COAST
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To: Cambria Community Health Care District

July 2017

From: Todd Robinson, P.E.
Coast Engineering & Survey, Inc.

RE: Retaining Wall Recommendations
2535 Main Street, Cambria CA

The purpose of this report is to provide an overview of the design recommendations for the subject property located at 2535 Main Street in Cambria California owned by Cambria Community Health Care District (CCHD). As a result of recent heavy rains, a surficial slope failure has occurred within the subject property causing failure to the existing wood retaining wall and slope failure extending into the existing parkway. As a result of this failure, a geological analysis was conducted to determine the numerical slope stability of the site. Based on results of this evaluation, it was determined that the critical static and pseudo-static factor of safety values are below the minimum standards which indicates an unstable condition on the slope at its current natural state (refer to Numerical Slope Stability Evaluation prepared by GeoSolutions, Inc., dated February 7, 2017 for more information).

In order to fully evaluate the current conditions and provide recommendations, Coast Engineering & Survey, Inc. (Coast, Inc.) has performed the following tasks:

- Meet with CCHD staff to discuss options and design alternatives - Bob Putney, Bob Sayers, Jerry Wood
- Meet with project geologist to discuss project design requirements
- Review GeoSolutions, Inc. Numerical Slope Stability Evaluation, dated February 7, 2017
- Perform a topographic survey and mapping of the subject property and adjacent hill side
- Perform multiple site visits
- Stake property corners

Coast, Inc has reviewed and analyzed several design options which are presented in the following sections:

Section 1: Redi-Rock Retaining Wall Design
Section 2: Conventional Retaining Wall Design
Section 3: CALTRANS Standard Retaining Wall Option
Section 4: Additional Slope Stability Options
Section 5: Drainage Considerations and Recommendations
Section 6: Building Relocation – No Retaining Wall
Section 7: Summary and Conclusions

Section 1: Redi-Rock Retaining Wall Design

Due to the existing unstable slope, it has been recommended by the engineering geologist that a retaining structure be constructed where site slopes exceed 2:1 (horizontal: vertical). In lieu of a conventional poured in place wall, a stacked wall may offer mitigation of the retaining slope. For the purpose of this analysis, a Redi-Rock stacked retaining wall system was analyzed. An initial alignment was analyzed that follows the approximate existing wood retaining wall and existing toe of slope. The proposed wall alignment and typical section view are shown below in Figure 1 and Figure 2 for reference. Structural wall calculations were performed using MSEW wall software and the Redi-Rock retaining wall design software provided by the manufacturer.

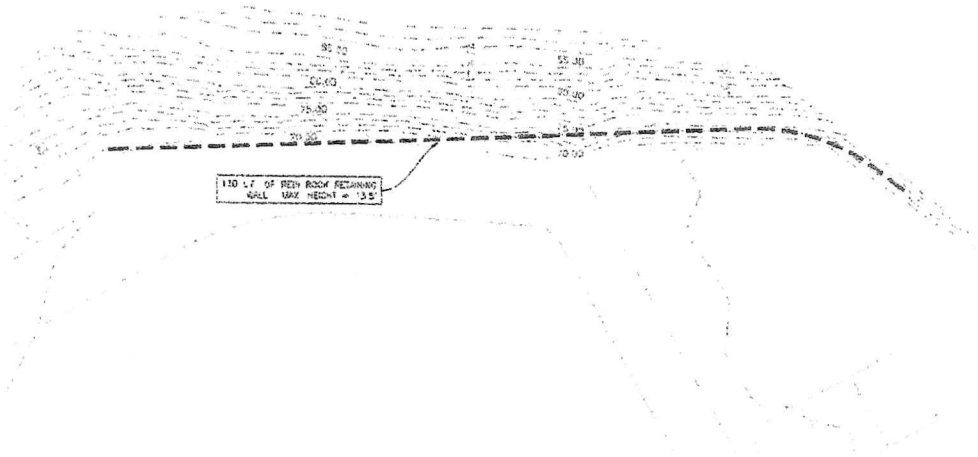


Figure 1. 13.5' Redi-Rock retaining wall alignment with minimal setback.

