



**CORONADO CAYS DEVELOPMENT**  
CORONADO, CALIFORNIA

**GEOTECHNICAL ASSESSMENT OF BULKHEADS  
AND THEIR ASSOCIATED ENGINEERING ELEMENTS**

SUBMITTED TO  
Mr. Henry Angelino  
Coronado Cays HOA  
505 Grand Caribe Causeway  
Coronado, CA 92118

PREPARED BY  
TerraCosta Consulting Group  
*an ENGEO company*

August 26, 2021  
**Revised:** September 17, 2021

PROJECT NO.  
T2904.070.001





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GEOTECHNICAL  
ENVIRONMENTAL  
COASTAL/MARITIME  
WATER RESOURCES  
CONSTRUCTION SERVICES

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Subject: Coronado Cays Development  
Coronado, California

**GEOTECHNICAL ASSESSMENT OF BULKHEADS  
AND THEIR ASSOCIATED ENGINEERING ELEMENTS**

Dear Mr. Angelino:

In accordance with your request, TerraCosta Consulting Group (an ENGEEO company), has performed a geotechnical assessment of the bulkheads within the Coronado Cays development, in Coronado, California. We performed an assessment of the panel joints, panel faces, and toe-berms, which support both the residential lots and common areas owned by the Coronado Cays HOA (CCHOA). The purpose of our assessment was to provide a summary of previous geotechnical work on the subject properties, perform an updated inventory and inspection of the bulkheads, and present our findings, conclusions, and recommendation for repair of the bulkheads. This report provides a summary of the existing condition of the bulkheads and provides an update to the global stability of the bulkheads relevant to the elevation of the passive soil berms buttressing the bulkheads.

We appreciate the opportunity to be of service on this project. If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

TerraCosta Consulting Group  
*an ENGEEO company*

Walter F. Crampton, GE, D.CE  
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wfc/cw/jg

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## 1.0 INTRODUCTION

### 1.1 PURPOSE AND SCOPE

TerraCosta Consulting Group, an ENGEO company, prepared this geotechnical report for the Coronado Cays Development, located in Coronado, California. We prepared this report as outlined in our agreement dated May 10, 2021, Proposal No. P2021.000.297. The purpose of this assessment was to perform a geotechnical assessment of the bulkheads at the Coronado Cays HOA, Green Turtle Cay, Montego Village, Jamaica Village, Bahama Village, Trinidad Village, Blue Anchor Cay, Spinnaker Way East, Port Royale Village and Mardi Gras Village, and provide an update to the global stability of the bulkheads and their associated engineering elements. We were authorized to conduct the following scope of services.

- Coordination and Research
- Visual Inspection and Inventory of Bulkheads
- Underwater Inspection and Inventory of Bulkheads
- Inspection and Inventory of Storm Drain Penetrations
- Limited Lead Line Survey
- Report preparation

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### 1.2 PROJECT LOCATION

Coronado Cays is a residential development located within the San Diego Bay, on the east side of a tombolo connecting Coronado Island to mainland San Diego. As shown in Figure 1, the development is bound by the San Diego Bay to the east, Silver Strand State beach to the west, the City of Imperial Beach to the south, and Loews Coronado Bay Resort to the north. Inland waterways are separated from the land by vertical concrete bulkheads, which have been constructed fronting nearly every waterfront lot. Construction of the waterfront residential development began in the early 1970s. The Coronado Cays development was reclaimed from low-lying coastal areas by constructing an anchored concrete sheet-pile bulkhead and placing fill soils behind the bulkhead.

Figure 1B provides a key map of the various villages and notes the appendix in which the results of the field studies for each village are summarized.



