GEOLOGIC AND GEOTECHNICAL SITE ASSESSMENT

CHOLLAS CREEK MULTI-USE PATH

SAN DIEGO, CALIFORNIA

Prepared for
PSOMAS
San Diego, California

Prepared by
TERRACOSTA CONSULTING GROUP, INC.
San Diego, California

Project No. 2820
January 6, 2014

TerraCosta
Consulting Group

TerraCosta Consulting Group

Geotechnical Engineering
Coastal Engineering
Maritime Engineering

Project No. 2820
January 6, 2014

Mr. Agustin E. Chang
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San Diego, California 92108

GEOLOGIC AND GEOTECHNICAL SITE ASSESSMENT
CHOLLAS CREEK MULTI-USE PATH
SAN DIEGO, CALIFORNIA

Dear Mr. Chang:

TerraCosta Consulting Group, Inc. (TCG) is pleased to submit this report presenting the results of our geologic and geotechnical site assessment for the proposed Chollas Creek Multi-Use (Bike) Path to be located easterly of the 32nd Street San Diego Naval Station.

The accompanying report was prepared in general accordance with our Proposal No. 12120 dated March 18, 2013. With respect to the technical aspects of the project, this report presents the results of our field observations and geologic/geotechnical assessment of the conditions along the proposed alignment, as well as our conclusions pertaining to the geotechnical aspects of the design, grading, site development, and construction.

We appreciate the opportunity to be of service and trust this information meets your needs. If you have any questions or require additional information, please give us a call.

Very truly yours,

TERRACOSTA CONSULTING GROUP, INC.

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GAS/BRS/sr
Attachments

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CHOLLAS CREEK MULTI-USE PATH
SAN DIEGO, CALIFORNIA

1 INTRODUCTION AND PROJECT DESCRIPTION

This report presents the results of our geological/geotechnical site assessment for the development of a new multi-use (bike) path that will extend from the Dorothy Petway Park to the main gate of the 32nd Street Naval Station in San Diego, California.

The proposed project alignment is located easterly of the 32nd Street Naval Station in San Diego, California. More specifically, the alignment generally runs from the southerly side of Dorothy Petway Neighborhood Park following the Chollas Creek drainage down to the intersection of 32nd Street and North Harbor Drive. The mid-point of the alignment is at approximately 32.69 degrees north latitude, 117.12 degrees west longitude. Figure 1, the Vicinity Map indicates the approximate location of the proposed alignment.

For planning purposes, the project alignment is divided into four distinct reaches:

- Reach 1: Hwy 5 to Rigel Street
- Reach 2: Rigel Street to Main Street
- Reach 3: Main Street to 32nd Street
- Reach 4: 32nd Street to Harbor Drive or Belt Street (railroad crossing)

As we understand, proposed improvements will include construction of approximately 4,000 lineal feet of multi-purpose (bike) path. In order to complete the project, approximately 1,500 lineal feet of retaining walls and associated improvements will be constructed to support the new path.

2 PURPOSE AND SCOPE OF INVESTIGATION

The purpose of this investigation is to provide geologic and geotechnical information to assist the City of San Diego and their consultants with geologic and geotechnical input for the planning and design of the project. Our scope of work for this project includes the following:

- Review of existing site surface conditions;
- Estimate of the general subsurface geologic and geotechnical conditions, including groundwater;
- Geotechnical characteristics of the site soils;
- Geologic hazards;
- Potential impacts and mitigation measures; and
- Significant unmitigated geologic impacts.

3 PREVIOUS STUDIES

As part of our assessment, we have reviewed available published and unpublished maps, reports, historical aerial photographs, and other available pertinent documents related to development along the alignment. A list of those documents is presented in the References at the end of this report.

4 SITE AND SUBSURFACE CONDITIONS

4.1 Local Site Development

The project alignment is located on the central east side of San Diego Bay easterly of Naval Base San Diego at the confluence of the north and south Chollas Creek drainages (Figure 2). Starting in the 1850s, development of portions of the eastern margins of San Diego Bay began. The first significant development in the local area was a wharf built in 1871 by Frank Kimball at the end of 17th Street. This wharf collapsed in 1877, and a 500-foot-long wharf was built by the Santa Fe Railroad in 1881, which was dismantled in 1894. After World War I, the Navy began additional expansion along the bay front and built a series of piers for the Naval Repair Base. As of the late 1930s, the general area of the project had remained as it was in the 1890s (see Figure 3). More extensive development, consisting of dredging and filling along the waterfront, created the shoreline configuration as it is generally shown today on Figures 2 and 4. Prior to reclamation, the area was judged to have been a tidal marsh with meandering channels, and the soils likely consisted of interbedded fine to coarse grained sediments flushed from the local drainages.

4.2 Regional Geology

From a geomorphic standpoint, the site is located within the Peninsular Ranges Geomorphic Province. Easterly of the site lies the dissected San Diego coastal plain, which abuts the San Ysidro and Jamul Mountains. To the east, carved out along the westerly margin of Otay Mesa (and San Diego coastal plain) is a series of coastal terraces formed during various sea level still stands during Pleistocene time. The Rose Canyon fault system has been identified as having right slip (lateral) displacement and is believed to represent a portion of the motion locally between the North American and Pacific Tectonic Plates. Regional uplift of faulting and erosion has modified these distinctive erosional features. Over the last million years, the San Diego region has risen at an average rate of about 5.5 inches per 1,000 years (Abbott, 1999). In the last 80,000 years, the rate of uplift has increased to nearly 12 inches per 1,000 years northwest of the Rose Canyon fault zone, and approximately 18 inches per 1,000 years southwest of the Rose Canyon fault zone.