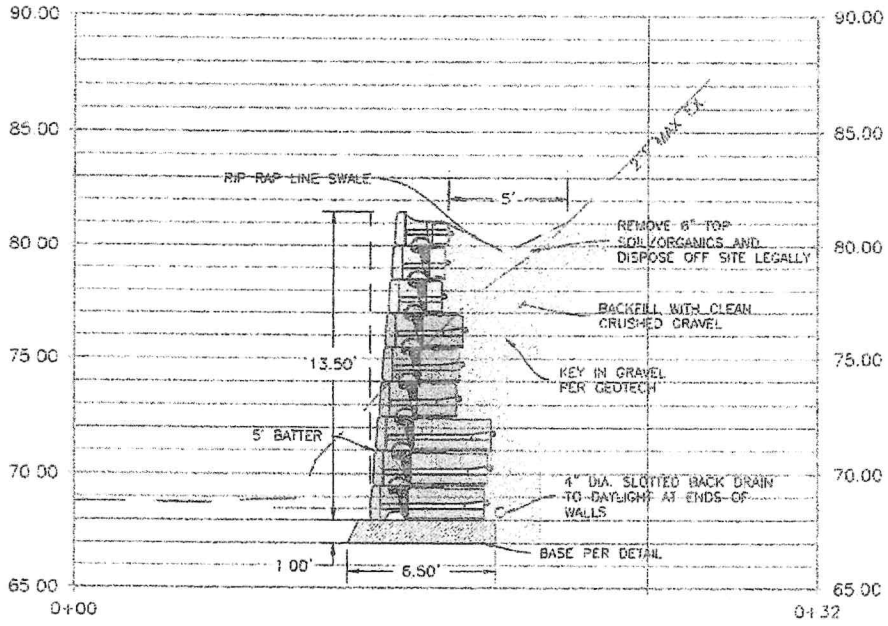


Figure 2. 13.5' Redi-Rock retaining wall section view.

The proposed 13.5' tall Redi-Rock retaining wall design satisfies code calculation requirements and allows for a 5' wide bench above the wall before matching existing grade. The intention of the 5' bench is to capture minor surficial slope failures that may occur above the wall. The swale behind the wall would need to be maintained and adequate drainage provided. A dense, impermeable, graded gravel base can be used that minimizes major excavation at the base of the wall which would be typical of conventional footings.

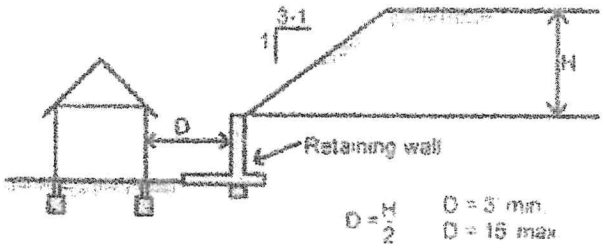


Figure 3. Retaining wall setback requirements.

Figure 3 above illustrates the setback distance behind the existing building. This minimum setback is not consistent with CBC requirements (shown in Figure 3) which requires the distance between the building and the toe of a wall to be a minimum distance of H/2 which in the area is approximately 9' feet.

Further, the numerical slope stability analysis recommends the top of wall be no less than 2' above the top of the previous slope failure, this wall does not satisfy that requirement and is not recommended. The top of the bank and required offset, shown in Figure 4, would require a 22.5' tall Redi-Rock wall.

