

Military Development and Geographic Change on San Diego Bay

Andy Yatsko

Abstract Interest in military geosciences spans a range of issues, including the role of terrains in past and modern warfare, management of military lands in different climatic regions, and the impact of local environmental conditions on military operations. Military geosciences can also seek to ascertain the degree to which past operational or facilities-related military activities themselves affected the associated environments; however, such evidence is often transient and dwarfed by the scale of surrounding natural landscapes. This is not the case at the maritime margin of the American desert southwest, where some military development has significantly altered the coastal geographies along which it occurred. This paper provides a historical overview of geographic change resulting from the development of Navy and Marine Corps installations around the margins of San Diego Bay during the first half of the twentieth Century. The consequences of this change continue to challenge the military's current and future use of San Diego Bay.

Keywords Navy · Land management · Coastal environment · Holocene · History · Marine

1 Introduction

The overarching themes of the 9th International Conference on Military Geosciences (ICMG) in Las Vegas were the role of deserts in past and modern warfare, management of military lands in desert regions, and the impact of desert environmental conditions on military operations. But also within the reach of military geosciences inquiry is how past operational or facilities-related military activities may themselves have affected their geographical environments.

In the American Desert Southwest, such effects are sometimes dramatic. This was certainly evident during the 9th ICMG's field trip to the Nevada National Security Site with the dramatic changes to the landscape from atomic testing between

A. Yatsko (✉)
Naval Facilities Engineering Command Southwest, 937 North Harbor Dr,
San Diego, CA 92132, USA
e-mail: andy.yatsko@navy.mil

1951 and 1992. But more often effects are ephemeral, transient or dwarfed by the scale of surrounding natural landscapes. This was seen during the post-conference field trip to the World War II Desert Training Center (DTC) created in the central Mojave Desert by General George Patton in 1942. The scars from training on the DTC landscape are now progressively subject to degradation by slow, but persistent, desert environmental processes, as well as increasing human recreational use of the landscape (BLM 2012).

By contrast, along the Desert Southwest's maritime margins in Southern California, past military development of installation infrastructures has also significantly, and permanently, altered coastal geographies through the filling of adjacent bays and estuaries. The 9th ICMG's post-conference field trip concluded with two days in San Diego touring selected Navy installations, for which the author provided access and indoctrination on their histories. The post-conference field trip saw, as all visitors to San Diego see, a setting around San Diego Bay that is much changed from that experienced by the Spanish and American immigrants that settled San Diego in the eighteenth and nineteenth centuries. But how much of this history of change on San Diego Bay is commonly known or recognized, even by local residents, is uncertain.

From the late nineteenth century to into the mid-twentieth century, Army, Navy and Marine Corps installations around the margins of San Diego Bay have been progressively developed to include facilities required to variously support harbor defense, early stages of naval aviation and carrier warfare, basic training of generations of sailors and Marines, and maintenance and supply of the U.S. Pacific Fleet. In an effort to provide for additional buildable land in response to these expanding installation infrastructure requirements, parts of these development histories include punctuated periods of artificial filling in portions of the adjacent San Diego Bay. The scale of geographic change resulting from these filling activities significantly changed the original configuration and marine environment of San Diego Bay and their histories provides dramatic evidence for the scale of this change. This paper provides an expanded discussion from the author's short, introductory overview at the 9th ICMG that preceded the post-conference field trip on the scale of geographic change associated with military development around San Diego Bay.

Punctuated periods of military development around San Diego Bay were directly influenced by larger historic patterns of conflict and economic change. The establishment or expansion of military installations on the bay mirrored great events at the time, including the Spanish American War, World War I, the Great Depression, and World War II. These influences, as well as parallel political and economic forces, frame the following discussion.

While the development of Army, Navy and Marine Corps facilities on San Diego Bay affected significant segments of the bay's margins, local civilian government and industrial development to support civic and commercial needs also contributed significantly to the change. Broadly, the scale of even just the bay-wide military-influenced changes is beyond the reach of this paper. Accordingly, the focus here is generally limited geographically to military installations clustered around the northern end of San Diego Bay. These include: former U.S. Army Fort Rosecrans (now Naval Base (NB) Point Loma) at the southern end of Point Loma west of the