Conversely, these tectonic forces have also caused rifting and down-dropping of the area centered about San Diego Bay. Following the Rose Canyon fault zone southerly, these tectonic forces spread across three major faults (and quite possibly other identified faults) that underlie San Diego Bay. These faults (the Silver Strand, Coronado, and Spanish Bight Faults) are believed to transfer these forces to the Descanso Fault, which lies offshore of Point Loma and continues southerly into Mexico. The right step, which occurs between the Rose Canyon and the Descanso fault zones, creates a releasing bend that causes the rocks underlying the bay to be stretched and down-dropped to accommodate the crustal movements. Typical movements along the faults that underlie the bay are observed to experience both a significant vertical and normal component to their movement.

From the standpoint of the overall geologic structure, San Diego Bay is a down-dropped faulted trough lying just west of a stable hinterland-coastal plain. Bedrock east of the zone has been slightly deformed as opposed to that on the west side. Faults to the east (i.e., La Nacion-Sweetwater Faults) display down-to-the-west normal displacement. The normal faults that parallel the bay to the east are likely a result of subsidence and compaction along the margin of the Pliocene-age San Diego Embayment.

4.3 Site Geology

As mentioned above, the area has been extensively modified over the past 90 to 100 years. An approximately 2000-foot-wide strip of artificial fill has been placed adjacent to the bayshore, inclusive of the area of the existing 32nd Street Naval Station. The fill was most likely derived from dredging of the harbor floor, as shown on the geologic map (Figure 2). The thickness of the fill is estimated to be very thin at its distal eastern edges, but thickness toward the bay reaches 15 feet near the waterfront.

Underlying the fill are young Holocene-age unconsolidated bay sediments that extend to a depth of approximately 25 feet (approximate elevation -13 feet, MLLW) at the waterfront. As subsidence occurred in the bay, sediment continued to be flushed out of the upland drainages and was continually deposited over the older Pleistocene-age sediments, forming the Bay Point Formation/terrace deposits, which now mantle the coastal terraces under the site and surrounding area (Figure 1). Overlying the San Diego Formation, these terrace deposits consist of both nearshore marine and non-marine deposits. These deposits are comprised of interbedded fine to medium grained, poorly to moderately consolidated silts, sands, and conglomerate. The sands generally vary from well to poorly sorted.

The terrace deposits were deposited on wave cut terraces formed on the Pliocene-age San Diego Formation. This old surface, formed during recessive and transgressive changes in sea level, is estimated to extend offshore to a depth in excess of 100 feet below present sea level. Where exposed inland, the San Diego Formation consists of semi-consolidated fossiliferous fine-grained yellow-white/gray sandstone, with lenses of well rounded cobble conglomerate. Reportedly, as the San Diego Formation extends southerly to Mexico, it reaches at least an estimated thickness of 300 feet. On the basis of the shear wave velocity profiles completed for other nearby projects and geomorphic projections of the formation, we estimate that the top of San Diego Formation is near elevation -100 feet, MLLW. Also, from our review of CPT soundings and the material descriptions of deep borings performed at the nearby Naval Station, sand and gravel deposits were encountered at an elevation of approximately -55 feet. These materials are consistent with materials either found in, or derived from, the San Diego Formation. It is unclear whether these materials are the San Diego Formation or materials re-deposited by the ancestral Chollas Creek drainages.

4.4 Stratigraphy (Soil Conditions)

Materials encountered along the alignment generally consist of fill soils overlying alluvial and estuarine deposits that overlay the Bay Point Formation, which is in turn underlain by the San Diego Formation. In general, these soils consist of loose to medium dense and soft to hard sands and clays, with lenses of interbedded gravels.

A description of the soil units likely to be encountered is presented below from oldest to youngest.

San Diego Formation: The top of the San Diego Formation is estimated to be at or near elevation -100 feet, MLLW within the ancient Chollas Creek drainage. The San Diego Formation consists predominantly of yellow-brown to gray-brown, fine to medium grained, poorly to moderately indurated sands and siltstone. The San Diego Formation is described in the literature as being late Pliocene to early Pleistocene in age, covering an area from the southerly flanks of Mount Soledad south to Rosarito Beach in Baja California, Mexico.

Terrace Deposits: Terrace deposits cover much of San Diego's coastline and generally include a series of middle to late Pleistocene-age paralic deposits derived from the local formational soils. Within the project site area, terrace deposits generally consist of interbedded, medium dense, red-brown to red-gray sands, silty fine sands, and fine sandy to clayey silts.

Alluvial and Estuarine Deposits: Located at the confluence of the north and south Chollas Creek drainages, the alignment is at least partially underlain by interfingered alluvial and estuarine deposits ranging from organic clays and silts to interbedded sands and gravels. These deposits are estimated to be upwards of 100 feet in thickness.

Fill: Fill soils encountered in the area generally consist of mechanically placed and compacted medium dense, yellow-brown, clayey sands with up to 15 percent gravels. The deepest fills are likely those that underlie the freeway embankments.

Pavements: Where encountered along the alignment, pavements consist of asphalt and/or Portland Cement Concrete, and will vary in thickness.

4.5 Faulting and Seismicity

4.5.1 *Regional Seismicity*

Movement between the North American and Pacific plates makes Southern California one of the more seismically active regions in the United States. Strain, caused by movement between the North American plate and the Pacific plate, is spread across a 150+ mile wide zone between the San Andreas fault zone, approximately 100 miles east of San Diego, out to and beyond the San Clemente fault zone located approximately 50 miles west of San Diego.

