The 16-inch Batteries at San Francisco and the Evolution of the Casemated 16-inch Battery

Bolling Smith

In the fall of 1936, the army began to construct a 16-inch gun battery at Fort Funston, south of San Francisco. A little over a year later, construction commenced on a second 16-inch battery at Tennessee Point, north of the Golden Gate. These 2-gun batteries, both completed in 1940, were of a new type, "casemated," with overhead cover to protect the magazines and ammunition service and partially protect the guns and their crews. This article will examine several interrelated subjects: the progression of plans for the first two 16-inch batteries at San Francisco, the evolution of 16-inch battery designs culminating in a national program of casemated batteries, and the changes in the casemate design.

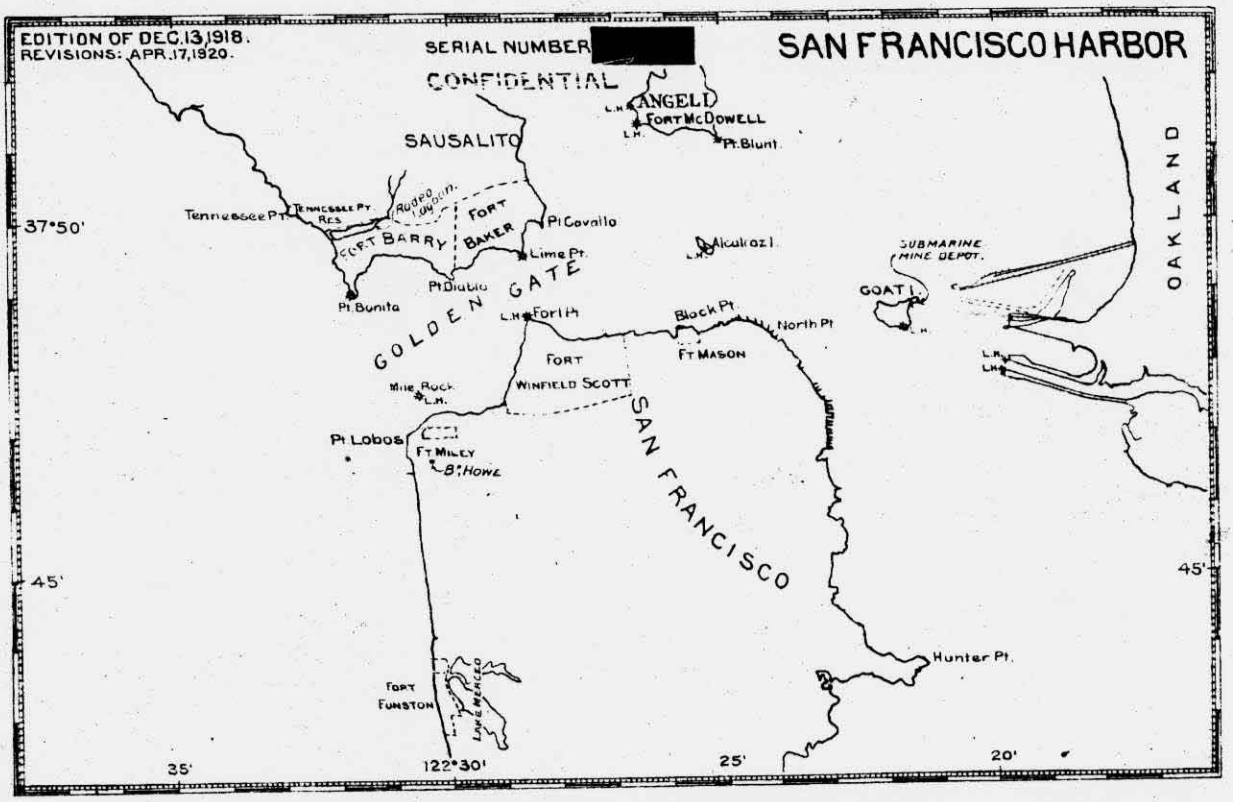
While overhead cover, particularly against air attack, today appears a natural, obvious development, it was certainly not so obvious at the time, nor was casemating ever the only option. The decision to casemate these two batteries was made at the highest level, and only after prolonged dispute between several branches of the army that seriously disagreed as to the nature and severity of the aerial threat, the effectiveness of passive protection and antiaircraft fire, and the relative importance of fields of fire versus protection. When the decision was made, cost was a critical factor, and when cost became less important, the time required to develop competing designs became key.

The files of the development and construction of the 16-inch batteries reflect the constantly changing national and international situation, and the rapid evolution of military engineering and ordnance. The records are full of designs not constructed, weapons never emplaced, and sites never fortified. Some of these designs, weapons, and sites were proposed but never approved, while others were approved, only to be discarded as circumstances and plans changed.

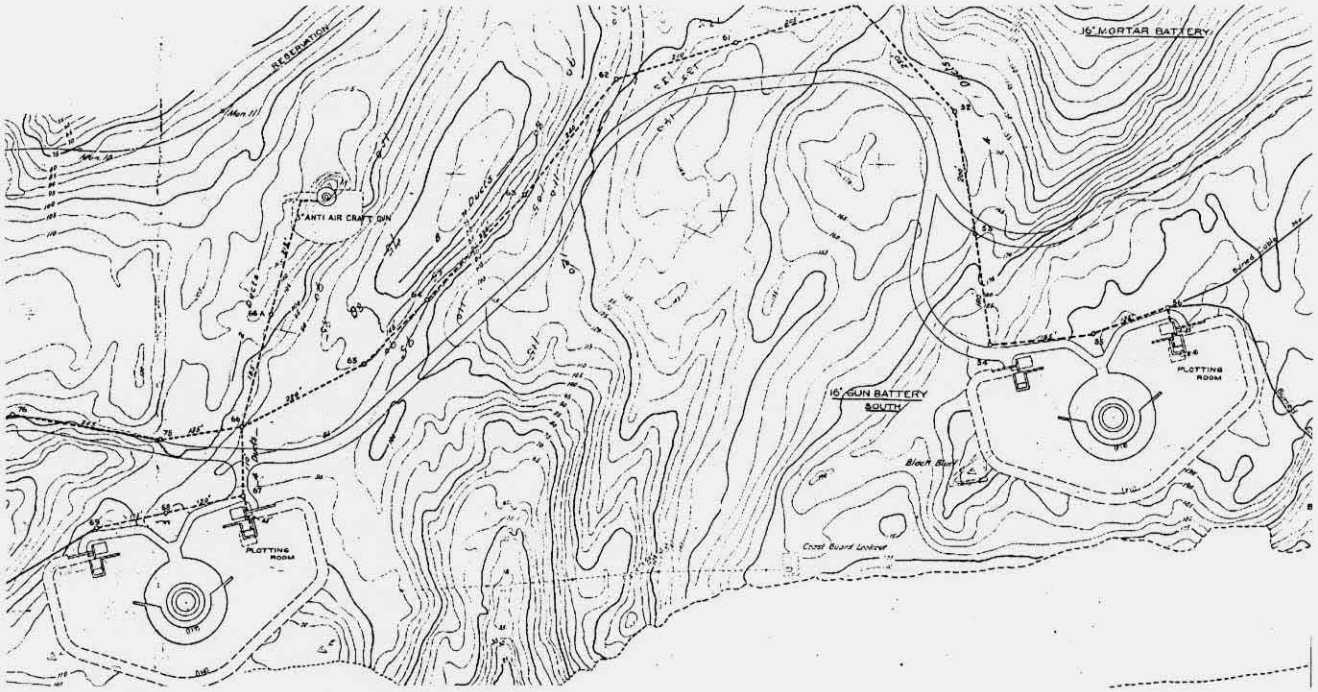
The primary records of the evolution of the plans for these batteries are in the National Archives. The records of the Office of the Chief of Engineers, RG 77, contain a large file dealing with the San Francisco batteries in the Harbor Defense Geographic files, and other more general documents in the Harbor Defense Decimal files. The records of the Adjutant General's Office, RG 407, contain the adjutant general's files corresponding to the geographic files in RG 77. Many duplicate the engineer files, but others contain additional material, including reports and studies from the War Plans Division (WPD) of the General Staff.

The archives contain many documents concerning the design of the 16-inch guns and batteries, and it is impossible to guarantee that all relevant records have been examined. It is hoped that others will contribute further information in the future, but meanwhile it is believed that the files examined reasonably depict the debates and resolutions leading to the introduction and refinement of the casemated 16-inch battery. Many of the documents were attachments to later correspondence and to be properly understood must be read in the order in which they were written.

American seacoast batteries evolved, usually by small steps, from one design to the next. Generally, each step was a modification or extension of the previous design, and there is little that can be said to be a radical departure from past practice. Casemates are, in general terms,



1. San Francisco Harbor, 1920.

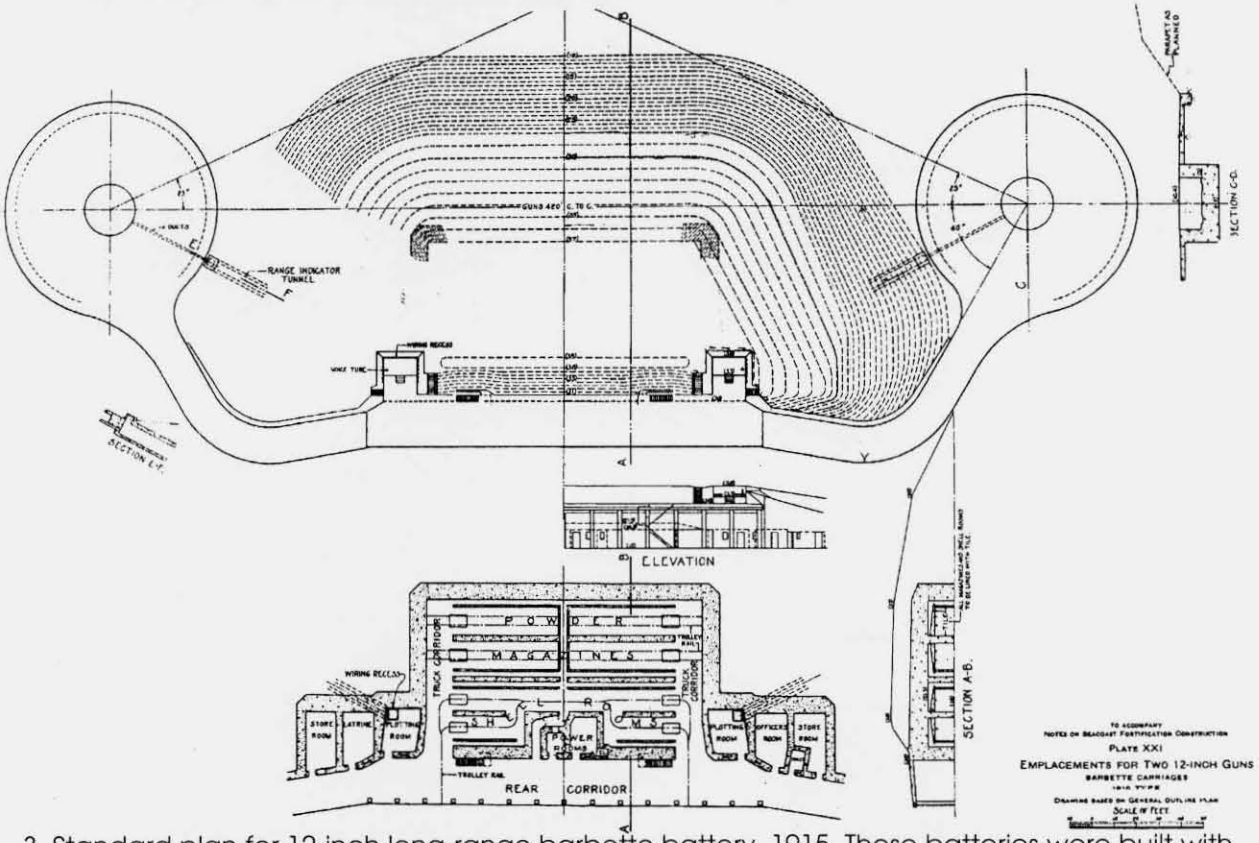


2. Proposal for two disappearing 16-inch guns at Fort Funston, 1918. NPS, GGNRA Archives

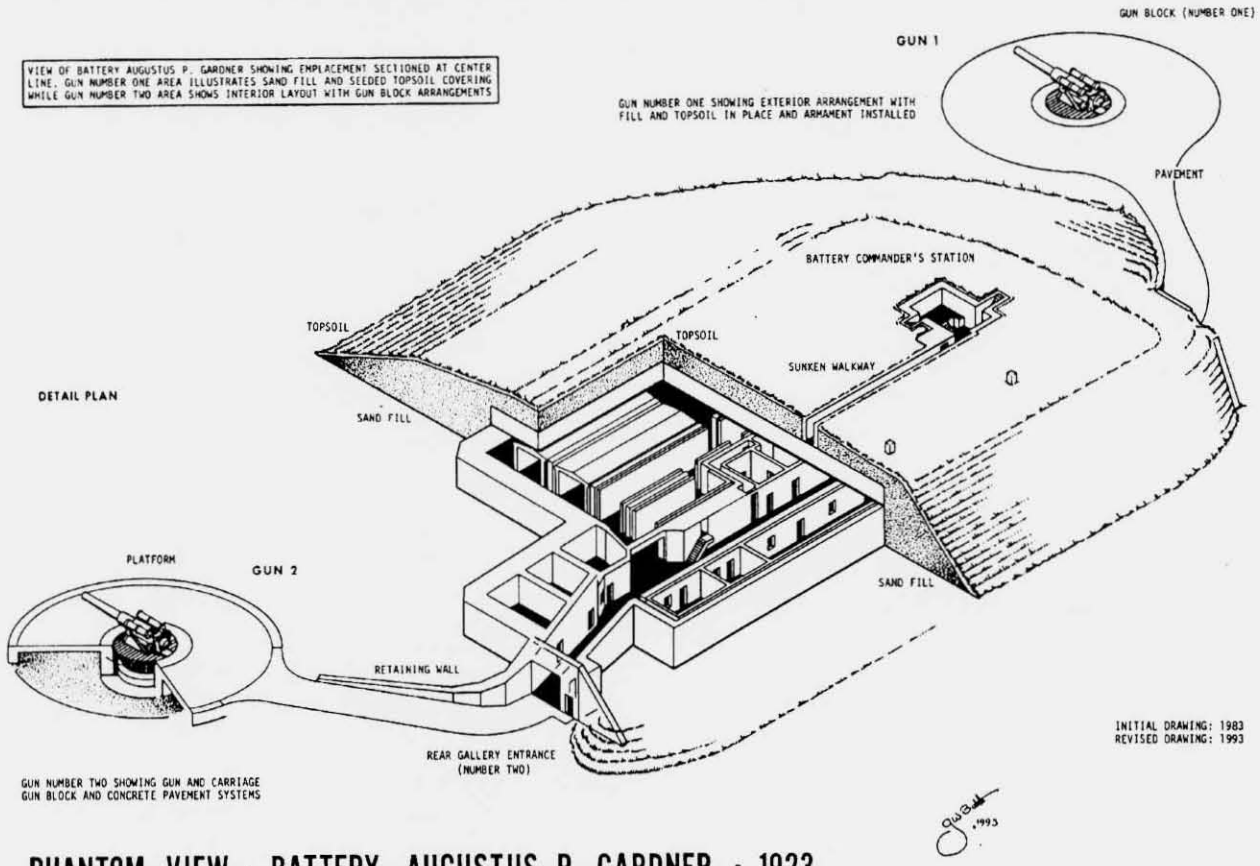
windows through which guns fire. In masonry forts they protected the guns and particularly their crews from the more numerous shipboard guns, as well as small arms fire from the ships, whose fighting tops frequently overlooked the shore batteries. These casemates were common during the Third System of Fortification, but by the end of the Civil War rifled naval guns could penetrate masonry walls with distressing ease, making them obsolete. Attempts to reinforce masonry walls with iron were unsuccessful, so as the coast artillery moved into the breechloading era, only a handful of coast defense guns were casemated. After World War I, the concern shifted toward protection from aerial attack, and the emphasis for casemates became overhead cover. A battery of 3-inch guns at Fort Mott, two batteries of 6-inch guns on Fort Drum, and one 155 mm gun on Corregidor were the only breechloading seacoast guns casemated by the U.S. Army before 1936, although several batteries of land-defense guns, manned by the coast artillery, were built on Oahu. Each location was unique, but all were intended to maximize the protection for the guns and especially their crews.

Dispersed Barbette Batteries

Meanwhile, as the disappearing-gun battery evolved, it became increasingly simplified. Eventually, the design for 14-inch disappearing-gun batteries was modified into the 12-inch long-range barbette batteries begun in 1916 **[Figs 3 & 4].** These stopgap batteries bore little resemblance the 1890's generation of barbette batteries. They mounted gun barrels already on hand on new barbette carriages that allowed higher elevation, and hence greater range, than the disappearing carriages. This increase in range was at the cost of the protection provided by the parapets in front of the disappearing guns. The new barbette battery stored its ammunition in a central bombproof magazine between the guns, but the guns and ammu-



3. Standard plan for 12-inch long-range barbette battery, 1915. These batteries were built with both open and closed backs.
Eben Eveleth Winslow, *Notes on Seacoast Fortification Construction.*

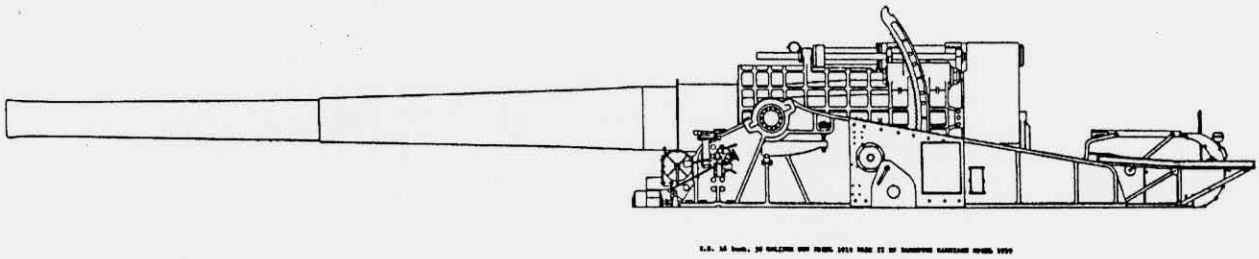


PHANTOM VIEW · BATTERY AUGUSTUS P. GARDNER · 1923

4. Battery Augustus P. Gardner was begun in 1918 at Fort Ruckman, HD of Boston. Gerald W. Butler, *Military Annals of Nahant, Massachusetts*

nition service were completely exposed. Withdrawing the guns from the shoreline provided some protection from naval observation and gunfire. Air attack was not a major concern in 1916, since aircraft were relatively small and flimsy, and large numbers could hardly accompany an attacking fleet before the development of aircraft carriers. However, as aviation increased in range and power, aircraft carriers began to enable a fleet to attack from the air as well as from the sea. The vulnerability of the barbette batteries became increasingly evident; with their guns sitting in the center of open, circular emplacements they were completely open to aerial observation and attack.

After the First World War, this concept was expanded for the next generation of batteries. As the range and power of naval guns increased, the army responded with the model 1919 16-inch gun **[Fig. 5]**. This 67-foot monster, weighing 385,847 pounds without its carriage, fired 2,400-pound armor-piercing shot some 49,000 yards and was the most powerful cannon in service in the world at that time. It was mounted on a barbette carriage similar to that used with the 12-inch gun but larger and more sophisticated, and could be fired at elevations up to 65°. The carriage rotated in the center of a 73-foot circle, no better protected than its 12-inch predecessor. The practicality of bombproofing even the magazine was questioned. The chief of coast artillery proposed dispersed, unprotected batteries in a January 20, 1920, memorandum to the chief of engineers, commenting on the Board of Engineers' emplacement designs. The principal argument for dispersal was economy. The chief of engineers



5. U.S. Army M1919 16-inch gun.
Drawing by Robert D. Fritz©, used by permission of Peter Fransden

estimated that a dispersed battery would cost $650,000, which was $1,250,000 less than the centralized type.(1)

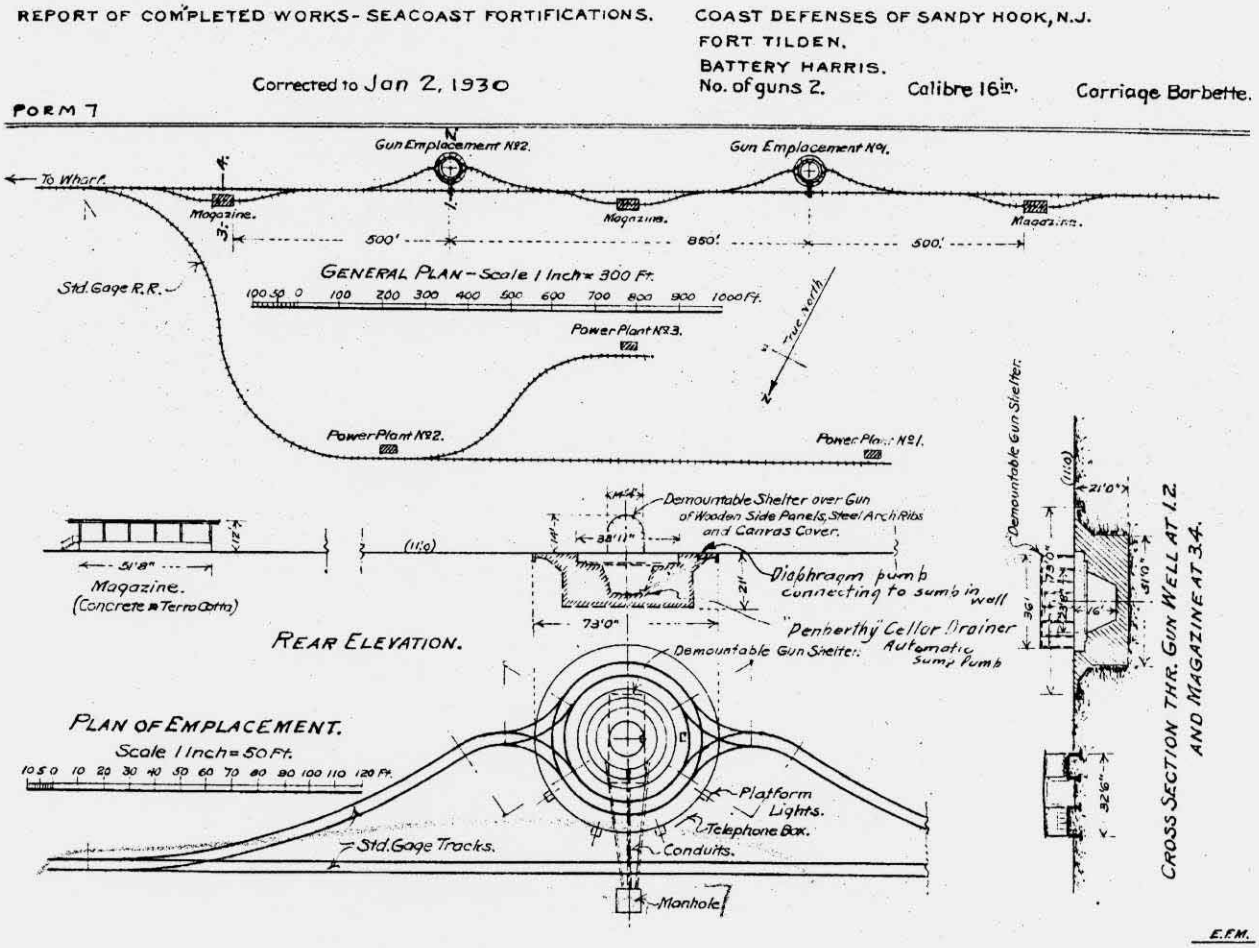
Corps of Engineers Mimeograph No. 1 for 1923, "Harbor Defense," issued May 21, concluded 16-inch batteries would require larger magazines, additional protection would be required to protect against larger naval guns and aerial bombs, and the resulting magazines, if bombproof, would not only be expensive, but very difficult to conceal from aerial attack. Therefore, unless prevented by restricted sites or the nature of the terrain, new batteries were to be protected by duplication, dispersal, and concealment, rather than bombproof construction. The magazines were to offer no more than protection from the weather, while the guns were not provided even this protection.

This design was used for the 16-inch howitzer battery at Fort Story, VA, and for two 2-gun 16-inch batteries, Harris at New York **[Fig. 6]**, and Williston on Oahu, all begun in 1921. While the guns in the WWI 12-inch batteries were about 420 feet apart, the guns at Battery Harris were separated by 850 feet, increased to 900 feet for subsequent gun batteries, and the 16-inch howitzers at Fort Story were 1050 feet apart. Both guns and magazines were completely unprotected, although the plotting rooms were bombproofed. Harris and Williston, the first two of this type, were each built with three detached magazines and railroad tracks from the magazines to the guns. Battery Williston had one bombproof power plant, but because of limited funds, Harris was built with three dispersed, unprotected power plants.(2)

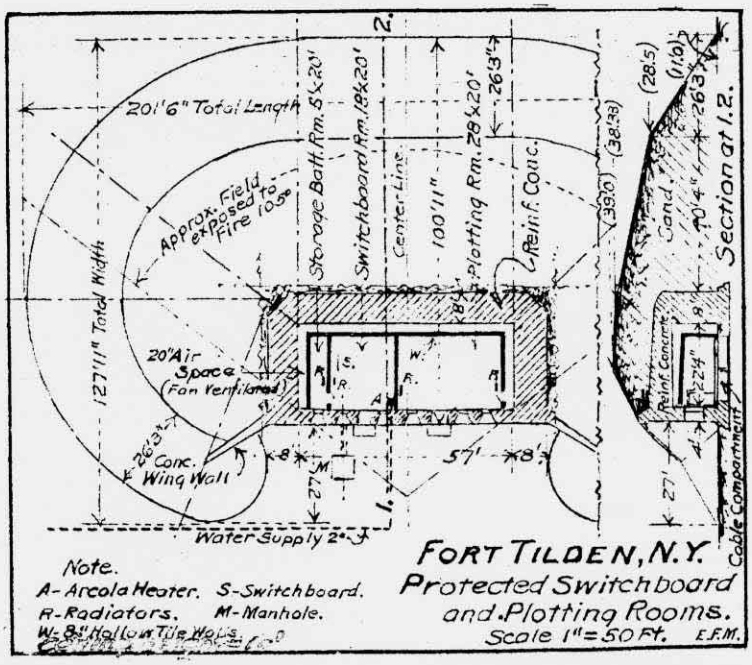
On February 11, 1922, the Office of the Chief of Engineers, referring to a 1920 layout for Battery Williston, noted that during the last two years the Ordnance Department had changed the design and operation of ammunition trucks. There had been many conferences between the Offices of the Chief of Engineers, the Chief of Ordnance, and the Chief of Coast Artillery on the design of the battery, with particular attention to "the rapid progress being made in the development of aerial bombardment."

Battery Williston's guns and magazines were now to be on sidings along a single-track, 3-foot-gauge railroad, connected in wartime with the commercial railway systems. Only limited ammunition was to be kept in the service magazines near the guns; the bulk was to be stored in reserve magazines further inland, 6 1/2 miles in a direct line, 20 miles by rail. Here it could be concealed and guarded, and brought to the guns by locomotives. The plotting and switchboard room and the powerhouse would be the only bombproof structures.

On February 13 and 16, 1922, Gen. William S. Peirce, assistant chief of ordnance, and Gen. Frank W. Coe, chief of coast artillery, concurred. On February 23, 1923, by order of the secretary of war, the adjutant general approved the plan as submitted by the engineers.



6a. Battery Harris, dispersed (Type A) 16-inch battery, was begun in 1921 at Fort Tilden, HD of Southern New York.



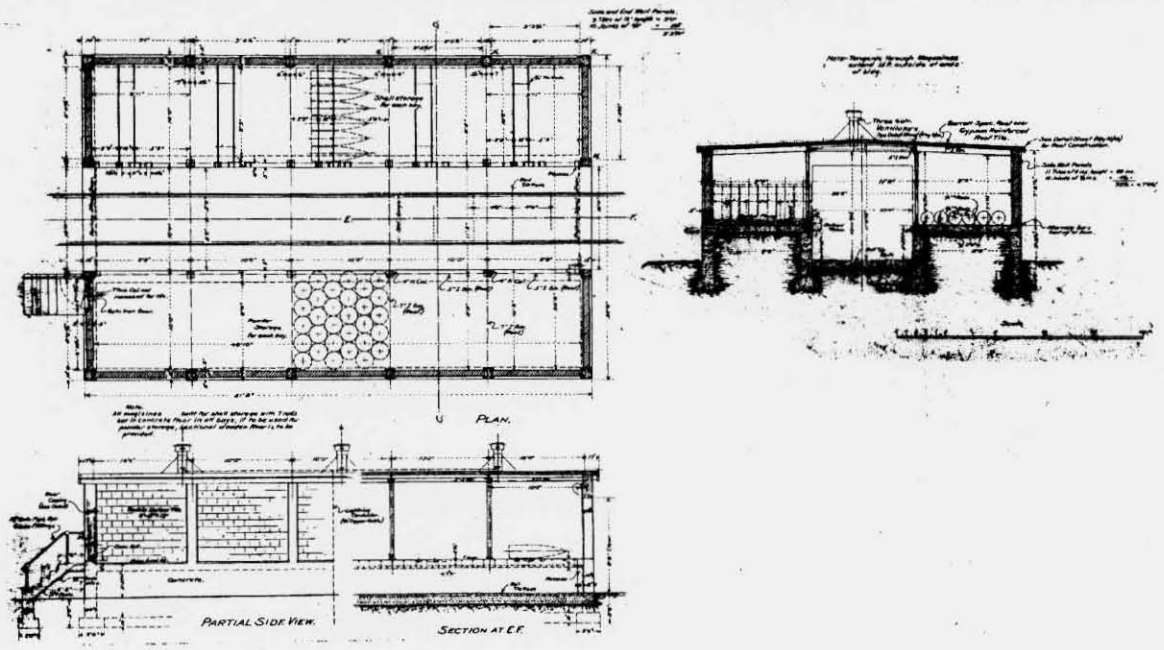
6b. Protected switchboard room and plotting room, Battery Harris.

REPORT OF COMPLETED WORKS - SEACOAST FORTIFICATIONS.

BATTERY PLAN - Sheet 2,-Magazines.
Corrected to Aug. 8, 1929.

Harbor Defenses of Sandy Hook.
Fort Tilden.
Battery Harris.
No. of Guns 2.- Caliber 16", Car. Bar.

Form 7.



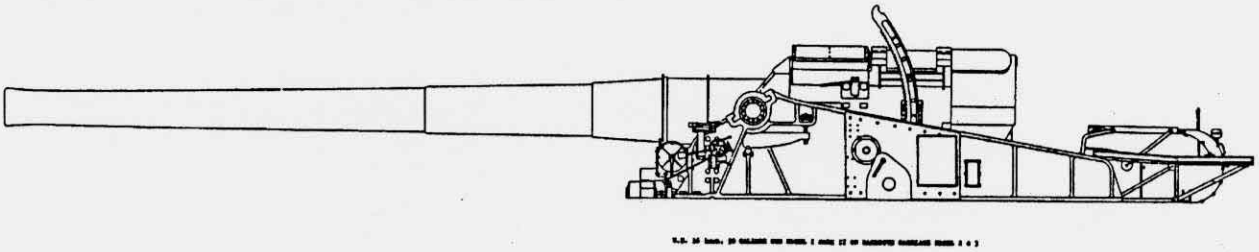
3 magazines as shown constructed
for 2 empl's of Battery Harris.

6c. Unprotected magazines for Battery Harris.

Several similar 16-inch gun batteries were built, Murray (begun in 1924) and Haan (1928) in Panama, and Hatch (1931) on Oahu. Battery Long, in Boston Harbor, was unique, built for 12-inch guns but armed with 16-inch guns. One change occurred as a result of the 1922 Washington Naval Treaty. Reductions in the number of warships left the U.S. Navy with surplus Mk. II 16-inch guns **[Fig. 7]**. Although virtually the same length as the army guns, they were lighter and somewhat less powerful, with a maximum range of some 45,000 yards with a 2,240-pound projectile. On the other hand, the built-up navy guns were more accurate than the wire-wound army models. The argument for economy was irresistible, and all future army 16-inch batteries would use navy guns on modified army carriages. The first to receive the navy guns was Battery Murray, then Haan and Hatch. With the completion of Battery Hatch in 1933, no other 16-inch batteries were under construction, but more barrels were available, and the army continued to review and update battery designs.(3)

16-inch Batteries for San Francisco

On April 11, 1924, Col. Herbert Deakyne, San Francisco district engineer, wrote Col. Percy P. Bishop, commanding the Coast Defenses of San Francisco, explaining that he had been directed to prepare plans and estimates for a battery of two 16-inch guns at San Francisco, based on Mimeograph No. 1 of 1923. The San Francisco 16-inch batteries were a much-diminished legacy of the proposals of the 1915 Board of Review **[Fig. 2]**. The open barbette emplacements would be at least 300 yards apart, with three service magazines, one



7. U.S. Navy Mk II 16-inch gun on army carriage.
Drawing by Robert D. Fritz©, used by permission of Peter Fransden

between the guns and one on each flank, at least 200 yards from the guns if possible. The three service magazines were to hold a total of 90 rounds; a reserve magazine would hold an additional 410 rounds.