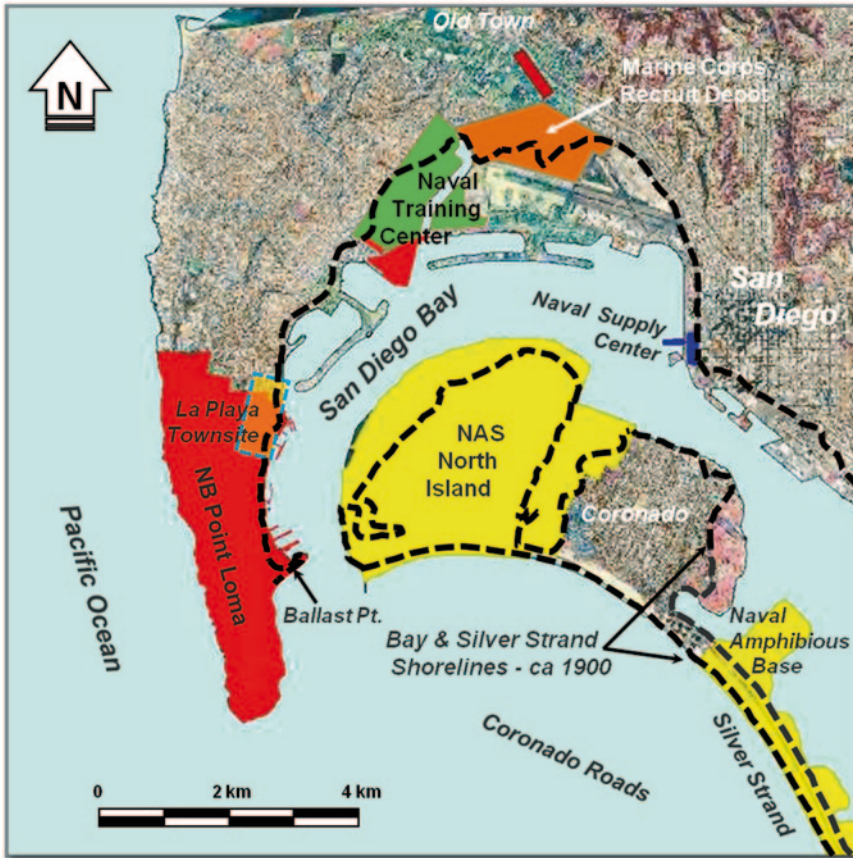


Fig. 1 Navy and Marine Corps installations on northern San Diego Bay, 2012, with ca. 1900 shorelines

entrance to the bay; Naval Air Station (NAS) North Island (now Naval Base Coronado) east of Point Loma across the bay entrance; and former Naval Training Center (NTC) San Diego (closed and privatized for commercial and residential use as Liberty Station in 1997 under the Base Realignment and Closure (BRAC) process) located further into the northern part of the bay (Fig. 1). But any discussion of change to San Diego Bay first requires a description of its natural geographic setting.

2 The Geography of San Diego Bay

At the time of first European entry into San Diego Bay with Juan Cabrillo’s landing on Point Loma in 1542, the configuration of its shorelines, bathymetry and onshore topography had been shaped by the combination of rising sea level and regional tectonics influencing sedimentation and erosion processes over the last 18,000

years (Masters 1988). The geology and geomorphology surrounding and underlying San Diego Bay is generally comprised of flat-lying Cretaceous, Tertiary and Quaternary sedimentary strata. These range from Cretaceous submarine fan sandstones and conglomerates that characterize Point Loma to Pleistocene non-marine and marine sandstones, representing deposition sea within shoreline and brackish estuarine back-bay environments during fluctuating sea levels, at lower elevations along the eastern margin of the bay, on North Island and Coronado near the bay mouth, as well as at the bay's southern extreme (Abbott 1999; Masters 1988). The margins of the bay including the prominent northwest-trending spit (Silver Strand) are composed mostly of Holocene-aged sandy beach sediments (and now artificial fill) (Fig. 1).

The configuration of San Diego Bay derives from the dynamic interaction between late Pleistocene into the middle Holocene rising sea level, general mechanisms of sediment transport and shore evolution responding to rising sea level, and topographic highs like Point Loma (Inman 1983; Masters 1988). The Point Loma peninsula bounds the northwestern margin of San Diego Bay. This upland results from active tectonic tension accommodated by northwest-directed strike-slip movement along the Rose Canyon fault zone that bisects northern San Diego Bay.

During the last glacial maximum toward the end of the late Pleistocene (~18,000 years ago), sea level was approximately 120 m below present sea level (mbpsl) (Fig. 2a). Rivers and streams that presently flow into San Diego Bay from the east (San Diego River, Chollas Creek, Sweetwater River and Otay River) flowed directly west and eroded deep channels across the exposed continental shelf before reaching the paleo-shoreline, then located 6 km west of Point Loma's present coastline (Masters 1988) (Fig. 2b). This paleo-shoreline was essentially straight, with Point Loma forming a massif above the exposed continental shelf. By 10,000 B.P., sea level rose and the coastline advanced to the east to a stand at approximately 20 mbpsl, forming a small embayment within a wave shadow created by the Point Loma upland. As the sea level rise slowed around 6000 B.P., the coastline north of the mouth of the Tijuana River formed within the Point Loma embayment, developing a strong, north-flowing reverse eddy. A sand spit grew north of the Tijuana River as the transport path for a portion of its sediments shifted with this eddy (Fig. 2c). This spit bridged the channels of Chollas Creek, Sweetwater River and Otay River, forming a tombolo that connected terraces north of the Tijuana River with the Coronado and North Island lowlands, creating the nascent San Diego Bay. At this time, all the eastern drainages flowed to the ocean through the San Diego River channel between Point Loma and North Island. By 3500 B.P., sea level stood within 1–2 mbpsl. Accompanied by dune building along its length, the tombolo and spit had also migrated east to its present position to become the Silver Strand (Fig. 2d).