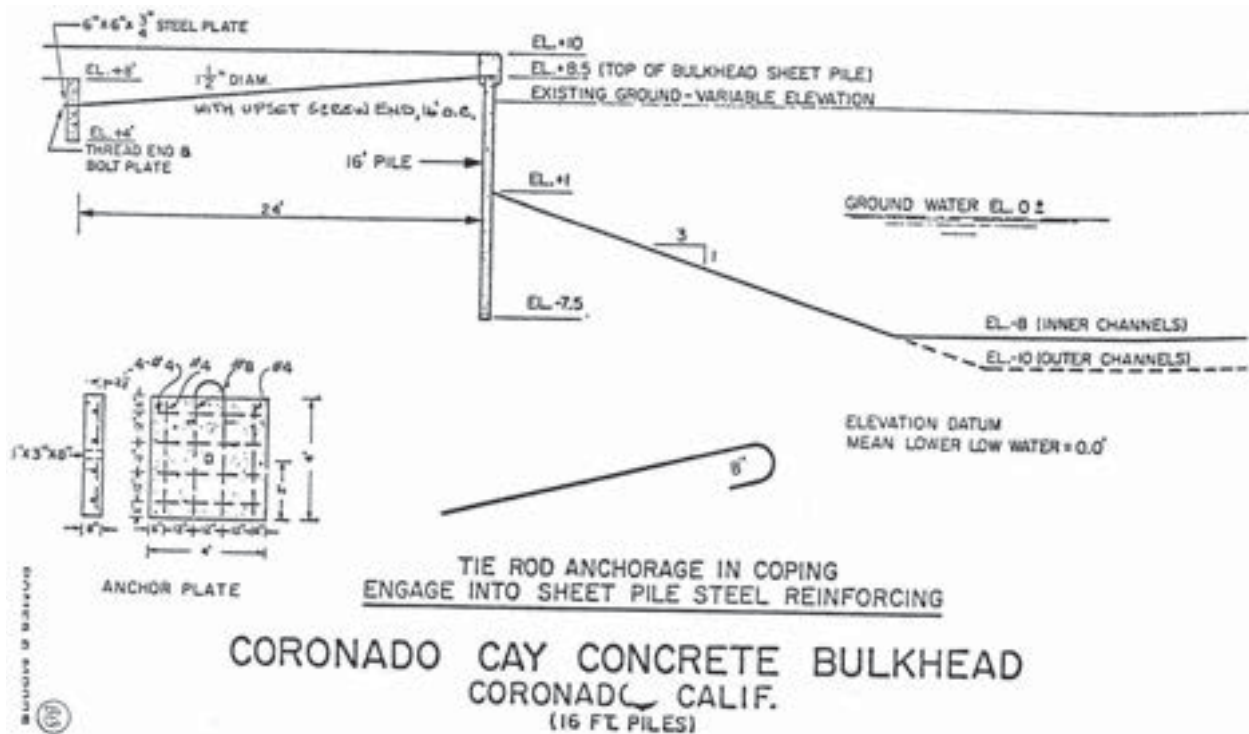
Figure 1 – Site Plan



Figure 1B – Key Map

### 1.3 PROJECT DESCRIPTION

The design of bulkheads incorporated either a 17½- or a 20-foot-long concrete sheet piles fronting the private waterfront properties, and 22-foot-long concrete sheet piles along the various City of Coronado-owned causeways. The bulkheads also incorporated a 22-inch-high concrete pile cap. The sheet-pile cap elevation throughout the Cays was set at elevation +10 feet, mean lower low water (MLLW) datum (+7.12 feet Mean Sea Level (MSL) datum). The original design called for a passive soil berm extending from elevation +1 foot MLLW (or 9 feet below the top of the pile cap), at the base of the bulkhead, to elevation -8 feet MLLW at the channel bottom. The soil berms were designed to extend 27 feet from the bulkhead into the fairway at a slope inclination of 3:1 (horizontal to vertical). Beyond the soil berms, the channel bottom was designed as a flat cross section dredged to elevation -8 feet MLLW. In addition to the passive resistance provided by the berms, the bulkheads are also restrained with a series of deadman anchors along the top of the bulkhead (see Figure 2).



**Figure 2 – Original Bulkhead Design Section**

The concrete sheet-pile bulkheads throughout the Coronado Cays Development utilize a combination of tongue-in-groove or groove-in-groove joints between adjacent panels, with the joint, immediately after panel installation, flushed with water, then grouted solid with a cementitious grout. The integrity of the grout making joints waterproof is affected by initial contamination during construction; minor misalignments of adjacent joints during construction, exposing the grout to increased hydraulic and marine degradation; minor post-construction movement of the panels; and overall degradation of the cementitious grout mix over time.

The passive soil berms fronting the bulkheads play an important role in the long-term stability of the bulkhead. The bulkhead stability is a function of geotechnical soil parameters, differential water level, integrity of the steel-reinforced concrete panels, and, most importantly, the elevation and configuration of the berm providing passive resistance for the bulkhead. For the studies performed to date, the criterion of a minimum factor of safety of 1.5 against rotation failure about the bulkhead anchor has been used to assess the stability of the Cays bulkhead. Typically, the computation of the factor of safety is based on the ratio of moments of forces associated with resisting rotation, compared to moments of forces associated with driving rotation. The moments associated with driving, or causing, rotation are commonly referred to as overturning moments. Usually, the forces located landward of the bulkhead are related to causing rotation, whereas the forces located bayward of the bulkhead are associated with resisting rotation.

Over time, the majority of the berms have flattened somewhat, likely for a variety of reasons, and it is apparent that prop wash from vessels backing into docks has contributed to the displacement of the berm material. These processes have resulted in localized areas having berm elevations below an acceptable level to adequately support the lateral forces with a sufficient margin of safety against failure.

Due to the importance of maintaining the passive soil berms, a periodic marine inspection program was designed to inventory the height of the berms and hence the passive resistance provided by the berms. In efforts to develop and maintain the inspection program, TerraCosta and its predecessor firms have completed periodic hydrographic surveys of the interior waterways within the Coronado Cays community since the mid 1980's. It should be noted that, since the City of Coronado (as with most cities) in the past used the National Geodetic Vertical Datum – NGVD 29 (Mean Sea Level) as their terrestrial survey datum, we have presented surveys in the MSL (NGVD 29) datum. MSL for San Diego County is 2.88 feet above MLLW. We should note that with sea level rise, the contemporary Mean Sea Level reported by NOAA for the 1983-2021 tidal epoch is 0.43 foot higher than NGVD 29. However, since all of the early surveys used the older MSL datum (NGVD 29), along with MLLW, in this study when we refer to MSL, we are using the MSL of 1929 or, more specifically, NGVD 29 to maintain consistency.