Colonel Deakyne had been instructed that the battery would probably be located at Fort Miley. However, since the flank magazines were to be 2100 feet apart, and Fort Miley was only 980 feet wide, clearly the battery would have to go elsewhere. Deakyne recommended three sites further south, at or near Fort Funston, which he felt would be better tactical locations than Fort Miley in any event. All three sites were feasible, but the first two had no advantages that justified the expense of acquiring land off the Fort Funston reservation.

The guns were to be 356 yards apart, 100 yards behind the bluff bordering the shore, at an elevation of 180 feet. Rising ground behind the guns would prevent them from being silhouetted against the skyline. Although the carriages were capable of 7° depression, Deakyne proposed to grade the land in front of the guns only enough to allow zero elevation; the small decrease in the field of fire close to the battery would reduce the battery's exposure. Earthen traverses would screen the magazines from the sea. The bombproof powerhouse and plotting-switchboard room were to be about 150 and 130 yards behind the battery, respectively.

Deakyne proposed to store the reserve ammunition in abandoned batteries at Fort Winfield Scott and bring it approximately nine miles to the battery by motor truck. As an alternative, if Battery Walter Howe, the mortar battery at Fort Funston, was abandoned, some or all of the reserve ammunition for the 16-inch battery could be stored in Howe's magazines, although Deakyne did not recommend keeping it all there.

Deakyne asked the coast defense commander for his views as to whether the ground should be further graded to allow the guns to fire below zero elevation, and as to the location of the reserve ammunition. Bishop concurred in Deakyne's site and plans, and agreed that the reserve ammunition be kept at Fort Scott until such time as Battery Howe might be abandoned, at which time funding could be requested for new arrangements.

A copy of this correspondence, with the accompanying mimeograph, was forwarded to Brig. Gen. Henry D. Todd, commander of the 9th Coast Artillery District. On June 23, 1924, Todd objected to the absence of a latrine at the left gun, and pressed for backup electrical power, either independent units or connection to the city mains. Todd must have gotten the attention of the engineers, however, when he insisted that "Overhead protection to magazines is essential. . . Walls of service magazines, as designed, could not support sand bag cover placed by troops." In short, Todd rejected the whole concept of dispersal that the branch chiefs had agreed on. The file contains no record of any reply to Todd.(4)

On January 12, 1927, Maj. John W. Schulz, now the district engineer, wrote Col. William F. Hase, commander of the Harbor Defenses of San Francisco. He forwarded correspondence from the chief of engineers, with associated indorsements and attachments, including a map of Fort Funston with positions for two 2-gun 16-inch batteries. The question was whether to build both batteries at or near Fort Funston or build one at Funston and one north of the Golden Gate.

Schulz reviewed the advantages and disadvantages of each course of action. Separating the batteries would decrease the likelihood that all four guns would be destroyed or neutralized by gas and provide greater flexibility in the event of fog, which plagues San Francisco much of the year. On the other hand, the terrain north and west of Fort Barry was unsuitable, the cost for land would be higher, and the location was remote. In addition, placing all four guns at Fort Funston would simplify some of the support services and allow all four guns to be directed as one battery if desired. Further, the southern site would offer more protection for the naval facilities concentrated in San Francisco Bay south of the city. Schulz recommended emplacing both batteries south of the Golden Gate, and requested the harbor defense commander's comments and recommendations.

On July 30, 1927, Colonel Hase wrote his superior, Col. Laurence C. Brown, commander of the 9th Coast Artillery District. Hase had visited all the locations listed by Colonel Schulz, and had concluded that tactical considerations outweighed all others. "The 4-16" guns in the San Francisco project should be emplaced where their full fire power may be developed over the water areas from which hostile naval vessels may attempt to contest the defense." To Hase, this meant one battery at Fort Funston and one at Fort Barry, north of the Golden Gate. If that location for the northern battery should prove too restricted, a site south of Tennessee Point could be purchased at nominal cost. A recent issue of the *Naval Intelligence Bulletin* stated that the new *Lord Nelson* class of battleships would be able to fire 49,000 yards. Since the seacoast batteries were to be limited to 44,600 yards, it was vital to place the batteries so as to prevent hostile warships from bombarding the forts and naval bases from beyond the reach of the coast artillery.

As a final thought, Hase recommended emplacing two 6-inch barbette guns at Fort Funston. He felt 155 mm GPF guns were unsuitable for use against rapidly moving targets.

On August 13, 1927, Colonel Brown added his indorsement. Guns at Fort Funston could adequately protect the shore establishments and naval elements within the bay, but batteries on either side of the Golden Gate would be required to support the fleet entering or debouching from the Golden Gate.

The next indorsement was from Col. Thomas H. Jackson, the next district engineer. Jackson submitted his plans for the northern battery, based on his inspection with Colonels Hase and Brown. The site was on Tennessee Point, with guns 315 yards apart at elevations of 195 and 255 feet. Two magazines would serve each gun, with powerhouse and plotting-switchboard rooms located behind the 420-foot hill. The land was expected to cost $400 an acre. Two days later, Colonel Brown concurred.

Three days after this Jackson wrote the chief of engineers submitting the locations agreed upon with the coast artillery, and explained that considering the increased range of naval guns, placing all four guns at Fort Funston was undesirable. The chief of engineers, in turn recommended the matter be referred to the commanding general of the 9th Corps Area for his remarks and recommendations.

Meanwhile, Gen. Andrew Hero, chief of coast artillery, added a few thoughts of his own. Without making a definite recommendation, he pointed out that the proposed navy yard at Alameda would be on a level with Fort Funston, which would therefore be the best location for guns to protect it. A landing south of the Golden Gate would be much more likely than north of it, making bombardment from the south also more probable. Fire control would be simpler if the guns were together, as well as avoiding the need to purchase land and to construct separate powerhouses and switchboard rooms. The Tennessee Point site was inaccessible, increasing the cost of construction and maintenance, and Hero believed that due consideration had not been given to the mountains north of the Golden Gate, which offered some protection from naval fire. Lastly, the reported range of the guns of the new battleships was an error. The navy now indicated that the ships would have no greater range than the coast defenses guns.

On July 9, 1928, the War Plans Division noted that the commander of the 9th Corps Area, the chief of engineers, and the chief of coast artillery, "as a result of much correspondence," now all agreed on one battery at Fort Funston and one at Tennessee Point. The WPD concurred and recommended approval, estimating the cost of the two batteries at $775,000 for ordnance, $1,675,000 for engineer, and $430,000 for fire control, a total of $2,880,000. Ten days later the WPD informed the adjutant general that the secretary of war had approved the recommendation.

The Office of the Chief of Engineers submitted a memorandum in reference to the Fort Funston battery with the October 1, 1928, indorsement. The elimination of the second battery at Funston would allow space to store all 500 rounds on the reservation, so eight magazines were proposed, four of which were to be service magazines. The protected power plant would house three Diesel generating sets, one stand-by 25 kW gasoline set, and a compressor to furnish compressed air for the carriages. If the main power plant were to generate direct current, power for lighting the storage magazines would be provided by a 5 kW gasoline set located in a bombproof near magazine No. 7. The question of AC or DC power was unsettled, but the Ordnance Department had been requested to provide AC motors for the guns. If this were done, the main power plant would be AC, with transformers at service points. If the motors were DC, the Ordnance Department had been requested to wire them for 220 volts, and a decision as to the details of the generating plant would be postponed.

The trackage design for the Tennessee Point battery was not viewed with favor; a less complicated layout was preferred, in addition to increasing the number of magazines from four to eight. Further, locating the battery several hundred feet higher would greatly reduce the ability of an enemy to range on the battery by observing "shorts and overs."(5)

On March 29, 1929, Maj. Elihu H. Ropes, the district engineer, wrote the chief of engineers suggesting the position recommended by the chief of engineers for the Funston battery be changed. Ropes recommended minor changes in the location of the No. 1 gun, increasing the distance between the guns and providing a better arrangement of the magazines. Ropes also requested information as to the type and size of the power units to be supplied.

Lt. Col. Robert Ralston, chief of the Military Division of the Corps of Engineers, replied to Ropes on July 23, 1929. He enclosed a map of the approved layout of the battery, which relocated magazines 1 and 3. He also informed him that the protected power plant was to house three 100 kW, 125-volt DC Diesel generating sets and one 25 kW DC gasoline set, with space for a possible future 25 kW DC-AC motor-generator set. Ralston requested Ropes prepare a detailed layout plan and cost estimates.(6)

The Office of the Chief of Engineers distributed "Circular Letter (Forts No. 6)" to division, district, and corps-area engineers in charge of fortification work on December 19, 1932. It set forth the principles to be observed in the design and layout of batteries:

1. Protection, wherever possible, by concealment.
2. Dispersal to minimize the effects of hostile fire.
3. Duplication to minimize the danger of crucial elements being put out of action.

Guns were to have all-around fire and maximum range, with no physical protection for the gun. Plotting and switchboard rooms were to be protected and gas-proof.

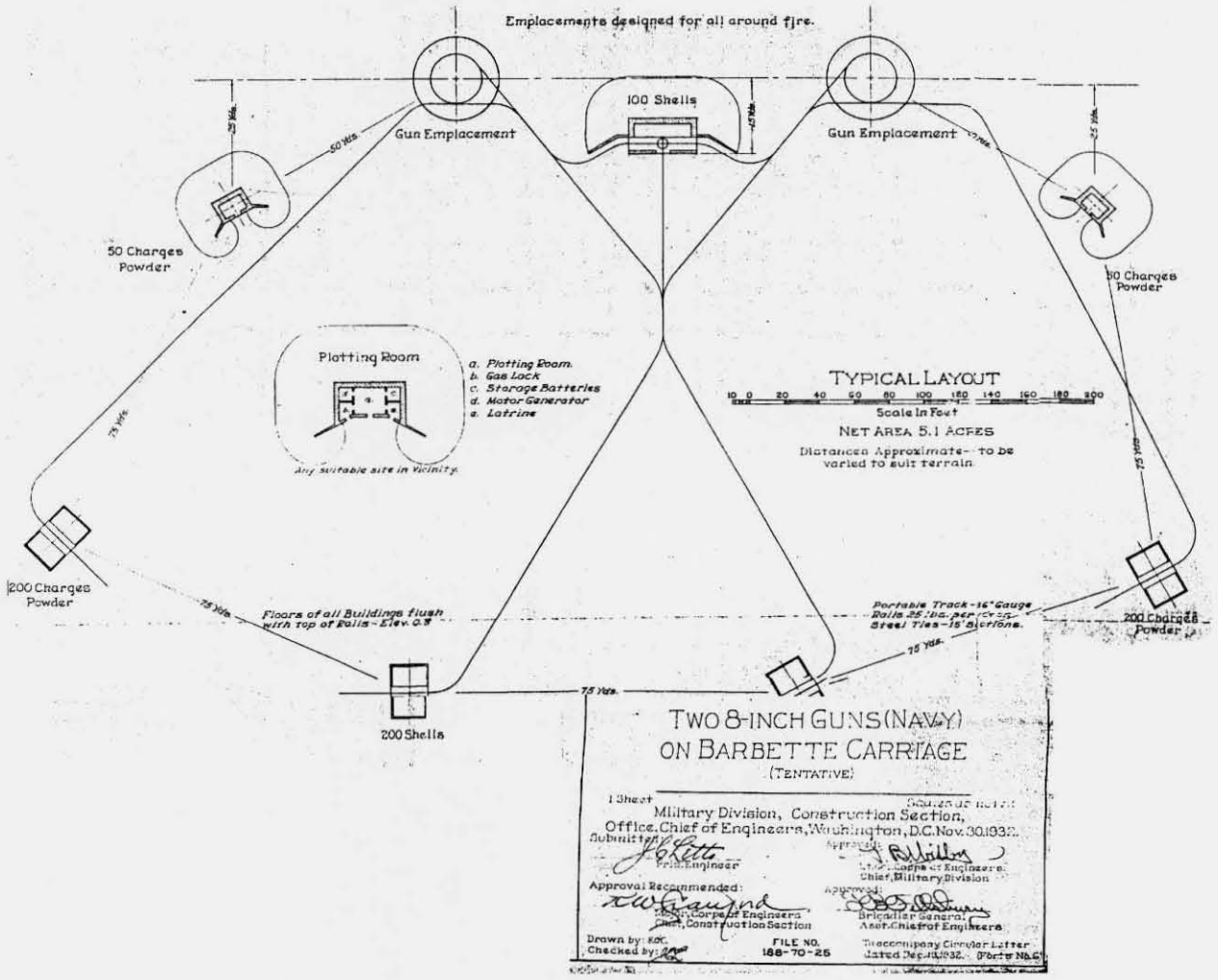
To minimize the effect of naval gunfire, dispersion should be lateral rather than in depth. To minimize the effectiveness of aerial attack, no three elements should be sited in a straight line. Grouping facilities under one roof should be avoided, while power plants could be in either a single protected structure or in dispersed unprotected structures.(7)

Protected Magazines

Strangely enough, the chain of events that disrupted the agreement on the layout of the new batteries was caused by the availability of surplus navy 8-inch guns for coast defense, due to the same Washington Naval Treaty. In an era of severely limited military funding, the army was expected to use the surplus 8-inch guns, like the Mk II 16-inch guns, rather than construct new weapons. On December 6, 1932, the chief of engineers submitted a planned layout for a dispersed 2-gun battery of 8-inch guns. The plan called for splinter-proof magazines for 50 rounds per gun in the vicinity of the guns, and essentially unprotected storage for an additional 200 rounds per gun. Ammunition service would be by push car along a narrow gauge track. Only the plotting-switchboard room would be bombproofed, as no power plant was contemplated. Two days later, the chief of coast artillery concurred. **[Fig. 8]**

The chief of ordnance concurred on December 21, 1932, with several reservations. A 100-round magazine placed between the guns would protect each gun from the accidental fire of the other. In addition, he opposed delivering ammunition by rail. On December 29 the chief of engineers explained that locating the guns and magazine in a line would make them a more ideal bombing target. Similarly, rail was thought to be less conspicuous than pavement, but if push cars were to be run onto the rotating carriage platform, it would clearly be impractical to use track. The chief of engineers emphasized that the plan was only tentative, intended primarily as a guide for siting the batteries and preparing estimates. The details would be subject to further modification. With these assurances, the chief of ordnance concurred on January 6, 1933.(8)

Army Regulations No. 100-20, dated August 26, 1932, continued to direct the War Plans Division of the General Staff to "consider the subject of defense in its broadest sense," and "state the definite mission of each element and such general principles as will enable the arms and services to accomplish their specific missions." On January 26, 1933, the War Plans Division reviewed the layout for the 8-inch batteries submitted by the chief of engineers, noting that the chiefs of coast artillery and ordnance had concurred, and that several batteries of this general dispersed type had been constructed at Fort Story, Oahu, Panama, and elsewhere. However, Brig. Gen. Charles E. Kilbourne, assistant chief of staff, War Plans Division, did not agree. He recommended that the plans be returned, through the president of the Harbor Defense Board, to be reconsidered with a view toward providing "positive



8. Proposed Type A 8-inch battery, 1932.

protection" to both the plotting room and the ammunition. The layout used for the 12-inch long-range batteries would enable the battery to remain in service longer if attacked. No specific reference to aerial attack was made.

Two days later, Maj. Gen. George V.H. Moseley, deputy chief of staff, replied that the 8-inch batteries were largely intended to take the place of railway guns for locations railway guns could not reach or for which the guns were not available. "History shows very clearly that if these batteries are to be subjected to navy gun fire only, the personnel may be considered safe." He therefore recommended against any outlay of funds to accomplish the WPD recommendations.

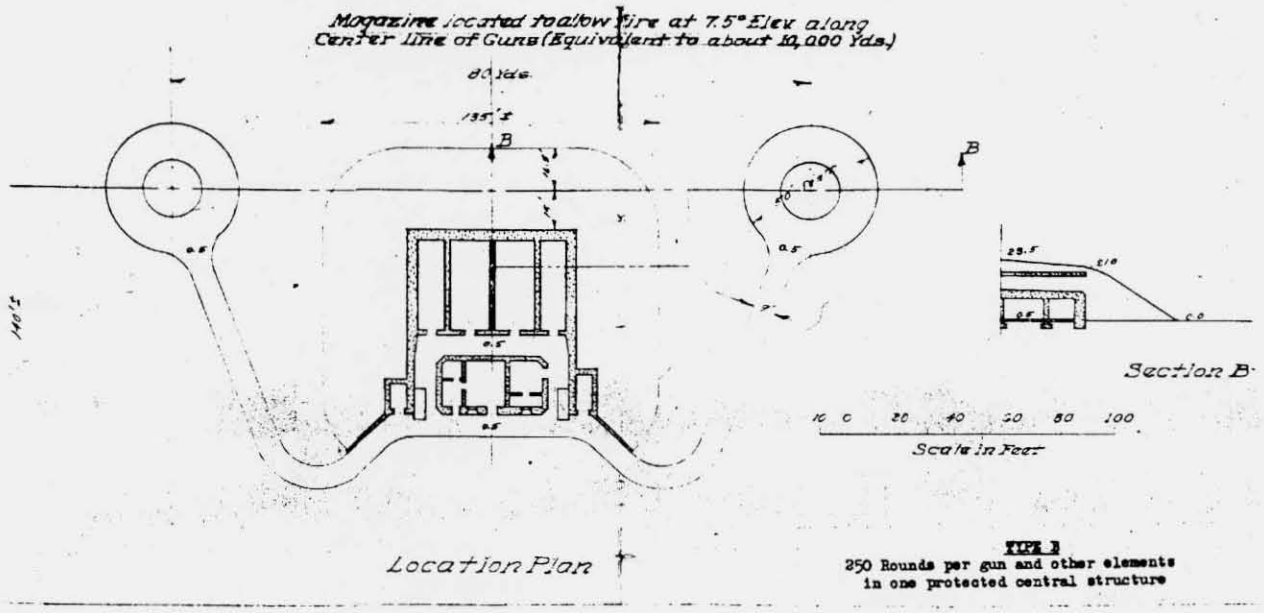
General Kilbourne, a former executive in the Office of the Chief of Coast Artillery, was undeterred, replying even more strongly two days later. When occupying a permanent position, "we should not deliberately accept avoidable disadvantages." Scattering batteries for dispersion was sound, but scattering parts of a battery merely enlarged the target. While it reduced the effect of any single hit, it increased the probability of such a hit, whether from naval or air attack. Kilbourne said that when he first saw the layout of the 16-inch howitzer battery at Fort Story, he was shocked. "I could not see how the 16-inch howitzers could continue in action. It was possible but hardly probable that all of the magazines would last

through a bombardment. If men in some of those powder magazines saw others being blown up, they might stand by and they might not." (Emphasis in the original.) Kilbourne thought it even less likely that the ammunition service tracks would survive, and urged some ammunition be kept at the guns, since returning fire was important for morale. He even went so far as to fly over the fort above the range of antiaircraft guns and take photos that showed the battery to be an ideal target. "I am convinced that the entire conception is seriously faulty."

The battery should provide "positive protection" to the plotting room and enough ammunition to last through a single engagement. Where the remainder of the ammunition was kept was a matter of convenience. Kilbourne was adamant. He referred to previous disputes over disappearing carriages, implying that he had objected to them also. He further noted that he would also be constrained to recommend disapproval of another plan, for Battery Williston, on Oahu [he may have meant Battery Hatch].(9)

The chief of engineers, in response to Kilbourne's memoranda, submitted a layout for the 8-inch batteries providing "positive protection," interpreted to mean protection against 8-inch projectiles and 500-pound bombs. The original, dispersed plan, now designated "Type A," provided magazines protecting 50 rounds per gun against 6-inch projectiles, while 200 rounds per gun remained unprotected. The new plan, "Type B," provided positive protection for 250 rounds per gun and for other elements in one central structure between the guns. The chief of engineers recommended Type B as the type plan for 8-inch navy guns where sites demanded heavy protection **[Fig. 9]**.(10)

Meanwhile, the Coast Artillery Board recommended to the chief of coast artillery on April 17, 1933, that the "Type A" (dispersed) battery, being greatly enlarged, would be more likely to sustain some damage from each enemy salvo or bombing attack. In addition, like General Kilbourne, they believed it unlikely the trackage would survive unscathed. Consequently, they recommended "Type B," the plan used for the 12-inch long-range batteries and for Battery Long, but with the plotting room removed from the magazine structure to a separate location, where it would be unaffected by the noise of the guns, power plant, and

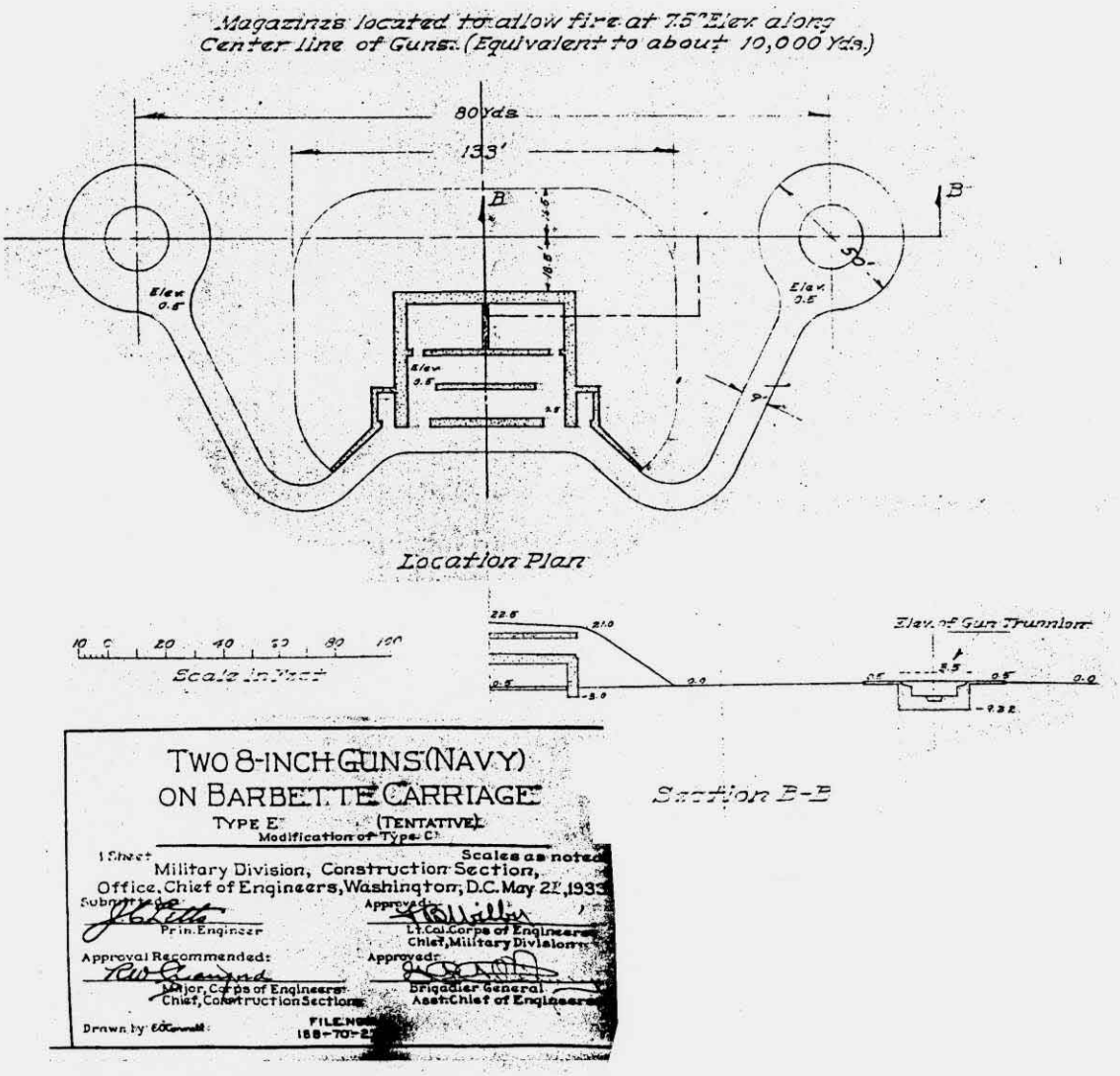


9. Proposed Type B 8-inch battery, 1933.

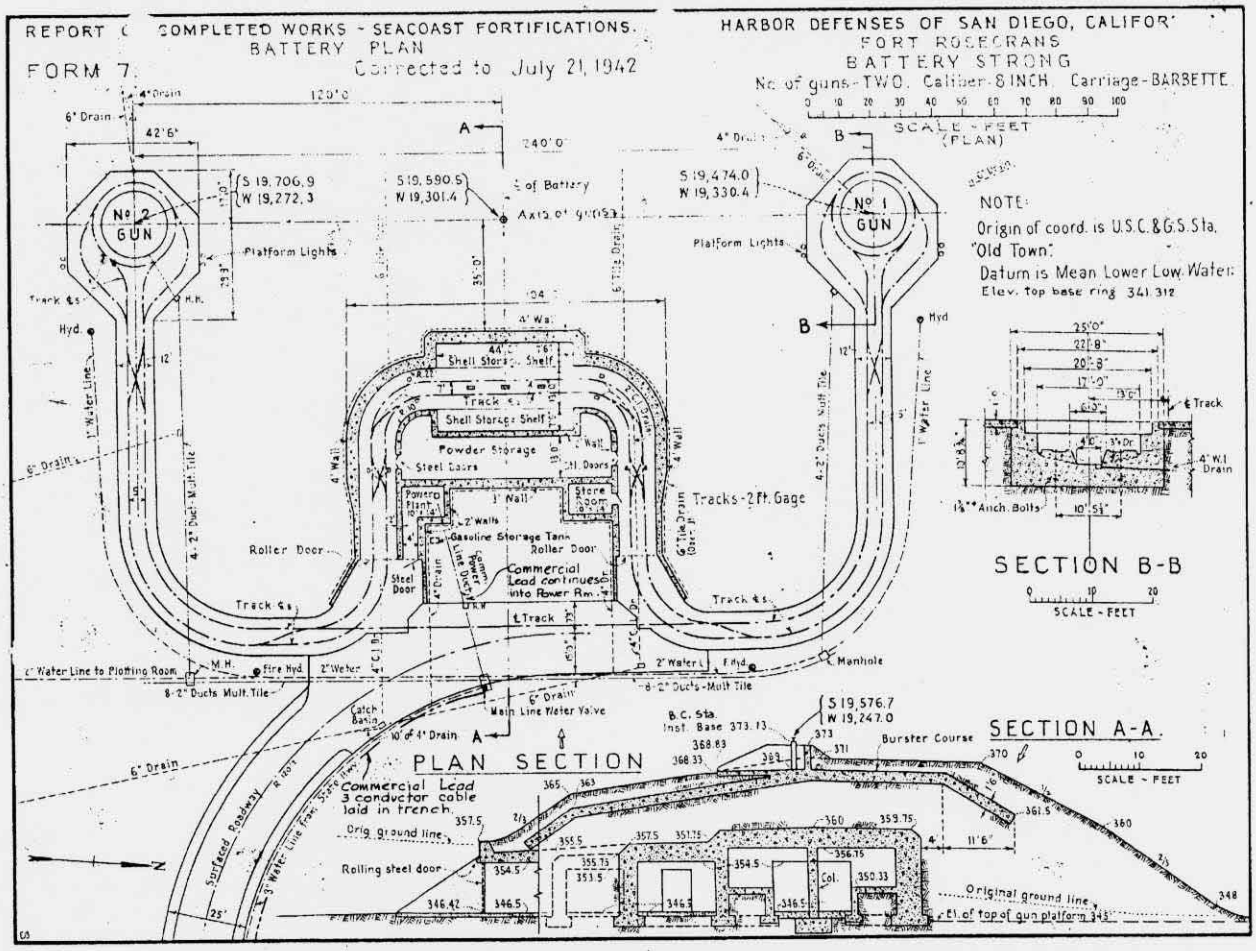
ammunition service. A position on either flank would be safer than one behind the magazine, as gunfire always had greater dispersion in range than azimuth.

The chief of coast artillery, in his April 24, 1933, indorsement on the chief of engineer's plans, echoed the Coast Artillery Board. He approved the Type B plans, with the proviso that the type plan should not be made mandatory in all its details at every site, and recommended that the plotting room be displaced as the board had recommended.

The chief of the Military Division of the Corps of Engineers, through his chief, submitted a plan labeled "Type E," on May 29, 1933. Type E was Type B with the plotting room in a detached structure, and the power plant removed from the central magazine, since the need for electricity was minimal anyway. "Where latrines for officers and enlisted personnel are necessary," it was recommended that separate structures be built. The chief of coast artillery approved Type E on May 31, 1933, and on June 7, the War Plans Division recommended approval, noting that Type E was expected to cost $107,000, the same as Type B, and only $15,000 more than Type A. By order of the secretary of war, the adjutant general announced approval of Type E on June 14. **[Figs. 10 & 11]**(11)



10. Proposed Type E 8-inch battery, 1933.

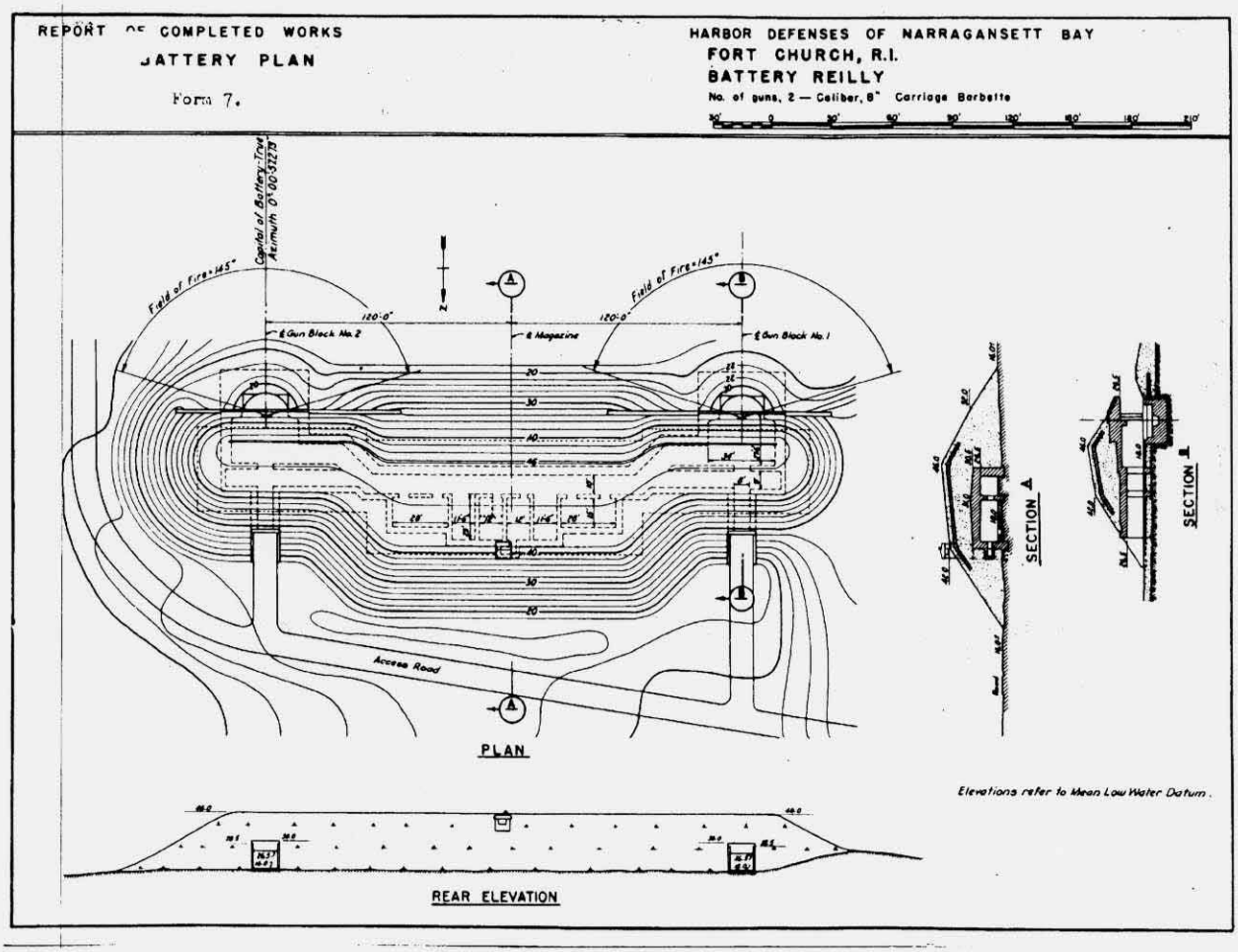


11. Battery Strong, an 8-inch barbette battery with unprotected guns, was begun in 1937 at Fort Rosecrans, HD of San Diego. A separate powerhouse was built.