Most tidal lagoons, and certainly those in the region north of San Diego Bay, are described as passive and dissipative, with their tidal ranges decreasing with distance from their openings. According to Masters (1988, after Redfield 1950), however, the length of San Diego Bay is responsible for the tidal body within the bay behaving as a partial quarter wave resonator. This characterizes a tidal flushing process more intense than would be typically the case in tidal lagoons. This holds profound

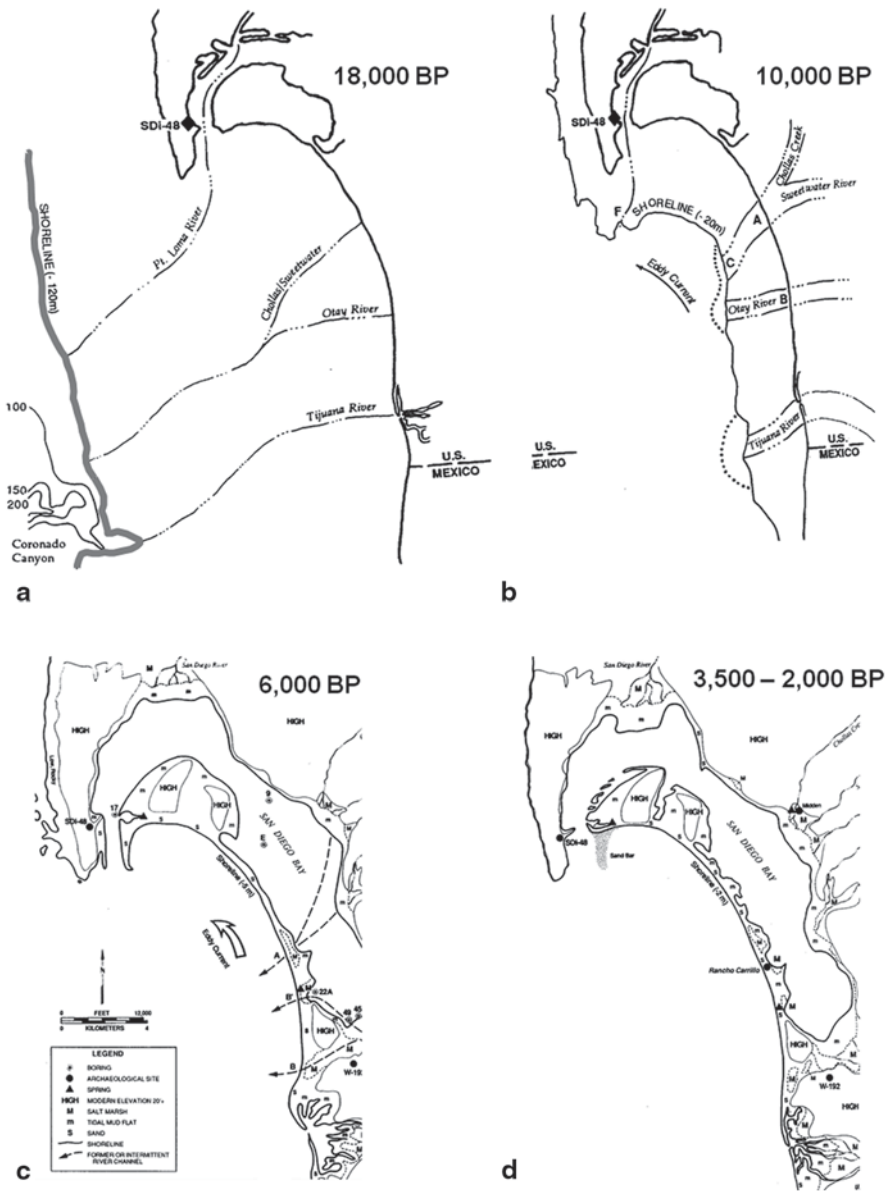


Fig. 2 Late Pleistocene—Middle Holocene evolution of San Diego Bay (from Masters 1988, Figs. 4.5 and 4.6)

inferences for the formation of San Diego Bay, implying the bay developed as a unit of nearly its present length, without land divisions like deltas intruding across its axis. This supports the general reconstruction of the bay having developed within a

relatively brief time period prior to 6000 B.P. In its natural state, the bay has always been well-mixed, with tidal currents strong enough to maintain a scour channel through to the entrance.

During formation of the bay, the various rivers and creeks emptying into it were building deltas as tidal flats and salt marshes, with these wetlands expanding rapidly around the protected bay margins. Prevailing winds from the northwest and west also created sandy beach environments along the east shore. Countering these natural filling processes, the bay's tidal currents were strong enough to flush much of these stream sediments out through the entrance channel, maintaining a clear, if shallow, channel running deep into the bay, closely encroached on by tidal flats and salt marshes (Fig. 3). This is the estuarine environment that was first encountered by Juan Cabrillo in 1542, and on the shores of which the Spanish first colonized Alta California in 1769.