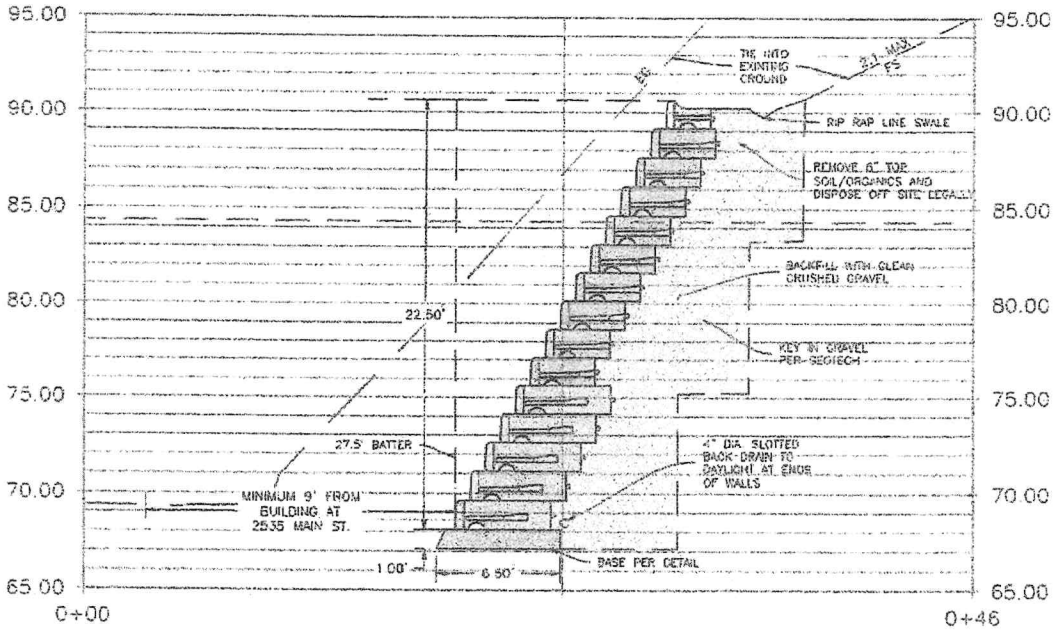


Figure 4. 22.5' Redi-Rock wall with 9' offset and matching top of failure slope.

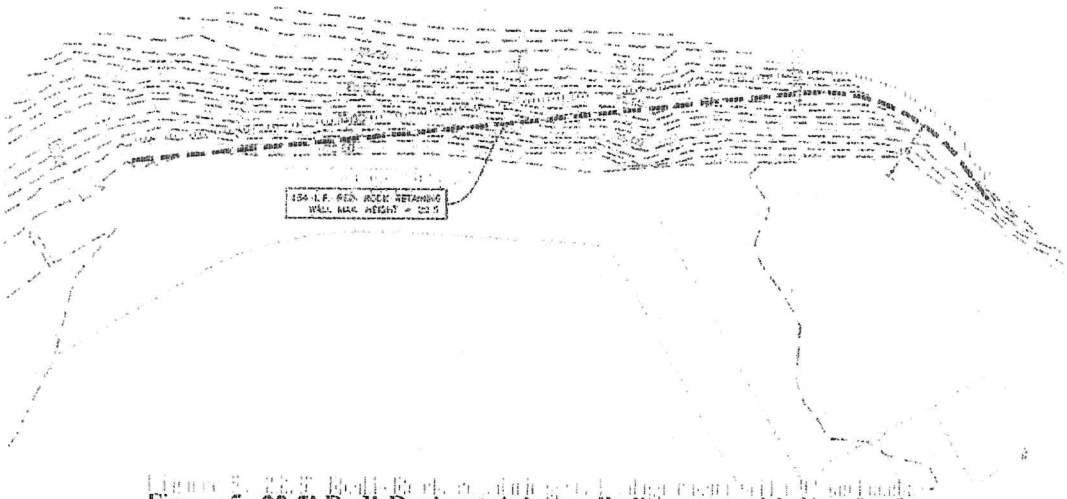


Figure 5. 22.5' Redi-Rock retaining wall alignment with 9' setback.

For the purposes of maintaining the necessary setback from the existing building, a 22.5' tall Redi-Rock wall with a 9' setback is analyzed which would notably allow for vehicle clearance between existing buildings and the retaining wall. Most notably, this design option would require major excavation of the slope due to an increased wall batter of 27.5° necessary based on our structural calculations.

Due to increased wall batter and extensive earth disruption to the existing hillside, this design is not recommended, extensive excavation and grading would be required.

Section 2: Conventional Retaining Wall Design

In addition to the stacked block wall system, Coast, Inc. reviewed and analyzed the feasibility of a conventional poured in place retaining wall design. The alignment shown below in Figure 6 illustrates a setback distance of 9' away from existing structures as dictated by CBC.