Nearing the end of the Miocene, approximately 5.5 million years ago, the boundary between the North American and Pacific plates moved eastward to its present-day position in the Gulf of California (Abbott, 1999). The resultant extension and stretching of the North American continental crust formed a rift between the two plates, creating the Gulf of California, which continues opening through the present day. The San Andreas, San Jacinto, Elsinore, Rose Canyon/Newport-Inglewood, and San Clemente fault zones are just a few of the resultant strain features (faults) created by this tectonic movement. Today, there is an estimated 55 to 60 centimeters per year of relative plate motion between the North American and Pacific plates, spread across the faults within this 150+ mile wide zone, of which the Rose Canyon fault zone is estimated to contribute 1.5 mm/year (±0.5 mm).

The project alignment is located near the westerly edge of the approximately 10-mile-wide terraced coastal plain, which bounds the Peninsular Ranges geomorphic province of California. The Peninsular Ranges are a northwest/southeast-oriented complex of tectonic-related blocks separated by generally parallel fault zones (Norris and Webb, 1990). Geomorphically, this province is known for its long, low mountain ranges separated by alluvial-filled valleys. Geologically, the Peninsular Ranges province extends from the Los Angeles Basin to the north, through Baja California to the south.

Offshore from Southern California is an area known as the Continental Borderland. While this area is not officially designated as a geomorphic province, many of those who study the area consider it a separate province due to its complexity. The Continental Borderland is composed of elevated blocks and ridges, which form islands and banks separated by deep, often enclosed, basins (Legg and Kennedy, 1991). The Continental Borderland extends from the Santa Barbara Basin to the north, south along the coastline into Mexico, and offshore approximately 160 miles out to the Patton Escarpment.

4.5.2 *Local Tectonics*

The topography for most of the San Diego coastal metropolitan area is relatively simple, consisting of uplifted ancient sea floors and shore platforms that have become the present-day westerly-sloping terraces. These terraces are in turn dissected by westerly-flowing rivers which have incised significant canyons (Abbott, 1999).

Of the major active fault systems in Southern California, the Rose Canyon/Newport-Inglewood fault zone has impacted the local San Diego region the most. In addition, the La Nacion fault zone to the east of the project has contributed to the local tectonic state of the area. Combined with the offshore fault zones, these two faults have contributed to form the San Diego Bay. South of La Jolla, the Rose Canyon fault zone changes its orientation from a northeast/southwest trend to a more north/south trend, creating a left bend in the fault zone. This left bend locally creates a locking mechanism within the predominantly right lateral Rose Canyon fault zone. The compressional forces within this zone have caused folding, uplift, and tilting of the overlying sedimentary rocks, thus creating Mount Soledad and the down-dropped Mission Bay area. In San Diego Bay, the Rose Canyon fault zone separates into a “horsetail splay,” spreading movement across the Silver Strand, Coronado, and Spanish Bight Faults (as well as several smaller faults) as it trends offshore toward the Descanso Fault. The Descanso Fault lies offshore from Point Loma, where it extends southerly toward the Agua Blanca fault zone in northern Baja (Legg and Kennedy, 1991). This right step, between movement along the Descanso and Rose Canyon fault zones, has created a releasing bend, causing the rocks to be stretched and down-dropped. In response, the rocks have not deformed elastically, but instead have responded with brittle fault failure (Abbott, 1999). The easterly boundary of this releasing bend is formed by the La Nacion fault zone, which consists of generally normal faults that down-drop to the west.

4.5.3 *Local Faulting*

The project alignment is located along the easterly margins of San Diego Bay and east of the Silver Strand Fault segment of the Rose Canyon Fault system. There are numerous other secondary fault strands that have been identified within this portion of the bay, including one such strand in the bay, easterly of the 32nd Street Naval Station.

Previous studies (Fugro, 2005) have considered this fault (located in the bay) likely active based on interpretation of fault offsets within the Holocene deposits. However, when one considers the historical development of the site, it is not clear that the interpreted offsets are related to fault activity or the product of sedimentation onto a previously excavated surface that contains faults within it. It is our belief that the activity of this fault strand is indeterminate, given the fact that the historic Holocene-age bay deposits have been removed by previous dredging operations, given the fact that the bay deposits we now see post-date the late 1930s.

5 GEOLOGIC HAZARDS

5.1 Introduction

Each project may be exposed to risks associated with various geologic hazards. Many of those hazards are related to the actions of earthquakes and faulting. In addition to geologic hazards associated with earthquakes and faulting, there are other potential geologic hazards that may impact the proposed project. These include: landslides, expansive soils, collapsible soils, corrosive soils, groundwater, and flooding. A brief description of the various geologic hazards and their impact on the project site is presented below.

5.2 Geologic Hazards Associated with Earthquakes

5.2.1 *General*

Geologic hazards generally associated with earthquakes include ground rupture, ground shaking, tsunamis, seiches, seismic-induced flooding, liquefaction, seismic-induced ground settlement, and seismic-induced slope instability. With respect to these hazards, we have the following comments.

5.2.2 *Ground Rupture*

Two fault strands were identified passing through the bay south of the alignment during work performed by TCG for the Navy. These fault strands are considered to be secondary faults within the Rose Canyon-San Diego Bay fault system. The most westerly fault strand has evidence of upwards of 15 to 20 feet of vertical displacement. The easterly fault strand has displacements that are estimated to be on the order of a few feet or less. The activity of these two strands is unknown. Some investigators concluded that these fault strands were active.