On May 22, 1933, while the 8-inch batteries were being discussed, Gen. Malin Craig, commanding the 9th Corps Area, generally approved the layout for the Fort Funston 16-inch battery submitted by the district engineer, which seemed to him as good as the topography and constricted site would allow, but he still suggested some modest changes in the location of a few of the magazines to better isolate them from the public highway and lessen the conflict with Technical Regulation 1370-A, which established the minimum distance between the reservation boundary and the magazines. To the extent that the regulations could not be complied with due to the smallness of the reservation, Craig requested that they be waived.

With respect to the battery at Tennessee Point, Craig essentially concurred with the local board of officers, recommending a bombproof service magazine tunneled into Wolf Ridge and two unprotected reserve magazines for each gun on the north, or reverse slope of the ridge, in contrast to the chief of engineers' proposal for unprotected magazines.

On June 16, 1933, the War Plans Division analyzed the plans for the two San Francisco batteries. General Craig had modified the layout for the Funston battery, but the chief of engineers now proposed to build a protected service magazine for 250 rounds of ammunition. The chief of coast artillery concurred, and the WPD agreed. The small size of the reservation made the usual dispersed magazines impractical, and the importance of the battery meant the magazines should be as close to the guns as possible, to minimize disruptions



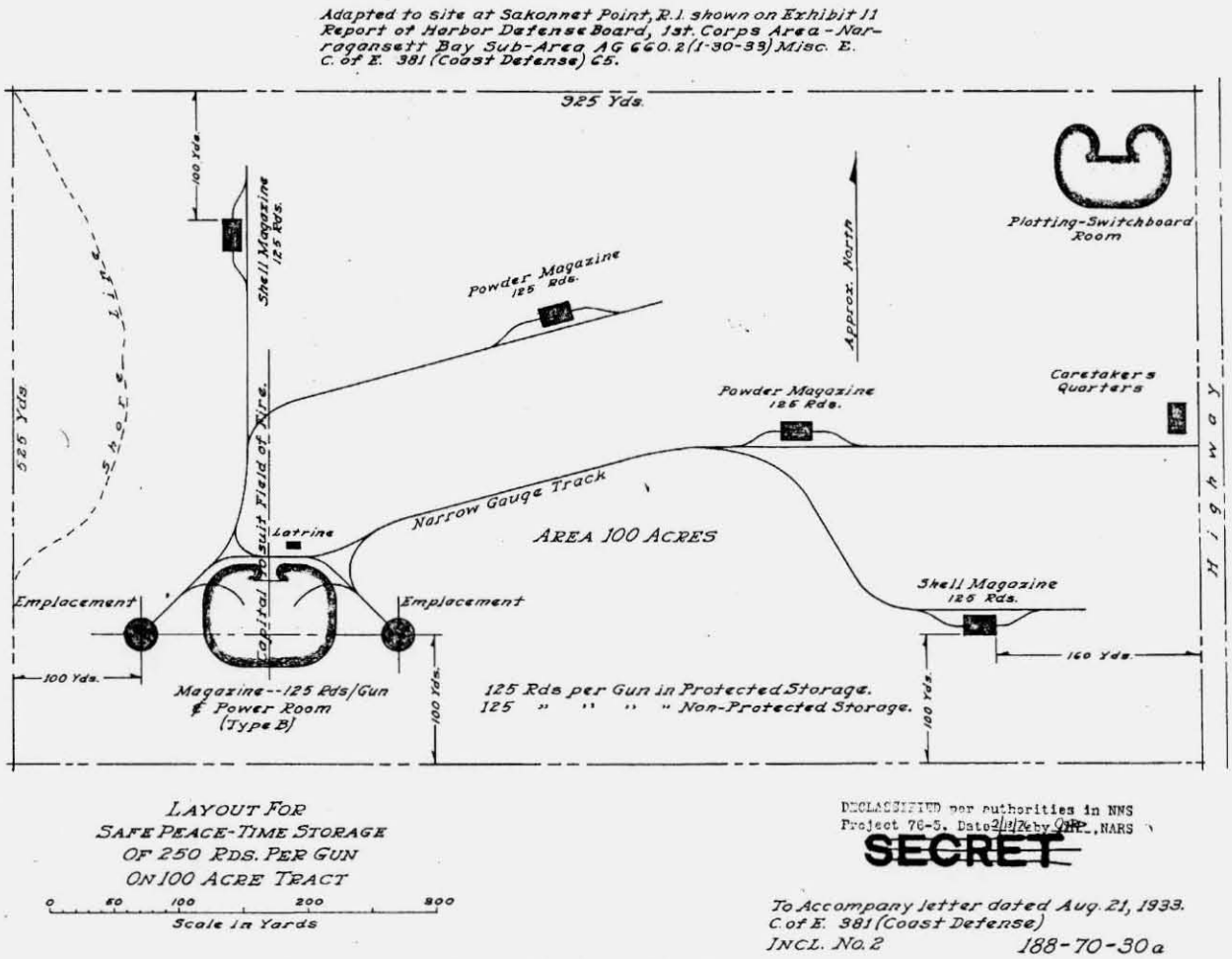
12. Battery Reilly, 8-inch casemated battery, was built in 1941 at Fort Church, HD of Narragansett Bay.

in the ammunition service. This closeness, however, required that the service magazines be bombproof. The remaining 250 rounds of reserve ammunition could probably best be stored off the reservation.**[Fig. 13]**

For the Tennessee Point battery, the War Plans Division concurred with General Craig's recommendation, and recommended authorizing the chief of engineers to begin purchasing land for the battery. The WPD's recommendations were approved.(12)

During the summer of 1933 Major Dabney Elliot, on temporary duty with the Construction Section of the Corps of Engineers, prepared a study of the San Francisco batteries, only the first two pages of which are in the archives. The commanding general of the 9th Corps Area had recommended relocating the unprotected magazines at the Funston battery further from the state highway at the rear of the reservation and constructing embankments between certain magazines and the highway. Elliot had no objections to this proposal, but noted he believed the chief of coast artillery and the WPD now favored protected magazines.

For Tennessee Point, the district engineer submitted five magazine layouts: one layout for dispersed unprotected magazines, two layouts for dispersed protected magazines, and two layouts incorporating protected central magazines. General Craig had suggested a centralized service magazine and dispersed unprotected reserve magazines. The district engineer thought dispersal was a substitute for protection, and if the magazines were protected, they should be concentrated near the guns.(13)



13. Proposed layout for Type B 16-inch battery, 1933.

While San Francisco had the highest priority, policy decisions on battery designs also affected planning elsewhere. On August 28, 1933, the commanding general, First Corps Area, was advised that sites for 16-inch (and 14-inch) batteries in the Harbor Defenses of Narragansett Bay should be based on a tentative layout, not yet approved, with a bombproof plotting room and a bombproof magazine for that portion of the battle allowance stored at the battery. The remainder of the ammunition would be stored where it would not be subject to fire directed at other defense installations.(14)

On November 6, 1933, the War Plans Division proposed a revision of the *Coast Artillery Field Manual*, which ordained dispersion in lieu of bombproofing. The WPD objected to the present manual for several reasons:

1. The lack of protection for the guns.
2. Separating the guns complicated the fire control.
3. The magazines, like the guns, were unprotected.
4. The lengthy ammunition service was also unprotected.

The WPD vigorously attacked the assumptions on which the dispersion was based. First, "dispersion in itself does not provide protection; it merely limits the number of personnel or the amount of materiel effected by a single effective hit." (Emphasis in the original.) Further, with the current system of labor employed in building the batteries, and the admission of the

public to the forts, there was no reason to expect that the location of the batteries would remain a secret from any nation willing to make the effort to find them.

European nations generally employed shields or turrets to protect their most important seacoast guns. Further, there was no reason to assume that the hastily trained levies that would be the mainstay of any wartime defense would continue to work in unprotected magazines after other magazines had been destroyed.

Reviewing the options, the WPD recommended:

1. Protected magazines containing enough ammunition for one hour at the normal rate of fire.
2. Minimum exposure of the ammunition service.
3. Protection for power plants and plotting rooms.
4. Splinter-proof shields to protect gun crews.
5. Minimum distance between guns, consistent with the above.

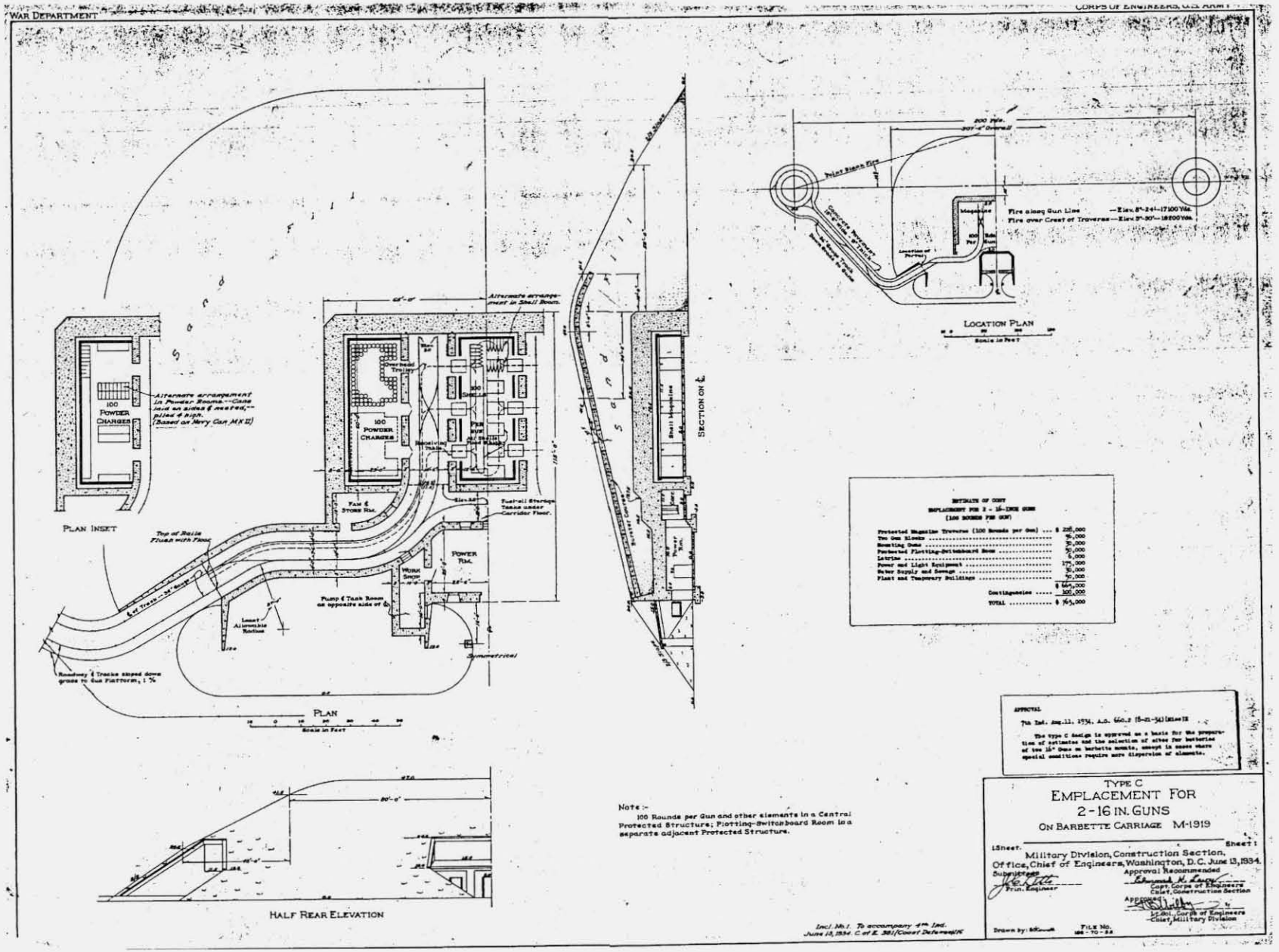
Maj. Gen. John W. Gulick, chief of coast artillery, replied first, on December 8, 1933. He felt that the whole subject was inappropriate for a field manual, which should be limited to "principles, doctrines, and methods governing the employment of the arms and pertinent reference data." He also objected to limiting the ready ammunition to that needed for one hour, since individual situations would vary, and in some instances provision of more ammunition might entail little additional expense.

Capt. Edmond H. Levy, chief of the Construction Division, wrote the chief of engineers on December 22, 1933, and in more detail on January 4, 1934. He explained that while the Type A (dispersed) battery was cheaper to build ($700,000, excluding cost of land and rights-of-way), it required more land. Where land was plentiful and cheap, Type A batteries were appropriate. Where land was restricted or expensive, Type B (bombproof switchboard-plotting room, power plant, and magazine for 125 rounds per gun at the battery, with dispersed, unprotected reserve magazines for another 125 rounds per gun) was to be preferred.

Land requirements for the various layouts varied widely. A completely concentrated battery (Battery Long) only required 8.55 acres, while a completely dispersed battery (Battery Haan) required 531 acres. Type B and Type C semi-centralized batteries (Type C was similar to Type B, but with a second bombproof magazine for 125 rounds per gun in place of the dispersed, unprotected reserve magazines **[Fig. 14]**) were estimated at 120 and 50 acres, respectively. The cost of land also varied widely, from an estimated $125 per acre at Sakonnet Point to $6,000 per acre for Fort Tilden.

Captain Levy saw General Kilbourne, of the War Plans Division, as preferring the Battery Long type, strengthened and spread out, with Type C as an alternative. Levy was of the opinion that the advantages offered by the concentrated, protected design-better control, better ammunition service, greater protection for personnel, and better morale-should outweigh any small differences in cost, but where the dispersed layout was substantially cheaper than the concentrated type, economy would require the dispersed layout.(15)

On January 31, 1934, Maj. Gen. Edward M. Markham, chief of engineers, wrote the War Plans Division, comparing the completely dispersed and the completely concentrated layouts. The cost of the concentrated battery was estimated at $976,000, exclusive of land and rights-of-way, while the dispersed layout, with unprotected magazines and power plants, was



14. Proposed layout for Type C for 16-inch battery, 1934.

estimated to cost $700,000. Interestingly, Markham gave the cost for land at Fort Tilden as $2,263 per acre, much less than the $6,000 per acre given by Captain Levy.

Reviewing the question of naval versus land artillery, Markham disagreed with the WPD, concluding that the advantages continued to lie with the land-based guns even if unprotected, but "the principal danger to land batteries is from aerial bombardment and not from naval gunfire."

Echoing Captain Levy, General Markham concluded that the advantages offered by the concentrated, protected design outweighed small differences in cost, but economy required the dispersed layout where it was substantially cheaper. The *Coast Artillery Field Manual*, Volume 1, Part I, therefore, should reflect this policy.

On March 19, 1934, the chief of ordnance, Maj. Gen. Samuel Hof, concurred with the War Plans Division's November 6, 1933, memorandum, as amended by the chief of coast artillery on December 8, with the exception of the splinter-proof shields. General Hof explained that these had been considered and even tried in the past. Armor heavy enough to provide real protection was so heavy that it was difficult to mount on the carriages. It endangered the carriage if supported rigidly, and if not, it vibrated when the gun was fired. In addition, if struck, the armor became the source of flying debris that threatened the crew and carriage. Hof therefore recommended that the proposed change to the *Coast Artillery Field Manual* dealing with shields be omitted.

On March 30, 1934, the Operations and Training (G-3) Division of the General Staff suggested that the *Coast Artillery Field Manual* should outline the advantages and disadvantages of the different methods of protection, without deciding the extent to which any method should be employed. They further suggested an informal conference between the arms and services involved to arrive at an agreement.

On April 17, 1934, the Supply (G-4) Division of the General Staff agreed with the G-3. While generally preferring the concentrated to the dispersed layout, the G-4 emphasized the importance of local conditions. The G-4 also noted that the approved plans for 8-inch batteries now called for central protected magazines, Type E, with detached plotting rooms.(16)

The War Plans Division summed up the entire drawn-out debate over the *Coast Artillery Field Manual* in August 1934, recommending against the conference recommended by the G-3, and repeating the recommendations contained in the memorandum of November 6, 1934. The only noteworthy changes were the deletion of the splinter-proof shields and the removal of the plotting room from the central magazine.

Major General Hase, chief of coast artillery, concurred, but recommended that up to two hours worth of ammunition be stored in the protected magazines, if there was no suitable unprotected location nearby to store the ammunition for the second hour.(17)

The general plan for the Fort Funston battery had appeared settled. After all, the adjutant general, on January 30, 1933, had approved plans for both the Funston and Tennessee Point batteries. On January 15, 1935, however, the district engineer, Lt. Col. Henry E. Finch, wrote the commanding general of the 9th Corps Area that he was preparing the detailed plans for these batteries when his office was "notified unofficially that the dispersion principle under which the tentative layouts of the two batteries had been prepared had been abandoned by the various branches concerned, and that a concentrated form of battery layout would be substituted." The two most significant changes were the provision of a bombproof combined central magazine and the reduction of the distance between the guns to 200 yards.

After six months study and work, Finch now submitted his new recommendations for the Funston battery. Gun No. 1 remained unmoved, while gun No. 2 was shifted closer to gun No. 1. The guns were now to be 239 yards apart. Any closer spacing would reduce the field of fire of the battery. A central bombproof magazine provided 100 rounds per gun. Since the ground sloped up from the rear of the magazine, there was no rearward entrance, but the entrances recommended would not be subject to enfilading fire. Reserve ammunition could be stored in old magazines on the Presidio, as Colonel Deakyne had recommended nine years earlier.

The powerhouse was located immediately in the rear of the magazine, in accordance with what was termed "Type C" [guns 200 yards apart, with a bombproof central service magazine]. Ducts in the radiator room would ventilate the magazine. The plotting and switchboard rooms would be located behind Hill 221, 190 yards from the magazine's north portal.

Finch estimated the cost of the battery at $695,000, including $240,000 for the protected magazine, $39,000 for the plotting/switchboard rooms (not including air conditioning and other equipment), and $58,000 for the gun blocks.

On February 21, 1935, Finch submitted a similar letter in reference to the Tennessee Point battery. He recommended the battery be at the 353-foot level, with 268 yards between the guns. The ground allowed the magazine to be built with an open back, simplifying ventilation. The plotting/switchboard rooms were to be at an elevation of 260 feet, in a ravine about 100 yards from the magazine.

The estimate for the Tennessee Point battery was $950,000, including $128,000 for excavation, $235,000 for the magazine, $44,000 for the plotting/switchboard rooms, and $90,000 for the gun blocks. The cost of the land was estimated at an additional $319,000, bringing the entire total to nearly $1,270,000.

Meanwhile, the chief of the Military Division informed the district engineer that emergency relief funds would probably become available for the construction of the two 16-inch batteries.(18)

On March 2, 1935, the chief of engineers again addressed the storage of ammunition at Fort Funston with respect to T.R. 1370-A, which required a minimum of 200 yards between a "barricaded" magazine and the nearest highway or building. The nearest magazine was only 315 feet from the edge of the reservation, so ammunition could not be properly stored there in peacetime. The chief of engineers proposed to move the battery about 250 yards northwest. The location for the No. 1 gun would then become the location for the No. 2 gun. The elevation of the guns and their field of fire would remain unchanged. The layout would be Type C, with a central bombproof magazine. The chief of ordnance indorsed the plan with respect to the storage of explosives.(19)

On April 3, 1935, the secretary of war approved the location, plans, and cost estimate of the Fort Funston battery, subject to the agreement of the commanding general of the 9th Corps Area. The layout was Type C, and the total cost for Engineer Department work had risen to $750,000.

In reply, the 9th Corps Area noted that the location had been shifted to guard against possible erosion of the cliffs in front of the battery, the No. 2 gun going where the old No. 1 had been planned.(20)

There was now agreement that the batteries should be constructed with unprotected guns and a central bombproof magazine, similar to the World War I vintage 12-inch batteries.

Proposed Battery Layouts For Unprotected Barbette Guns

All plotting rooms bombproof

Eight-Inch Batteries

Type	Svc. Mag.	Res. Mag.	Power	Plotting	Date
A	SP-D	C-UP	none	S	Proposed CoE 1932
B	C-P	D-UP	none	C	Proposed CoE 1933
E	C-P	UP	none	S	Approved 1933

Sixteen-Inch Batteries

Type	Svc. Mag	Res. Mag	Power	Plotting	Date
A	D-UP	D-UP	D or P	S	Approved 1920, 1923
B	C-P	D-UP	C-P	S	
C	C-P	C-P	C-P	S	Approved 1935

C-Combined **D**-Dispersed **P**-Protected **S**-Separate **Res. Mag.**-Reserve magazine
SP-Splinterproof **Svc. Mag.**-Service magazine **UP**-Unprotected

The Chief of Coast Artillery Proposes Turrets

On April 19, 1935, however, the new agreement began to come unraveled when Lt. Col. Henry T. Burgin, acting chief of coast artillery, told the adjutant general "serious doubt arises, in view of modern developments in warfare, as to whether the open type of emplacement as shown in the enclosures is suitable. Considering attack by ships' gunfire alone, the proposed type of emplacement is satisfactory. Considering attack from the air, the emplacement is certainly not satisfactory." Turrets would protect the battery from both naval and air attack, and Burgin recommended new studies on the proper type of emplacement for the San Francisco batteries, to include cost estimates for turrets.

Meanwhile, the chief of engineers proposed leaving the magazine for the Funston battery as suggested, but moving the No. 1 gun about 50 feet and the No. 2 gun approximately 200 feet. Col. George A. Wildrick, then acting chief of coast artillery, replied on April 30 that if a Type C emplacement was to be built at Fort Funston, the chief of engineer's plans were fine. However, Wildrick referred the adjutant general to the April 19, 1935, indorsement by the Office of the Chief of Coast Artillery, which applied as much to the Funston battery as to Tennessee Point.

The chief of ordnance reported on June 27, 1935, that his department had no design for a 16-inch turret, but he recommended consideration of the 3-gun navy turret, which would allow a maximum elevation of 40°. Based on figures from the navy, a completed turret with guns and armor was estimated to cost $1,250,000. No data was available as to its resistance to a direct bomb hit. The 3-gun turret had 8 inches of roof armor supported on structural framing, and presented a horizontal target only 50% larger than a single barbette carriage.(21)

By July, the adjutant general had requested the views of the bureau chiefs on turrets for Fort Funston and Tennessee Point. The chief of engineers noted that two complete and four partially complete 16-inch barbette carriages were available. If the completed carriages were used, with available navy guns, the turret emplacement for Funston would cost $2,487,500; $1,737,500 more than the Type C emplacement. Using two of the partially completed car-

riages would increase the cost for the Type C emplacement by $200,000, the amount necessary to complete the carriages. In view of the cost, the chief of engineers recommended Type C emplacements, as already approved.

On August 5, 1935, the Coast Artillery Board evaluated four types of 16-inch emplacements:

a. Dispersed, unprotected magazines, with guns at least 300 yards apart.
b. Type C, with a bombproof central service magazine and guns 200 yards apart or closer.
c. Type C, with a 1-inch splinter-proof shield enclosing the top carriage, breech, and essential parts of the racer, providing both overhead and all-around cover.
d. Turrets similar to 2-gun naval turrets. Ammunition supplied from bombproof underground magazines beneath the turret.

The advantages and disadvantages of these four designs were carefully weighed. In terms of simplicity, which was desirable, the four types ranged as given, from least to most complex. The turret was the only type in which any action disabling one gun would likely disable the other. Only the dispersed type could continue in action if a magazine was destroyed.

Simplicity, however, was weighed against vulnerability. The board did not believe seacoast works would be attacked in the future by naval gunfire alone. The "ability of a seacoast battery to withstand aerial and chemical attack will be the deciding factor in selecting the most desirable type."

While the turret had superior resistance to naval gunfire, the board, as noted, did not consider unsupported naval attack likely, but some protection for the vulnerable parts of the carriage and rammer, not to mention the crew, from splinters, debris, and sand was urged. This eliminated the first two alternatives, leaving only the shielded barbette and turret.

In terms of aerial attack, the shielded barbette and turret were most easily concealed, as they had superstructures to which camouflage could be attached. The turret, with no exposed magazine or ammunition service, was the least conspicuous. The number of heavy bombs that could be delivered was believed to be limited, and a direct hit was considered unlikely. The board concentrated on the threat from smaller fragmentation bombs, with attendant splinters and fragments of rock and concrete.

The turret was entirely protected against small bombs, the shielded barbette less so, but probably adequately. Only the turret however, protected the ammunition route, while the dispersed type did not protect its magazines at all. Both the dispersed and the Type C failed to protect the vulnerable cables, conduits, hydraulic lines, and other easily damaged parts.

Only the turret protected the gun, crew, and ammunition service from strafing by low-flying aircraft. The shielded barbette protected the gun and crew, while the dispersed and Type C offered no protection at all, allowing the battery to be suppressed at the critical moment.

Only the turret could provide collective protection for all personnel against chemical attack. Similarly, in the event of land attack at the critical moment, only the turret could remain in operation. In all other types, the ammunition service, if not the guns, would be vulnerable.

While careful not to denigrate the individual courage of any member of the coast artillery, the board noted the "exceptional susceptibility to disorganization of seacoast artillery by even a small number of casualties," and concluded that the morale as well as the survival

of the crews were essential to the efficient service of the battery, and these were clearly best provided by the turret.

The turret, with its guns together, would simplify fire control. The board believed this would more than compensate for the flexibility provided by separated guns. While the turret would probably require more maintenance due to its complexity, it would in some measure compensate by protecting critical equipment from the elements.

The most troubling problem was that the guns achieved their maximum range at an elevation a little over 45°, no problem for the barbette carriages used by the first three types. Naval turrets capable of 40° elevation would reduce the range by only about 1,000 yards, which the board felt was an acceptable tradeoff. On the other hand, the 1934 edition of *Jane's Fighting Ships* reported that naval turrets were limited to 30° elevation. If so, this would cast serious doubt on the suitability of naval turrets for coast artillery. Further information from the navy was needed to answer this question.

The last but scarcely least important factor was cost. The estimates were confusing, comparing emplacements of one type with guns to those of other types without guns, but the board concluded that a turret battery should cost approximately 20% more than a Type C battery, while the cost of a shielded-barbette battery should be between the two figures.

The board concluded that turrets offered the best protection against all forms of attack, greater ease of fire control, and best maintained morale. On the other hand, they would be more expensive, and "slightly" more difficult and expensive to maintain. The board, pending resolution of the question of gun elevation, recommended turrets for the 16-inch batteries at San Francisco. If turrets proved impracticable, the board recommended shielded-barbette, Type C, and dispersed layouts, in that order.

On August 9, 1935, Lieutenant Colonel Burgin, again acting chief of coast artillery, forwarded the Coast Artillery Board study to the adjutant general with a strong endorsement. Burgin stressed that if the 16-inch batteries were put out of operation, battleships could bombard the Hunter's Point Dry Dock, the fleet anchorage, and the city of San Francisco without being fired on by any seacoast battery. The probable means of putting the batteries out of action was aerial attack, and the Type C battery was an ideal target.

Burgin declared "these 16-inch batteries should never be emplaced without protection to personnel and materiel from air attack. The turret type emplacement will furnish this protection." Further, blueprints for 2 and 3-gun navy 16-inch turrets had been received, and the turrets were indeed capable of 40° elevation, eliminating the only concern about the turrets.

Burgin insisted:

- There should be no compromise in this case due to the fact that certain materiel is on hand for installing Type C emplacements. The more expensive turret emplacement gives assurance that the guns will remain in action when needed. The cheaper Type C emplacement does not give this assurance.
- It is recommended that the turret type emplacement be adopted for the Fort Funston 16-inch battery.

Money for battery construction was now beginning to become available, and on September 5, 1935, the adjutant general pointed out that "Unless otherwise authorized by the War Department, justification before the Bureau of the Budget and Congress for funds included in the F.Y. 1937 War Department Estimates for commencing construction of this battery will be based on the approved Type C layout, utilizing guns and carriages on hand."

With that in mind, the adjutant general requested comment and recommendations from the affected bureau chiefs on the August 9 indorsement from the acting chief of coast artillery, enclosing copies of that indorsement and the Coast Artillery Board study. Included should be revised estimates of the cost of the three types under consideration: the approved Type C layout, "Any practicable modification of the Type C layout designed to furnish greater protection to equipment or personnel," and a 2-gun turret.

The chief of ordnance replied on December 7. He noted that conditioning the two completed carriages and shipping them to Fort Funston would cost $30,000 apiece. Completing two additional carriages would cost $140,000 apiece, plus $20,000 each to ship them to Tennessee Point.

The chief of ordnance was not enthusiastic about shields. A 1-inch splinter-proof shield for one 16-inch carriage would weigh 35 tons and cost $65,000. Since it would not be properly supported in the center of the horizontal surface, the shield could become an actual liability; a bomb or shell might distort and disable delicate carriage machinery, and the shield itself could become the source of flying debris, endangering both crew and carriage.

The Type C emplacement, however, might be modified by enclosing the trackage from the magazine to as near the gun as possible. This would reduce the visibility from the air, as well as protect the ammunition service.

The chief of ordnance also dashed cold water on the idea of turrets. A 2-gun navy turret, less guns, yokes, and partially finished cradles on hand, would cost $1,200,000. Shipment to the west coast alone would cost $125,000. Since no such turrets had been built, the turret would first have to be shipped to a proving ground for testing, at a cost of $83,000. On top of this, the roof armor of the 2-gun turret was only 5 inches thick, rather less than for the 3-gun turret, and the chief of ordnance doubted this would withstand a direct bomb hit. He concluded by recommending that until some means of protecting turrets against bombs had been proven effective, consideration of turrets be deferred.

Six days later, the chief of the Air Corps concurred with the chief of ordnance, emphasizing the need to not only protect personnel and equipment but also to conceal all elements of the installation from aerial observation. The next day the chief of chemical warfare service noted that no battery layout would avoid the need for individual protection, as navy tests had not so far shown it practical to gas-proof turrets.

As might be expected, the engineers had more say on the subject. On January 2, 1936, Col. Warren T. Hannum, chief of the Military Division, weighed in for the chief of engineers. First he modified the estimate of the Type C emplacement to incorporate recent changes and modifications. The estimate now rose to $939,750, including ordnance costs of $60,000. He estimated a turret would cost $2,645,500, including ordnance costs of $1,408,000.

Hannum objected to the chief of ordnance's recommendation for protecting the ammunition service. Bombproofing already would protect the ammunition and power plant. To extend this protection for the sake of the 17 men per gun in the ammunition detail would make the entire structure more visible from the air. In addition, tunnels might confine the blast of a bomb or shell, or trap poison gas. Lastly, a bomb or shell striking the reinforced-concrete track pavement would disrupt the ammunition service less than one striking on or at the entrance to a tunnel.

The most probable form of aerial attack was from machine guns and small bombs. With sufficient advance warning, all that was necessary was to provide "small, inconspicuous dug-

outs, built adjacent to the track and gun block, into which the gun and ammunition crews can take cover during an attack." These inexpensive shelters could be constructed with the battery or deferred until wartime. Hannum concluded by recommending the Type C layout, essentially as approved.

The Chief of Coast Artillery Proposes Casemates

The correspondence now reached the Office of the Chief of Coast Artillery. On January 18, 1936, in light of the surprising cost estimates, the chief of coast artillery withdrew his recommendation for turrets. From this point onward, turrets were never seriously considered for the San Francisco batteries. However, citing the Air Corps' indorsement, the chief of coast artillery repeated his August 9, 1935, statement that the batteries should never be without protection from aerial attack. The acting chief of coast artillery now proposed a new alternative, a modified casemate form of emplacement. This casemate, however, would have to protect a carriage not designed to be casemated. The casemate would therefore have to be large enough to protect the 73-foot rotating platform, and so would have to be massive, far larger than any casemate envisioned before. This major shift in casemate design was forced by the size of the gun and the need to use the existing center-pintle barbette carriages. There was no money to pay for developing a new front-pintle carriage, which would allow a smaller casemate, and in any event such a redesign would delay construction of the batteries for years.

The Office of the Chief of Coast Artillery, in conjunction with the Office of the Chief of Engineers, had already made a preliminary study of this type of emplacement, and it appeared that such a battery could be built within the current estimates.

The chief advantages of the new layout were:

a. Both personnel and materiel were bombproofed, except for that portion of the gun tube extending out of the casemate.
b. Only the gun muzzle was visible from the air, and that could be easily camouflaged.
c. Overhead trolleys could replace awkward railroad engines for moving the ammunition.
d. Existing guns and carriages could be used without alteration.

In the interest of saving time, the concurrence of the affected bureau chiefs, including Colonel Hannum, had already been obtained, and Burgin recommended that the correspondence be immediately forwarded to the commanding general of the 9th Corps Area for his comments and recommendations.