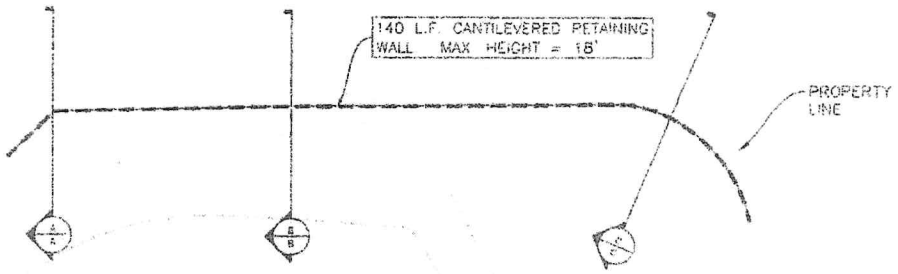
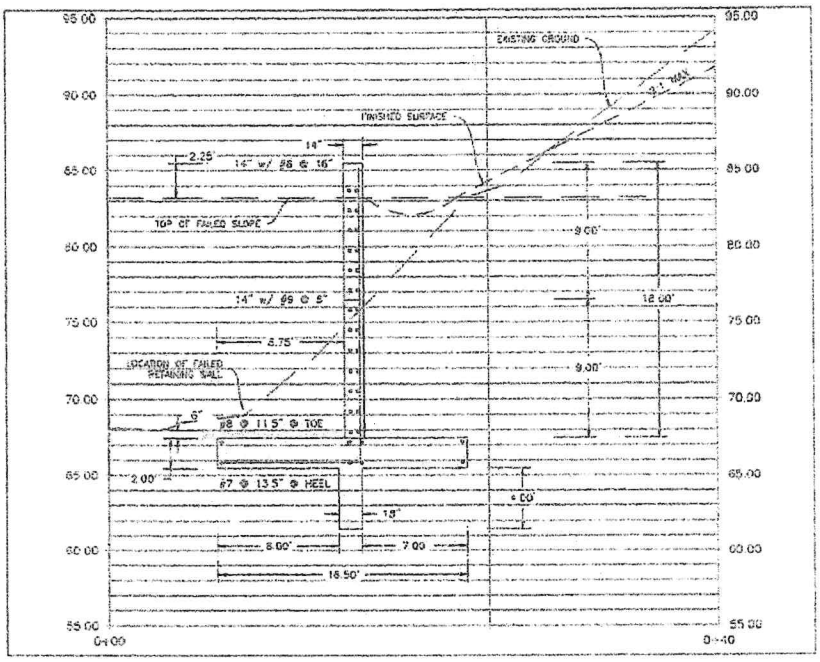


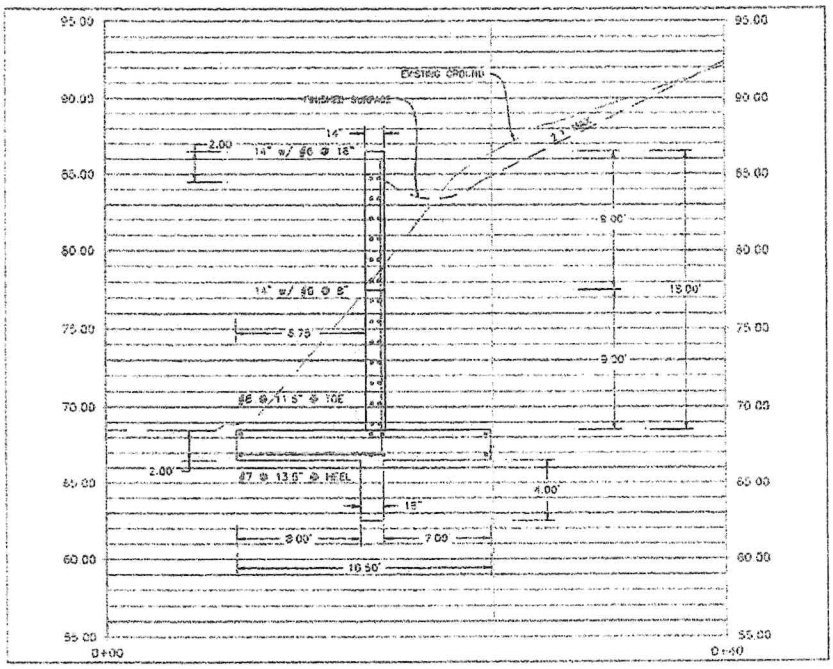
Figure 6. Proposed cantilever retaining wall location relative to existing structures.

Based on our analysis, an 18' tall cantilever concrete retaining wall would be required. Based on the geological analysis recommendations, the wall shall extend approximately 2' above the top of slope to provide additional free board protection from any slope failures which may overtop the wall. This design provides a 6' wide swale behind the top of wall which will tolerate minor slope failures and can be more easily remedied and/or maintained. It is imperative for this design (and all other design alternatives) that proper drainage be installed and swales be kept clear of debris to avoid potential drainage issues. Prior to final design, a soils analysis detailing in situ soil properties is necessary.

Figure 7 below illustrates the proposed retaining wall configuration and its incorporation into existing topography at the sections shown in Figure 6 above. As seen from the dashed red line, significant removal of material would be required in order to excavate the location of the retaining wall footing.