The area has been dredged with the result that likely all of the historic Holocene-age deposits have been removed by the dredging. As such, we consider the activity of these fault strands to be indeterminate and, considering evidence found in other parts of the San Diego Bay, are likely potentially active.

Additionally, the Silver Strand segment of the Rose Canyon system is located approximately 1.4 miles to the west and the La Nacion Fault is located approximately 2.25 miles to the east. These faults are considered active or potentially active by numerous investigators. No known active or potentially active faults are mapped as crossing the alignment. Therefore, the risk of fault rupture is considered low.

5.2.3 *Ground Shaking*

It has been estimated that approximately ten low magnitude earthquakes (Magnitude 2.5 to 3.5) have occurred within the immediate vicinity of the project. In addition, four earthquakes with Magnitude 5.5 or greater have occurred within 50 km (31 miles) of the project. The closest historically documented earthquake is reported to have occurred approximately 13 km (8 miles) from the project. This earthquake is reported to have occurred on May 27, 1862, and had an interpreted Magnitude of 6.2. Lastly, using the computer program EQSEARCH and a Soil Class D, we estimated the peak ground accelerations likely to have occurred at the site from a database of historical earthquakes from 1800 to 2000. The largest historical peak ground acceleration was estimated to be 0.356 g at the project alignment.

On the basis of the above information and the results of our site-specific assessment of ground motion for the project, the risk to the site from ground shaking is considered to be high.

5.2.4 *Tsunamis and Seiches*

Tsunamis and seiches are considered likely hazards at this project site. A review of the Tsunami Inundation Map for Emergency Planning for the National City Quadrangle (Figure 5) dated June 1, 2009, indicates that the site is lying within a tsunami inundation area and may experience surging of flood waters up the creek channel during an event.

5.2.5 *Liquefaction*

Three key ingredients are required for liquefaction to occur: liquefaction-susceptible soils, groundwater, and strong earthquake shaking. Soils susceptible to liquefaction are generally loose to medium dense sands and non-plastic silt deposits below the water table. The soil deposits underlying the site are comprised of loose to medium dense sands and non-plastic silt deposits, bay deposits, and both Quaternary-age and Tertiary-age deposits, all of which exist below the water table.

The risk for liquefaction at the site is dependent upon the location of interest. Results of our liquefaction assessment indicate that the Bay Point and San Diego Formation soils are not liquefiable. However, the fill soils below the groundwater and the alluvial and estuarine deposits are potentially liquefiable. As such, the risk for liquefaction is considered to be **high**, depending upon the level of occurrence of an earthquake event. A review of the City of San Diego's Seismic Safety Study, Map Sheet 13, indicates that the project alignment has a moderate to high potential for liquefaction.

5.2.6 *Lateral Spreading*

We anticipate that portions of the project alignment could be subjected to lateral spreading. It is beyond the scope of this study to assess the stability of the channel embankments, and additional testing and engineering, as it relates to lateral spreading and other impacts associated with liquefaction, will be required.

5.3 **Landslides**

A review of aerial photographs, published reports and geologic maps, and our site reconnaissance, did not reveal any features indicative of ancient natural landslides on or adjacent to the proposed project site limits. In our opinion, the risk associated with landslides at the site is negligible

5.4 **Collapsible Soils**

No collapsible soils were reported in the literature reviewed or encountered during our site reconnaissance. As such, it is our opinion that the potential for collapsible soils is low.

5.5 Expansive Soils

No expansive soils were reported or encountered during our site reconnaissance. As such, it is our opinion that the potential for collapsible soils is low.

5.6 Corrosive Soils

As with any areas within or near a marine environment, conditions should be considered moderately corrosive. Testing will be required during a site investigation to determine the corrosive nature of the soils.

5.7 Groundwater

Surface water was observed in the creek at the time of our site reconnaissance. The depth to groundwater is likely directly related to the level of water within the creek and, as such, is expected to vary with rainfall and runoff. Groundwater is estimated to be relatively shallow at ±10 feet.

6 DISCUSSION

6.1 General

The results of our geologic and geotechnical site assessment indicate that from a geotechnical viewpoint, it is feasible to construct the facilities as proposed.

Depending upon the final design, geotechnical recommendations will be needed for different facets of the proposed construction. A brief discussion of each of these issues is presented below.

7 LIMITATIONS

Geotechnical engineering and the earth sciences are characterized by uncertainty. Professional judgments presented herein are based partly on our evaluation of the technical information gathered, partly on our understanding of the proposed construction, and partly on our general experience. Our engineering work and judgments rendered meet the current professional standards. We do not guarantee the performance of the project in any respect.

We have investigated only a small portion of the pertinent soil, rock, and groundwater conditions of the subject site. The opinions and conclusions made herein were based on the assumption that those rock and soil conditions do not deviate appreciably from those encountered during our field investigation. We recommend that a soil engineer from our office observe construction to assist in identifying soil conditions that may be significantly different from those encountered in our borings. Additional recommendations may be required at that time.