3 Historic Use of San Diego Bay

3.1 Spanish-Mexican Period

When the Spanish came to San Diego Bay in 1769, they established their first settlement with a strategic defensive intent by building a presidio (fort) on a ridge overlooking the mouth of Mission Valley. Located in what is now Old Town San Diego, this is where the San Diego River exited from its confined, channel across a series of elevated marine terraces that comprise the inland terrain and turned south into that bay. From here, the nearest bay shore was 3 km south. However, this bay shoreline opened onto wide and soft tidal mud flats unsuitable for travel and landing or shipping goods by sea. The nearest suitable sandy shoreline was at a place named La Playa, located 8 km to the southwest on the bayside of Point Loma near the entrance to San Diego Bay. This became the port for Spanish Colonial, and eventually Mexican, San Diego. La Playa was the local port of call for the international hide and tallow trade that characterized and sustained Spanish Colonial California's economy in the early nineteenth century. And La Playa is where American naval forces landed in 1846 to take possession of San Diego during the Mexican War.

3.2 Early American Period

More than the local Spanish-Mexican inhabitants, the first American colonizers after the Mexican War understood the importance of developing bay-front residence and infrastructure for the purpose of expanding maritime commerce and increasing the economic benefits of San Diego Bay. With that in mind, La Playa was the first location for the townsite mapped out by the Americans in San Diego. It's significant that a resulting 1849 townsite plat already indicated an early intent to artificially fill



Fig. 3 1857 U.S. Coastal Survey Map of San Diego Bay showing mudflats, sand bars and tidal scour channel through bay

adjacent, firm bottomed bay shallows to create buildable land. While La Playa continued to function as the port of San Diego through the 1860s, the actual economics and expense of filling any significant portion of the bay front precluded affecting this goal.

Early in the American period, however, as land speculators established New Town San Diego further east along the bay's shore at another sandy beach and firm bay bottom opposite Coronado, the focus of the bay's economic development shifted away from La Playa. But even at New Town, filling the bay margin to create

new land was considered a prohibitively expensive enterprise. Maritime commerce was instead supported and encouraged through the construction of numerous commercial piers along New Town's water front (Heilbron 1987). Substantial bay filling in the interest of increasing maritime commerce continued to be an important goal of New Town developers, the emerging San Diego Chamber of Commerce, and local and federal politicians (Jensen 1965; Linder 2001, 2003). All these interests understood that an important catalyst for accomplishing this economic impetus would best be found in establishing a permanent U.S. Navy presence on San Diego Bay.

3.3 U.S. Military on San Diego Bay

Through the late nineteenth century, the U.S. Navy was only an intermittent and transient presence on San Diego Bay. The Gold Rush had firmly established San Francisco Bay as the economic and population hub of the state. In 1854, coincidental to the United States' effort to extend its naval power into the Pacific Ocean around the time of California statehood, the Navy established the first permanent installation on the Pacific Coast at Mare Island north of the San Francisco Bay. For the remainder of the nineteenth century and into the early twentieth century prior to World War I, Mare Island and San Francisco Bay were the home base for the Pacific Fleet. Elements of the Pacific Fleet on patrol along the West Coast treated San Diego only as an occasional port of call. But the common Navy wisdom was that San Diego Bay's narrow, shallow channel and encroaching sand bars made it unsuitable for basing naval vessels. This perspective began to change with the advent of the Spanish American War and the resulting shift in American interests in the Pacific.

3.3.1 Spanish American War Era

In 1852 shortly after California statehood, the southern half of Point Loma had been reserved by the United States as a military reservation in support of harbor defense, as it had been under the Mexican government. However, the Army only began to take an interest in developing defenses there in the 1870s, when it expelled squatters and began construction of a battery. That battery was still incomplete in 1896 when new construction of four batteries on Ballast Point was directed, with plans for barracks and associated buildings nearby. With the beginning of the Spanish-American War in April 1898, there was a fresh sense of urgency to provide additional defenses on all coasts, including construction of three new batteries at the San Diego harbor entrance, which was completed by 1900 (Thompson 1991). This early coastal defense development, and in fact nearly all such Army development up to World War II, did not result in artificial filling of adjacent bay.