This the adjutant general did on February 7, 1936. At the same time, he also wrote the chiefs of coast artillery and engineers, estimating the cost of the three types of batteries:

a. Type C: $939,000
b. Casemate: $1,149,750
c. Turret: $2,645,500

He asked the chief of engineers and chief of coast artillery to cooperate on studies to cover the following points:

1. The type of battery that should be constructed in the event funds were provided in the 1937 appropriation. Informal information from the Office of the Chief of Engineers indicated that the Type C emplacement could be adapted to casemates, providing the

distance between guns was reduced to 140 yards, so the decision to casemate or not could wait until the magazine portals were to be constructed, about the close of the first year's construction.
2. The fields of fire for turrets and casemates.
3. The protection each type would provide against explosives and poison gas.
4. Comparative visibility from the air and how well each type could be camouflaged.
5. Blast and smoke within the casemate.
6. The need for overhead protection, in addition to the bombproof magazine, in view of the antiaircraft protection to be provided.
7. If additional protection against air attack was necessary, could it be provided more cheaply by additional AA weapons or small dugout shelters?

The commanding general of the 9th Corps Area replied on March 10, 1936, in separate letters for each battery site. He approved the casemated emplacement, although the sites might not permit the distance between the guns to be reduced to 140 yards. He also brought up another problem. The engineers' design for the casemates provided a 120° field of fire for the battery, covered by both guns. This was insufficient to cover Drakes Bay on the north and Halfmoon Bay on the south with all four guns. Ideally, the casemates could be modified, increasing the field of fire to 130° for Tennessee Point and 145° for Funston. If not, the gun emplacements should be splayed, allowing one gun of each battery to cover each extreme flank. Should this not be possible, the best that could be done was to site the Tennessee Point battery to cover Drake's Bay and the Fort Funston battery to cover Halfmoon Bay.

The chief of coast artillery referred the adjutant general's request to the Coast Artillery Board, which replied on March 21 with 20 pages of argument and conclusions supporting their chief's position, organized in response to the adjutant general's questions.

1. Noting that neither shielded barbettes nor turrets had been found technically or economically feasible, the board concluded that the casemates should be approved, with axes of fire diverging by 10°. It further recommended "small" shields on each carriage to protect personnel and materiel from bullets, splinters, and flying sand or other debris.

2. While the Type C emplacement would allow 360° fire, except when masked by the magazine, the casemate would only allowed a 120° field of fire. However, by fanning the emplacements 10°, Drake's Bay and Halfmoon Bay could each be covered by at least one gun. The casemated guns would be unable to fire on land targets or into San Francisco Bay, but this was not considered a serious deficiency.

   The casemate limited gun elevation to 46° 10', compared with 55° for the Type C. Technically Type C would offer better plunging fire against the decks of enemy ships, but in reality, plunging fire required different powder charges, and since only full charges were to be furnished with the navy guns, high-angle fire was not practicable. There was therefore no significant advantage for either type emplacement.

3. The board considered the casemate proof against 600-pound bombs or smaller, except those that struck directly in front of the embrasure, providing 75% of the protection of a

turret. Protection against machine gun attack, however, was more limited, since the casemate would provide "a conspicuous aiming point and a vulnerable target." The casemate would offer substantial protection against gas attack, but not as much as a turret.

The board concluded that the casemate, while not offering as much protection as a turret, would, if carefully designed and defended and provided with a splinter-proof shield, afford satisfactory protection from aerial attack. In this context, the Type C emplacement was not discussed, presumably because it clearly offered no protection at all.

4. While strongly emphasizing the necessity of considering camouflage during construction of the battery, the board did not believe the type of layout as important as careful attention to approved principles of camouflage.

5. The board had little to guide them in estimating the smoke in a casemate. With respect to smoke, the only examples available were a casemated 155 mm position on Corregidor and the 6-inch casemated batteries on Fort Drum. Experience with these suggested that smoke could be managed by forced ventilation, and that the compressed air scavenging of the navy 16-inch guns, which would blow the smoke out the muzzle after firing, would prevent serious problems.

   The board admitted that they had little information on which to base even a conjecture on blast effect in a casemate, and could only offer the report of the 1934 firing of the 16-inch disappearing gun on Fort Michie, which mentioned neither damage nor inconvenience from blast. The board speculated that neither blast nor smoke would seriously hinder the service of the gun, but recommended that the chief of engineers prepare a study of blast effects.

6. The board, understanding the adjutant general to be asking whether any overhead cover in addition to that of the magazine was necessary if adequate antiaircraft gun protection was provided, concluded that it was. Stressing the intensity and persistence with which a determined enemy might be expected to press home attacks against such key installations, and also the danger of surprise attack, the board viewed with alarm the suggestion by the chief of engineers that the gun crew could take shelter during aerial attack. Pointing out that such attack could be expected to coincide with naval action, the board was adamant that there could be no consideration of allowing the guns to be neutralized at such a vital moment. Lastly, the board pointed out that the cost of providing complete antiaircraft defense for a Type C battery would rival the cost of turrets, and greatly exceed the cost of casemates. In any event, such a level of antiaircraft gun protection was neither currently funded nor likely to be funded in the future.

Gen. Archibald H. Sunderland, chief of coast artillery, concurred with the board, and forwarded its report on April 16, 1936, along with additional arguments. He pointed out that the shoreline prevented placing antiaircraft weapons as far advanced as they would otherwise be. A 3-inch AA gun at the shore would only have 20 seconds to fire on a 200 mph bomber at 17,100 feet, and but 41 seconds at 5,000 feet. Sunderland also insisted that once

the big guns were fired, no effective camouflage was possible. Protective smoke was dismissed as unpredictable and liable to blind fire control stations, as could antiaircraft searchlights.

Sunderland admitted that Type C emplacements would protect against naval gunfire, but dismissed the likelihood of naval attack without aerial support. The movement of ammunition by rail in the Type C emplacement was inflexible, and damage to the rail would seriously endanger the ammunition service. Casemating might even reduce the incentive for air attack, by presenting a less vulnerable, and hence less attractive target.

After emphasizing that each additional antiaircraft battery would cost over $260,000, and that there was no possibility the antiaircraft weapons needed would be provided, Sunderland concluded that casemates furnished the necessary overhead protection without unduly restricting the field of fire. He recommended construction of the batteries with 140 yards between guns, to enable the batteries to be either completed as Type C or casemated and that he and the chief of engineers continue to study the proper type of emplacement, submitting a final report by October 1, 1936.

Now it was the turn of the Corps of Engineers to object to a plan previously agreed to. On May 1, 1936, Colonel Hannum, who had concurred in the recommendation for casemates in January, cited engineer studies that indicated casemating would seriously curtail the effectiveness of the guns. He answered the adjutant general's letter:

1. Antiaircraft guns, camouflage, and light smoke could effectively protect against bombing, and casemating would reduce the field of fire of the guns. Therefore, "no reason is seen for the further consideration of any type of battery other than Type C."
2. Casemating would limit the field of fire to 120° and fanning the guns was unsound, as both guns of a battery would not cover the same water areas. In addition, reducing the field of fire to 120° was unacceptable at other locations, specifically Panama and Hawaii, hence casemating could not be standard.
3. A Type C emplacement "is not a remunerative bombing target." While casemating would provide overhead protection for the gun and crew against bombs of up to 600 pounds, demolition bombs would probably be larger, and protection against them would be prohibitively expensive. As it was, casemating would increase the cost of the battery by $200,000, while the explosion of a bomb or shell close to or within the casemate would probably disable both gun and crew.
4. Neither Type C nor casemated batteries had an advantage as regards camouflage and visibility from the air.
5. Gun blast would probably be very severe, requiring the rear of the emplacement to be left open, at least until tests could determine the effect of the blast.
6. With "properly placed antiaircraft gun and machine gun defense, to keep bombers well up in the air and to prevent low flying diving attacks," and with smoke and camouflage, overhead protection was unnecessary. Antiaircraft protection could be provided at the same cost as casemating, along with inexpensive bombproof dugouts.

Hannum concluded by recommending that the engineers be authorized to proceed with a Type C battery at Fort Funston, with the guns 200 yards apart, and that the engineers and the coast artillery jointly study the best means to protect gun and crew from fragments or splinters.

On the same date, Hannum replied more specifically to the chief of coast artillery's indorsement, taking it apart, page-by-page and line-by-line. Most of the arguments are the same as in his previous letter, with emphasis on gun range and fields of fire. In addition, Hannum now informed the adjutant general that ammunition service in the Type C emplacement was under review, and overhead trolleys could readily be installed.

Hannum explained that his office had initially proposed reducing the distance between the guns from 200 to 140 yards, but further study indicated that the slight savings did not warrant that course of action. He closed by repeating his recommendation that further studies be made of shields and dugouts to protect guns and crews.

The issues were now clearly drawn.

- The engineers believed that narrowing the field of fire was unacceptable, while the coast artillery did not.
- The engineers downplayed the danger of aerial attack, and put their faith in antiaircraft and machine guns, aided by camouflage and smoke. The coast artillery was considerably less sanguine about antiaircraft defense, and felt that no defense, active or passive, could reliably prevent an attack from reaching the batteries.
- The engineers asserted that enemy bombs would probably exceed 600 pounds, negating the value of the casemates. The coast artillery believed smaller bombs would be more likely.
- Lastly, the engineers felt that during an aerial attack the crews could take shelter, abandoning their guns for the duration of the attack. This the coast artillery adamantly rejected.

General Sunderland fired the next salvo. On May 7, 1936, he stood by his indorsement of April 16, adding strongly "to place these magnificient (sic) 16-inch guns out in the open with no protection from intensive air attack is simply inviting disaster and forces the operating arm to provide and rely on the questionable expedient of camouflage."

He concluded by rejecting Hannum's proposal to shift antiaircraft batteries to cover the seacoast guns. The entire antiaircraft defense project, he said, was carefully calculated to be mutually supporting, and the shift would derange this careful plan.(22)

On May 13, the War Plans Division asked the chief of engineers to confirm their understanding that with guns 200 yards apart, a Type C emplacement would cost $939,750 and a casemated emplacement $1,149,750, a difference of $210,000. The savings from reducing the distance between guns to 140 yards amounted to less than $5,000 for Type C emplacements, and probably not over $10,000 for casemates.

The chief of engineers replied with the figures for the engineer costs, not the total figure, but he essentially agreed, the difference between emplacement types being $200,000. Should the casemate emplacement be built with the guns 140 yards apart, the savings might be as much as $15,000, but the reduction in dispersion and the increased blast effect made this undesirable.

On June 1, 1936, the WPD summarized the views of the chief of engineers and the chief of coast artillery:

1. Both rejected turret mounts.
2. The chief of engineers believed casemates would seriously curtail the effectiveness of the guns by restricting the field of fire; the chief of coast artillery believed this would not

affect the most vital water areas protected by either battery and a casemate might be developed to allow a wider field of fire.

3. The chief of engineers stated that casemates might not protect against direct bomb hits and in addition would not extend over the entire gun and carriage; the chief of coast artillery stated that the casemate would adequately protect against attacks by light bombers and attack planes, which was sufficient.
4. The chief of engineers stated that effective protection against air attack could be provided by antiaircraft and machine guns, and recommended an additional 3-inch antiaircraft battery; the chief of coast artillery stated that additional overhead protection would be cheaper and more effective.
5. The chief of engineers believed that the distance between guns should not be reduced, and the guns should not be fanned; the chief of coast artillery believed that whichever type was adopted, the distance between guns should be reduced to 140 yards to save construction costs.
6. The chief of engineers favored the Type C emplacement, the chief of coast artillery favored casemates.

The WPD noted that the question of the layout did not have to be settled at that time. The only decision immediately required was the location of the guns blocks. The WPD therefore concluded that the savings from reducing the distance between the guns would not justify the decreased dispersal and that the gun axes should not be fanned. The WPD recommended construction of two gun blocks at Fort Funston, 200 yards apart, and that further studies be made as to the final form of the emplacements. Funding for Tennessee Point was not yet provided. By order of the secretary of war, the adjutant general implemented the WPD's recommendations on June 3.(23)

Construction Begins on the Fort Funston Battery, with the Battery Type Undecided

On June 6, 1936, the adjutant general directed the chiefs of engineers, ordnance, and coast artillery to report on the type emplacement, other than turret, to be used for the Fort Funston and Tennessee Point batteries, and additional protective measures to be adopted if the Type C emplacement was selected. These reports, due no later than October 1, 1936, initiated another round of studies and memorandums.

Meanwhile, on August 11, 1936, the San Francisco district engineer wrote the chief of engineers, noting that War Department approval for seacoast batteries to be constructed during the present fiscal year was not on file in his office, and requesting confirmation or correction of the status of each battery.

For Fort Funston, the district engineer had thought casemate construction, with 157 yards between gun centers, was still under consideration by the War Department. However, it was now understood from the chief of engineers that the gun centers would definitely be 200 yards apart.

On August 22, 1936, Major William F. Heavey, chief of the Corps of Engineers Construction Section, submitted an August 18 "Study on Type of Emplacement to Be Used for Fort Funston and Tennessee Point Batteries," for the approval of the chief of engineers before further conferences with the coast artillery and ordnance.

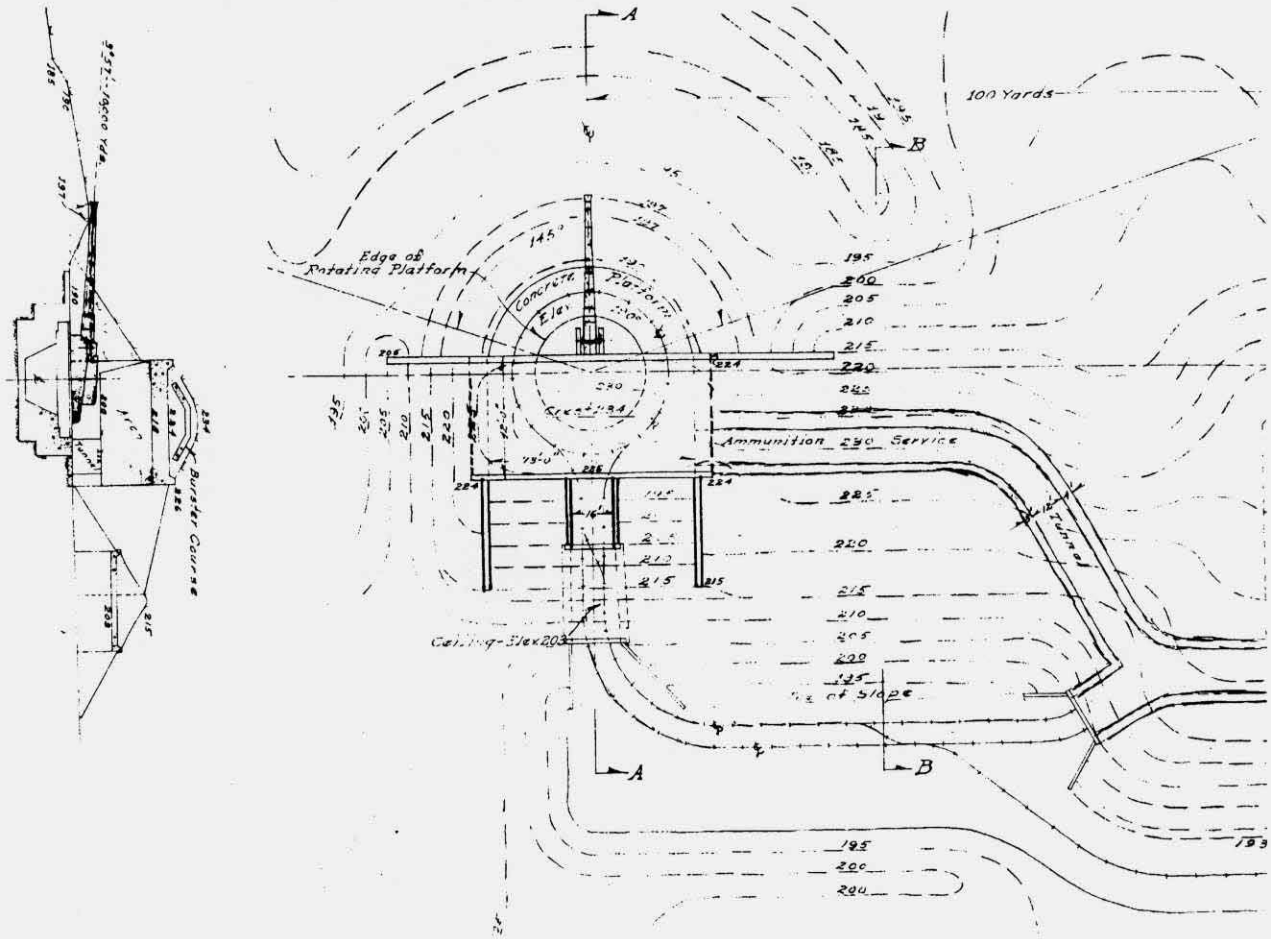
The study compared three types of emplacements:

1. Type 1 casemate, as suggested by the Office of the Chief of Engineers.
2. Type 2 casemate, as suggested by the Office of the Chief of Coast Artillery.
3. Splinter-proof shelter, as suggested by the Office of the Chief of Engineers.

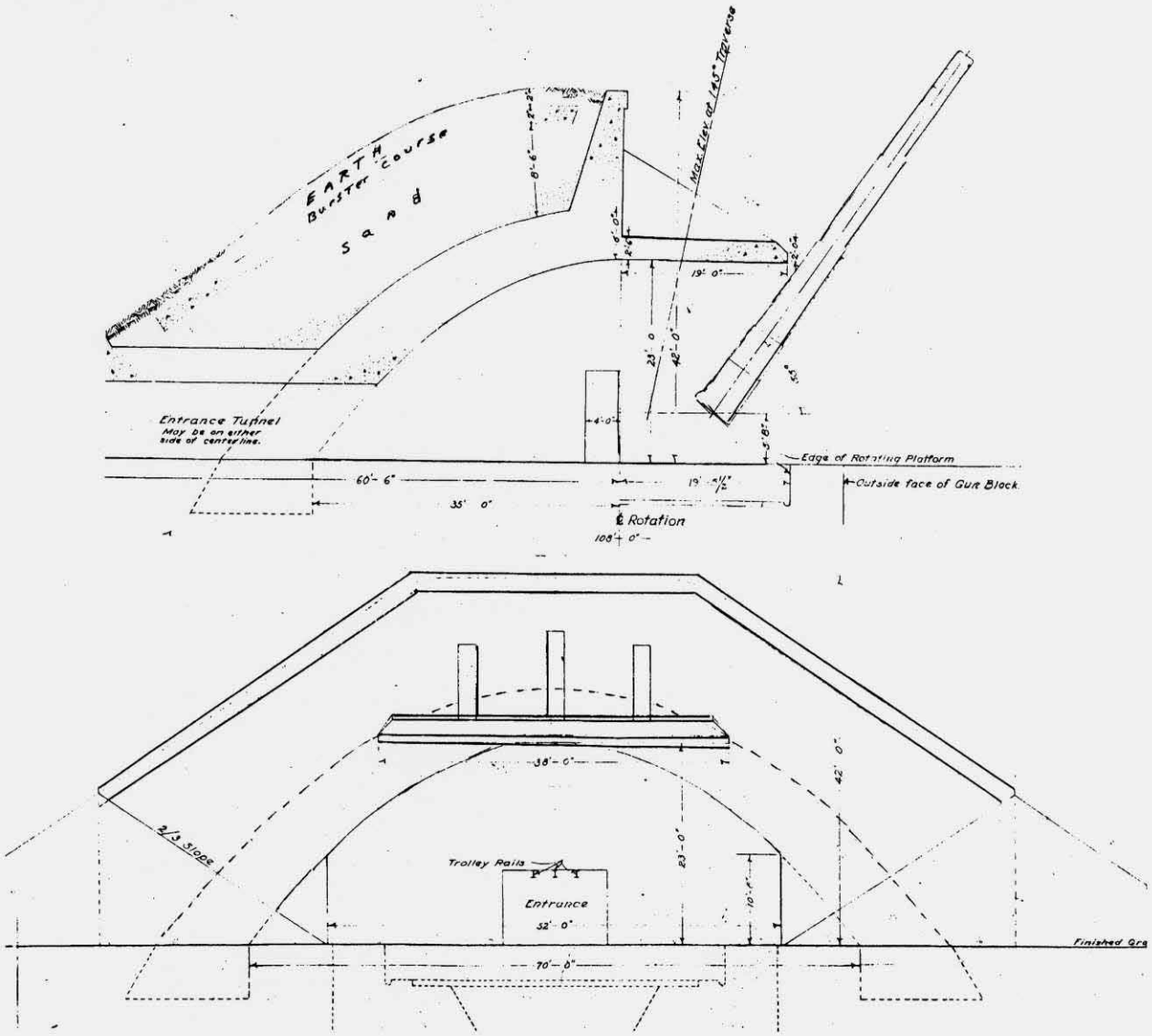
The Office of the Chief of Coast Artillery had asked the engineers to prepare tentative plans for two types of casemates to illustrate the coast artillery recommendations. The chief of coast artillery originally recommended the Type 1 casemate, but later suggested Type 2.

Both casemate designs allowed a 145° field of fire and elevation up to 55°, and were designed to withstand 600-pound bombs. The primary difference was that the face of the Type 1 casemate would be almost five feet behind the gun trunnions, while the Type 2 would increase this distance by six feet, adding a light roof or canopy over the rotating platform. In addition, the Type 1 casemate partially closed the rear by an earth parados, allowing the escape of gas and smoke and reducing the blast. The Type 2 casemate had an enclosed rear, but the Type 1 casemate could be modified to give the same rear protection. The Type 2 casemate, because of its high front retaining wall, was more conspicuous than Type 1, and somewhat more vulnerable to aerial attack, especially if bombs struck the canopy, whose ability to resist a direct hit by even a small bomb was doubted. **[Figs. 15 & 16]**

Otherwise, the advantages and disadvantages of the two casemate designs were the same. In their favor, the casemates' fields of fire were adequate, at least for the San Francisco batteries. In addition, the casemates offered some protection to gun and crew from machinegun



15. Proposed design for Type 1 Casemate for 16-inch battery, 1936.



16. Proposed design for Type 2 Casemate for 16-inch battery, 1936.

fire and bomb fragments. Aerial attack was limited to the front, simplifying the antiaircraft defense.

On the negative side, a direct hit from a 600-pound bomb would probably dislodge large pieces of concrete, putting the gun out of operation at least temporarily, while a larger bomb would demolish both casemate and gun. A bomb falling at 70° could strike the rotating platform of the carriage, disabling it. Changing the ammunition service from railway cars to overhead trolleys would require modifying the carriage, and the service tunnels would tend to increase the concentration of poison gas in the magazines.

Instead of casemates, the third design called for a "rotating light armored shelter," 15 feet high and 44 feet in diameter. Armor plate 3/4-inch thick should protect against .50-caliber machine guns. The shelter would not rest on the carriage, but would rotate electrically, synchronized with the carriage. In addition, small concrete dugouts along the approach track and around the gun would provide temporary protection for the crew from machinegun fire

and bomb fragments. This layout did not restrict elevation or fields of fire, and simplified the replacement of the gun tube, but offered no protection from a direct bomb hit. In addition, the shelter and its roller path would have to be maintained, as would any mechanical device. The Office of the Chief of Engineers preferred the shelter to either casemate design.

In August 24, 1936, the chief of ordnance registered his preference for the Type A, or dispersed, layout, with the Type C as his second choice. Like the chief of engineers, he believed guns and camouflage could provide adequate antiaircraft protection, although 105 mm antiaircraft guns would be required, along with multiple mounts of intermediate-caliber machine cannon similar to 1.1-inch guns being installed on naval ships, all in addition to the 3-inch antiaircraft batteries now contemplated. No cost estimate for these batteries was given.

The chief of ordnance disapproved of casemates because they restricted the field of fire and because fragments from the overhead cover could endanger personnel and materiel. The armor suggested by the chief of engineers might work, but even small bomb fragments or machinegun bullets might interfere with its free rotation, and the concussion from a bomb striking the shelter would be more severe than without a cover.

Light metal shields, attached to the carriage to protect personnel and vital parts, would be practical, to a limited extent. The advantages would be offset by hiding most of the crew from the view of the battery commander and complicating maintenance. In any event, not all vital parts could be protected. The chief of ordnance did fully support gas-proof dugout shelters, which were beginning to evolve into something more complicated than originally intended.

General Sunderland wasted no time in replying. He wrote the chief of engineers and chief of ordnance on August 25, 1936, arguing for casemates. He emphasized that "opportunities to fire on naval targets will be few and of short duration. They should not be lost due to neutralization of the batteries."

Sunderland repeated his previous arguments. He doubted both the provision of sufficient antiaircraft guns and their ability to adequately protect his batteries. Also, aerial photography showed the Type C emplacement to be more prominent than any other element of the harbor defenses.

While arguing for overhead protection, Sunderland did not dispute the need for camouflage. Although expensive, he recommended dummy batteries as the most effective deception, but insisted, ". . . depending on deception alone, like depending on a small probability of hitting when bombing from high altitudes, is more hope than protection."

On August 28, 1936, the chief of engineers repeated his argument for Type C emplacements, without casemates, and with 200 yards between guns, emphasizing the impossibility of providing complete overhead protection. He attached a copy of the August 18, 1936, study and a letter from the chief of ordnance, which offered nothing new, other than the inability of the Ordnance Department to estimate the cost of the rotating shield suggested by the chief of engineers.

Meanwhile, the chief of ordnance proposed a design for overhead protection, sending a sketch to the chief of engineers. On September 12, 1936, the chief of engineers replied that the design was fatally flawed because the casemate rested in part on the gun block, which it would unbalance. In addition, the low casemate opening limited the gun elevation to 45°

10'. On the positive side, the chief of engineers did approve of the shield the chief of ordnance showed rotating with the carriage.

The positions of the chief of coast artillery and chief of engineers had become hardened. Both branches had studied the question, and reached their conclusions. Correspondence now largely repeated arguments already made.

On September 15, 1936, General Sunderland submitted his recommendations to the adjutant general, virtually retyping his August 25 letter to the chiefs of engineers and ordnance. He did spell out more fully his concept of the casemates, calling for a cantilever roof or canopy and a closed back with three openings, one in the rear large enough to replace the gun, one to the magazine, and one on the outside flank for personnel. A shield should rotate with the carriage to protect its front.

Six days later, Colonel Hannum, replying for the chief of engineers, again emphasized the impossibility of providing complete overhead protection, and asserted that for the gun to fire through a small enough casemate opening would require the redesign of the carriage. He objected that no canopy could protect against 600-pound bombs and questioned the need for the door on the flank. Lastly, he criticized the details of Sunderland's system for ammunition service, continuing to prefer railcars to overhead trolleys.

On October 3, 1936, the chief of ordnance likewise maintained his preference for the Type A layout, and if not that, the Type C. He maintained that the current carriages "are center pintle barbette carriages designed for all round fire and are not suitable for installation in a casemate or turret." He further pointed out that the casemate, even with a canopy, would provide only limited protection against bombs falling at an angle, and that the vertical surfaces of the casemate emplacement would make it more visible than the Type C. His position on shields also remained unchanged.

On October 31, the adjutant general asked the chief of ordnance whether the carriages would require major modifications for casemates. Four days later the chief of ordnance responded in the negative. In November construction began on the Fort Funston battery, and a final decision as to the layout could not be delayed much longer.(24)

Once again, on February 3, 1937, the War Plans Division analyzed the issues and made their recommendations.

The WPD noted the chief of coast artillery recommended casemates, the chief of engineers recommended Type C emplacements, and the chief of ordnance recommended a dispersed, unprotected layout, but preferred Type C to the casemated layout.

The WPD compared the cost of the differing layouts, to include the cost of the 3-inch AA battery called for by the chief of engineers. With that $385,000 included, Type C layouts were more costly than casemates.

The WPD concluded:

1. Casemates would allow the guns to cover the vital water areas, and there was little likelihood that they would need to fire on land targets.
2. Camouflage and additional protective measures advocated by the chief of engineers were of doubtful efficacy.
3. Casemates offered the best overhead protection for the least money.
4. The "arched" casemate design suggested by the chief of engineers was superior to the "arch and dome" design offered by the chief of coast artillery. (The differences between these designs were not detailed.)

5. The disadvantage of the large casemate opening could be partially overcome by the use of shields.

These conclusions were submitted as recommendations to the General Staff. The assistant chief of staff, G-4 (supply), demurred, but Gen. Walter Krueger, chief of the WPD, insisted "War Plans Division considers that the provision of overhead protection for these batteries is of vital importance, and the additional expense is justified."(25)

The First Two Casemated Batteries

The War Plans Division recommendations were approved on February 8, 1937, and two days later the adjutant general announced, "The casemate (reinforced concrete) emplacement is approved for the 16-inch batteries to be installed at Fort Funston and Tennessee Point, California," while stipulating, "The above approval does not establish a general policy for the emplacement of long range seacoast guns. The selection of the type of emplacement for any particular locality will be made the subject of a special study which will take note of local conditions." Although the San Francisco batteries were to be casemated, turrets as well as other forms of protection would be considered for future batteries.

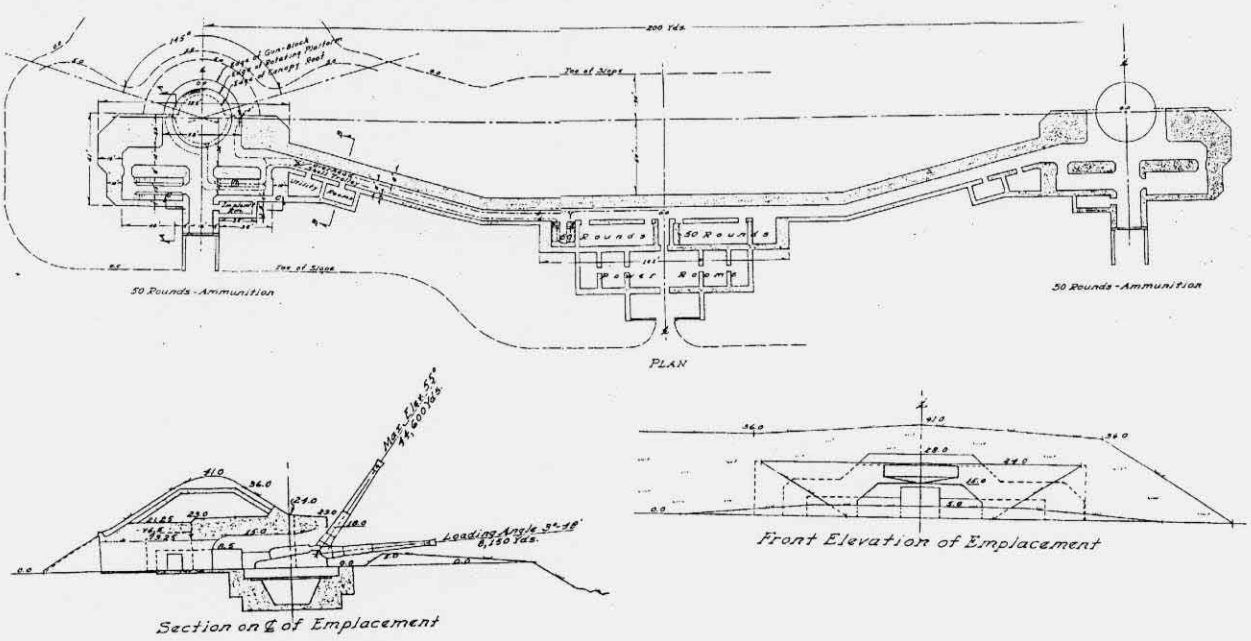
The chief of engineers, in collaboration with the chief of ordnance and the chief of coast artillery, was directed to draw up the design and submit it on or before March 15, 1937.**[Fig. 17]** With the major question decided, agreement on the details came relatively easily. The chief of engineers and the chief of coast artillery agreed on the layout, reducing the maximum elevation of the gun to 46° 10' to enable the casemate opening to be lowered to 15 feet. The shield was to be made of 2-inch mild steel, and the maximum depression of the gun was to be 0°. Although the chief of coast artillery recommended against it, the chief of engineers advocated splinter-proof armor between the casemate wall and the gun shield. The WPD supported the engineers and the armor was approved.**[Figs. 18-22]**

Further minor details were to be worked out between the chiefs of engineers, coast artillery, and ordnance. Much of the remaining correspondence concerned mundane but no less vital matters of finance-what expenses were to be charged to which accounts.