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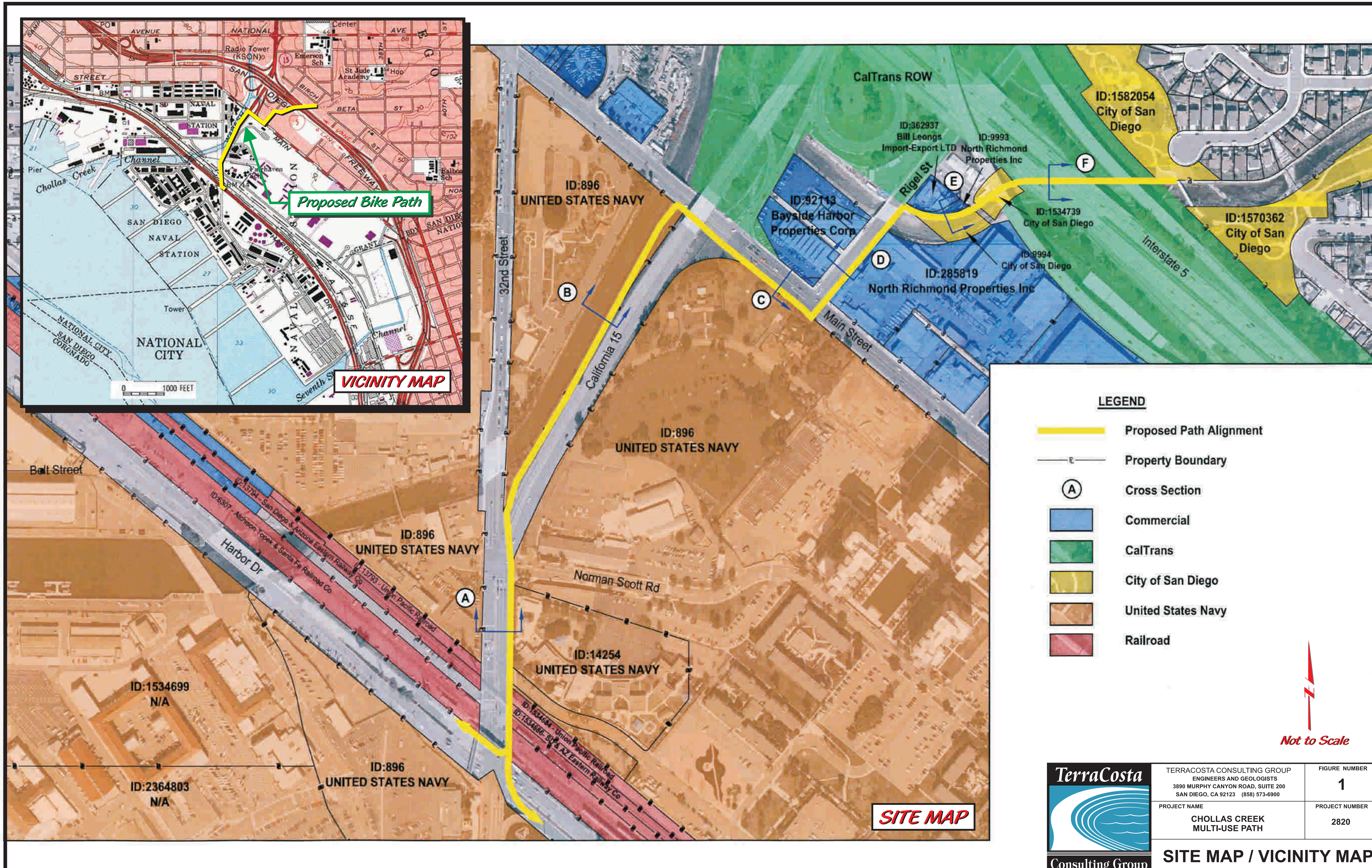
VICINITY MAP
Proposed Bike Path
NATIONAL CITY
Chollas Creek
SAN DIEGO NAVAL STATION
1000 FEET
SITE MAP
CalTrans ROW
ID:1582054 City of San Diego
ID:362937 Bill Leongs Import-Export LTD
ID:9993 North Richmond Properties Inc
ID:92113 Bayside Harbor Properties Corp
ID:1534739 City of San Diego
ID:1570362 City of San Diego
ID:9994 City of San Diego
ID:285819 North Richmond Properties Inc
Interstate 5
Rigel St
Main Street
32nd Street
California 15
ID:896 UNITED STATES NAVY
ID:896 UNITED STATES NAVY
ID:896 UNITED STATES NAVY
ID:896 UNITED STATES NAVY