The Spanish American War also stimulated the Navy's interest in developing logistical support facilities in San Diego Bay. In 1901, the Navy segregated 360 acres along the San Diego Bay shoreline of Fort Rosecrans at the former La Playa

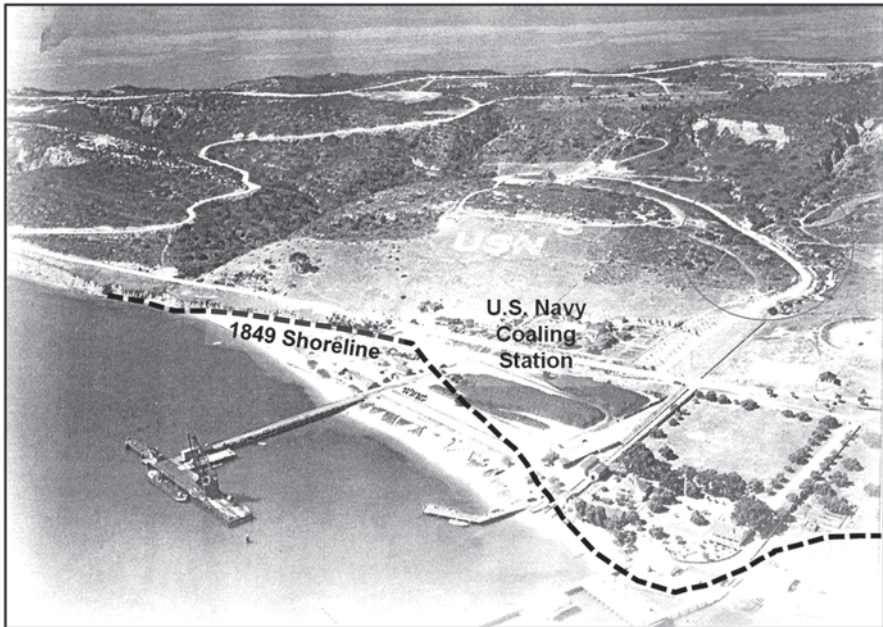


Fig. 4 Navy La Playa Coaling Station on Point Loma in 1920s, showing extent of ca 1903 filling

townsite to develop a coaling station (Schmidt and Byrd 2004). The La Playa Coaling Station facility was commissioned in 1904. Its construction involved the first instance of military-related filling of a portion of San Diego Bay. In this case, the filling process involved borrowing from adjacent upland areas, with the natural, gradually-sloped terrain leveled and the borrowed spoil graded out into the San Diego Bay shallows, partially realizing the original vision of the 1849 townsite plat (Fig. 4).

As dramatic as the Army’s response to the Spanish American War was in its expansion of coastal defense facilities on Point Loma, the La Playa coaling station represented the only real Navy infrastructure investment on San Diego Bay until 1917. Even the Navy’s Bureau of Yards and Docks reporting in 1898 that San Diego was the preferred site in southern California for a naval repair base and dockyard, in addition to a 1900 Navy survey of the bay, which identified it as “the only good harbor south of San Francisco,” didn’t spark interest within a Navy Department that “lacked a West Coast vision” (Linder 2003, p. 6). It would take the run-up to World War I to awaken a wider Navy interest in the bay.

3.3.2 World War I and the 1920s

Bruce Linder (2003, p. 5), a retired Navy captain and well-respected chronicler of San Diego’s naval history (Linder 2001), has suggested that the period between

1917 and 1922 was the most consequential to establishing a significant Navy presence on San Diego Bay. Over those years, the bay changed from an infrequently visited naval logistics stop to the permanent homeport for over 100 warships. The naval presence expanded dramatically from minor and disconnected facilities into an integrated, bay-wide naval complex. According to Linder (2003, p. 5), by 1922 the Navy's presence on San Diego Bay had reached a "critical mass," the point where it became self-sustaining and virtually assured ongoing naval investment.

The catalyst for this Navy growth, and its interconnected influence on the local growth of a Marine Corps presence, was a convergence of increased naval requirements in response to World War I and local San Diego economic politics. Among San Diego City fathers, there had been disagreement on whether to pursue the Los Angeles model for encouraging new industries, manufacturing and development, or to guide the city towards an economy based on tourism, agriculture and commerce. Coming out of a mayoral election of early 1917, the Navy emerged as the perfect compromise "industry," representing economic progress without the smokestacks (Linder 2003, p. 7).

The consequence of World War I was an expansion of Navy and Marine Corps facilities, including docks, repair yards, training centers, supply depots and a naval air station. Because the bay's shoreline still consisted largely of undeveloped mud flats, this immediately began a new, military-driven, and now federally-funded, initiative to fill submerged tidelands to create buildable land. These included: development of the Marine Corps Recruit Depot (MCRD; 1918), built partially on artificial fill placed on the Dutch Flats tidelands at the northeast of the bay; the U.S. Destroyer Base (1921) at the mouth of Chollas Creek on the east shoreline south of the city, which involved an early use of dredge spoils as fill; the Naval Supply Center at the foot of Broadway in downtown San Diego, also built on dredge spoils; and westerly adjacent to MCRD, the Naval Training Center (NTC; 1922–1923), which was laid out on the eastern slope of Point Loma and adjacent tidal flats using artificial fill from nearby sources.

Naval Air Station (NAS) San Diego (now NAS North Island) had also been established in 1917. Into the 1930s, the air station jointly occupied North Island with the Army's Rockwell Field, the first permanent Army air field, originally a Signal Corps aviation school established there in 1913. Both the Army and Navy expanded facilities through World War I and into the early 1920s, with North Island initially providing sufficient space to preclude the need to fill additional areas in the bay.