WALL SECTION
SCALE AS SHOWN
A/A



WALL SECTION
SCALE AS SHOWN
B/B

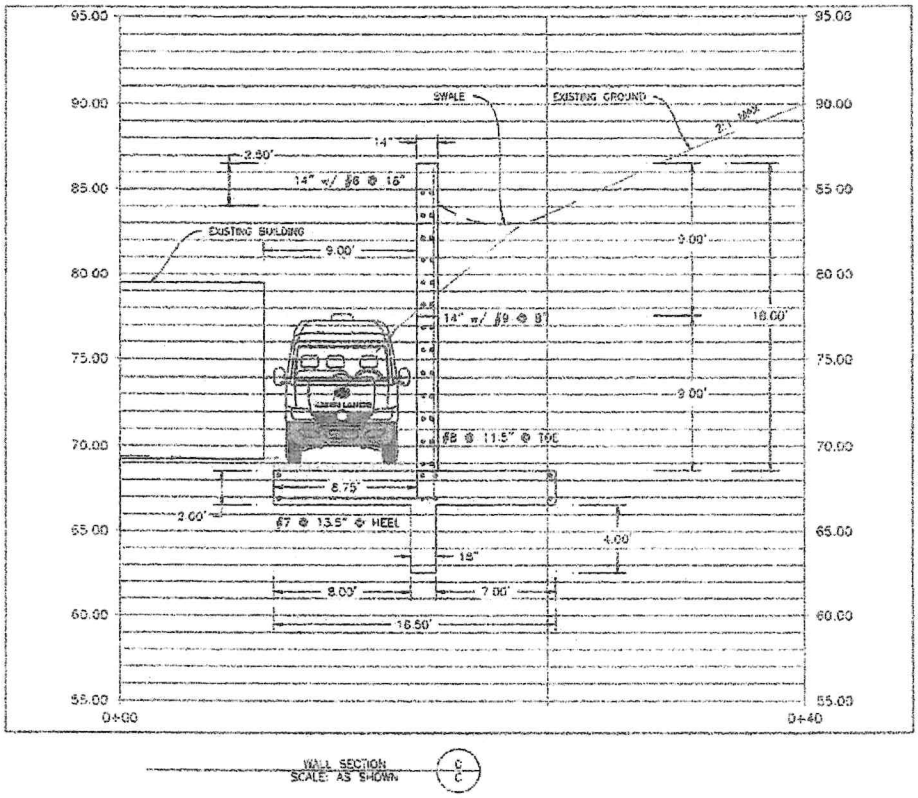


Figure 7. Cantilever retaining wall section views.

Section 3: CALTRANS Standard Retaining Wall Option

Coast, Inc. reviewed the feasibility of an alternate poured in place tapered concrete wall using an 18' CALTRANS Type 1 (Case 2) retaining wall. The standard wall detail would require a minimum of 13' - 9" to be excavated beyond the back of wall to accommodate the heel of the footing and would require the top of the footing be buried a minimum of 2', adding further excavation requirements on the site.

Due to the extensive excavation and costs required to construct this design and the proximity to the existing adjacent property line, a CALTRANS type wall is not recommended.