In addition to performing varying bathymetric surveys, TerraCosta and its predecessor firms performed visual inspection of the integrity of the bulkheads. During our visual inspections, we documented areas experiencing continued settlement, piping, and piping behind the bulkheads, along with cracks and distress within the bulkheads and bulkhead penetrations.

Our most recent assessment program was conducted to continue our evaluation of the bulkhead integrity and to update our bathymetric survey data, specifically addressing potential variations in the height of the passive soil berms fronting the bulkheads. This report provides a geotechnical assessment of the bulkheads, in addition to providing a reassessment of potential berm stabilization needs.



## 2.0 Background

As part of our scope of services for the current project, we performed a review of previous geotechnical and geologic publications, including historical assessments, recorded bathymetry, previous surveys, and other relevant geotechnical data collected at Coronado Cays. TerraCosta and its predecessor firm, Group Delta Consultants, have collectively been involved in various engineering studies and inspection programs in and adjacent to the interior waterways of the Coronado Cays development since 1985. The site development history is informative, providing insight into the need for additional maintenance, and importantly the requirement that power boats never back into the slips using forward thrust to stop a boat's movement, as this would then scour the easily erodible soil berm that prevents the bulkhead from failing.

The history of the Mardi Gras bulkhead stabilization is important in that it shows the very modest initial design criteria, the 1 foot of erosion seaward of the bulkhead that caused movement in 1993, the repairs to the bulkhead in 1997-98, and the additional failures in 2003 associated with yet more erosion.

As with the Mardi Gras bulkhead, all of the bulkheads within the Coronado Cays require a sufficient berm elevation to maintain the stability of the bulkhead. TerraCosta and its predecessor's previous work for the last 35+ years is summarized in Appendix A, which provides a history of past engineering studies.

## 3.0 SCOPE OF SERVICES

Based on our understanding of the Coronado Cays development history, and the bulkhead stability issues, we have performed the following scope of work.

**Coordination and Research:** Under this task, we met with the Coronado Cays Homeowners Association to coordinate access and discuss their expectations and understanding of the stability issues the community faces. We also reviewed previous surveys, engineering reports, assessments, and repairs.

**Visual Inspection and Inventory of Bulkheads:** Under this task, we observed the bulkhead panels, pile caps, panel joints, and panel penetrations for distress and cracking, and settlement behind the bulkheads, where accessible. We looked for signs of lateral movement or rotation, and the general condition of the flatwork behind the bulkheads that could indicate washouts, voids, or piping of wall backfill soils below the water surface, in addition to observing the facing of bulkhead panels for cracking, spalling, exposed rebar, or signs of distress or failure. This survey was performed by our field crew of engineers and geologists within the channels during low tide.

**Underwater Inspection and Inventory of Bulkheads:** Under this task, an underwater inspection and inventory of the bulkheads was completed. Work included inspection of the bulkhead panels for separations of joints, cracking, and other damage, location of bulkhead penetrations, and evidence of soil piping and lost ground from behind the bulkhead.

**Voids Inspection:** Under this task, inspections by an Engineering Geologist indicated the presence of ground loss at specific panel joints. The adjacent panels were inspected for settlement and voids resulting from soil piping.

**Storm Drain Penetrations:** Under this task, we observed and photo documented the individual storm drain penetrations to identify where pipes have settled, separated, have been fouled by roots or debris, or have been structurally compromised.

**Lead Line Survey:** Under this task, we surveyed the top of the berm adjacent the bulkheads to assess the geometry of the top of the existing berm. This survey was performed by our field crew of engineers and geologists within the channels in order to confirm the elevations of the areas where it was difficult to perform low tide berm surveys.

**Report Preparation:** Under this task, we completed this written report providing our findings, conclusions, and recommendations. We present a description of observed distress features, bulkhead penetrations, elevation of soil berm, and areas where soil piping and settlement were observed.

## 4.0 FINDINGS

### 4.1 FIELD OBSERVATIONS

Between May 19 and June 25 2021, TerraCosta performed a geotechnical reconnaissance and inventory to assess the overall condition of the Coronado Cays Development bulkheads and their associated engineering elements. Our work consisted of observations, assessments, and photographic and written documentation of those areas that were observed to exhibit distress, or evidence of settlement and/or lost ground. In addition, soil berm elevations were measured for areas where erosion and lost ground might affect the stability of the bulkheads.

In general, our observations indicate that minor settlement of backfill soils has occurred in localized areas behind the bulkheads. We observed both significant and minor cracking and spalling of concrete, corrosion of steel reinforcement, and general distress of the bulkhead panels, panel joints, pile caps, architectural façade, and other associated improvements. We observed some privacy walls between lots have separated up to 3 ½ inches from the pilaster at the top of the bulkhead's pile cap. Separation between the pilaster and the privacy wall commonly indicate lateral movement of the bulkhead. These areas are described in the appended village-specific tables.