ID:14254 UNITED STATES NAVY
Norman Scott Rd
Belt Street
Harbor Dr
ID:1534699 N/A
ID:2364803 N/A
A
B
C
D
E
F
LEGEND
Proposed Path Alignment
Property Boundary
Cross Section
Commercial
CalTrans
City of San Diego
United States Navy
Railroad
Not to Scale
TerraCosta Consulting Group
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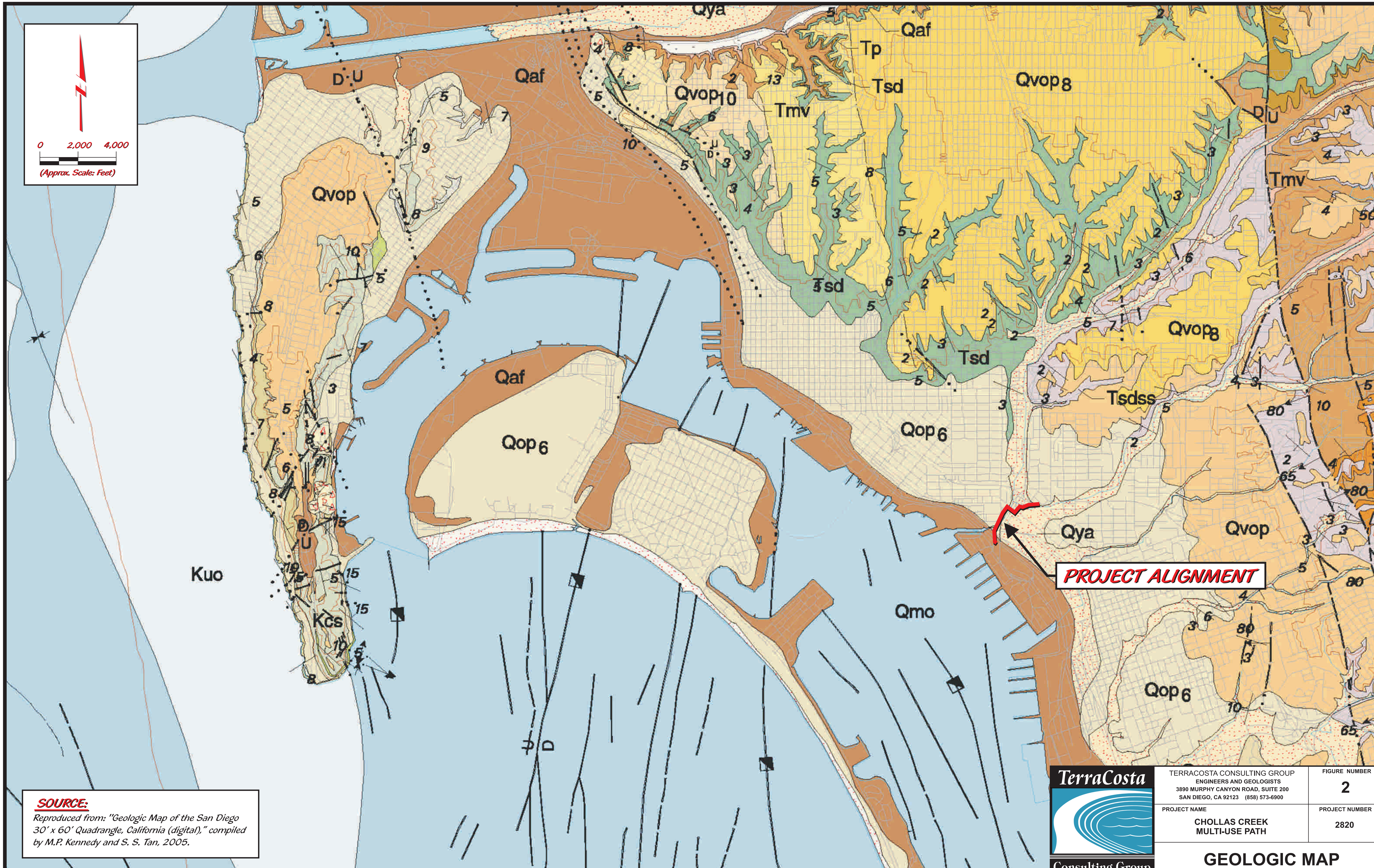
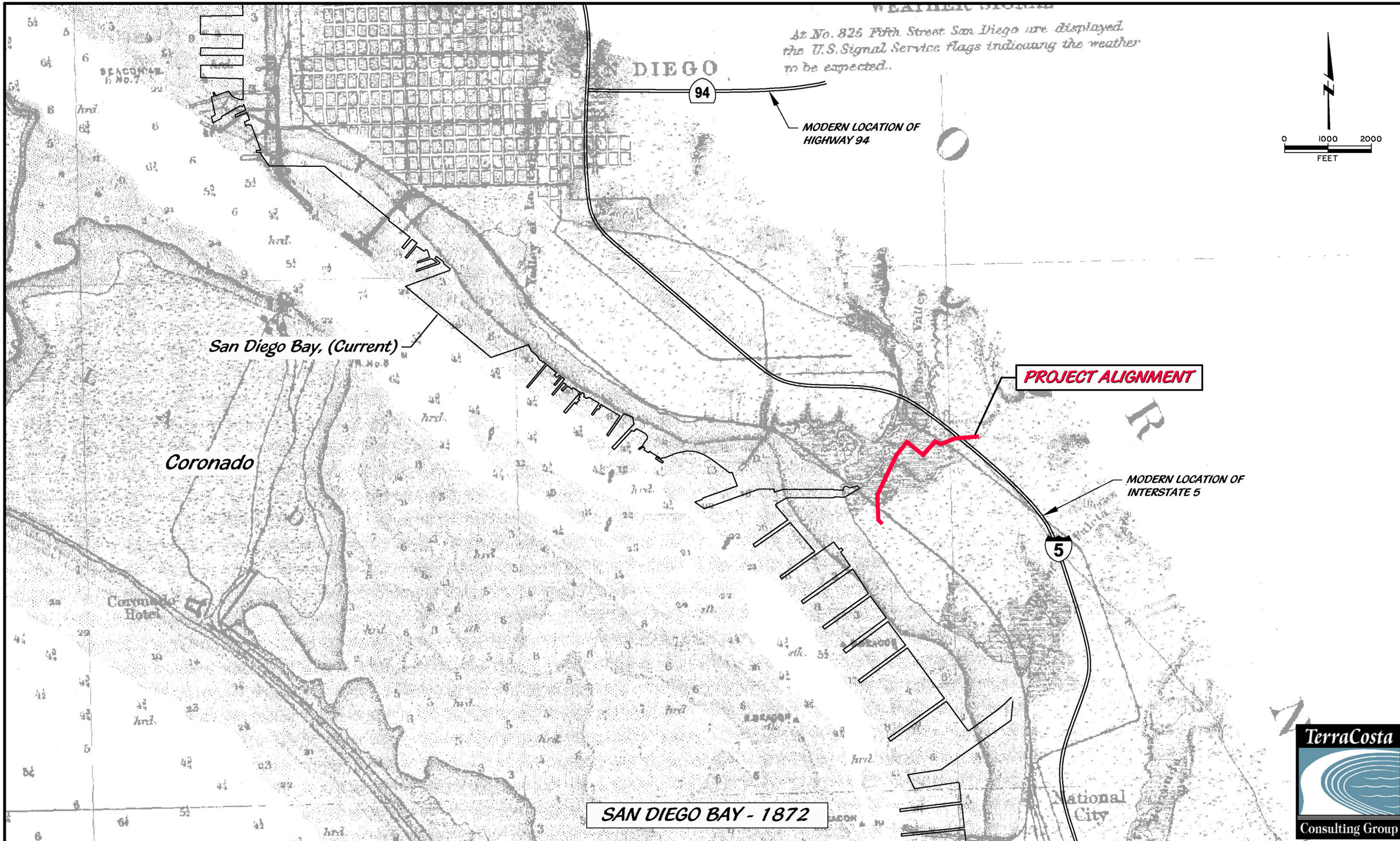
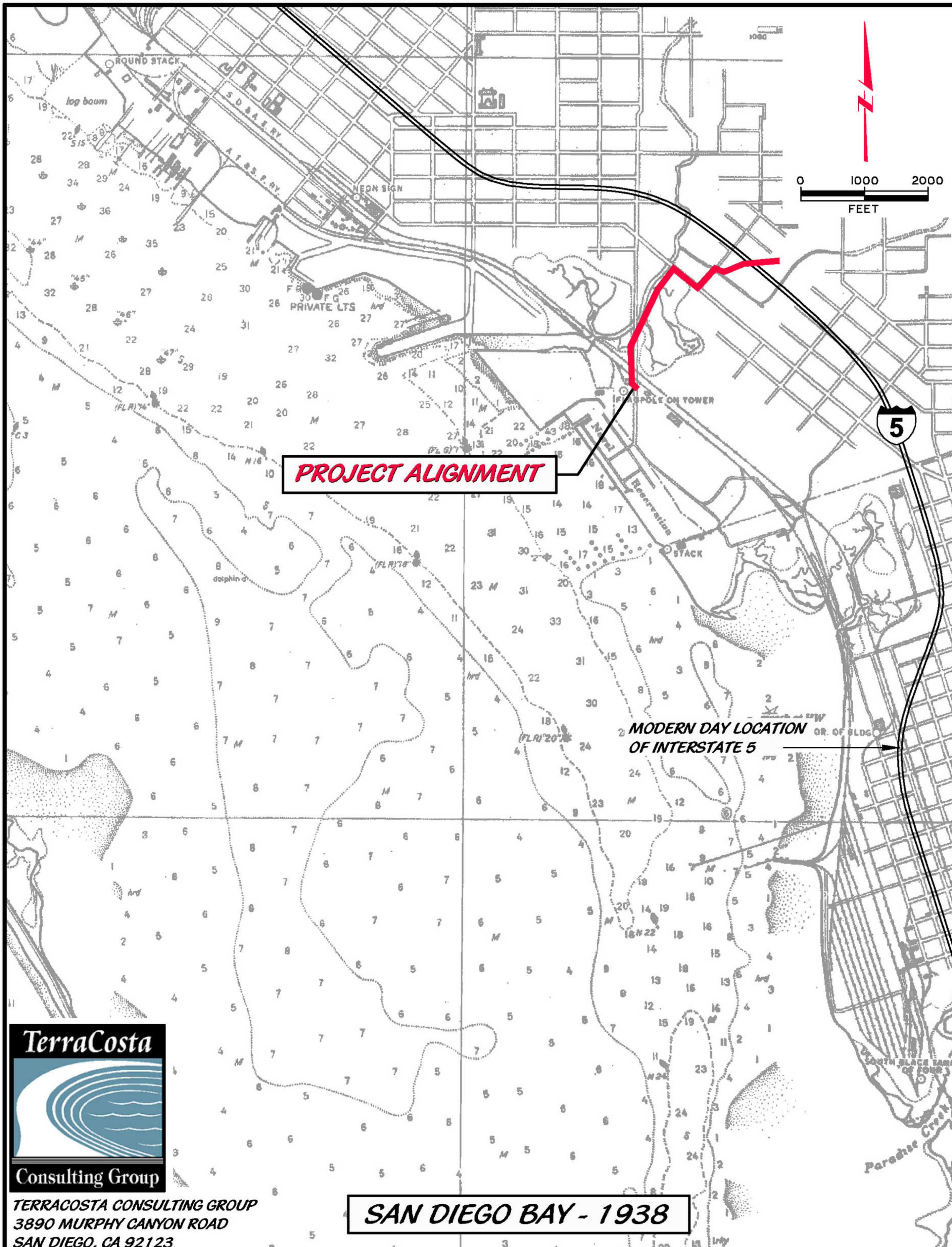
ENGINEERS AND GEOLOGISTS
3890 MURPHY CANYON ROAD, SUITE 200
SAN DIEGO, CA 92123 (858) 573-6900
FIGURE NUMBER
1
PROJECT NAME
CHOLLAS CREEK MULTI-USE PATH
PROJECT NUMBER
2820
SITE MAP / VICINITY MAP