NAS San Diego was originally designed as a seaplane base, reflecting the early, pre-World War I philosophy about the nature of naval aviation. However, lessons learned during World War I rapidly redirected Navy strategic aviation thinking toward the use of aircraft carriers. In November 1924, the first Navy carrier, the USS Langley (CV-1), a converted collier, arrived at North Island. This began the air station's eventual preeminent role in defining carrier warfare strategies that would later serve the Navy successfully during World War II.

The mid-1920s San Diego Bay still represented a relatively shallow, narrow-channelled anchorage; requiring all ships above the size of a destroyer to anchor in the naturally scoured channel, with no ability anywhere on the bay to tie up at a pier. The "controlling depth" for the majority of the navigable portions of bay was

between 32 and 35 ft. This was considerably less than the 40–45 ft which the safe navigation of capital ships at the time required, eventually including the Navy's new carriers (Shragge 2003). A solution lay in extensive dredging of the bay to deepen and widen the channel and its margins. The challenge was finding the necessary funding. This was difficult to find in the best of times, but assumed even harder with the onset of the Great Depression in 1929.

3.3.3 The Great Depression and the 1930s

In 1930, the economic consequences of the Great Depression already pressed hard on the San Diego region. But in an early attempt to hold back the national economic slide, the Hoover administration proposed broad federal public works projects as an economic stimulus (Shragge 2003). Congress examined San Diego harbor to determine how dredging there might be part of this program. Congress directed \$10,250,000 (\$500,000,000 in 2010 dollars) to San Diego Bay, over 80% earmarked for its naval bases. Under Franklin Roosevelt's New Deal in 1933, the federal government pledged another \$8,750,000 (\$400,000,000 today) for additional public works around San Diego Bay, most again directed at its naval operating base. By 1940, Congress would appropriate an additional \$6,500,000 (\$250,000,000 today) toward further harbor dredging.

These dredging funds passed from the federal Public Works Administration (PWA) to the War Department, which applied it to deepening and widening the harbor entrance (Shragge 2003). From the beginning, the dredging generated millions of cubic yards of sandy spoils. Access to San Diego Bay for aircraft carriers involved shore-side berthing and maintenance facilities, and space to construct these. Accordingly, NAS North Island used dredge spoils to expand approximately 550 acres along the bay margin for carrier facilities (Fig. 5). Other naval installations also benefitted from the sedimentary largess. Through the late 1930s, NTC added an additional 240 acres. Further down the bay at Naval Station San Diego (former U.S. Destroyer Base), 120 acres of tidal flats and salt marsh were also filled.

3.3.4 World War II

Notwithstanding the incremental, but substantial military development around San Diego Bay preceding 1941, the onset of World War II represented a new watershed event that caused exponential expansion and intensification of the military's presence in the San Diego region. As the Navy, Marine Corps and Army established numerous new installations across the wider region, those around San Diego Bay received new pressure to expand buildable land. This was again accommodated using dredge spoils from the continued widening and deepening of the bay's navigation channel and anchorages to support increasing numbers of Navy ships, particularly the new, deeper-draft Essex-class aircraft carriers (Shragge 2003).

At Fort Rosecrans on Point Loma, the Army, which had not previously had need to fill their bay margins, filled in the cove behind Ballast Point at the harbor's en-



Fig. 5 Filling bay adjacent to NAS North Island in 1936. Viewed east toward downtown San Diego. City of Coronado is to the right, separated from North Island by the Spanish Bight

trance, the very place where Juan Cabrillo had anchored in 1542. This provided for barracks space to accommodate additional Army coastal artillery personnel required to man the new coastal defense batteries in construction at Fort Rosecrans between 1941 and 1944.

The Navy further expanded the NTC, adding another 160 acres out into the bay to increase the training center's capacity for training the personnel demands of the Pacific Fleet. Concurrent with this filling, the City of San Diego filled the remaining in-shore portion of the Dutch Flats tidal area to become what is now the San Diego International Airport.

On North Island, the naval air station expanded by 450 acres with the filling of the Spanish Bight, the shallow tidal embayment that had separated North Island from Coronado. On Coronado's opposite shore, the Navy filled 40 acres of the bay to provide for construction of housing for Navy families. And south of Coronado on the Silver Strand, the Navy filled 210 acres of bay to create the Naval Amphibious Base, which used the adjacent beaches and offshore Coronado Roads to train Navy and Marine Corps forces for the island-hopping campaign that characterized the war in the Pacific. In southern San Diego Bay, a collective 500 acres of bay and salt marsh were also filled in building out Naval Station San Diego and other facilities.

World War II represented a high water mark in the artificial filling of San Diego Bay's margins. Substantially all post-war filling was by municipalities bordering the bay and by a newly created port district, in the interest of expanding both com-

merce and tourism. The rate of filling slowed progressively through the 1950s and 1960s, and effectively ceased after 1970.