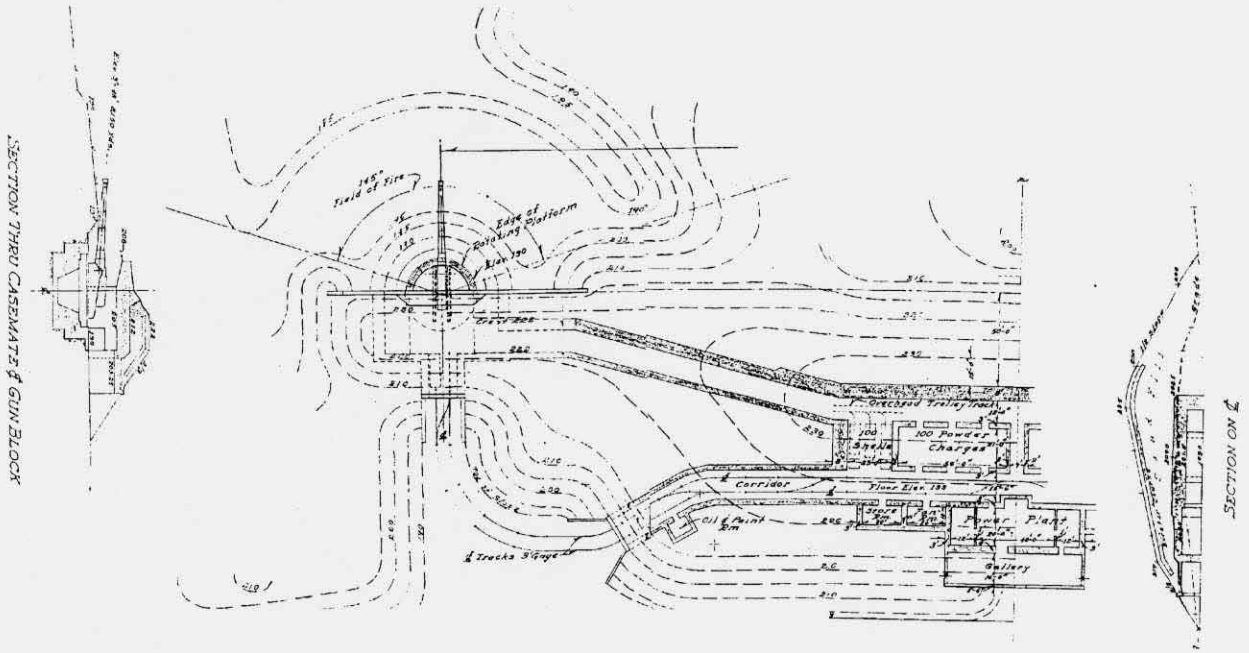
Overhead protection in the new battery varied from front to back and from casemate to magazine, being thicker to the front and over the guns. A 2-foot-thick reinforced-concrete burster course just below the surface was intended to detonate bombs or shells before they could penetrate the main concrete structure below, beneath a thick layer of earth. The concrete above the main corridor was about eight feet thick; that over the magazines slightly less. At the casemates, protection increased from about five feet over the rear entry corridor to about 13 feet directly over the breech of the gun.**[Fig. 23]**

The structure was curved, the casemates being advanced in dumbbell fashion. This was more pronounced in the case of Battery Townsley **[Fig. 26]** than Battery Davis. The power plant was midway between the casemates, behind the central corridor. Powder and projectile storage rooms were on either side, the projectiles being stored closest to the guns. The powder charges, more vulnerable than the projectiles, were stored deeper within the battery.

The Fort Funston emplacements were named Battery Richmond P. Davis, and those on Tennessee Point, begun in January 1938, were named Battery Townsley, while the Tennessee Point reservation became Fort Cronkhite. Battery Davis' guns were 600 feet apart, while due to the topography, Battery Townsley's guns were in echelon only some 350 feet apart, the

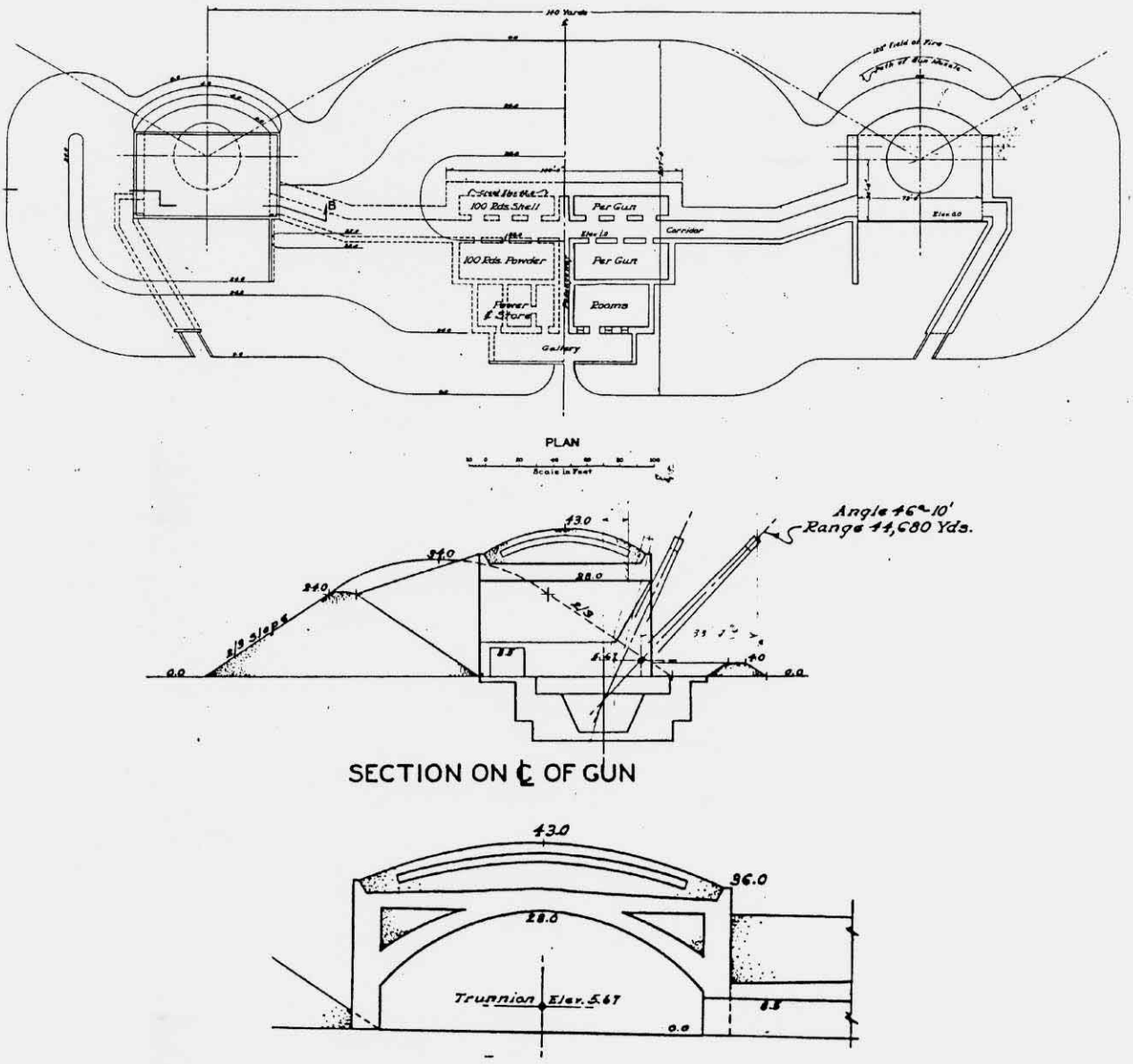


17 a, b. Proposed designs for 16-inch casemated battery at Fort Funston. See fig. 23 for the design that was eventually constructed. NPS, GGNRA Archives



right gun some 160 feet in advance of the left gun. Townsley was asymmetrical, with a long entrance corridor coming into the rear of the right, or number one, casemate. Later 16-inch batteries had 500 feet between guns.

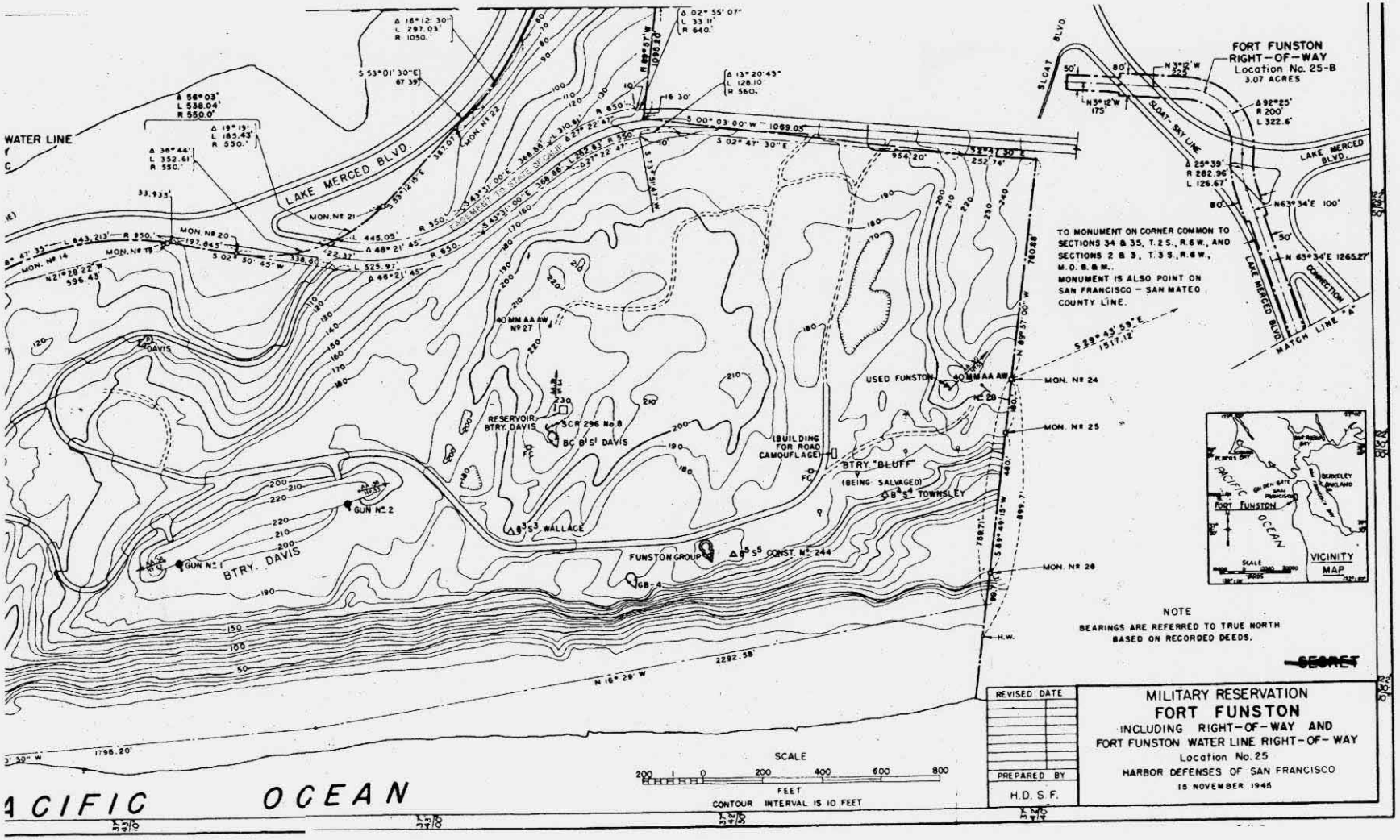
Although the adjutant general specifically asserted that these batteries were not approved models for future emplacements, as it turned out they were, at least in general terms. Neither Davis nor Townsley were replicated exactly; Townsley especially, with its guns in echelon, was unlike any other 16-inch battery. Nonetheless, the first two San Francisco batteries were



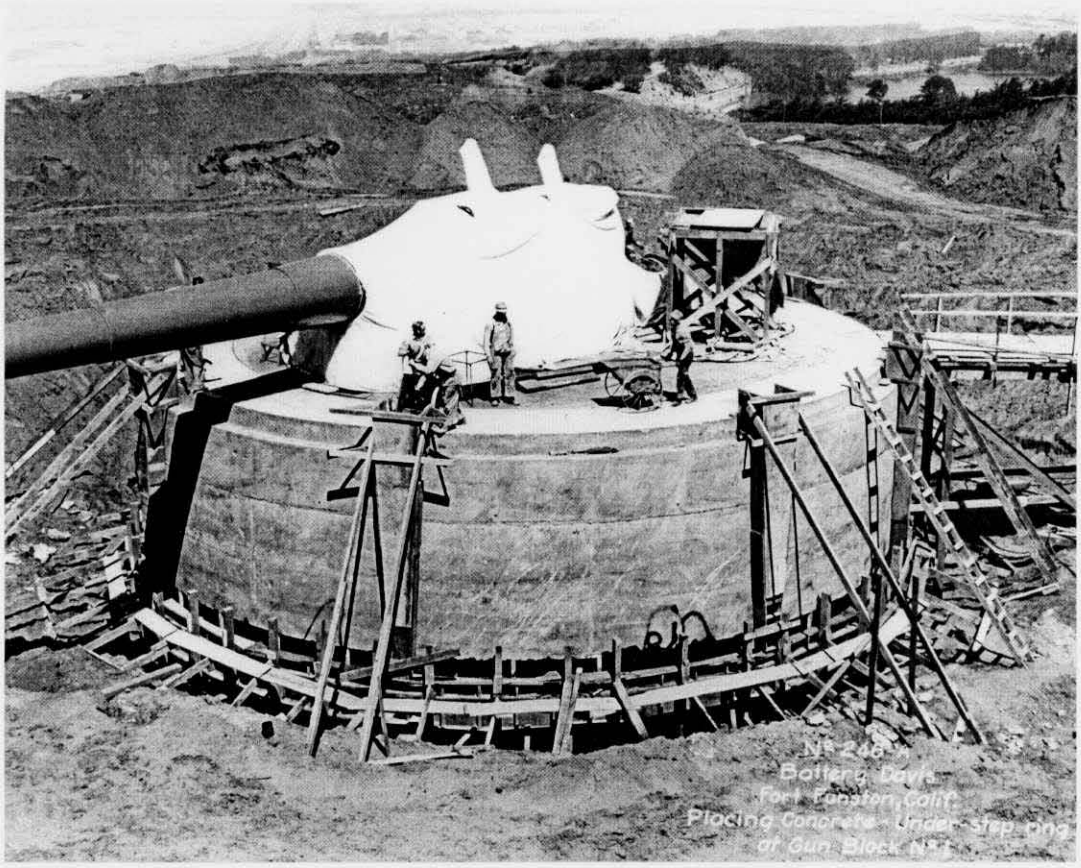
17 c. Proposed designs for 16-inch casemated battery at Fort Funston. See fig. 23 for the design that was eventually constructed. NPS, GGNRA Archives

considered successful, and although it was specific policy that all types of protection would be considered for each future battery, the factors that resulted in the adoption of casemates at San Francisco also proved decisive in the design of all future 16-inch batteries. Never again would the United States construct major-caliber open barbette emplacements.

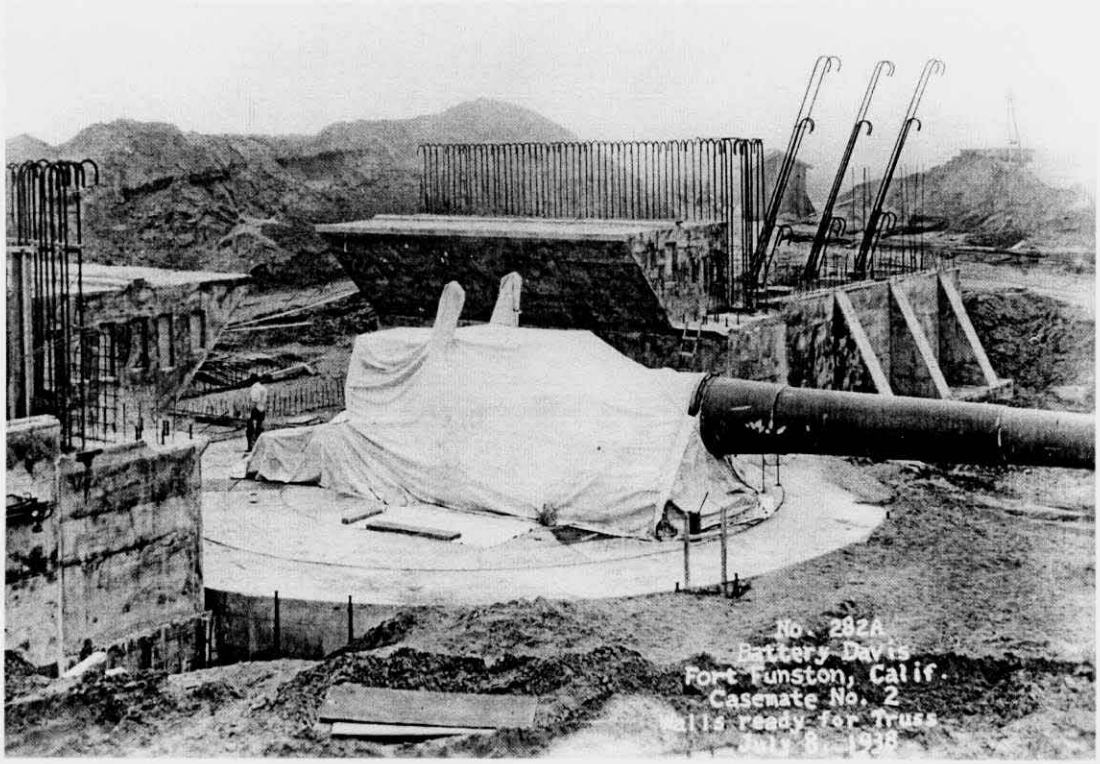
Meanwhile, on December 16, 1938, the Coast Artillery Board reported on Project No. 1149, "Overhead Protection for 16-inch Guns." Should future 16-inch batteries have no overhead cover, splinter-proof shields, or more complete protection, such as turrets or casemates? After reviewing previous studies by the board and by the Office of the Chief of Coast Artillery, the board dismissed the open, dispersed, battery as incapable of guaranteeing protection against aerial attack. Shields would provide adequate protection for the gun and carriage, but not for the ammunition service, and therefore should only be used for existing



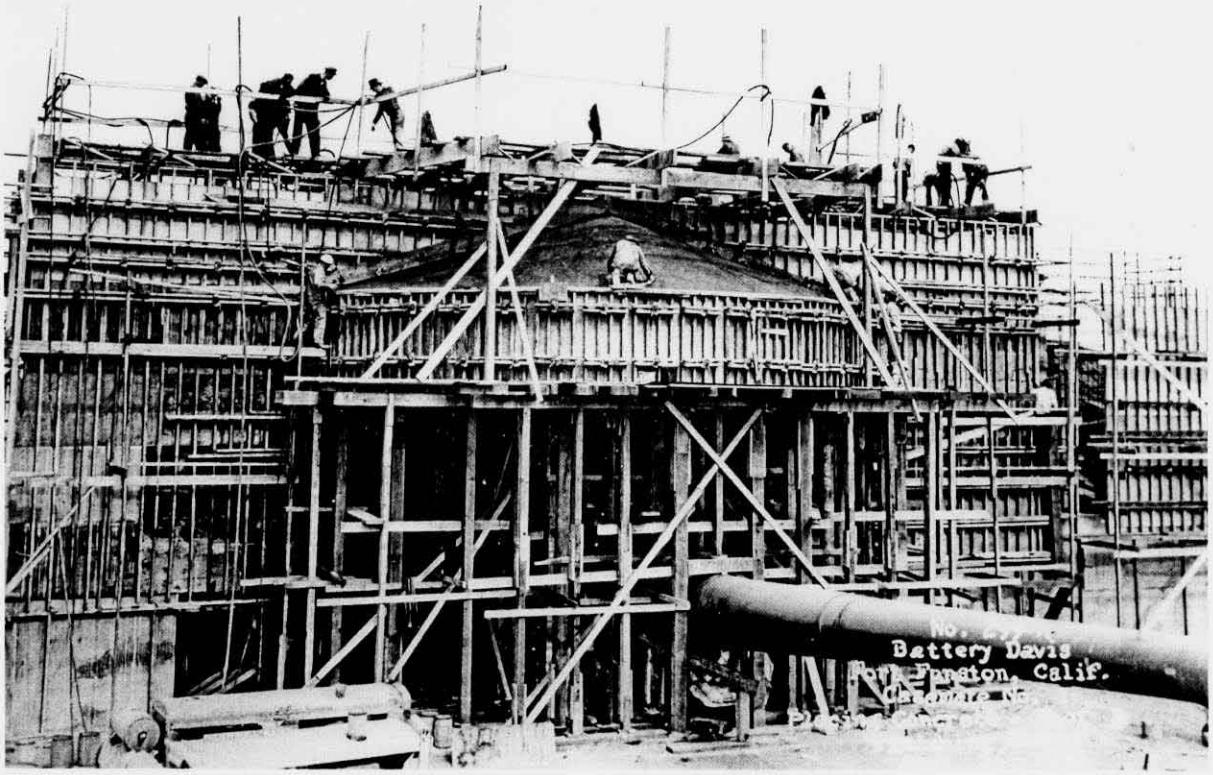
18. Fort Funston, 1945. *Supplement to Harbor Defense Project, HD of San Francisco, 1945*



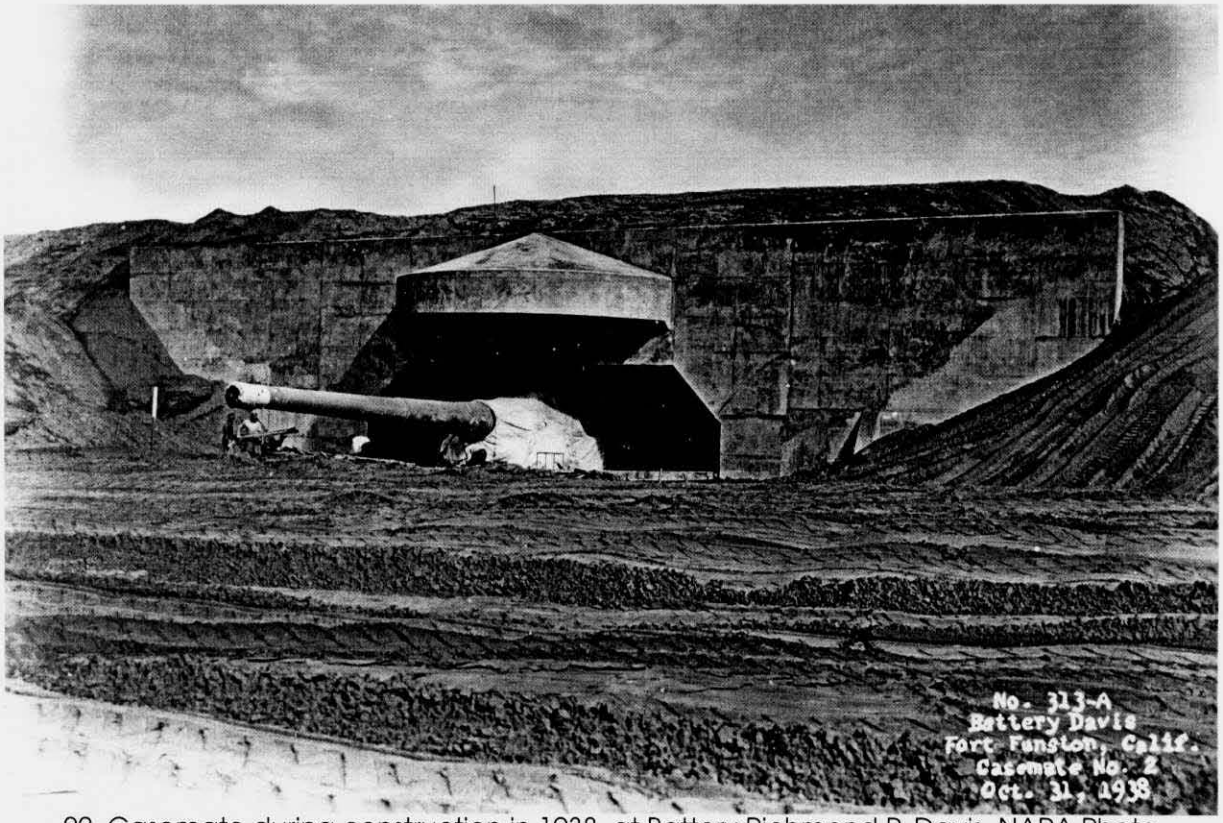
19. Gun block with 16-inch gun, Battery Richmond P. Davis, Fort Funston, HD of San Francisco. NARA Photo.



20. Construction of central traverse magazine in 1938, at Battery Richmond P. Davis. NARA Photo



21. Construction of casemate at Battery Richmond P. Davis. Atypically, Battery Davis' casemates were built after the guns were mounted. NARA Photo



22. Casemate during construction in 1938, at Battery Richmond P. Davis. NARA Photo

REPORT OF COMPLETED WORKS - SEACOAST FORTIFICATIONS
(Central Traverse Magazine)
Corrected to September 21, 1940
Form 1

HARBOR DEFENSES OF SAN FRANCISCO
FORT FUNSTON, CALIFORNIA
BATTERY RICHMOND P. DAVIS
No.of guns-2. Caliber-50. Carriage-L.F.

GENERAL		ELECTRIC CURRENT	
Battery commenced	November 1936	Sources of	Battery Power Plant
Battery completed	May 1, 1940		
Date of transfer	Sept. 21, 1940	Max.KW. required for lights	50.06 at 125 volts
Cost to date of transfer	$670,356.49	Max.KW. required for motors	282.32 at 125 volts
Materials of construction	Reinf. Concrete		
Type of cement	Conf.to Fed.Spec. SS-C-191(for cement)	Present condition of battery	New
		Rooms wet or dry	Dry
WATER AND SEWER:		How ventilated	Ventilating Doors. 18" diameter vent shafts in Magazines. Transite vent covers.
Connected to water supply	Yes		
Connected to sewer	Yes		
Type of latrine	Reinf.Concrete	Type of data transmission	Telephone (Installed by Signal Corps)
Trunnion elevation in btry	Gun #1 - 195.82	Remarks	
	Gun #2 - 195.80		
Datum plane	M.L.L.W.		

ARMAMENT

Emplacement Number	Guns or Mortars: Cal.	Length	Model	Serial No.	Manufacturer	Mounted	Carriages: Type	Model	Serial No.	Manufacturer	Motor
Gun #1	50	68 ft.	1919	64	Navy	yes	Barbette	1919	10	Navy	Each Gun
Gun #2	50	68 ft.	1919	74	Navy	yes	Barbette	1919	14	Navy	Elev.Motor-50HP
											Rammer " 30HP
											Traverse " 7½HP
											Comp. " 30HP

HOISTS

Emplacement Number	Type	Delivery	Motor: Serial No.	Maker	H.P.	Volts	RPM	Type of control	Date of transfer	Remodeled for long points
One Level Battery - No Ammunition Hoists required Twenty-five 1½ ton, hand-powered hoists for conveying shells to guns										

Note: The Central Traverse Magazine includes two gun emplacements in casemates, two magazines, several storerooms and a power room. Cost to date of transfer, if Plotting and Switchboard Room, Radio Station, B.C.Station, boundary fence, utilities, protective concealment, and maintenance to date of transfer are included - $893,138.47.

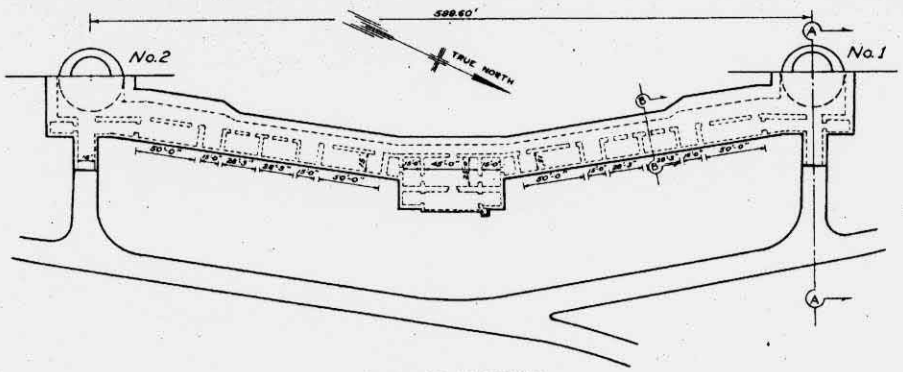
Superseded - See Form 1 corrected to July 1943

23 a. Report of Completed Works, Form 1, Battery Richmond P. Davis, 1940. This RCW contains several errors

REPORT OF COMPLETED WORKS - SEACOAST FORTIFICATIONS
BATTERY PLAN

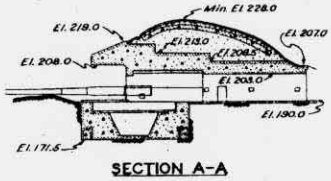
FORM 7 CORRECTED TO SEPT. 21, 1940

HARBOR DEFENSES OF SAN FRANCISCO
FORT FUNSTON CALIF.
BATTERY - RICHMOND P. DAVIS
NO. OF GUNS 2 CALIBER 50 CARRIAGE LF
SCALE AS SHOWN



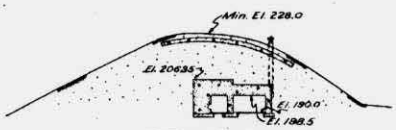
PLAN OF BATTERY

Scale: 1"=100'

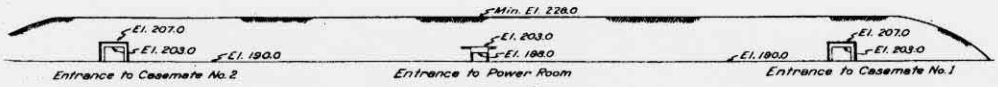


SECTION A-A

Scale: 1/8"=1'0"



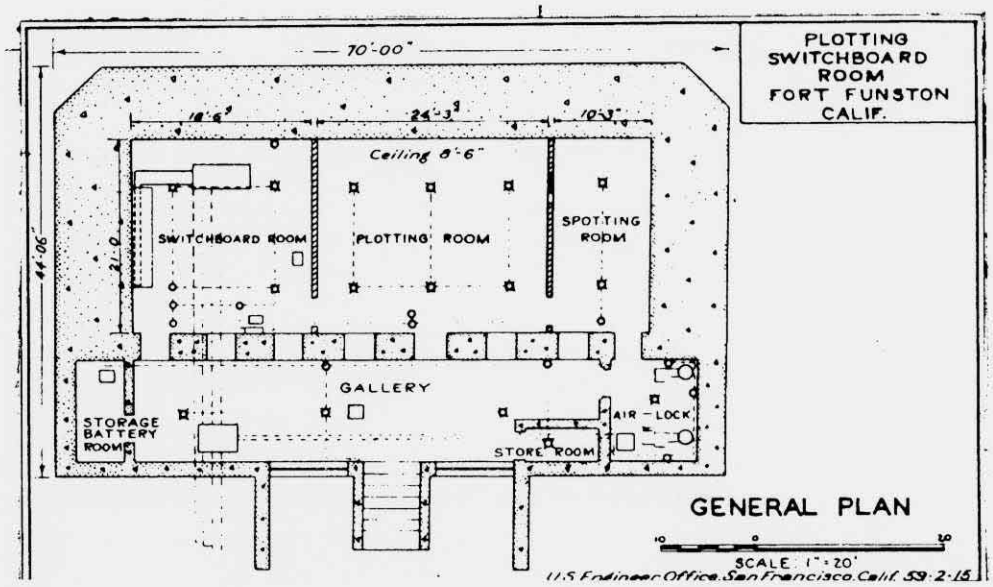
SECTION B-B



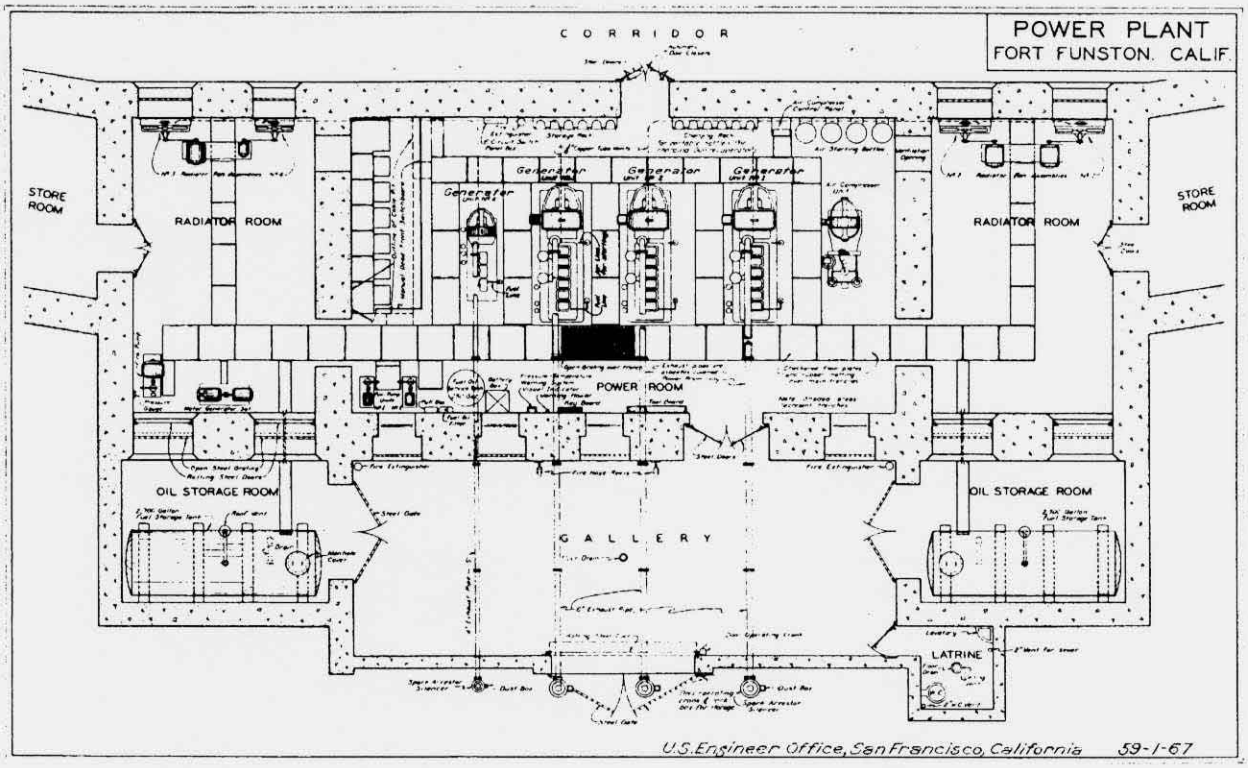
REAR ELEVATION

U.S. Engineer Office, San Francisco, California 59-1-66

23 b. Report of Completed Works ,Form 7, Battery Richmond P. Davis, 1940.