We also noted 24 areas where talus piles have formed at the base of panel joints. The formation of a talus pile indicates soil piping of the bulkhead's structural backfill. As the backfill material migrates through panel joints, it leaves loose soil and potential voids behind the bulkhead that can translate into surface settlement above. Settlement behind the bulkhead may affect concrete flatwork, patios, pools, and other backyard improvements adjacent to the bulkheads. We inspected the panels on either side of the panel joint where talus piles were observed and where accessible, the ground behind the pile cap. We noted areas that presented signs of subsurface voids and surface deformation. These areas are noted on the appended village-specific figures and described in the village-specific tables. All joints having talus piles should be stabilized with either chemical or polymer grouting.

## 4.2 BULKHEAD INTEGRITY AND BATHYMETRIC DATA

In order to simplify the presentation of our recent observations and bathymetric data collection, we provided separate appendices for areas within CCHOA jurisdiction, and each of the following villages/cays:

- Appendix B: Coronado Cays HOA (including Antigua Court and Kingston Court)
- Appendix C: Green Turtle Cay
- Appendix D: Montego Village
- Appendix E: Jamaica Village
- Appendix F: Bahama Village
- Appendix G: Trinidad Village
- Appendix H: Blue Anchor Cay
- Appendix I: Spinnaker Way East
- Appendix J: Port Royale Village
- Appendix K: Mardi Gras Village
- Appendix L: Tire Island

In each Appendix, we have included a series of figures showing a tabulated summary of our observations of the bulkheads and their associated engineering elements, the elevation of the berm within the limits of each individual lot or CCHOA common areas, and select photographs of our observations. The elevation of the berms has been presented in the same format of similar figures produced for previous studies, which show color plots indicating a particular elevation range.

A summary of our findings for each of the area follows:

**Coronado Cays (including Antigua Court and Kingston Court):** Evidence of settlement and voids under walkways, and talus piles near the base of the bulkheads was noted. The talus piles are an indication of soil leaking through joints between the bulkhead panels. These areas should be further explored and the joints sealed and voids filled.

**Green Turtle Cay:** This area includes Admiralty Cross, The Point, Sandpiper Strand, Sixpence Way, and Green Turtle Road. Measurements and observations indicated that one location near No. 4 and No. 6 Sixpence Way and numerous areas on the southerly side of Green Turtle Road have berm elevations within the “cautionary” zone that need placement of fill to raise the elevations of the berms. Additionally, talus piles were observed at four locations on Green Turtle Road, including a talus pile at the northerly end of the bulkhead near Green Turtle Road Causeway, and at one location on Sandpiper Strand.

**Montego Village:** Observations and measurements indicate that berms are within acceptable elevations, and do not require any additional maintenance or fill placement.

**Jamaica Village:** Observations and measurements indicate that berms are within acceptable elevations, and do not require placement of additional fill. Evidence of possible voids under the sidewalk was observed in one area adjacent to Gangway 2.

**Bahama Village:** Observations and measurements indicate that the berms generally located at the base of the bulkheads adjacent to the HOA clubhouse and pool are located within the

“cautionary” zone. Additional fill should be placed to raise the berms to acceptable elevations. One smaller area was also observed between Lots 89 and 91.

**Trinidad Village:** Our observations and measurements revealed three locations where berm elevations were within the “cautionary” zone, which will require the placement of fill. Additionally, talus was observed at one location adjacent to an open space easement between 29 and 33 Port of Spain Road.

**Blue Anchor Cay:** Observations and measurements indicate that berms are within acceptable elevations, and do not require the placement of any additional fill.

**Spinnaker Way East:** As with Mardi Gras and Port Royale Villages, a small beach fronts the bulkheads along all but the northern end of this area. Observations and measurements indicate that there is approximately 250 to 300 lineal feet of bulkhead within the “cautionary” zone.

**Port Royale Village:** As with Mardi Gras Village, a small beach fronts the bulkhead in this area. Observations and measurements indicate that approximately 200 feet of the bulkhead is within the “cautionary” zone, requiring the placement of fill.