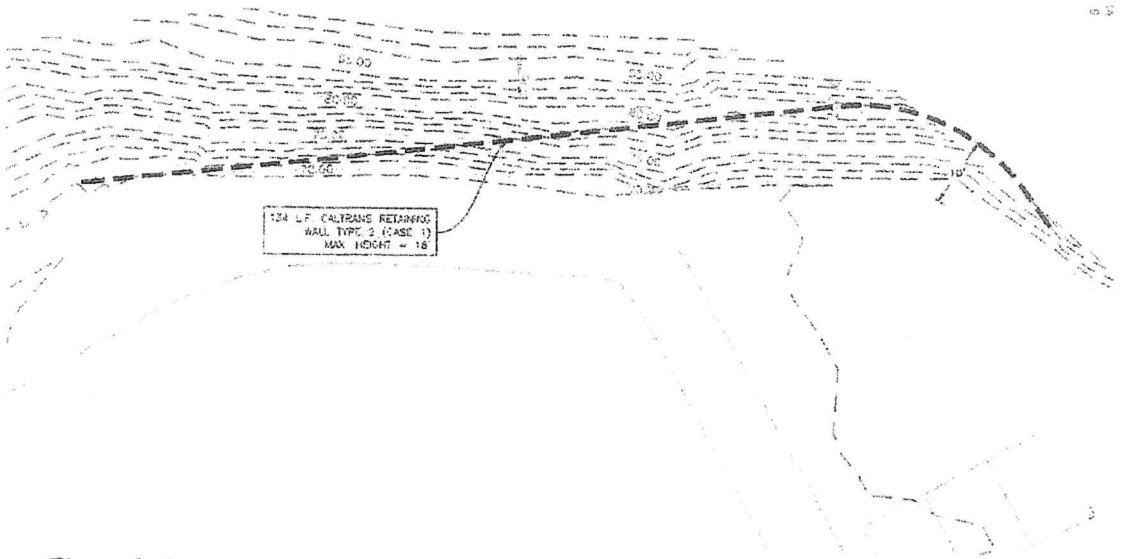


Figure 8. Wall alignment analyzed for CALTRANS typical tapered retaining wall design.

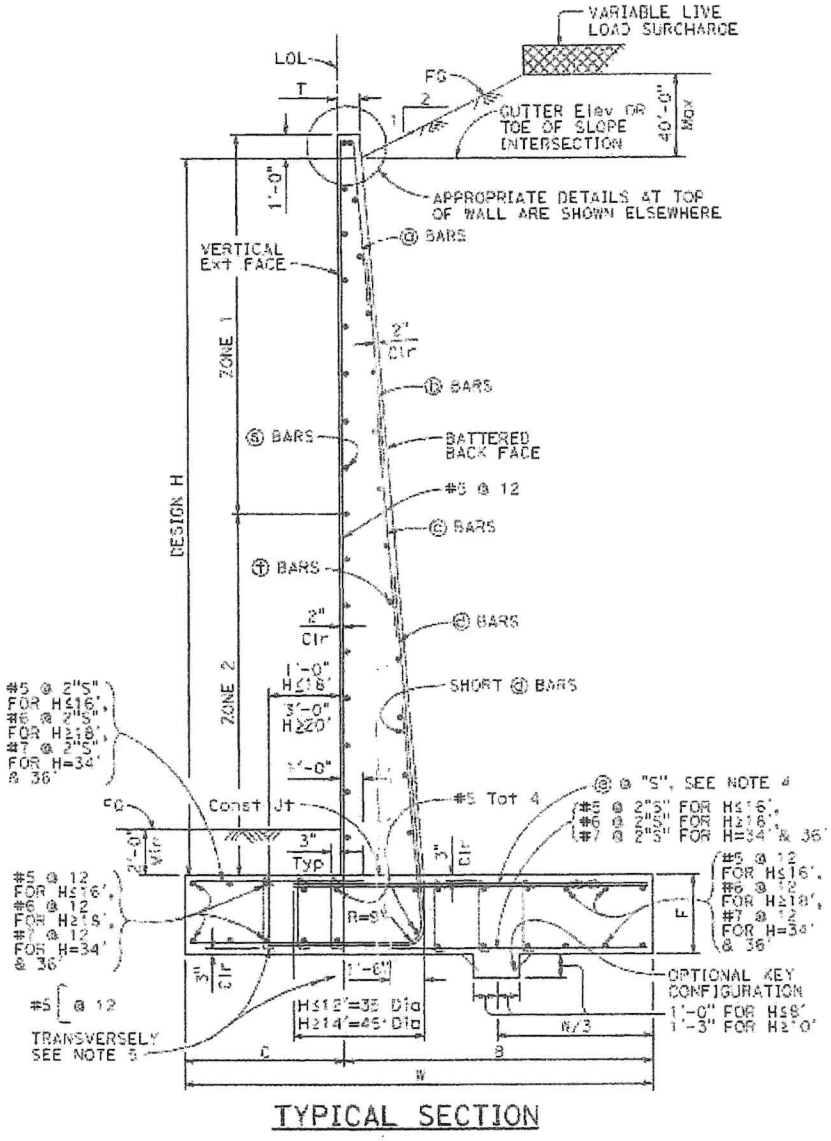


Figure 9. CALTRANS typical tapered retaining wall section.

Section 4: Additional Slope Stability Options

The recommended swales behind the retaining walls offer some relief from small slope failures in the future. but adding a slope stability system above the wall could provide additional support for the hillside by reducing erosion and retaining small slope failures before they reach the swales.