4 San Diego Bay Today

In the early twenty-first century, the U.S. armed forces continue to play an important role in the San Diego region, both as a presence and as an economic engine. The military generates \$18.3 billion for the local economy, amounting to 13.68% of economic activity in the region (Hamsik and Moore 2007). The Navy accounts for about 65% of this and the Marine Corps for 23%, with 150,000 military personnel in the region. San Diego Bay continues to be an essential focus of the Navy on the West Coast, with the BRAC process since the late 1980s concentrating all California-based ships in San Diego. But the processes of simply filling in more bay to accommodate growth is a thing of the past, with especially the Navy facing challenges growing out of what have come to be viewed as its sins of the past.

4.1 *Long-Term Environmental Consequences of Bay Filling*

Immediate consequences of the filling of San Diego Bay's margins from the 1920s into the late 1960s were certainly initially perceived by both the military and the civilian community as beneficial. However, as late twentieth century political processes have progressively focused on effects to the environment by human activities, these original economic and operational benefits have increasingly come into a different balance with concerns now defined under environmental laws and regulations.

4.1.1 **Habitat Loss and Restoration**

It is objectively the case that the civic and military activities that created new land around San Diego Bay caused significant losses to natural estuarine and adjacent upland habitats. The Navy and Marine Corps alone filled more than 2500 acres of former tidal wetlands and open bay. Together, military, civic and private filling activities over the past 125 years have resulted in the loss of 42% of San Diego Bay's historic shallow sub-tidal habitat, 84% of its intertidal mudflat habitat, and 70% of its salt marsh habitat (USFWS 2012). Most adjacent wetland/upland transition and native upland habitats have also been lost to development.

Since the early 1970s, evolving environmental laws and regulations, especially "no net loss" policies associated with the Clean Water Act, have increasingly negated the option to fill wetlands without substantial mitigation. Mitigation usually involves setting aside existing wetlands, rehabilitating damaged wetland habitats,

and creating or recreating wetlands or open bay around San Diego Bay and other regional estuary systems. One consequence of this evolved regulatory sensitivity is increased public scrutiny of processes affecting San Diego Bay and wider recognition of the need to protect and restore the bay's historic coastal habitats. Instances of this have directly linked with ongoing Navy requirements for berthing space.

In the late 1990s, NAS North Island needed to fill 17 acres of open, previously-dredged bay bottom along its northeastern margin to construct new berthing facilities sufficient to support three Nimitz-class aircraft carriers, which was directed by Congress to be their home port by the early 2000s. The mitigation for this planned filling required the Navy to restore tidal wetland and bay bottom habitats on the northern margin of North Island near the bay entrance by removing 25 acres of fill previously placed there in the 1930s.

In a similar instance, the Navy loaned the ex-USS Midway (CV-41) to a San Diego non-profit organization in 2003 to become an aircraft carrier museum. Its permanent berthing at the former Naval Supply Center's pier created environmental effects requiring wetland mitigation elsewhere on the bay. The 4-acres of permanently shaded bay bottom created by the Midway adversely affecting essential fish habitat, requiring mitigation through rehabilitation of a small tidal marsh originally isolated by earlier shore development. While the non-profit organization bore the expense of this mitigation, this again reflects the regulatory sensitivity on estuarine habitat issues around San Diego Bay.

4.1.2 Seismic Risk

As noted earlier, the Rose Canyon Fault Zone (RCFZ) directly underlies many filled areas around San Diego Bay, particularly at the bay's northern extreme where the fault zone parallels Point Loma. San Diego County does not have the history of earthquakes common to the rest of southern California, and the RCFZ is the only major earthquake fault in the urban San Diego area (SCEC 2012). But even though the RCFZ has not produced a major earthquake since long before European settlers arrived in the area, it is still considered seismically active by the State of California for having had a history of generating large magnitude earthquakes in the last 11,000 years. And certainly other parts of the fault zone (i.e., Newport-Englewood fault zone) north of San Diego into Los Angeles County have been subject to historic seismic activity (Grant and Shearer 2004). But by any account, a major earthquake along the RCFZ beneath these artificially and non-engineered fill areas composed of variable mixtures of loose and saturated silty to sandy sediments over bay muds could have devastating consequences to buildings and infrastructure due to amplified shaking and potential liquefaction. This risk is further exacerbated with the understanding that nearly all permanent construction from before the late 1930s at places like NAS North Island, MCRD and NTC is comprised largely of unreinforced masonry and shallow foundations. This remains a known, but an unresolved, concern for the Navy and Marine Corps in San Diego.

5 Conclusions

This discussion on the consequences of geographic change from the development of Navy and Marine Corps installations around San Diego Bay is presented as a contrasted alternative area for military geosciences inquiry. But the San Diego Bay example is also contrasted in being somewhat an exception where the local civilian community was very much a willing partner, and frequently the political instigator, in seeking federal aid to expand military, and not coincidentally civilian, facilities through significant modifications to the natural geographic conditions of San Diego Bay. A more common experience for military land use in the American desert southwest has been through temporary or permanent withdrawal of public lands, often including the expropriation of private in holdings, during periods of historic duress to provide for the reservation of large scale landscapes for military needs. General Patton's World War II DTC is an early example in California's Mojave Desert, with examples still persisting in places like the Marine Corps Air Ground Combat Center Twentynine Palms, the Army's Fort Irwin National Training Center, and the Cold war-era-driven Nevada National Security Site in Nevada.