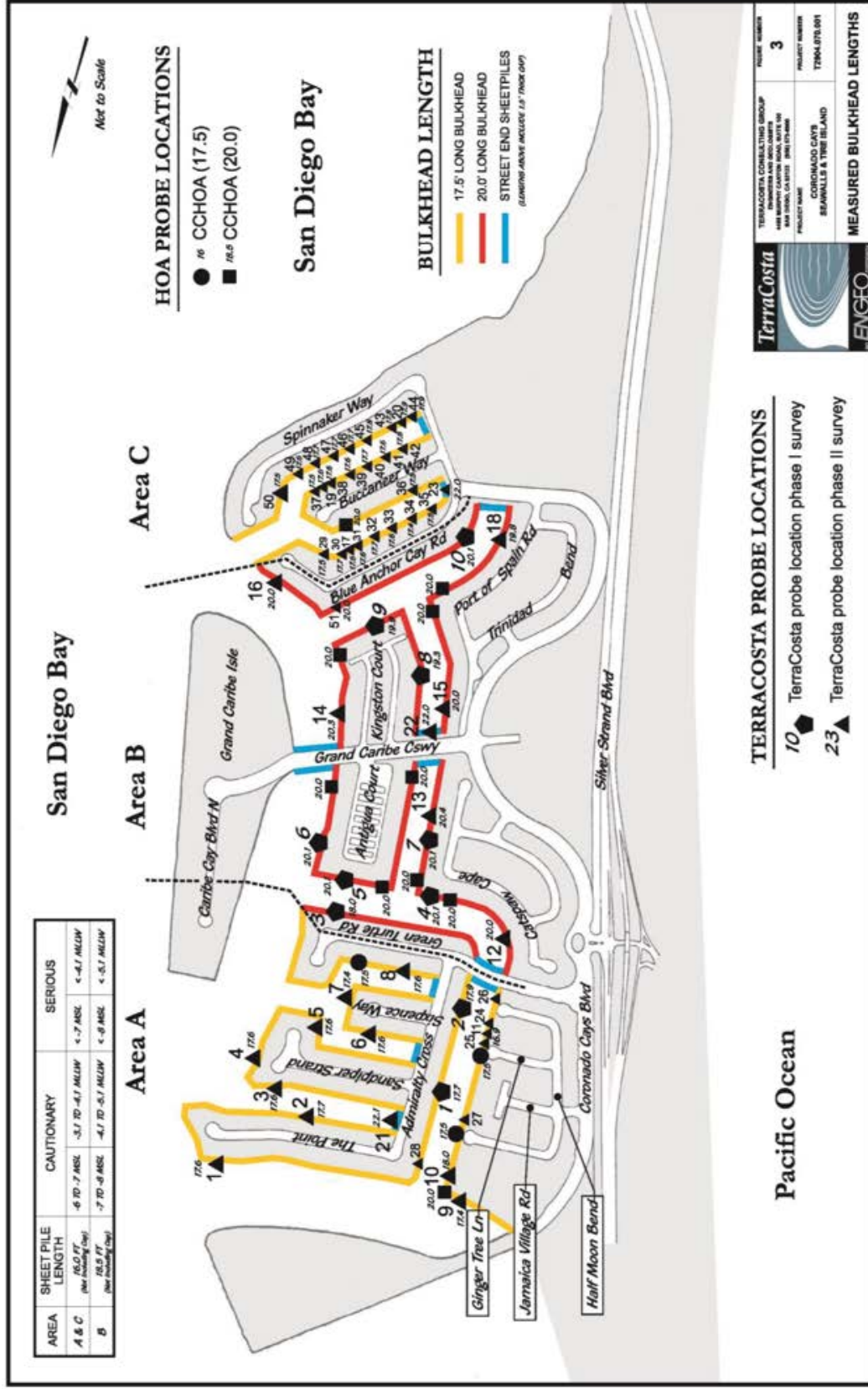
**Mardi Gras Village:** This area is located at the southerly end of the Coronado Cays and is rather unique in that it includes a beach area fronting the bulkhead. Measurements indicate that approximately half of this bulkhead is located within the “cautionary” or “serious” category. Fill should be placed to prevent yielding of the wall where not previously stabilized by anchors.

**Tire Island:** A detailed discussion on the Tire Island wave attenuator is provided in Appendix L.

### 4.3 BULKHEAD STABILITY ANALYSIS

For our analyses, we have utilized the same designation criteria that was established in our 2006 report as a means of identifying areas that are cautionary and serious. Cautionary soil berm elevation thresholds for 17.5-foot long bulkheads (Areas A and C, Figure 3) are between -6 and -7 feet, Mean Sea Level (-3.1 and -4.1 feet MLLW). Serious soil berm elevation thresholds for 17.5-foot long bulkheads (Areas A and C, Figure 3) are below -7 feet, Mean Sea Level (-4.1 feet MLLW).

Likewise, cautionary soil berm elevation thresholds for 20-foot long bulkheads (Area B, Figure 3) are between -7 and -8 feet, Mean Sea Level (-4.1 and -5.1 feet MLLW). Serious soil berm elevation thresholds for 20-foot long bulkheads (Area B, Figure 3) are below -8 feet, Mean Sea Level (-5.1 feet MLLW).



No berm elevations within the interior fairways within the Coronado Cays have been designated as “serious.” Recommendations are provided in Section 9 – Recommendations for stabilization of those berms within the Cays that are designated as “cautionary.” Several cantilevered bulkheads adjacent Tunapuna Lane and one cantilevered bulkhead adjacent Spinnaker Way are designated as “serious” with more cantilevered bulkheads adjacent Tunapuna Lane, Aruba Bend, and Spinnaker Way designated as “cautionary.”

## 5.0 TIRE ISLAND SURVEY

The Coronado Cays “Tire Island” wave attenuator is located approximately 900 feet southeast of The Point cul-de-sac on Green Turtle Cay, the location of which is shown on Figure 1B. We surveyed the remains of the wave attenuator during our site visit on June 4, 2021. We observed only two of the piles with tires floating at water level. Bottom elevation of bay muds/sand was generally -3.8 feet MLLW. The base of the piles are thickly encrusted with marine life. A debris field ranging a distance of 10 to 20 feet from the piles in either direction and between each pile consisted of scattered minor concrete debris, a concrete block approximately 2 feet in height, several 12-inch square piles, what appeared to be two boat masts, and encrusted rubber tires scattered around the bottom near the base of the piles. Additional detail and photographs are provided in Appendix L.