23 c. Power Plant, Battery Richmond P. Davis



23 d. Plotting-switchboard room, Battery Richmond P. Davis

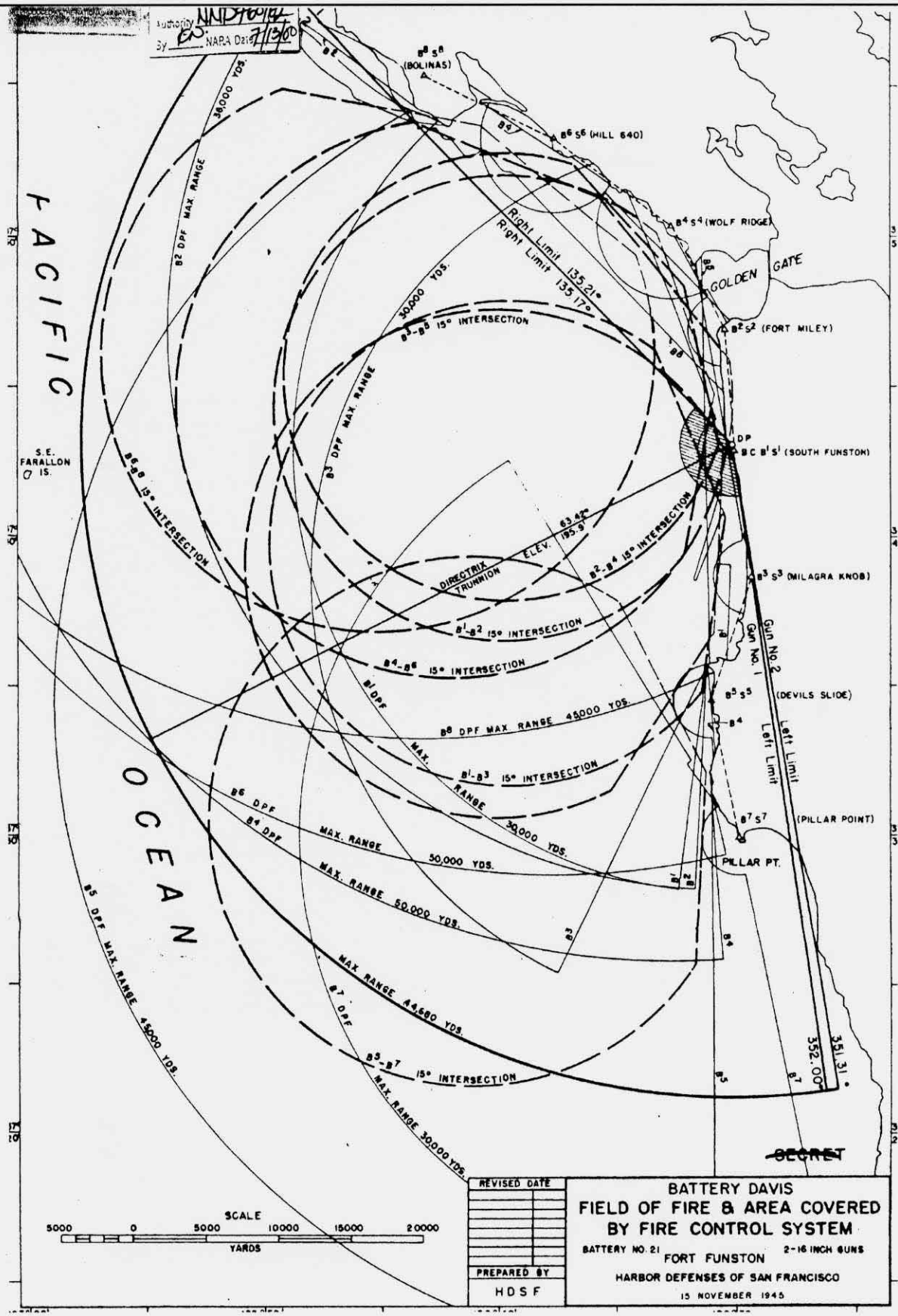
batteries. The final recommendation of the board was that 2-gun turrets be adopted for future 16-inch batteries, except where fields of fire were restricted enough to allow the use of casemates.(26)

Subsequent 16-inch Batteries

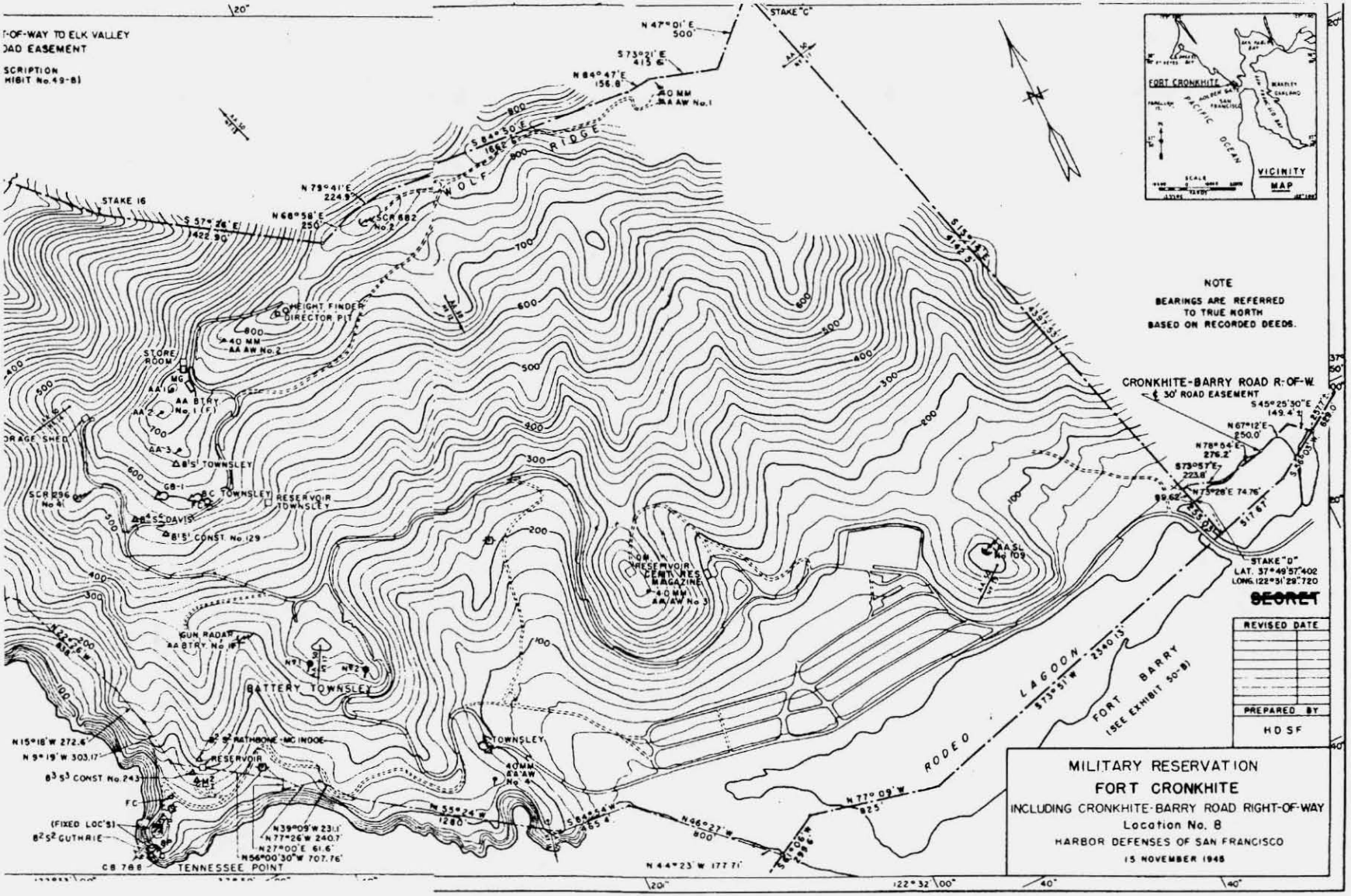
The debate continued, but all subsequent 16-inch batteries were casemated, and four of the six 16-inch batteries previously constructed were casemated. The two exceptions were Battery Haan, in Panama, and Battery Williston, in Hawaii. In each case, the non-casemated battery was paired with a casemated 16-inch battery. Battery Williston was left open so that it could cover the entire shoreline of Oahu. Battery Haan's casemates were approved but deferred in favor of higher priority projects.

The finality of these decisions should not be overestimated. No one at the time considered these decisions final. Casemates were no one's first choice, they were selected because they offered the best protection within budgetary limits. But in the end, the decision for casemates was final. This was in part because everyone admitted that the San Francisco batteries were successful, and in part because of the pressures of first money and then time. Ironically, when the army had the time to develop turrets, it did not have the money, and when it had the money, it no longer had the time, desirable though turrets might have been. Finally, the relatively rapid American success in the Second World War eliminated the need for another generation of coast artillery that might have taken a different course. Meanwhile, even basic principles continued to be challenged, and many details were altered.

On March 30, 1939, the adjutant general referred to the decision on the San Francisco batteries and ordered a study to evaluate the advisability of employing turrets in the next few



24. Field of fire, Battery Richmond P. Davis. *Supplement to Harbor Defense Project, HD of San Francisco, 1945*



25. Fort Cronkhite, 1945. *Supplement to Harbor Defense Project, HD of San Francisco, 1945*

C-129

REPORT OF COMPLETED WORKS - SEACOAST FORTIFICATIONS

(Central Traverse Magazine)

HARBOR DEFENSES OF SAN FRANCISCO
FORT CRONKHITE, CALIFORNIA
BATTERY TOWNSLEY

Form 1 Corrected to July 1943

No. of Guns 2 Caliber 50 Carriage L.F.

GENERAL:		ELECTRIC CURRENT:	
Battery commenced	Jan. 1938	Sources of	Battery Power Plant
Battery completed	July 1,1940		
Date of transfer	July 24,1940	Max. kw. required for lights	57.24 at 125 Volts
Cost ot date of transfer	$595,000.	Max. kw. required for motors	274.99 at 125 Volts
Materials of construction	Rein.Concrete		
Types of cement	Conf.to Fed.Spec. SS-C-191(for cement)		
WATER & SEWER:		Present condition of battery	New
Connected to water supply	Yes	Rooms wet or dry	Dry
Connected to sewer	Yes		
Type of latrine	Reinf.Concrete	How ventilated	Vent. Doors. 18" diam. vent shafts in Magazine. (Transfer vent covers)
		Type of data transmission	Telephone (Installed by Signal Corps)
Trunnion elevation in btry.	Gun#1-345.64		
Datum plane	Gun#2-345.66 M.LL.W.	Remarks-(see reverse side)	

ARMAMENT

Emplacement or mortar No.	Guns or Mortars: Cal.	length	model*	Serial No.	Manufacturer	mounted	Carriages: Type	model	Serial No.	Manufacturer	Motor
Gun# 1	50	68 ft.	1919	87	Navy	Yes	Barb.	1919	15	Navy	Each Gun
Gun# 2	50	68 ft.	1919	86	Navy	Yes	Barb.	1919	16	Navy	Elev.Motor 50 H.P.
3											Rammer Motor 30 H.P.
4											Traverse Motor 7-1/2H.P.
5											Comp Motor 30 H.P.
6											
7											
8											

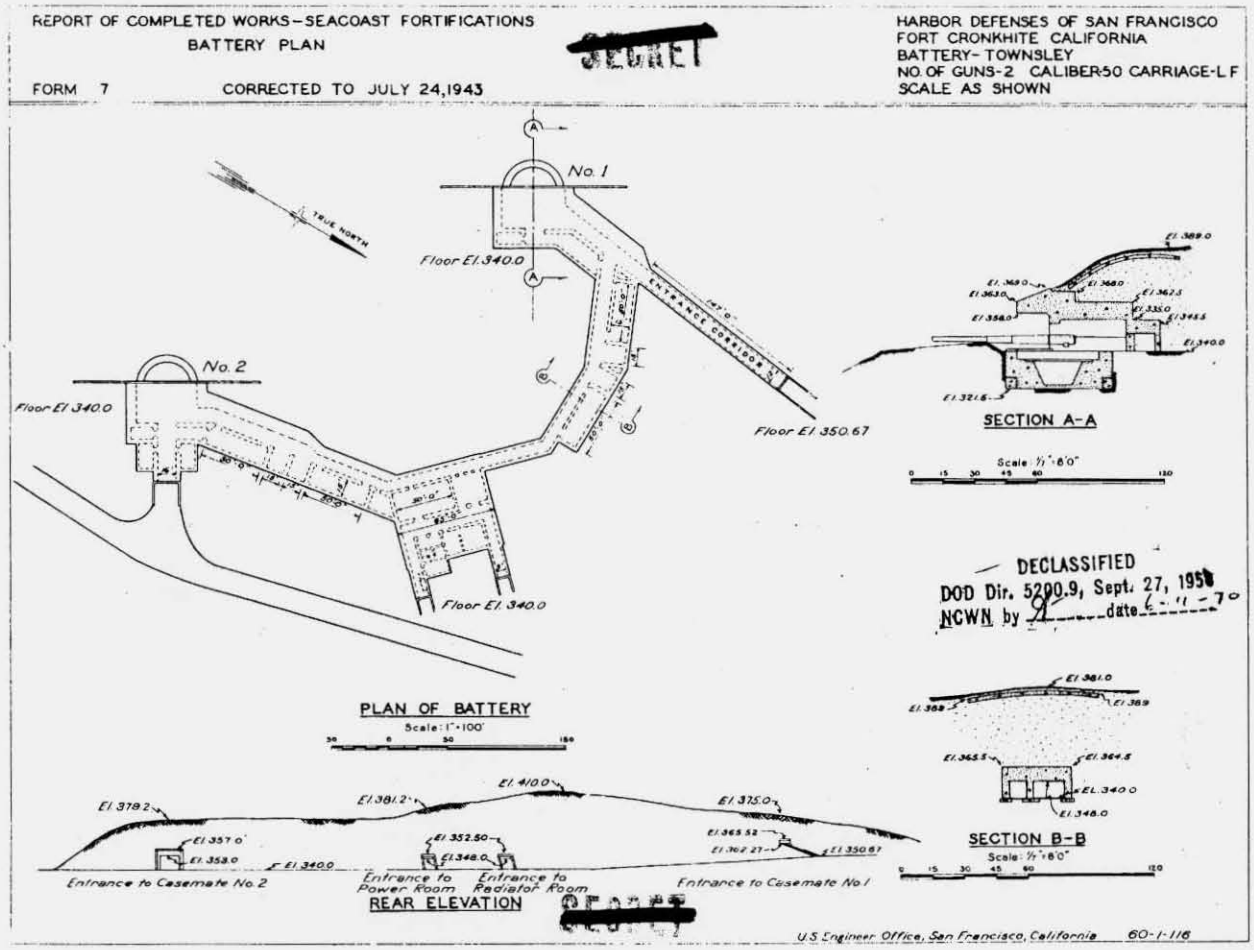
HOISTS

Emplacement Number	Type	Delivery	Motor: Serial No.	Maker	H.P.	Volts	RPM	Type of control	Date of transfer	Remodeled for long points
1		One level Battery - No Ammunition Hoists required Twenty-five 1-1/2 ton, hand-powered hoists for conveying shells to guns.								
2										

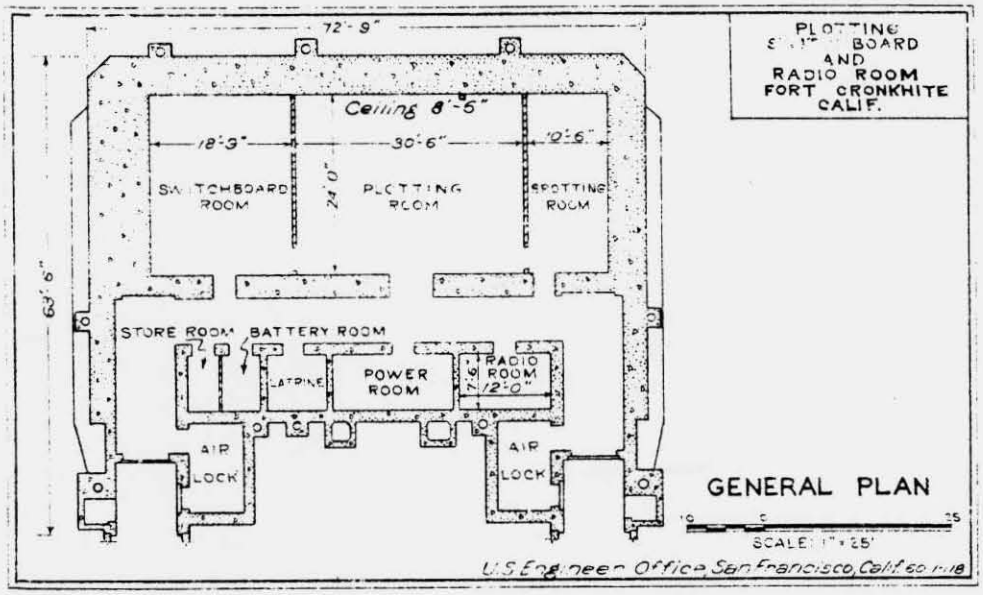
Note (see reverse side)

SECRET

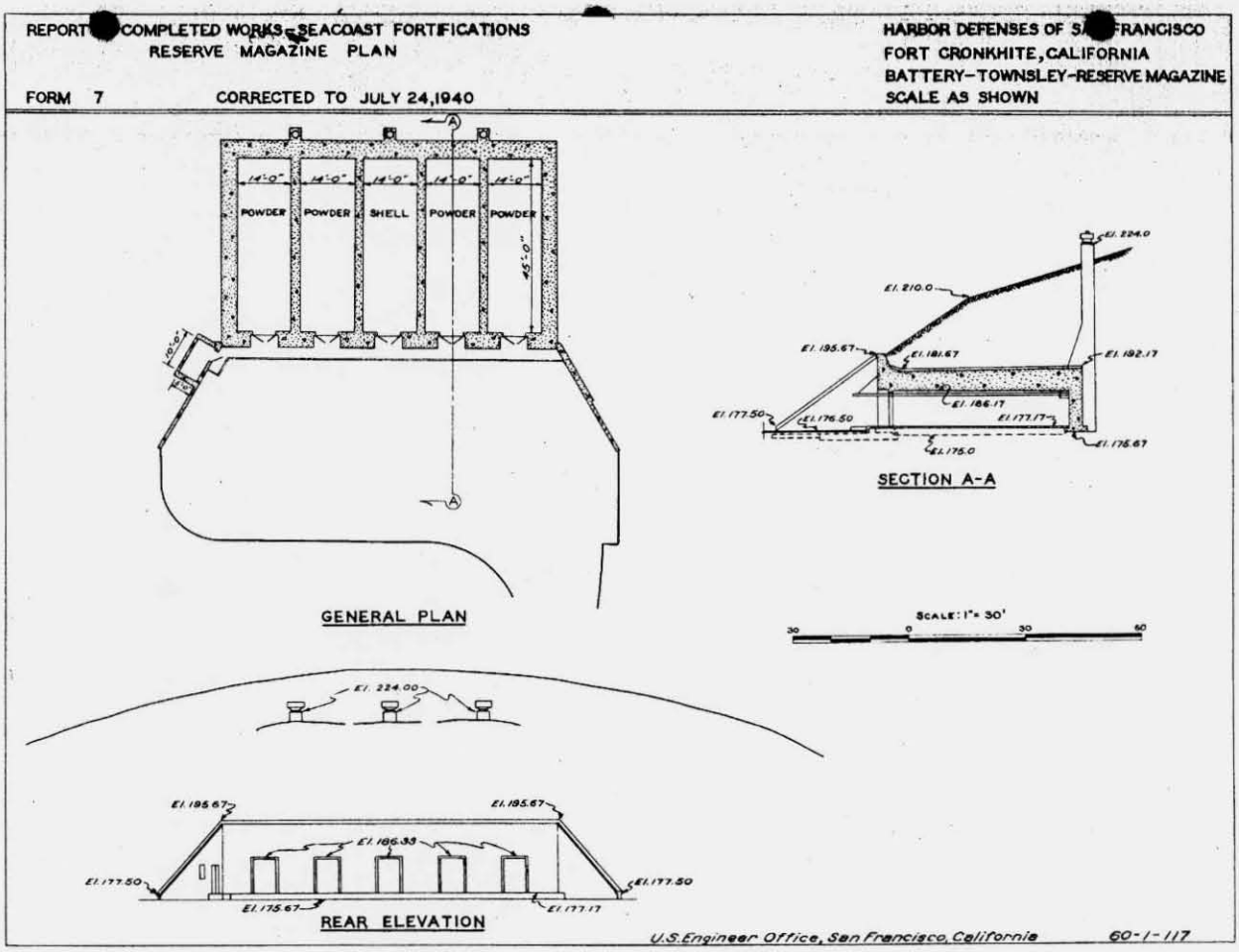
26 a. Report of Completed Works, Form 1, Battery Townsley, Fort Cronkhite, HD of San Francisco. This RCW contains several errors



26 b. Report of Completed Works, Form 7, Battery Townsley, Fort Cronkhite, HD of San Francisco. This RCW contains several errors



26 c. Plotting, switchboard, and radio rooms, Battery Townsley



26 d. Reserve magazine, Battery Townsley

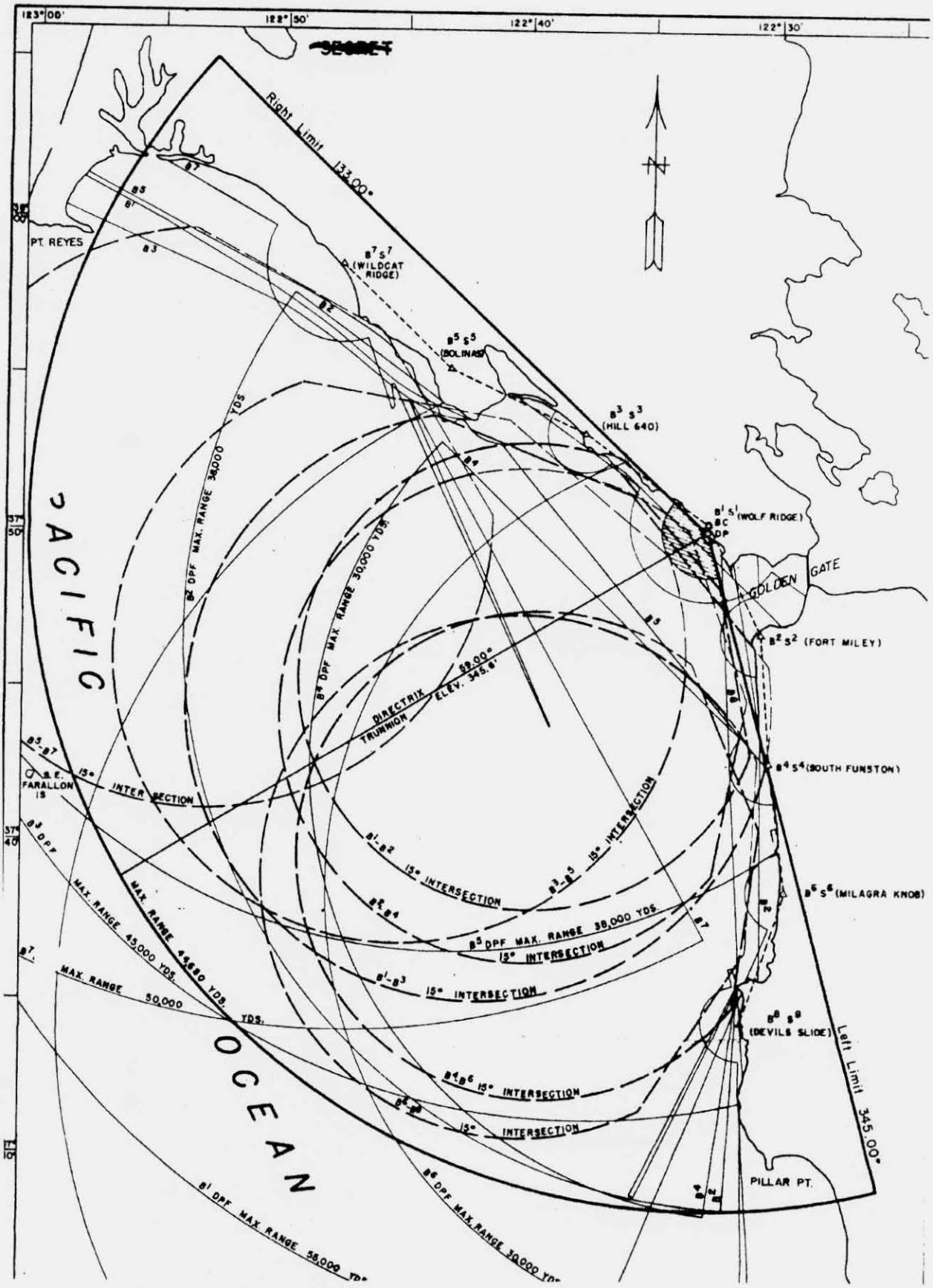
batteries. These batteries were all to occupy positions where wide fields of fire would be desirable, consequently the turret vs. casemate decision was critical.

This study was submitted almost a year later, on February 19, 1940. General Wesson, chief of ordnance, reported that the Army Air Corps had produced some interesting statistics. For a 90% chance of hitting a 16-inch gun, the Air Corps would need to use 38 aircraft with 2000-pound bombs. A 50% chance of hitting, however, could be accomplished by either 12 aircraft with 2000-pound bombs or only four airplanes with four 600-pound bombs each. In any event, the Air Corps would consider a 16-inch battery a desirable target and a very feasible mission. The antiaircraft guns that could be provided were considered insufficient to completely protect the guns under all conditions.

The Ordnance Department continued to oppose shields. They could offer little or no protection against a 600-pound bomb striking closer than 20 feet, and therefore, Wesson did not recommend their use after the Sakonnet Point battery. (In the final event, the battery at Sakonnet Point was built casemated.)

The casemated batteries, as built in San Francisco, were considered excellent, protecting against both naval gunfire and aerial bombardment. The only drawback was the limited fields of fire, and this could be solved with 3 or 4-gun batteries.

Comparing cost estimates, Wesson believed a 4-gun casemated battery would cost no more than a 2-gun turreted battery, and would be superior. Lastly, and perhaps most tellingly,



27. Field of fire, Battery Townsley. *Supplement to Harbor Defense Project, HD of San Francisco, 1945*

the design for casemated batteries already existed, while that for turrets would require two years to develop. Therefore, Wesson recommended casemates for all 16-inch batteries for which funds were to be available during FY 1941 and 1942, with 3-gun casemated batteries at Point Judith, RI, and Fort Sherman, CZ.

Col. George Mayo, chief of the Construction Division, reported to Gen. John J. Kingman, chief of engineers, on September 12, 1939, that in his opinion, the shielded battery of the type intended for Sakonnet would provide all the overhead cover necessary. Antiaircraft guns would keep enemy planes high enough to make the chance of hitting the small target remote; all that was needed was to protect the material, as opposed to personnel, from splinters and fragment. Mayo said the members of the Harbor Defense Board had informally expressed the same opinion.

The next day, Mayo noted for the record that in a telephone conversation, Lt. Col. Robert W. Crawford, of the War Plans Division, told him a new type battery requiring at least a year and a half to design could not be used in the present emergency program. Clearly, this ruled out turrets; they could not be competed in time.

On December 15, Mayo prepared another memorandum, this one for Col. Frederick S. Strong, in the Office of the Chief of Engineers. It compared the cost of 2, 3, and 4-gun casemated batteries, turret batteries, and batteries using tunnel shields. The 3 and 4-gun batteries were further divided into Case I and Case II, depending on whether the magazine, power, and plotting rooms would remain the same as for the 2-gun batteries or be proportionately increased. The total costs, engineer and ordnance, for the different battery types were:

2-gun Casemate:	$2,120,000
3-gun Casemate, Case I:	2,780,000
3-gun Casemate, Case II:	3,025,000
4-gun Casemate, Case I:	3,440,000
4-gun Casemate, Case II:	3,890,000
2-gun Turret:	3,850,000
2-gun Tunnel Shield:	1,820,000

On March 20, 1940, Maj. Gen. Julian L. Schley, chief of engineers, largely agreed, but asked that a turret design be prepared and a battery built and tested to determine its suitability for future use, although Schley acknowledged that they could not be used for batteries to be built within the next six years. The cost of a 3-gun casemated battery could not be justified for Point Judith, so a 2-gun battery was recommended. A 3-gun casemated battery was recommended for Montauk Point, while Fort Sherman might require a 3 or 4-gun battery. Schley did not entirely rule out tunnel shields, but confined himself to suggesting their economy and all-around fire be weighed against the need for more complete protection.

Maj. Gen. Joseph A. Green, now chief of coast artillery, submitted his opinion on April 1. He agreed with Schley's recommendation to construct a turret battery for comparison against the casemated batteries. The need for overhead protection for batteries requiring wider fields of fire than afforded by the casemate design made this all the more urgent.

While Green acknowledged that each future site was to be evaluated on its own, there was the matter of the six barbette carriages for which the chief of ordnance requested authorization. Green reviewed the seven sites projected to receive the next 16-inch batteries and

concluded that a reduction in the desirable fields of fire was justified by the superior overhead protection offered by the casemated battery. He therefore supported construction of the six additional carriages.

It may be noted that of those sites where the desirable fields of fire were substantially greater than allowed by casemates (Point Judith, Montauk Point, Fort Story, Cape Henlopen, Cape Charles, and Fort Sherman), three sites (Point Judith, Montauk Point, and Fort Story) eventually received two casemated 16-inch batteries each. Cape Henlopen received one 16-inch casemated battery, while a new casemated 12-inch battery replaced a second 16-inch casemated battery during the planning stage. Cape Charles only received one casemated battery, and Fort Sherman never received any 16-inch batteries, nor any other modernized armament, although one 12-inch battery was casemated and proposals for 16-inch batteries persisted until after the war.

On May 2, 1940, the adjutant general announced the adoption of General Green's recommendations, with considerable reservations. Construction of the turret battery was not approved, pending further studies, and tunnel shields were eliminated from future consideration, although not yet rejected for Sakonnet Point. (They eventually would be.) Funds were requested for four 16-inch barbette carriages for Point Judith and Fort Story. Construction of the two additional carriages was not approved.

In June of 1940 the chief of coast artillery detailed a Board of Review, Harbor Defense Projects, under the president of the Coast Artillery Board, to make recommendations to the Harbor Defense Board concerning installations and armament no longer required for seacoast defense. The board recommended new armament needed for the harbor defenses on July 12:

- An additional four 16-inch and 28 12-inch batteries
- All seacoast armament should be provided with overhead protection
- Batteries for which that could not be done should be replaced.
- For new 12 and 16-inch batteries, turrets were preferred; they were essential where necessary fields of fire were too great for casemated batteries.

The total cost of a 2-gun turret battery was estimated at $2,950,000, which was $830,000 more than for a 2-gun casemated battery, but where one turret could serve in place of two casemated batteries, turrets would be cheaper.

On July 16, 1940, Colonel Mayo reported that Battery Townsley had been test fired and the casemate design appeared satisfactory in all respects.(27)

On July 20, 1940, Colonel Mayo reported to the chief of engineers on the July 19 meeting with the Board of Review. The navy's plans for a new turret, using a new 16-inch gun the navy was about to procure, were discussed. The turret was to have 8-inch top armor, 13-inch face, and 12-inch side armor. By putting the ammunition service on the same level as the turret, the depth of the emplacement below ground level could be reduced to about 32 feet, plus a few additional feet required for footings.

Manufacture and delivery of the turrets would require two to three years, with six months more for installation, whereas the carriages would take 18 months. By comparison, casemates could be built in about 20 months.

