974;911;816;745;690];
W = 18; %Wt of ball,mass slugs
R = [27;55;109;219;328;438;656;875;1094];
PH = [80.7;78.3;75.2;69.7;66.5;63.4;57.9;52.4;47.3];
for n=1:2
D(:,n) = 0.00178*S(n)*N*((W/A)^.7)*(V-100)*K;
Din = D*12;
end
Soil1 = S(1);
Soil2 = S(2);
table(W,A,Soil1,Soil2,N)
PDft1 = D(:,1);
PDft2 = D(:,2);
Din1 = D(:,1).*12;
Din2 = D(:,2).*12;
table(R,V,PDft1,PDft2, Din1,Din2,PH)
figure(1)
plot(R,Din1)
hold on;
plot(R,Din2)
plot(R,PH,'k+');
title('Penetration VS. Range');
xlabel('Range yards');
ylabel('Penitration inches');
legend('S= 8','S= 10','Historic data')
hold off;
figure(2)
plot(V,Din1)
hold on;
plot(V,Din2)
plot(V,PH,'k+');
title('Penetration VS. Velocity');
xlabel('Velocity at impact ft/sec');
ylabel('Penetration inches');
legend('S= 8','S= 10','Historic data')
Bibliography

2. Map by Lt Edward Fage British Artillery, drawn then updated 1776 to 1779.
   (Available from Google as a Free download)
   http://arc.id.au/CannonballDrag.html
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