## 6.0 LOST GROUND AND SETTLEMENT

Where accessible, we investigated the areas at the tops of the bulkheads for evidence of lost ground and settlement. This was done by either hand-probing the exposed soil or grass areas, or by tapping with a hammer to listen for a hollow sound in the areas covered with concrete. During our survey, we noted ten areas in Kingston Court, one large area and numerous other suspected areas on the northerly side of the CCHOA clubhouse on Catspaw Cape, an area between Half Moon Bend and Ginger Tree Lane, and three areas in the common space on Antigua Court. These areas are noted in the appendices.

It should be noted that not all of the areas identified are coincident with a talus pile and/or potential ground loss. During our assessment, we were made aware of voids that were discovered by a contractor during the demolition of concrete flatwork adjacent to the bulkheads on Blue Anchor Cay.

It is our opinion that other areas of settlement and ground loss may develop from holes used as sheet-pile lifting points or unused area drains in the bulkhead panels that were not sealed with grout after construction. The highest observed tide in San Diego Bay was 8.24 feet MLLW observed in November 2015. The highest astronomical tide typically reaches 7.72 feet MLLW. These tides are high enough to reach these bulkhead penetrations, which may result in the piping of soil if no filter is installed to capture and retain soil. We recommend that these penetrations be investigated and sealed where not used as drains or where there is evidence that no filter medium has been installed.

## 7.0 SPINNAKER WAY, PORT ROYALE, AND MARDI GRAS VILLAGE DISCUSSION

As we discussed during the June 29, 2021, Coronado Cays townhall meeting regarding the Mardi Gras, Port Royal, and Spinnaker Village bulkheads, we noted that unlike all of the bulkheads facing the interior fairways, these easterly facing walls were of cantilever design and relatively

sensitive to the amount of unsupported wall height. Although described further in the History of Engineering Studies at Coronado Cays (Appendix A), these cantilevered walls are 12 feet in length and designed to accommodate a maximum 4 feet of unsupported wall height. Beach scour over the years resulted in excessive yielding of the wall in 1993, with repairs completed in 1997; with yet additional yielding of the wall in 2003 associated with more beach scour, with additional repairs completed several years ago. While we do not know the actual design of the more recent repairs, we must assume that they were designed to accommodate over 6.3 feet of unsupported wall height, since the cantilevered wall fronting 113 Tunapuna Lane currently has an unsupported wall height of 6.3 feet. Without knowing the design of the recent additional soil anchors installed from 85 to 113 Tunapuna Lane, we cannot comment on the stability of the bulkhead fronting these lots. However, as indicated in Section 9 – Recommendations, Lots 23 through 29, 71, 75 through 95, and 97/99 on Tunapuna Lane, Lots 3 through 17 on Aruba Bend, and Lots 59 through 69 on Spinnaker Way currently have a “cautionary” designation, while Lots 17, 21, and 31 on Tunapuna Lane and Lot 61 on Spinnaker Way currently have a “serious” designation. In our opinion, these bulkheads are in immediate need of stabilization.

Specific to Lots 1 through 9 at the north end of Spinnaker Way, we do not know the stability of the bulkheads seaward of these lots since, at least for Lots 1 through 7 with as much as 7.3 feet of unsupported wall height, additional restraint has to exist for the bulkheads fronting these properties, the extent of which is unknown. Although these lots are listed on Table 1 (below), the designation is indicated as “Unknown” and we would recommend that additional studies be performed along these lots to confirm and ensure the stability of these lots.

**Table 1 – Maintenance Infill Data**

STREET NAME	LOCATION / ADDRESS	BULKHEAD DESIGNATION	PROPOSED INFILL LENGTH (FT)	BERM ELEVATION (FT, MSL)	PROPOSED INFILL VOLUME (CY)
Antigua Court	Common Area	B	55	-7.2	44
Antigua Court	55	B	11	-7.2	9
Antigua Court	59 / 61 / 63	B	53	-7.2	42
Antigua Court	69	B	18	-7.4	18
Antigua Court	77 / 79	B	30	-7.2	24
Sixpence Way	4 / 6	A	80	-6.0	64
Mardi Gras Village	17-35, 71, 75-81	Cantilevered	245	+2.2 to +3.0	115 (800)*
Mardi Gras Village	85 – 113	Tied-Back	560	-2.0 to +2.7	Unknown
Aruba Bend	3 – 17	Cantilevered	190	+2.7 to +3.0	25 (130)*
Spinnaker Way	59 – 67	Cantilevered	230	+2.2 to +2.9	60 (355)*
Spinnaker Way	1 – 9	Unknown	365	-0.2 to +2.7	Unknown
TOTAL:			912		401

PROJECT TOTAL (401 CY/912 LF)	0.44 CUBIC YARDS PER LINEAL FOOT
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\*These values included in table. The smaller number represents the immediate required volume. The number in parentheses represents the long-term required volume. The total proposed volume includes the immediate required volume.