Colonel Mayo noted that the coast artillery continued to prefer turrets, but would accept casemates where fields of fire could be restricted. The Board of Review changed its earlier

recommendation calling for 28 12-inch batteries to a recommendation for an equal number of 16-inch turrets. Mayo reported he told the board he ". . . believed the Chief of Engineers would be startled by the departure from former recommendations but his [chief of engineers'] policy in general was to give the using service what they wanted." Mayo then recommended his chief approve the Board of Review's action.(28)

On August 9, 1940, Colonel Mayo noted for the record that he had discussed with Colonel Crawford two differing approaches to casemating the dispersed batteries already constructed. The distance between the guns in these early batteries was too great for a single magazine and casemates. Either separate magazines would have to be provided or the guns would have to be moved closer together. Mayo preferred to abandon one original gun block and build a new block closer to the second original block, constructing a magazine between the old and new blocks, to completely protect the ammunition service. He estimated the cost at $1,180,000. Colonel Crawford preferred to provide a casemate and small magazine for each gun, without relocating either gun block. Mayo estimated the cost for this at $600,000. Casemating the guns of a battery that already had a central protected magazine (Battery Long) would only cost by $300,000, since the magazine was already built.(29) Batteries Harris and Hatch were eventually given separate casemates for each gun, as proposed by Colonel Crawford.

With the fall of France in the summer of 1940, the possibility of naval attack on the Atlantic and Gulf coasts had to be seriously reappraised. In June 27, 1940, the Harbor Defense Board recommended adding 27 16-inch batteries to the 10 previously authorized (some which had been completed several years ago). In September, the secretary of war approved this recommendation in the "Modernization Program of Harbor Defenses, Continental United States." All existing and projected major-caliber barbette batteries, except those in the Philippines, were to be provided overhead cover. The new defenses, when completed, could be manned by substantially fewer troops than the less efficient armament they would replace. One hundred and twenty-eight older batteries were slated to be eliminated when the 27 new 16-inch and 50 new 6-inch batteries in the continental United States were completed.(30)

On March 17, 1941, Colonel Mayo again remarked in a letter that one San Francisco battery (Townsley) had been proof fired and "is considered a pretty good installation." Much thought had been devoted to turrets, but the engineers had dropped the idea when the Ordnance department assured them they could not be produced in less than 6 years.(31)

Early in 1941 the chief of coast artillery distributed "Notes on Type Harbor Defense Installations" to officers detailed to local boards or concerned with harbor defense projects. The weakest portions of the major-caliber casemated batteries were to be protected against 600-pound demolition bombs, and against 2000-pound demolition bombs where practical. Casemated 16-inch batteries would have a maximum field of fire of 145° per gun, with a maximum of 200° for the battery. The magazines were to hold 100 rounds per gun. Plotting, switchboard, and radio rooms, as well as the battery commander's station and the primary base end station, were to be located away from the casemate structure.

Carriages were to be provided with two-inch common-steel shields, but consideration was being given to increasing this to four inches.

In May 1941, the commanding general of the 9th Coast Artillery District asked for sleeping and cooking facilities in the batteries, but the chief of coast artillery and the chief of engineers felt that providing such facilities would encourage the quartering of troops in the

batteries instead of nearby barracks, which would interfere with the operation of the batteries. However, "prison-type" steel bunks to accommodate 150 men were installed in each battery during 1943. In March of 1942, the division engineer asserted that the design for Batteries Davis and Townsley was "fundamentally wasteful of steel and concrete and unsound," and that "a great saving in reinforcing steel would result if the roofs of the 10-foot and 14-foot corridors in the magazine structure are arched instead of using horizontal slabs as shown on the type plans." The Office of the Chief of Engineers energetically rejected this contention, and the roofs remained flat. Proposals by the Coast Artillery Board to return the plotting/switchboard rooms to the magazine were also rejected, for the reasons that led to their removal in the first place: The noise and shock from the guns and the likely damage to the gasproof doors from repeated firing.

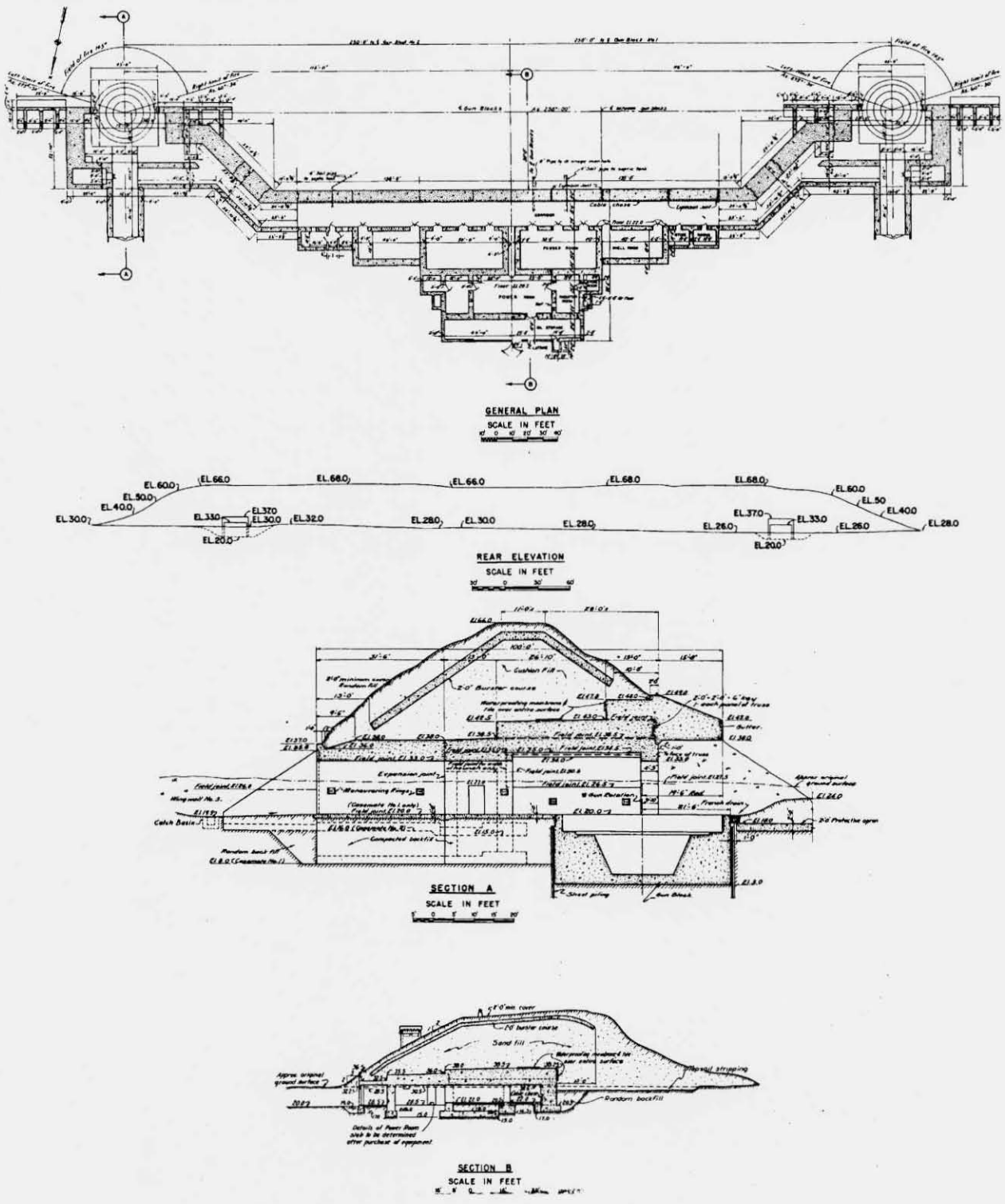
By July 2, 1941, a total of 37 continental batteries had been authorized, including the two batteries at New York and Boston that had been authorized and completed almost 20 years previously and the two San Francisco batteries completed more recently. Five more were under construction: one each at Narragansett Bay, Delaware Bay, and Long Island Sound (Montauk Point), and two at Chesapeake Bay **[Fig. 28]**. The War Plans Division reviewed the role of seacoast artillery, in view of America's rapidly growing air power and the vulnerability of naval forces to air attack, and concluded that the number of batteries was excessive. The WPD recommended a total of 21 continental 16-inch batteries, as an additional precaution and to "meet the needs of seacoast communities for protection." Batteries currently approved, with those recommended for elimination, were:

Location	Approved	Recommended	Loss	Final
Portland	2	0	2	1
Portsmouth	1	0	1	1
Boston	4	2	2	3
Narragansett Bay	4	2	2	3
Long Island Sound	4	2	2	3
Sandy Hook	3	2	1	2
Delaware Bay	2	1	1	1
Chesapeake Bay	5	3	2	3
Charleston	1	1	0	0
San Diego	2	2	0	2
Los Angeles	2	1	1	2
San Francisco	4	3	1	3
Puget Sound	3	2	1	1
TOTAL	37	21	16	25*

* This total includes all continental 16-inch batteries substantially completed, including several never armed.

The WPD's recommendations were not implemented, at least in their entirety, but the War Department decided in late summer to defer those 14 batteries that could not be completed before the end of June 1944. Construction on other batteries continued, but not all were ever completed.(32)

By FY 1942, the Corps of Engineers began to casemate most of the 16-inch batteries built before the adoption of casemates. Casemating Batteries Long and Harris **[Fig. 33]** began on



28. Battery Hamilton, BCN 108, a Type A 16-inch battery, was begun in 1940 at Fort Greene, HD of Narragansett Bay.

September 1 and October 14, 1941. Batteries Hatch and Murray were begun on May 17 and July 30, 1942. At the same time, almost all the more numerous WWI-vintage 12-inch batteries were casemated **[Figs. 36 & 37]**. Since the guns involved were often the most powerful weapons in the defenses, instructions emphasized that one gun of each battery was to remain in service at all times during casemating. In addition, several new 12-inch and one new 8-inch **[Fig. 12]** battery were built casemated, and some batteries in Hawaii were casemated to protect them from rocks falling from above their tunnel openings.(34)

Measurements were made to determine whether firing the guns caused any lateral displacement of either casemates or gun blocks. Again, the instruments were not entirely satisfactory, but the movement measured was within the allowable error for the type measurements.

Lastly, several methods were used to try to measure the vibration in the gun blocks at both batteries. The results were somewhat ambiguous, but it was concluded that the gun blocks vibrated sufficiently to cause settlement in finer soils if the guns were fired enough.

Meanwhile, the Corps of Engineers, in conjunction with the Office of the Chief of Ordnance and the Army Air Corps, had conducted tests that demonstrated the need to increase the overhead protection for the casemated batteries. As the chief of engineers explained to the chief of coast artillery on August 11, 1941, six feet of reinforced concrete were found to be necessary to stop a 2000-pound bomb, and 16 feet to defend against 16-inch projectiles. In response, two new designs were developed.

Type A, modified, was the present design with additional overhead protection. The layout was not changed, but the overhead burster course was extended down the slope to protect against bombs striking just outside the structure. The course was to be increased in thickness to six feet, and widened to 37 feet.

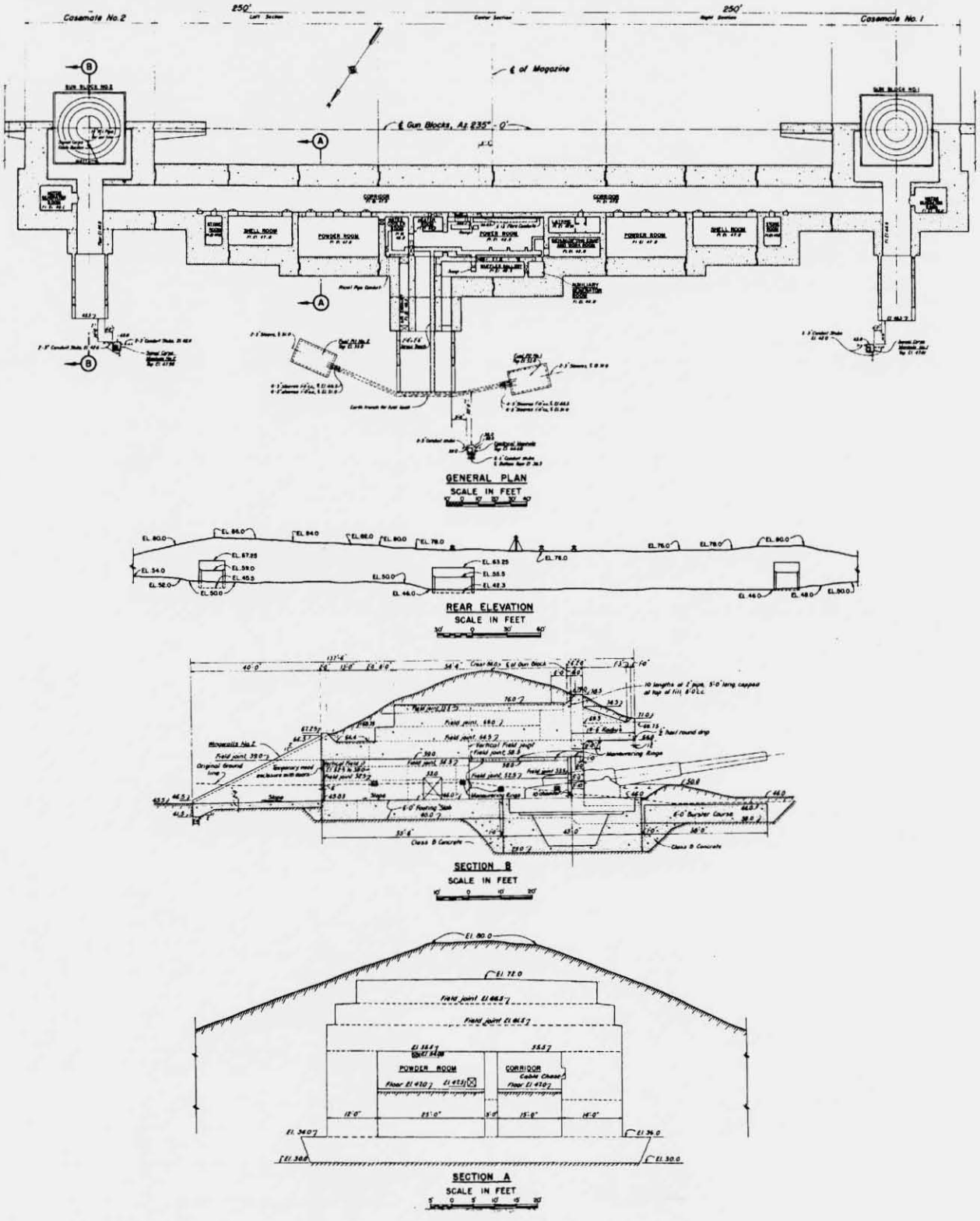
Type E was a more radical redrawing of the plan **[Figs. 29 & 30]**. The casemates were withdrawn 22 feet, eliminating the dumbbell effect that made them more conspicuous. The connecting corridors were straightened and entry to the casemates was from the rear, eliminating the need for the heavy girder over the corridor entrances. The service galleries were also eliminated, but space was provided in the corridor for parking ammunition trucks and overhead carriers. The space between the burster course and the ceiling was to be solid concrete, protecting against 2000-pound bombs. (If concrete filled the space between the burster course and the ceiling, in effect the burster course ceased to exist.)

Of the 37 approved continental batteries, four were completed (Battery Long, Boston; Battery Harris, New York, and Batteries Davis and Townsley, San Francisco) and four (BCN 107, Sakonnet Point; BCN 108, Point Judith; BCN 118, Cape Henlopen; and BCN 120, Fort Story) were under construction. These eight would not be affected by the changes.

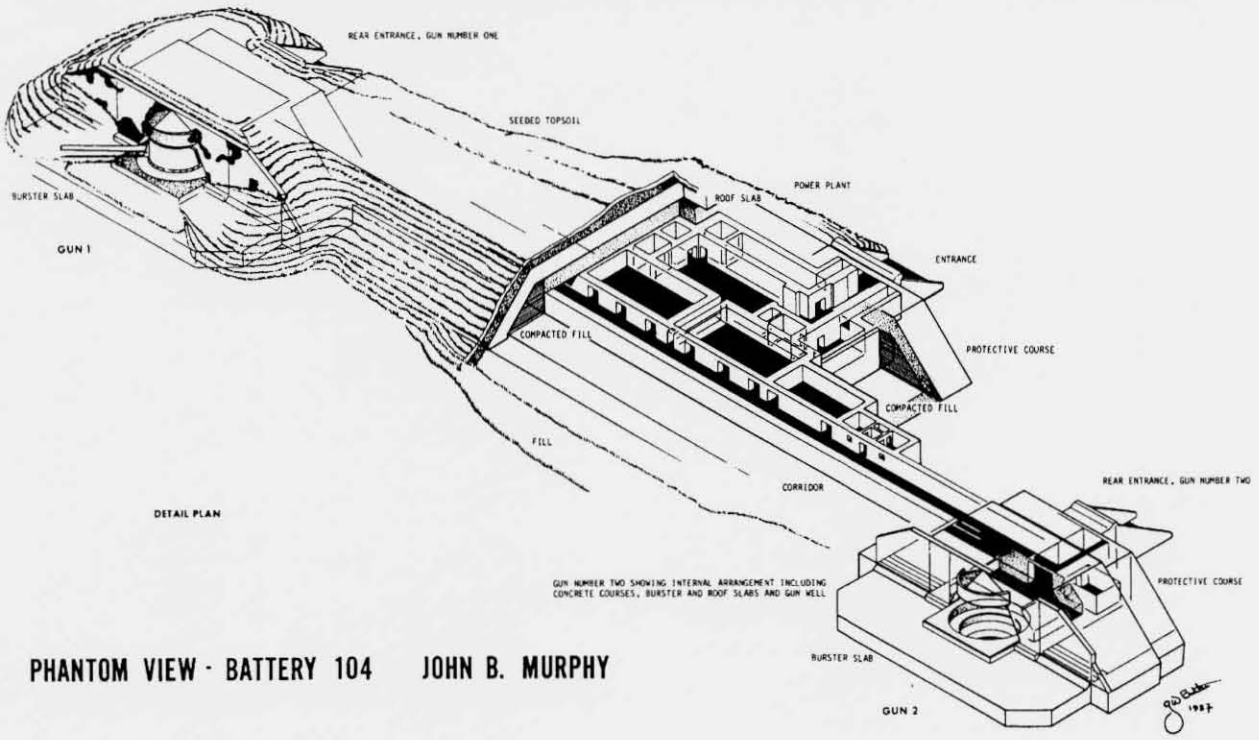
BCN 119, the second 16-inch battery approved for Cape Henlopen (subsequently replaced by a 12-inch casemated battery), and BCN 121, the second 16-inch gun battery approved for Fort Story, were considered best adapted for Type A, modified.

BCN 129, Fort Barry; BCN 130, Milagra Ridge, CA, (never built); and BCN 131, Striped Peak, WA, were considered suitable for either type. All other batteries were believed best suited for Type E. Eighteen days later, the Office of the Chief of Coast Artillery concurred.

In the end, no Type A, modified, batteries were ever constructed. All further construction was of Type E, with the exception of BCN 129, at Fort Barry, which was, like the other San Francisco batteries, unique **[Fig. 35]**.(33)



29. BCN 109, a Type E 16-inch battery, was begun in 1942 at Fort Greene, HD of Narragansett Bay.



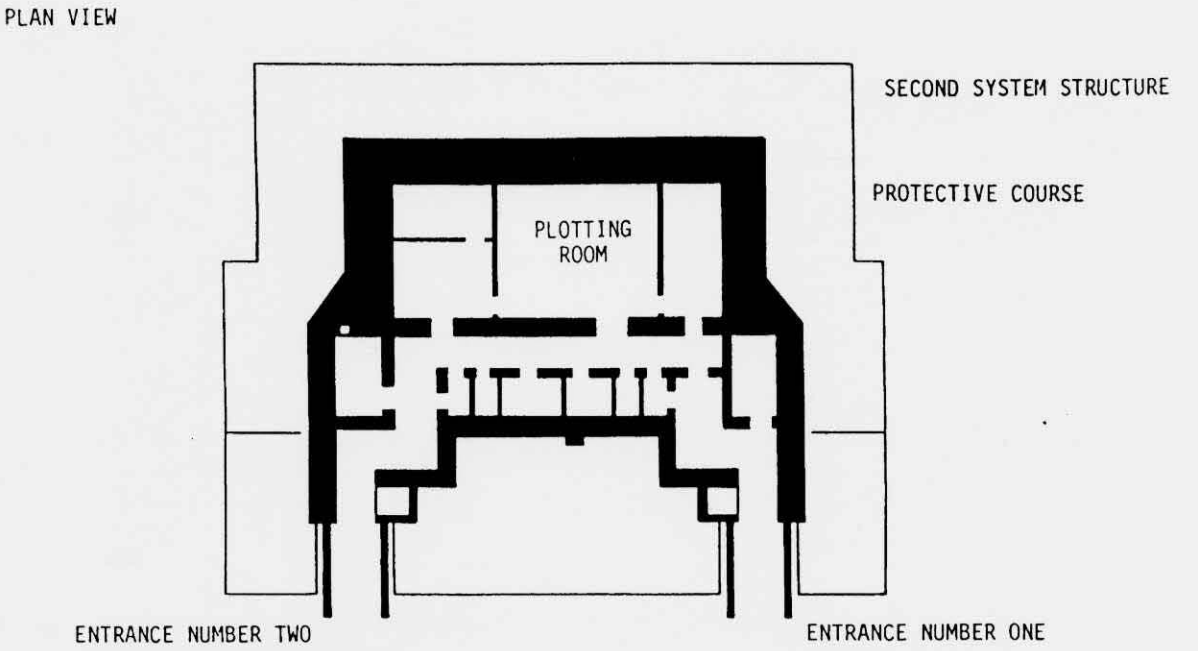
30. Battery John B. Murphy, BCN 104, a Type E 16-inch battery, was begun in 1942 at East Point M.R., Nahant, HD of Boston. Gerald W. Butler, *Military Annals of Nahant, Massachusetts*

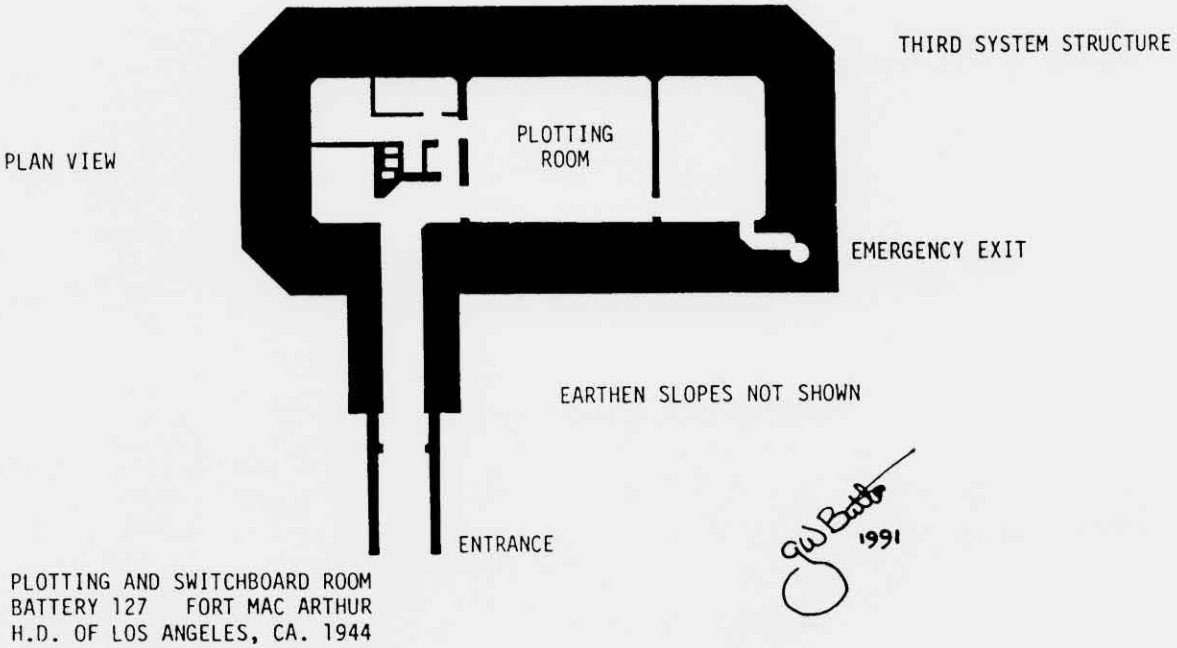
By FY 1942, the Corps of Engineers began to casemate most of the 16-inch batteries built before the adoption of casemates. Casemating Batteries Long [Fig. 33] and Harris began on September 1 and October 14, 1941. Batteries Hatch and Murray were begun on May 17 and July 30, 1942. At the same time, almost all of the more numerous WWI-vintage 12-inch batteries were casemated #[Figs. 36 & 37] and several new casemated 12-inch batteries were built. (Even one existing 8-inch battery was casemated and one new 8-inch battery was built casemated #[Fig. 12].) In addition, some batteries in Hawaii were casemated to protect them from rocks falling from above their tunnel openings. Since the guns involved were normally the most powerful weapons in the defenses, instructions emphasized that one gun of each battery was to remain in service at all times during casemating.(34)

By now, additional parties were involved in the discussion. The War Plans Division was abolished in a War Department reorganization, and the Army Ground Forces was created. The AGF convened a conference on September 8, 1942, to discuss military attaché recommendations following the fall of Hong Kong, Singapore, and the Philippines. Representatives of the Coast Artillery Corps, Signal Corps, Corps of Engineers, Ordnance Department, Army Ground Forces, and General Staff attended. The agenda included overhead protection and landward fire of fixed seacoast batteries.

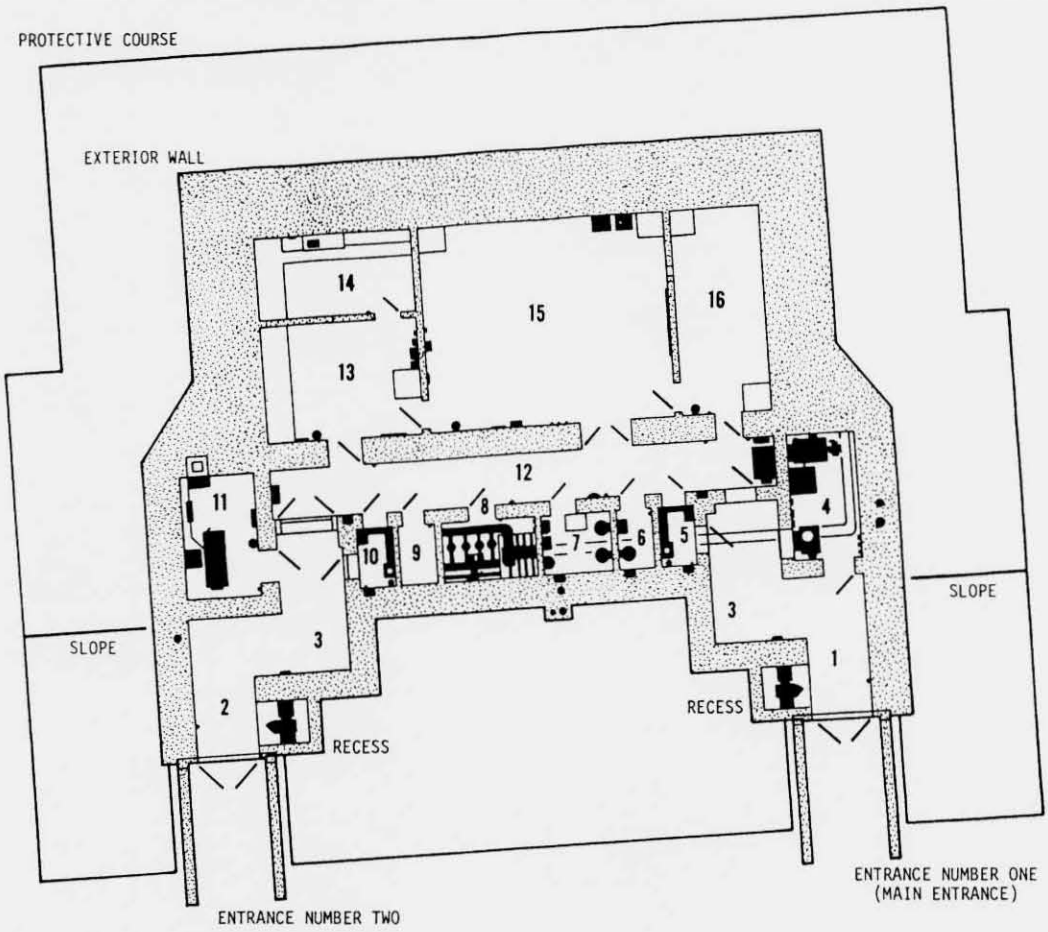
In support of the conference, the Coast Artillery Board had been requested to submit a study. The board strongly recommending turrets for all major-caliber seacoast guns, but the conference concluded:

1. The current modernization program was generally satisfactory and was at a point where radical changes should not be made.
2. Casemating of 12 and 16-inch batteries should not preclude adoption of turrets in the future.





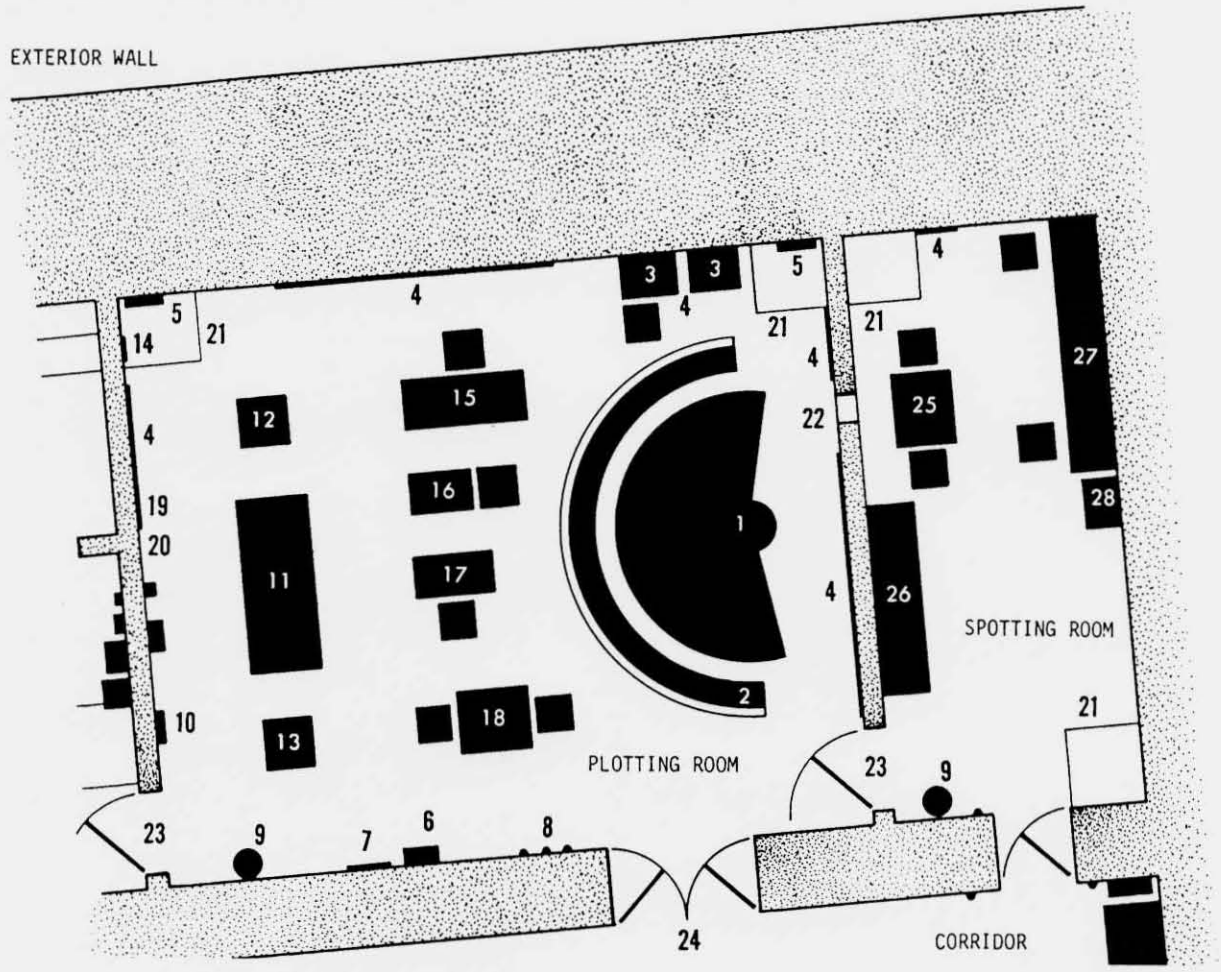
31. Two styles of plotting rooms constructed for 16-inch batteries.
Gerald W. Butler, *Military Annals of Nahant, Massachusetts*



32a. The plotting room for Battery John B. Murphy. Rooms: 1) entrance hall #1, 2) entrance hall #2, 3) blast trap, 4) heating & dehumidifying room, 5) air lock #1, 6) officers' latrine, 7) enlisted men's latrine, 8) Chemical Warfare Service room, 9) storeroom, 10) airlock #2, 11) power and storage battery room, 12, corridor, 13) fire control switchboard room #1, 14) fire control switchboard room #2, 15) plotting room, 16) spotting room. Gerald W. Butler, *Military Annals of Nahant, Massachusetts*

3. One factor in the adoption of casemates was the delay necessary for the design of turrets.
4. Turret designs should be completed to ensure that they were available in the future.