The TECCO® SYSTEM^3 is an engineered slope protection and stabilization system which is used to stabilize steep slopes of unconsolidated or rocky material and to prevent loose or weathered material from settling further down the protected slope. The mesh is attached to the ground by system spike plates. By tightening the nuts on the spike plates, the slope stabilization system is pretensioned to a predefined force. This system can be installed around larger trees but some vegetation removal may be required.

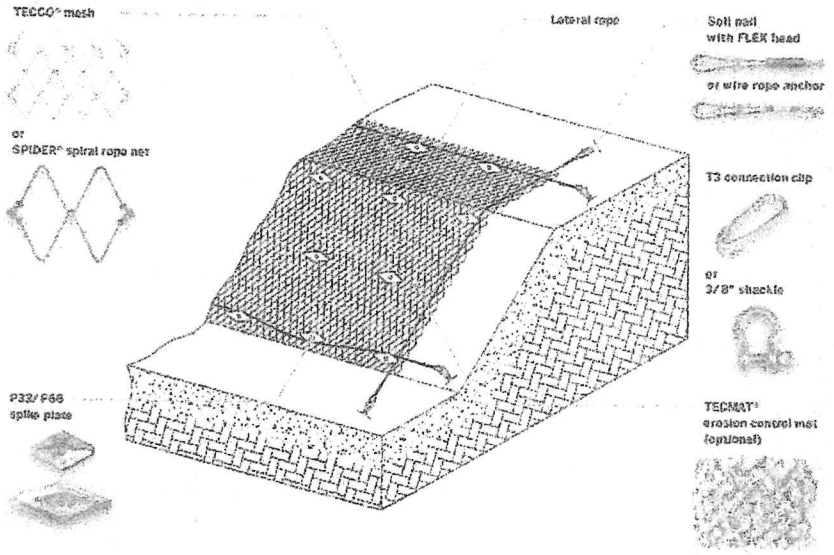


Figure 10. Example of slope stabilization with the TECCO® SYSTEM^3

Section 5: Drainage Considerations and Recommendations

A principal cause of retaining wall/slope failure is the additional loading imposed by an increase in the water content in the material behind the wall or slope. These conditions can greatly increase the lateral loads behind the wall/slope and reduce the soil shear strength resulting in failure. To alleviate this, adequate drainage in the forms of subsurface drains, behind wall swales, and interceptor swales higher up the slope should be implemented. These swales are most often rip rap lined earthen channels but can be concrete channels. Collected water is then distributed down and away from the slope through energy dissipation. Concentrated over-slope drainage should be avoided and any collected water should be diverted and discharged away from the slope.

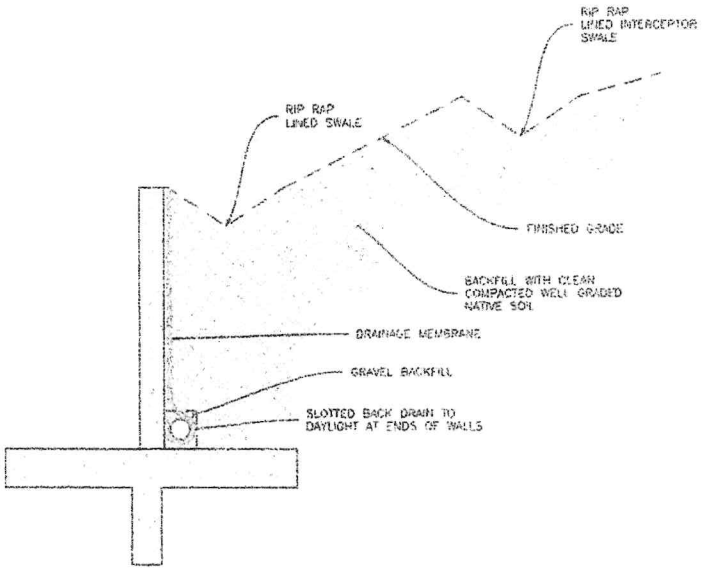


Figure 11. Retaining wall drainage considerations.

Section 6: Building Relocation – No Retaining Wall

Based on the building setback distance from descending slopes. a minimum setback distance of 15 feet is necessary from the toe of the slope if a retaining structure is not utilized. Coast, Inc. has identified two options:

1) Complete removal of the building and or relocation of the building to the parking lot area.
2) Remove a portion of the building to meet the requirements of CBC.

Figure 12 illustrates the percentage of building within the 15' offset from the existing toe of bank. Approximately 37% (270 sq.ft.) of the existing building would be required to be removed in order to satisfy the building code requirements in lieu of a retaining structure as shown in Figure 13.