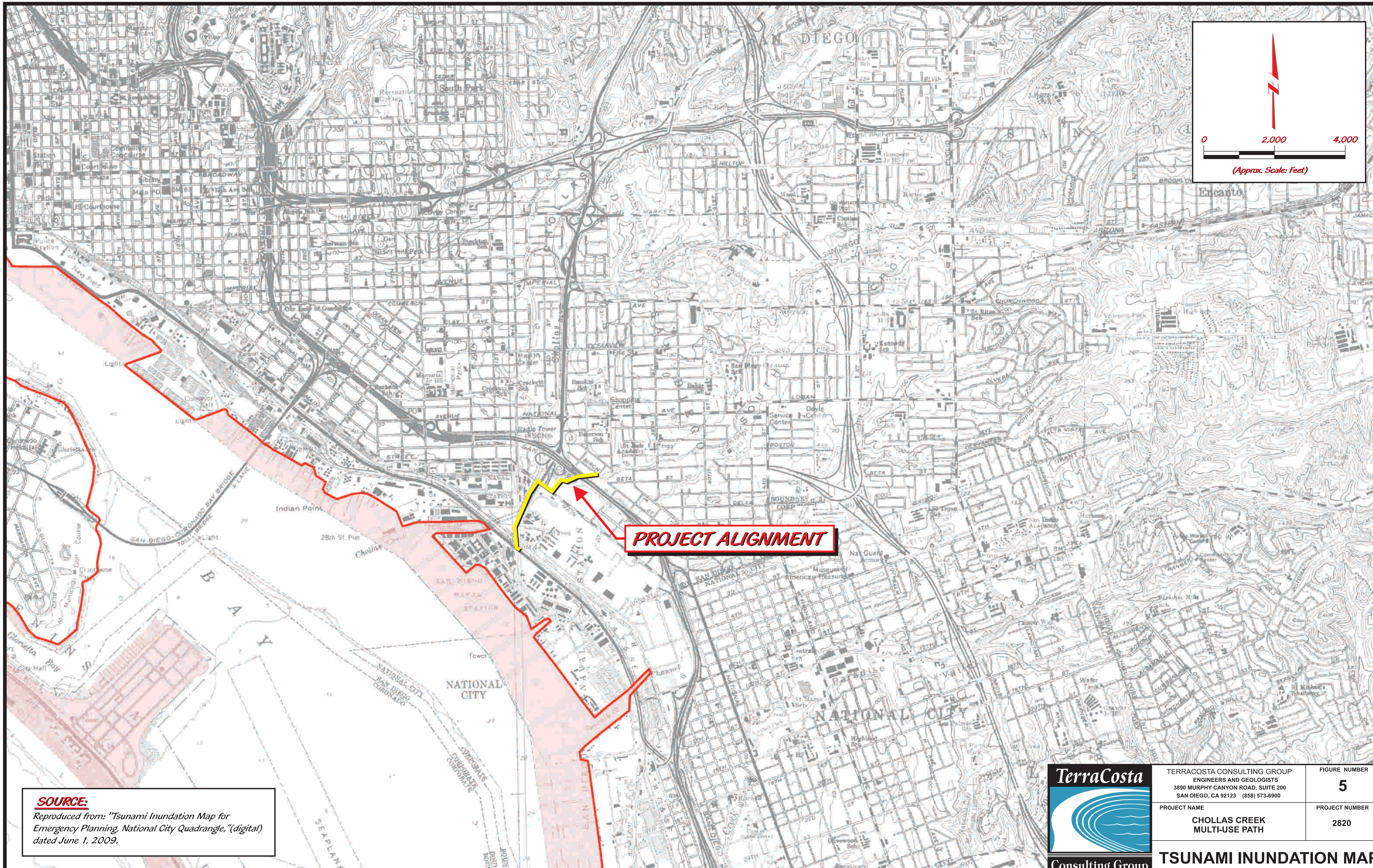
SOURCE:
Reproduced from: "Geologic Map of the San Diego 30' x 60' Quadrangle, California (digital)," compiled by M.P. Kennedy and S. S. Tan, 2005.