The conference recommended the chief of ordnance initiate action as soon as possible to design 16-inch turrets, but no other major changes should be made in present plans for overhead protection of fixed batteries. The Office of the Chief of Ordnance objected to this, explaining on September 21 that designing turrets would involve several million dollars and a large investment of engineering talent and facilities. Given the competition for facilities and material, diversion of effort into designs that could not be produced in time to be of value in the present war would be a mistake. The Ordnance Department repeated earlier proposals to add a third or fourth gun to the casemated batteries where the field of fire desired was too great to be covered by two casemated guns. The Ordnance Department strongly felt that turrets had been considered in the past and rejected, and this policy should not now be reversed. The commanding general, Army Ground Forces, agreed with the chief of ordnance, and so informed the chief of staff on October 23, 1942.(35)

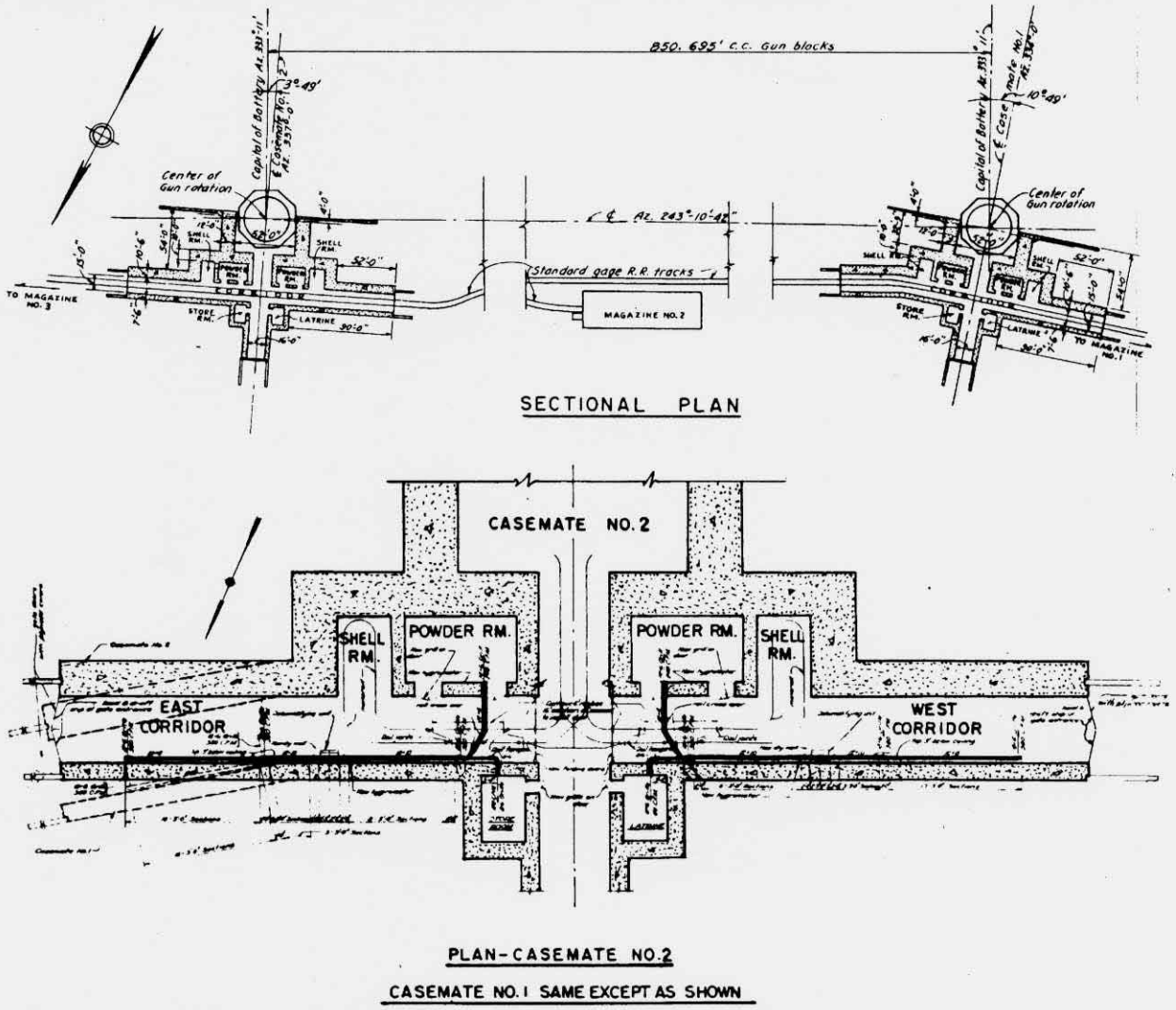


INITIAL DRAWING: 1969
REVISED DRAWING: 1995

32b.Detail layout of the plotting room for Battery John B. Murphy. Plotting room equipment: 1) plotting board M-4, 2) operator's bench, 3) switchboard BD-94, 4) EE-91 telephone panel, 5) telephone junction panel box, 6) temperature controller, 7) instructions for air conditioning, 8) light switches, 9) fire extinguisher, 10) main junction box – data transmission, 11) gun data computer M-1, 12) azimuth transmitter M5, 13) elevation transmitter M6, 14) time interval bell, 15) range correction board M1A1, 16) fire adjustment board M1, 17) percentage corrector M1, 18) deflection board M1, 19) wind component indicator, 20) meteorological message board, 21) Signal Corps hand hole, 22) passage, 23) steel door type "L," 24) double steel doors type "J," 25) spotting board M-3, 26) range scale storage cabinet, 27) radio receivers and transmitters, 28) radio, marine telephone. Gerald W. Butler, *Military Annals of Nahant, Massachusetts*

The battle of Midway in June of 1942, the pivotal event of the war in the Pacific, had great impact on the construction of fortifications on the west coast. In addition, by this time it was also clear that the British navy would continue to be more than a match the German and Italian surface fleets, while the French navy no longer posed a threat. In September 1942 the army, with navy concurrence, eliminated 10 batteries that had been deferred, and subsequently cancelled even more.(36)

An October 4, 1944, request for comments and suggestions for improving the design of seacoast fortifications produced a flood of responses from engineer and coast artillery officers. Complaints about humidity and condensation were particularly common, as were complaints about damage from the blast of the big guns. The Corps of Engineers expanded

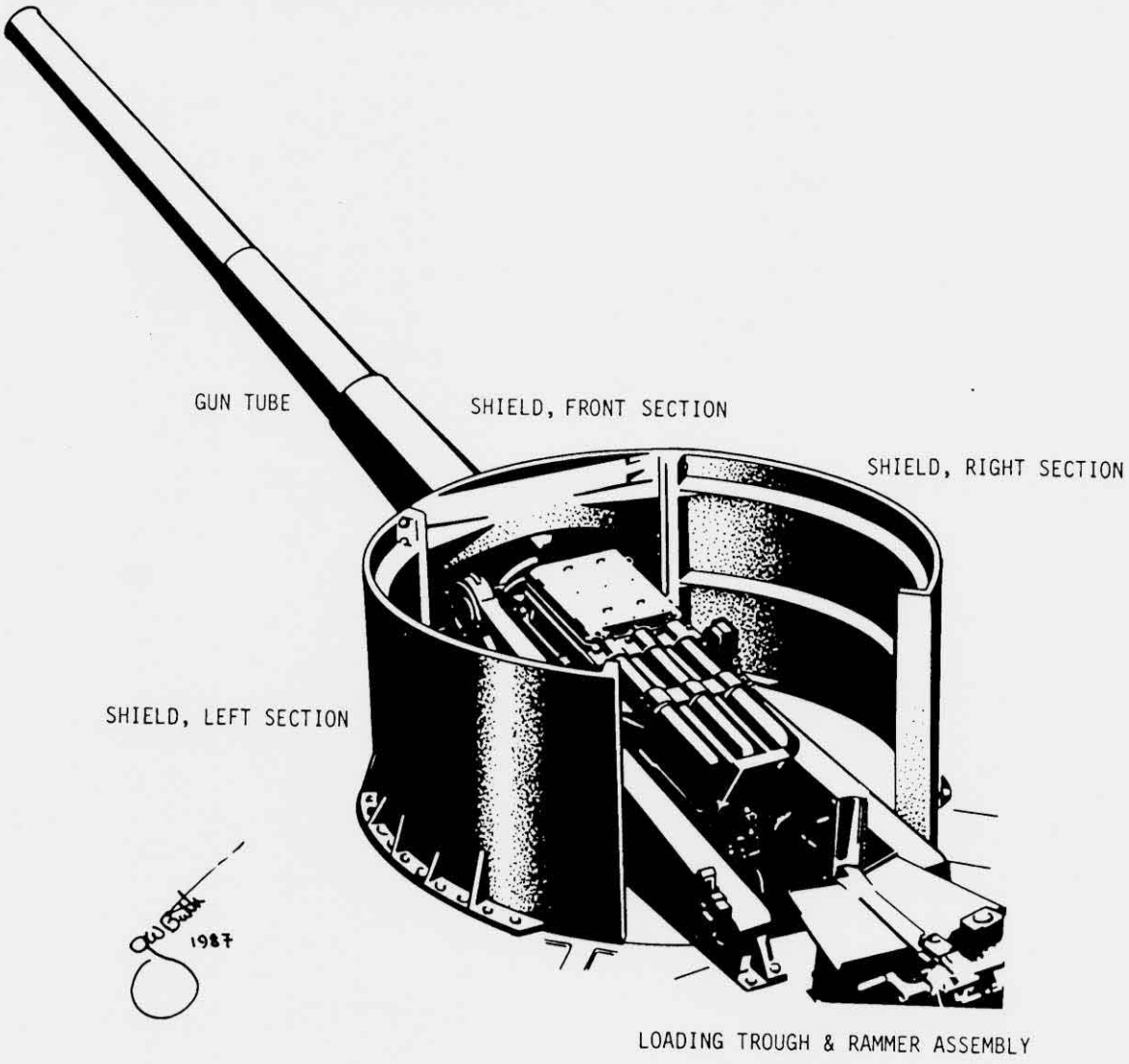


33. Battery Harris was originally built as a dispersed 16-inch battery, but was casemated during WW II as shown here.

heating and dehumidification apparatus and generally labored throughout the rest of the war to modify the batteries to alleviate these complaints.

Meanwhile, the Joint Chiefs of Staff concluded on March 20, 1945, "As to major-caliber and minor-caliber fixed seacoast artillery, all that we now have, emplaced in continental and overseas harbor defenses, should be retained and maintained in serviceable condition, with the recognition that subsequent developments may demonstrate the desirability of substituting some type of new weapon therefore."(37)

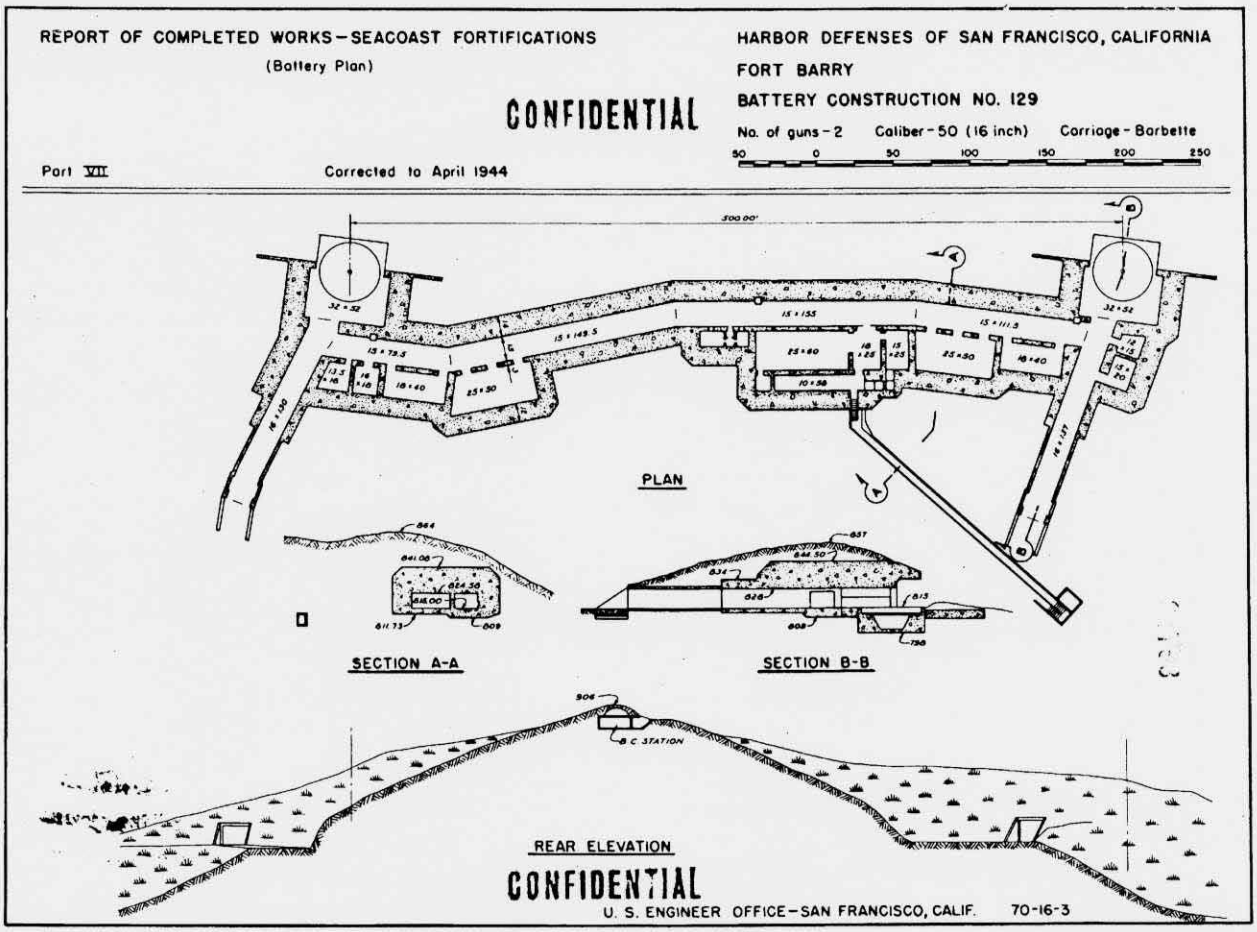
By the end of 1945, however, what was the realistic need for major-caliber seacoast armament? The United States had the greatest navy and air force in the world, in addition to sole possession of the atomic bomb. The only nation that had posed a surface naval threat now lay occupied, in smoking ruins. Although proposals to emplace turrets, especially for the defense of the Panama Canal, continued to be considered, the reality was soon clear. America had built its last major-caliber seacoast batteries. By 1949, the mighty coast artillery guns, which between 1940 and 1945 had cost a quarter of a billion dollars, were cut up for scrap. While a coast defense role was still envisioned for dual-purpose rapid-fire guns, the era of seacoast fortifications had passed.(38)

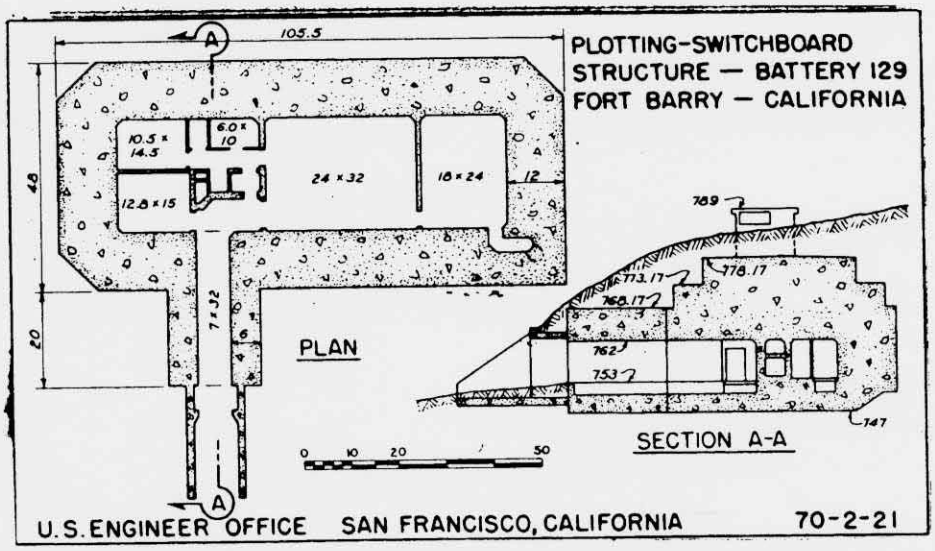


34. Rear view of navy 16-inch Mk II gun on M4 carriage.
Gerald W. Butler, *Military Annals of Nahant, Massachusetts*

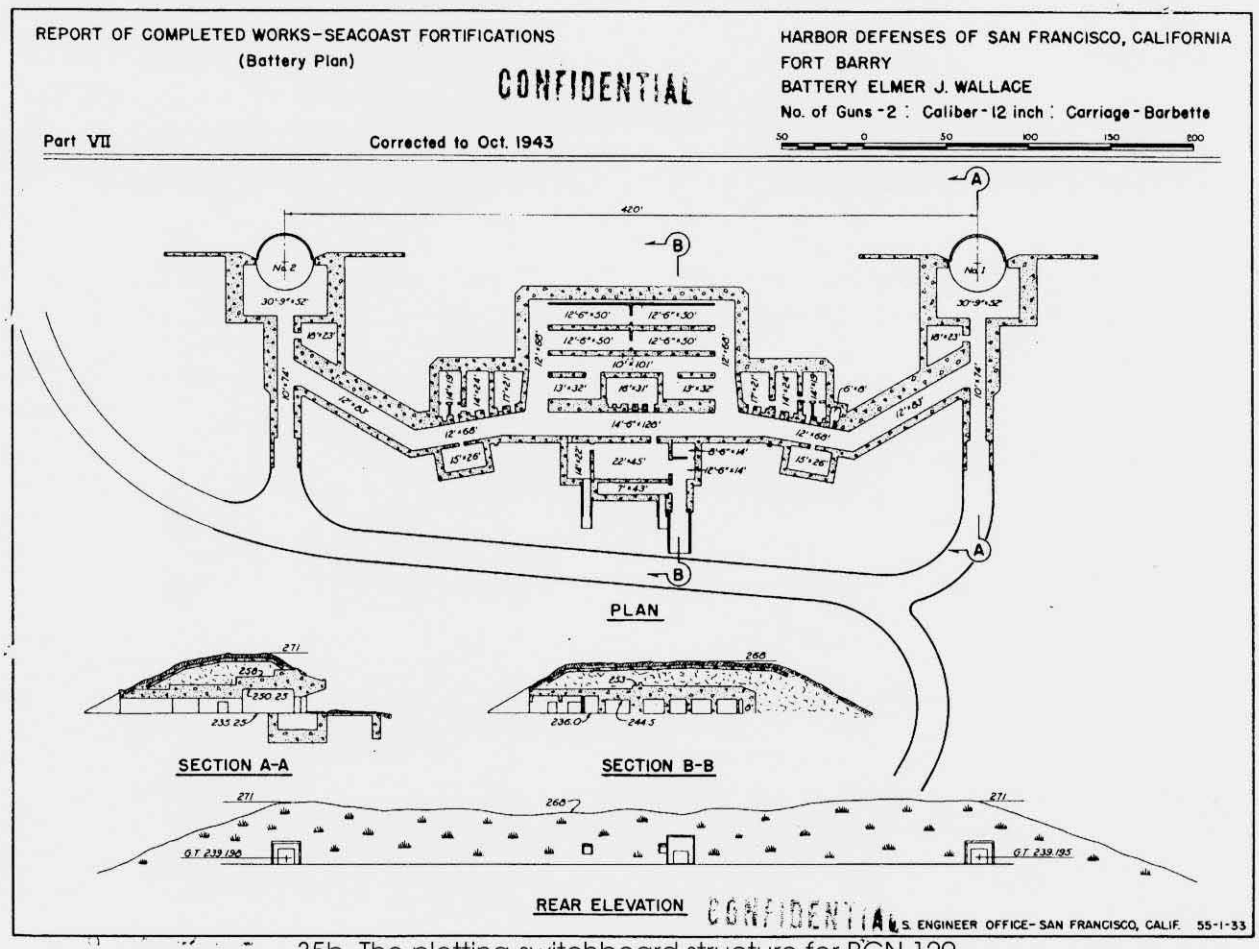
Summary

As the first new 16-inch batteries were installed in the 1920s, the guns and other battery elements were dispersed and almost completely unprotected. Subsequently, protected central magazines were approved, leaving the guns still unprotected. By early 1935, recognizing the growing threat of air attack, serious consideration was given, principally at the urging of the chief of coast artillery, to mounting the heavy guns in turrets. However, after almost a year of extensive study, it became clear that because of their cost, and the time necessary to develop and build them, turrets could not be employed at San Francisco. Continuing to emphasize the critical need for protection against air attack, the chief of coast artillery immediately proposed the guns be casemated. This was the origination of what was to become the WWII 16-inch casemated battery program. Despite the rejection of turrets for the San Francisco defenses being built at that time, the desirability of coast defense turrets remained strong. It transpired, however, that when expanded funding finally became available beginning in 1940,





35a. BCN 129, begun in 1942 at Fort Barry, HD of San Francisco.



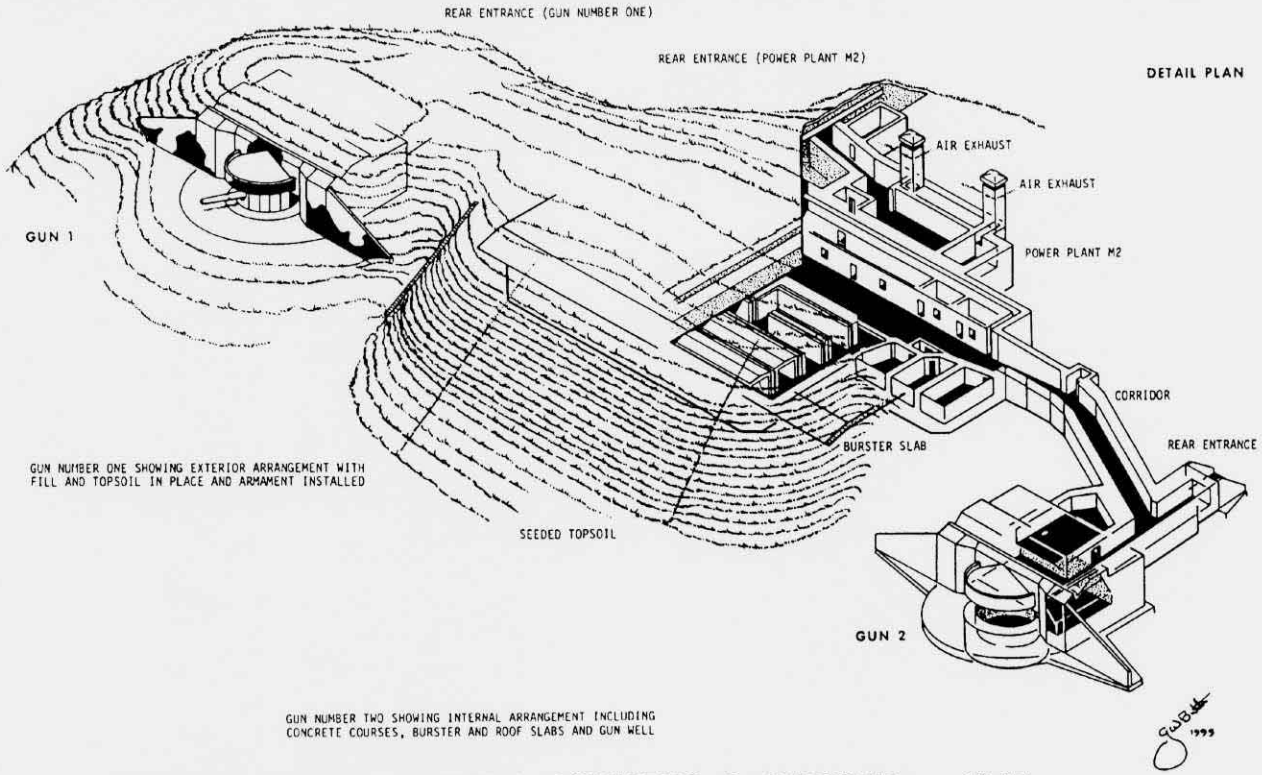
35b. The plotting-switchboard structure for BCN 129.

36. Battery Wallace, Fort Barry, HD of San Francisco, was built as a barbette 12-inch battery, similar to fig. 3. During WW2, it was casemated, as shown here.

there was no longer enough time to design, test, and build turrets. The rapid approach of war demanded that whatever was adopted had to be immediately available. Nevertheless, the advantages of turrets fueled continued interest, at one level or another in the War Department, until after WWII. But by then, no need could be demonstrated. While some still spoke of future construction, the day of the fixed fortified gun had passed. The casemated 16-inch batteries ended up as America's final generation of major-caliber batteries.

Conclusions

The process by which the designs were finalized is also instructive. The lengthy process, the differing perspectives, and the key role of the War Plans Division all stand out. While further research is necessary, the evidence suggests the War Plans Division had the greatest input into the final decisions concerning coast defenses, especially when the bureau heads failed come to any real agreement. Later, with the War Department reorganization, Army Ground Forces, and to a lesser extent Army Service Forces, played a key role. The extent to which these disagreements became personalized and affected attitudes and judgments between bureau members, cannot be discerned from the written record. All correspondence was proper and professional; individual emotions are left to the imagination. When deci-



PHANTOM VIEW - BATTERY AUGUSTUS P. GARDNER - 1945

37. Battery Augustus P. Gardner, begun in 1918, was built as a barbette 12-inch battery (fig. 4). During WW2 it was casemated, as shown here.

sions were reached, the officers on all sides united to implement the decision. It is interesting to note how the engineers cooperated with the coast artillery to design casemated batteries, even while advocating against their adoption.

Much has been written about the vulnerability of seacoast fortifications to air attack. This perception of vulnerability has been interpreted by some to mean that seacoast defenses were useless in the face of air power, and that American military planners ignored this "obvious" fact. The record clearly shows otherwise. Although another argument for another time, coastal fortifications proved quite resistant to air attack, as shown by the German batteries that survived the Allied aerial onslaught before D-Day, and Japanese defenses on several rocky islands. Even Corregidor, with outdated weapons virtually without overhead cover and with meager antiaircraft defense, successfully defied Japanese aerial attack, only to fall to starvation and the relentless hammering of siege artillery.

The happy circumstances of the American victory at Midway and the rapid success in the Pacific saved the new American coast defenses any actual trial against Japanese air and naval power. Nonetheless, since at least 1922, American military planners had seen the threat from the air, and the last generation of American seacoast defenses, with casemated 16-inch batteries, was primarily an effective response to this aerial threat.

Acknowledgements

Greg Hagge, Bob Zink, Bill Gaines, and David Hansen took the time to look over drafts of this article and offer valuable suggestions and advice. I am particularly grateful to Dave Kirchner, who freely shared his knowledge of the period; his numerous suggestions saved me from many mistakes. Those that remain are mine alone. I am also indebted to Gerald Butler, for his gracious offer of the use of the superb illustrations from his book, The Military Annals, of Nahant, Massachusetts, *published by the Nahant Historical Society in 1996.*

Sources

1. National Archives and Records Administration, Archives II (NARA-all citations are from Archives II, College Park, MD), Records of the Office of the Chief of Engineers, RG 77, Harbor Defense Files (HDF), Entry 1006, 662B; 662.2 I-1, 2nd ind.
2. Engineer Department, Engineer Mimeograph No. 1, 1923, "Harbor Defense." War Department, Corps of Engineers, Reports of Completed Works-Seacoast Fortifications, Batteries Harris, Williston, Murray, Haan, Hatch, and Pennington.
3. NARA, RG 77, Entry 1007, Harbor Defenses, Geographical Files, San Francisco (SF) 662. Emanuel Raymond Lewis, *Seacoast Fortifications of the United States: An Introductory History*, (Washington D.C.: Smithsonian Institution Press, 1970), p. 111.
4. NARA, RG 77, Entry 1007, Harbor Defenses, Geographical Files, San Francisco (SF) 662.
5. NARA, Records of the Adjutant General's Office, RG 407, Decimal files 662 (Ft. Funston).
6. NARA, RG 77, Geographic files, 662B SF 30.
7. NARA, RG 77, HDF, 662B.
8. NARA, RG 77, HDF, 662B 87.
9. NARA, RG 77, HDF, 662B, WPD 3655.
10. NARA, RG 77, HDF, 662.2 I-1.
11. NARA, RG 77, HDF, 662B 94/1.
12. NARA, RG 407, AG 662; AG 662 WPD 399-19.
13. NARA, RG 77, Geographic files, 662B SF 26.
14. NARA, RG 77, HDF, 662B WPD 3655-1.
15. NARA, RG 77, HDF, 662B 106. War Department, *Coast Artillery Field Manual, Vol. 1, Seacoast Artillery, Part One, Tactics* (GPO, 1933), p. 6.
16. NARA, RG 77, HDF, 662B 118; G3 33061; G4 30087.
17. NARA, RG 77, HDF, 662B, WPD 3655-1.
18. NARA, RG 77, Geographic files, 662B SF 54.
19. NARA, RG 407, AG 662 256.
20. NARA, RG 77, Geographic files, 662B SF 50.
21. NARA, RG 407, AG 662 (Ft. Funston) 257, 256.
22. NARA, RG 77, Geographic files, 662B SF 61
23. NARA, RG 407, 662 WPD 3837; AG 662B (Ft. Funston) 7.
24. NARA, RG 77, Geographic files, 662B SF 73; 68; 75; 76; 78; 79.
25. NARA, RG 407, AG 662B (Ft. Funston) WPD 3837-2.
26. NARA, RG 77, HDF, 662B 188. War Department, Corps of Engineers, Reports of Completed Works-Seacoast Fortifications, Battery Richmond P. Davis, corrected to September 21, 1940; and Battery

Townsley, corrected to July 24, 1940. The RCWs for Battery Townsley contain some remarkable errors in elevation. NARA, RG 77, HDF 662B 218/3.

27. NARA, RG 77, HDF, 662B 218; HDF 662.1/X-9.

28. NARA, RG 77, HDF, 662B 248; letter, Colonel Mayo, OCE, to Colonel Stamps, U.S.M.A., March 29, 1939, file 662B 225.

29. NARA, RG 77, HDF, 662B 6E.

30. NARA, RG 77, HDF, 662B/475; 662B 217; letter, Colonel Mayo, OCE, to Colonel Stamps, U.S.M.A., March 29, 1939, file 662B 225. Stetson Conn, Rose C. Engelman, and Byron Fairchild, *Guarding the United States and Its Outposts*, in The Western Hemisphere, part of United States Army in World War II (Washington, D.C.: Office of the Chief of Military History, Department of the Army, 1964), pp. 48-50. Konrad Schreier, Jr., "The Termination of U.S. Army Coast Defenses, 1945-1948," *Coast Defense Study Group News*, Vol. 6, No. 1 (Feb. 1992), p. 20.

31. NARA, RG 77, HDF, letter, Colonel Mayo, OCE, to Colonel Stamps, U.S.M.A., March 21, 1941, file 662B 354.

32. NARA, RG 77, HDF, 662B 475. RCWs, Batteries Davis and Townsley, July 1943. Conn, Engelman, and Fairchild, *Guarding the United States and Its Outposts*, pp. 46, 49.

33. NARA, RG 77, HDF, 1006, Fortification Div., S.F. Dist., U.S. Engineer Office, "Report on Blast and Foundation Tests Conducted during Firing at Battery Davis, Fort Funston and Battery Townsley, Fort Chronkhite," 1941. NARA, RG 77, HDF, 662B 547.

34. NARA, RG 407, AG 660.2 (2-11-42) MC. Whether Battery Williston ever received the tunnel shields intended for it remains uncertain to this day. No other tunnel shields were ever installed. References in the archives to "shields" may be to either shields, such as tunnel shields, to protect barbette guns without overhead cover, or to shields protecting casemated guns. "Status of Secoast Batteries, as of 31 December 1943," courtesy of David Kirchner.

35. NARA, RG 77, HDF, 662 CM-19635.

36. Conn, Engelman, and Fairchild, *Guarding the United States and Its Outposts*, pp. 53-54.

37. Ibid., p. 54. NARA, RG 77, HDF, 662 CM-127701.

38. Lewis, *Seacoast Fortifications of the United States,* p. 124. Department of the Army, *Medium and Heavy Antiaircraft Artillery*, FM 44-4 (GPO, 1954), pp. 38-39.