## 8.0 CONCLUSIONS

Considering the fact that the bulkheads are approaching 50 years in age, they have generally performed well. While many areas throughout the Coronado Cays Development have experienced minor settlement-related distress, there were no indicators suggesting imminent threat to the stability of the walls or adjacent properties and improvements observed.

Given the preceding, all of the walls within the Coronado Cays development consist of pre-cast reinforced concrete panels. The reinforcing steel does not appear to have any corrosion protection, and throughout the Cays, there are multiple indications of severe corrosion of the wall reinforcing steel, which will, in the long term, compromise the integrity of the concrete bulkheads. We have conducted limited inspections of several of the bulkheads in the past with other port and harbor engineers, and have generally concluded that within the next 15 to 20 years, we anticipate these bulkheads will start failing, ultimately necessitating a major restoration project. We have discussed this in the past with Coronado Cays HOA Staff, and Board Members, suggesting that consideration be given to proactively explore the eventual need for bulkhead replacement. Again, we anticipate that bulkhead remediation progressing through the entire Cays will need to commence within the next 15 to 20 years.

The width of most of the fairways is 200 feet, and the most likely methods of bulkhead restoration would be the construction of a new either cantilevered or tied-back bulkhead constructed immediately outboard of the existing bulkhead, with a new architectural façade.

Notably, the previously reported 95-foot-long “cautionary” area on the east side of Antigua Court within the San Diego Unified Port District’s jurisdiction has filled-in sufficiently to be removed from its previous “cautionary” designation. This area was checked twice during our recent assessment to confirm the higher berm elevations and more stable condition of these bulkheads.

## 9.0 RECOMMENDATIONS

While the bulkheads have performed relatively well, minor repairs should be completed to prolong their life. In addition, any areas where spalling and cracking have occurred should be assessed for temporary repairs (i.e., patching or epoxy injection) to prevent intrusion of sea water to extend the life of the reinforced concrete panels. We have provided Sika concrete stabilization product literature to the CCHOA Board, and discussed with Board members our recommendation that a Sika representative visit the site and provide specific product recommendations for treating the various concrete degradation issues. Sika product information can be viewed on their website at [usa.sika.com](http://usa.sika.com).

### 9.1 BULKHEAD JOINT STABILIZATION

As indicated in Section 4.1 – Field Observations, a total of 24 talus piles were encountered within the Coronado Cays; fourteen talus piles on Kingston Court, four talus piles on Antigua Court, three talus piles on Green Turtle Road, seven talus piles on Port of Spain Road, one talus pile on Half Moon Bend, and one talus pile on Sandpiper Strand. The locations of these talus piles are shown on the corresponding Goggle Earth images for the various villages and cays provided in Appendices B through G. We recommend that all of these joints be stabilized with either a chemical or polymer grout behind the wall adjacent the joint down the tip elevation of the bulkhead, as shown on Figure 3. Eagle Lift ([www.eaglelifting.com](http://www.eaglelifting.com)) has been performing polymer grouting



along failing joints throughout the Cays for several years, and the CCHOA should request a quote from them for any polymer grouting needs.

## 9.2 BERM STABILIZATION

With regard to berm stability, we recommend lots designated as “cautionary” and “serious” (Table 1), have their soil berm buttresses restored to prevent catastrophic failure. We believe these bulkheads have a static factor of safety of less than 1.5 and that increasing the passive resistance of the bulkheads will be necessary to prolong the life of these walls.

To help the CCHOA members understand approximate quantities and fees associated with restoring soil berm buttresses reported as “cautionary” and “serious” to their original design elevations, we provide the following calculations:

### Interior Fairway Tied-Back Bulkheads

As indicated previously, there are no berm elevations within the interior fairways of the Coronado Cays resulting in a designation of “serious.” There are, however, several areas where the berm elevations are low enough to warrant a “cautionary” designation, and these areas should be stabilized. Figure 4 presents the proposed stabilization approach for any “cautionary” (or “serious”) berm elevations. The proposed maintenance infill volumes for various lots are presented in Table 1.