TerraCosta Consulting Group	TERRACOSTA CONSULTING GROUP ENGINEERS AND GEOLOGISTS 3890 MURPHY CANYON ROAD, SUITE 200 SAN DIEGO, CA 92123 (858) 573-6900	FIGURE NUMBER 2
	PROJECT NAME CHOLLAS CREEK MULTI-USE PATH	PROJECT NUMBER 2820
	GEOLOGIC MAP	


At No. 825 Fifth Street San Diego are displayed the U.S. Signal Service flags indicating the weather to be expected.
SAN DIEGO
94
MODERN LOCATION OF HIGHWAY 94
0 1000 2000
FEET
San Diego Bay, (Current)
PROJECT ALIGNMENT
Coronado
MODERN LOCATION OF INTERSTATE 5
5
Coronado Hotel
National City
SAN DIEGO BAY - 1872
TerraCosta
Consulting Group



Project Name: Chollas Creek Multi-Use Path • Project Number: 2820 • Figure 4



SOURCE:
Reproduced from: "Tsunami Inundation Map for Emergency Planning, National City Quadrangle," (digital) dated June 1, 2009.

TerraCosta Consulting Group

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FIGURE NUMBER	PROJECT NAME	PROJECT NUMBER
5	CHOLLAS CREEK MULTI-USE PATH	2820

TSUNAMI INUNDATION MAP