The early military-civilian collaboration discussed in this chapter was clearly of critical importance for the local community in the placing San Diego Bay as a significant node in evolving U.S. geopolitical and strategic interests in the Pacific. This will certainly continue with a renewed national policy focus on "the Pacific Rim." But as is also pointed out, even these good military and economic benefits have evolved to have an environmental price to pay as well. This continues to be the challenge for the military and civilian partnership that uses San Diego Bay. Although this ongoing use can no longer involve further encroachment on the bay by artificial fill, it will continue to develop or redevelop on land this historical process created around San Diego Bay. And because of the local geomorphology over which the artificial fill was created, a geosciences perspective will increasingly need to be applied in the planning for this ongoing use and reuse.

References

- Abbott PL (1999) *The rise and fall of San Diego*. Sunbelt Publications, San Diego
- Bureau of Land Management (BLM) (2012) World War II Desert Training Center, California-Arizona Maneuver Area. www.blm.gov/ca/st/en/fo/needles/patton.html. Accessed Aug 2012
- Grant LB, Shearer PM (2004) Activity of the offshore Newport-Inglewood Rose Canyon Fault Zone, coastal southern California, from relocated microseismicity. *Bull Seismol Soc Am* 94(2):747–752
- Hamsik B, Moore C (2007) San Diego military economic impact study commissioned by San Diego Regional Chamber of Commerce. http://www.sddt.com/files/2007_Military_Economic_Impact_Study.pdf. Accessed Aug 2012
- Heilbron RF (1987) Horton's purchase, the real story. *J San Diego Hist* 33(1):63–71
- Inman DL (1983) Application of coastal dynamics to the reconstruction of paleocoastlines in the vicinity of La Jolla, California. In: Masters PM, Flemming NC (eds) *Quaternary coastlines and marine archaeology; toward the prehistory of land bridges and continental shelves*. Academic Press, London, p 1–49
- Jensen JM (1965) The politics and history of William Kettner. *J San Diego Hist* 11(3):26–30

- Linder B (2001) *San Diego's navy: an illustrated history*. Naval Institute Press, Annapolis
- Linder B (2003) 1917–1922: The decisive years in San Diego's relationship with the navy: Mains'l Haul. *J Pac Marit Hist* 38(4)/39(1):4–12
- Martin J (2010) The San Diego Chamber of Commerce establishes the U.S. naval coal station, 1900–1912; San Diego's first permanent naval facility. *J San Diego Hist* 56(4):217–232
- Masters P (1988) Paleo-environmental reconstruction of San Diego Bay, 10,000 years B.P. to present. In: Gallegos D, Kyle C (eds) *Five thousand years of maritime subsistence at Ballast Point prehistoric site SDi-48 (W-164), San Diego, ERCE*, p 4–22
- McClain M (2008) “Liberty Station” and the Naval Training Center in San Diego. *J San Diego Hist* 54(2)73–85
- Redfield AC (1950) The analysis of tidal phenomena in narrow embayments. In: *Papers of Physical Oceanography and Meteorology, Massachusetts Institute of Technology*, vol. 11(4):36
- Schmidt A, Byrd DS (2004) Evaluation of eligibility for the National Register of Historic Places, FISC Point Loma, San Diego. Irvine, CA, Jones and Stokes, p 20. Report on file, NAVFACSW EV52, San Diego
- Shragge AJ (2003) Perfecting nature's handiwork: aircraft carriers and the development of San Diego Harbor since 1930: Mains'l Haul. *J Pac Marit Hist* 38(4)/39(1):55–68
- Southern California Earthquake Center at USC (SCEC) (2012) San Diego County earthquake hazards. <http://www.shakeout.org/sandiego/hazards.html>. Accessed Aug 2012
- Sudsbury E (1967) *Jackrabbits to jets, the history of North Island, San Diego, California*. San Diego Publishing Co, San Diego.
- Thompson EN (1991). *The guns of San Diego, San Diego harbor defenses, 1796–1947*. http://www.nps.gov/history/history/online_books/cabr/index.htm. Accessed July 2012
- U.S. Department of the Navy (DON) (1999) *Final environmental impact statement for developing home port facilities for three Nimitz-class aircraft carriers in support of the U.S. Pacific Fleet, Coronado, California; Bremerton, Washington; Everett, Washington; Pearl Harbor, Hawaii*. vol 1
- U.S. Fish and Wildlife Service (USFWS) (2012) *Western Salt Pond Restoration Project on the San Diego Bay National Wildlife Refuge*. <http://www.fws.gov/sandiegorefuges/Western%20Salt%20Ponds%20Restoration%20Project3.html>. Accessed May 2012