Figure 12. 15' offset from toe of bank to existing building.

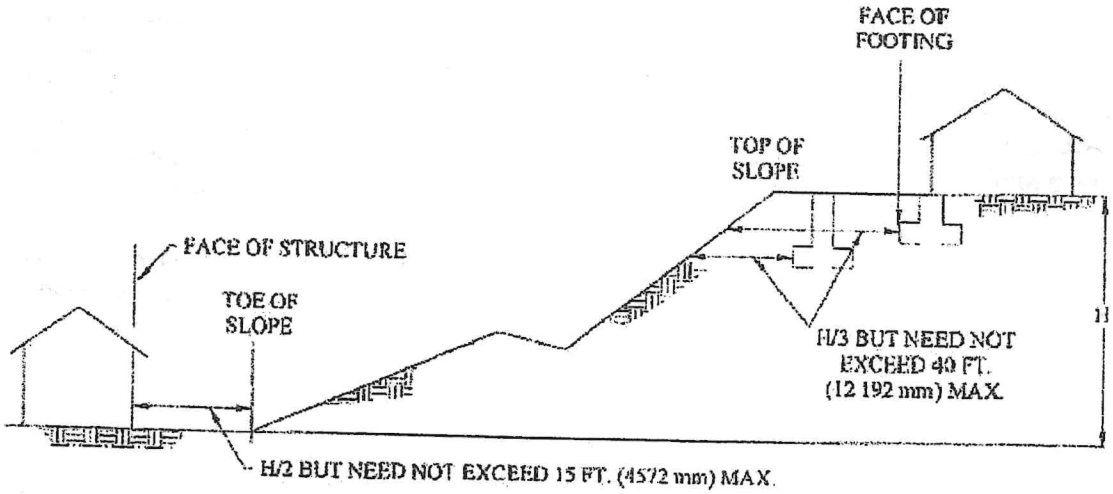


Figure 13. Building setback distance with no retaining wall.

Section 7: Summary and Conclusions

Coast, Inc. reviewed and analyzed the following alternatives:

- Redi-Rock retaining wall design
- Conventional poured in place reinforced concrete retaining wall
- CALTRANS standard tapered concrete retaining wall
- TECCO slope stability "blanket"
- Additional drainage requirements/recommendations
- Relocation of the existing building

It is understood that the structure closest to the slope has historically been used to house and sleep emergency personnel. For this reason, Coast, Inc. recommends that if the building's purpose is to sleep emergency personnel, it should be relocated at least 15 feet away from the existing toe of slope.

Alternately, if the building is to be re-purposed, a conventional poured in place wall is recommended. The alternate options such as a smaller Redi-Rock retaining wall (13.5') meet building code design requirements, but it does not meet the recommendations of the geological engineer's slope stability analysis. A larger Redi-Rock retaining wall (22.5') complies with the geological engineer's recommendations, but due to the steepness of the existing slope, building offset requirements, and additional batter required for structural stability, it is the opinion of Coast, Inc. that this option may be economically infeasible. Similar to the Redi-Rock wall, the CALTRANS standard design requires a large footing be poured into the existing slope, which would require significant earthworks and associated costs.

The TECCO® slope stability system is recommended to provide additional slope stability, however, it is noted this type of system would add significant cost to the project since it is recommended that the system be used in conjunction with a retaining structure. Regardless of the retaining wall option decided upon, it is recommended that additional drainage management be implemented that assures adequate drainage off the slope and away from the toe of the slope. These drainage management concepts include: top of slope and mid-slope interceptor swales, and underdrain and underground drainage pipe to properly discharge runoff away from the toe of the slope and any structures.

Below is a summary of engineering cost estimates for material and installation for each option. These values are provided as approximate costs based on conversations with local contractors:

Mitigation Alternatives	Engineers Estimate for Construction
Ready-Rock Retaining Wall	$200k - $300k
Conventional Retaining Wall	$250k -$350k
CALTRANS Wall	$300k - $500k
TECCO "blanket"	$200k -$300k
Drainage Improvements	tbd
Building Relocation	tbd

It is noted that further geotechnical investigation will be required to verify key native soil properties such as bearing capacities and earth pressure which will be used during the final design process. Current designs presented in the analysis utilize CBC assumptive minimum values.

Kind Regards,

Todd Robinson, P.E.