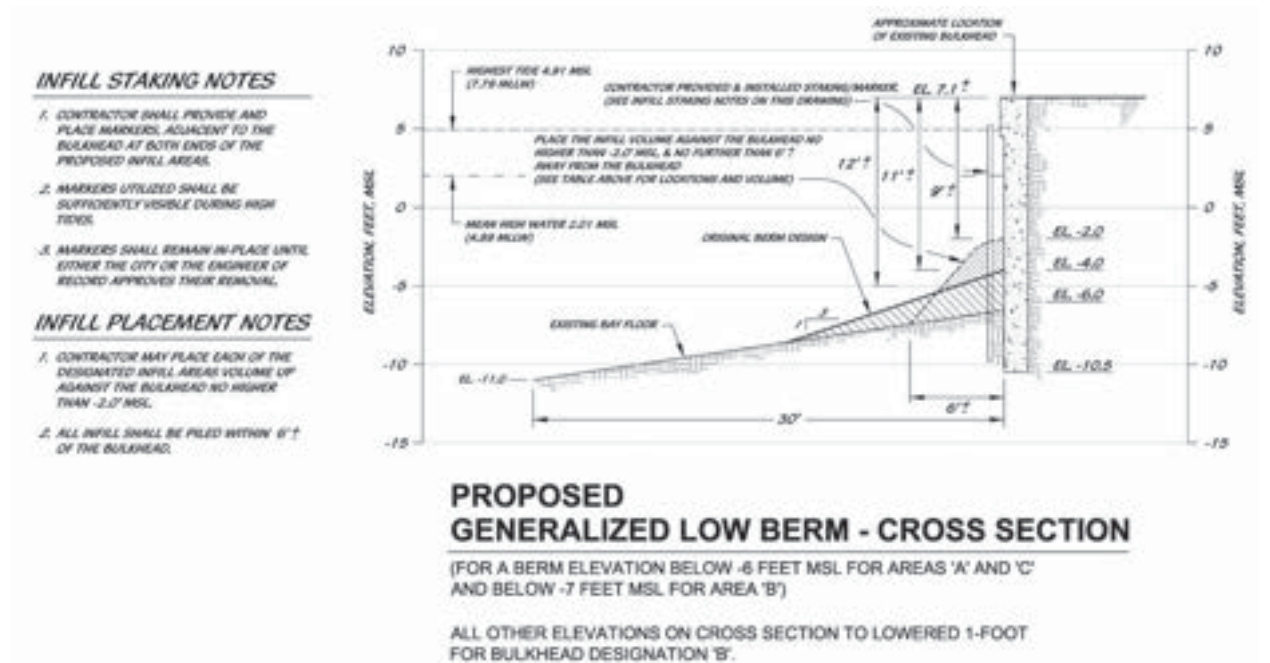


Figure 4 – Proposed Generalized Low Berm – Cross Section

### Southeasterly Cantilevered Bulkheads

Lots 17 to 35, 71, and 75 to 81 Tunapuna Lane within the Mardi Gras Village will require placement of a minimum of 115 cubic yards of clean concrete wash sand to raise the elevation from the current “cautionary” and “serious” state to the original top of berm design elevation of 3.1 feet NGVD29, or +6 feet MLLW (see Figures K-1 and K-2 in Appendix K).

Lots 3 to 17 Aruba Bend within the Port Royale Village will require placement of a minimum of 25 cubic yards of clean concrete wash sand to raise the elevation from the current “cautionary” state to the original top of berm design elevation of 3.1 feet NGVD29, or +6 feet MLLW (see Figure J-1 in Appendix J).

Lots 59 through 67 Spinnaker Way within Blue Anchor Cay will require placement of a minimum of 60 cubic yards of clean concrete wash sand to raise the elevation from the current “cautionary” state to the original top of berm design elevation of 3.1 feet NGVD29, or +6 feet MLLW (see Figure I-1 in Appendix I).

While the minimum recommended soil berm buttress stabilizes the southeasterly bulkheads, a severe Santa Ana from the south could still displace some of these sands. Ultimately, long-term, these low areas should be backfilled to the same general slope that exists along the remainder of this shoreline, which we have estimated at 1:200 (vertical:horizontal). For this larger, more conservative stabilized foreshore, we would conservatively estimate 355 cubic yards for Blue Anchor Cay; 130 cubic yards for Port Royale Village; and 800 cubic yards for Mardi Gras Village.

Air Pump USA ([www.airpumpindustries.com](http://www.airpumpindustries.com)) performed previous berm fills for the City of Coronado, along the City-managed causeways. Currently, they charge \$2,600 per day and can pump approximately 100 to 150 tons per day. The weight of 60 cubic yards will be about 90 tons, and can easily be pumped in one day.

The shoal area near the northern edge of Spinnaker Way has been identified as a potential sand source for Blue Anchor Cay, Port Royale Village, and Mardi Gras Village. Sand along the shoal could be mined and re-deposited back in the low areas affecting all three villages. Assuming a yield of approximately 1,000 pounds of sand per day, we estimate that it would take about 4.5 weeks to build the stabilization berms and about 29 weeks to completely replace all of the lower-lying areas that have been scoured over the past 40+ years.

It should be noted that any imported beach fill will require California Coastal Commission approval, as well as approval from other regulatory agencies, including the San Diego Unified Port District. While this option may be the simplest and most economical, an unknown level of effort will be required to obtain necessary permits. As an alternative, additional lateral restraint can be provided through the use of an additional grade beam with properly designed tiebacks, similar to the existing section of tied-back wall along the southern portion of Mardi Gras Village. As with Mardi Gras Village, a tied-back wall design must evaluate a conservative worst-case scoured beach scenario to ensure adequate capacity for the tied-back wall design.

While we have not observed evidence of imminent wall failure at the Coronado Cays development, and we believe there is potentially another 15 to 20 years of service life left in the walls, we recommend that the walls have a rigorous evaluation completed by a structural engineer experienced in evaluating concrete structures built in marine environments. Specialized geophysical or destructive testing may be required to evaluate the structural integrity of the reinforced concrete wall panels.

We strived to perform our professional services in accordance with generally accepted principles and practices currently employed in the area; there is no warranty, express or implied. We appreciate the opportunity to assist the CCHOA and trust this information meets your needs. If you have any questions or require additional information, please give us a call.

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