

Preconstruction Plan for Stairs at West Cerro Vista Apartments

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Students at California Polytechnic University have created an unsafe dirt trail down a hillside west of the Cerro Vista Apartment Complex on the university's campus. This heavily traveled trail is a shortcut to an existing pedestrian pathway which connects Village Drive to Poly Canyon Village, as well as the R-3 and R-4 parking structures. The use of this trail raises alarm for potential safety concerns for students using it, especially during winter months when the hillside becomes very slippery. This paper outlines the design and preconstruction plan for the West Cerro Vista Stair Project, which proposes replacing the current trail with two independent concrete stairways. The scope of the preconstruction plan includes the preliminary design of the stairway, estimate of cost to construct, construction schedule, project cost forecast, site logistics plan, traffic control plan, risk hazard analysis, as well as a land acquisition and permitting plan. The purpose of this paper is to bring awareness of the safety concern with the existing trail, as well as provide a potential solution that may be continued into a final design phase and constructed in the proposed location.

Keywords: Preconstruction, Estimate, Design, Logistics, Plan

Introduction

The Cerro Vista Apartment Complex is an on-campus housing facility on the campus of California Polytechnic State University, San Luis Obispo. The complex houses a wide variety of students from first-year students, to continuing education and graduate students. These students often have to travel back and forth from the Poly Canyon Village Housing Complex, R-3 and R-4 parking structures, among many other locations north-west of the Cerro Vista Apartment Complex. The current path that students are supposed to travel takes them very far out of the way in the opposite direction, and as a result, the students often decide to traverse the hillside down an unsafe foot trail. The trail goes directly down the hillside west of the Cerro Vista Apartments, across Poly Canyon Road, and eventually connects to an existing pedestrian path. The trail is a safety hazard to the students, especially in the winter time when it becomes muddy and very slippery.

The objective of this paper is to bring awareness to the safety concern with the existing trail, as well as to initiate the mitigation of the issue through a preconstruction plan including the design of a potential solution to the problem. With the tools provided in this senior project, Cal Poly Facilities will be able to determine the demand for such a project, the cost of construction, potential risks, and duration of construction. The goal after completion of this senior project is for Cal Poly Facilities to initiate a final design process, and construction phase of the proposed stairway.

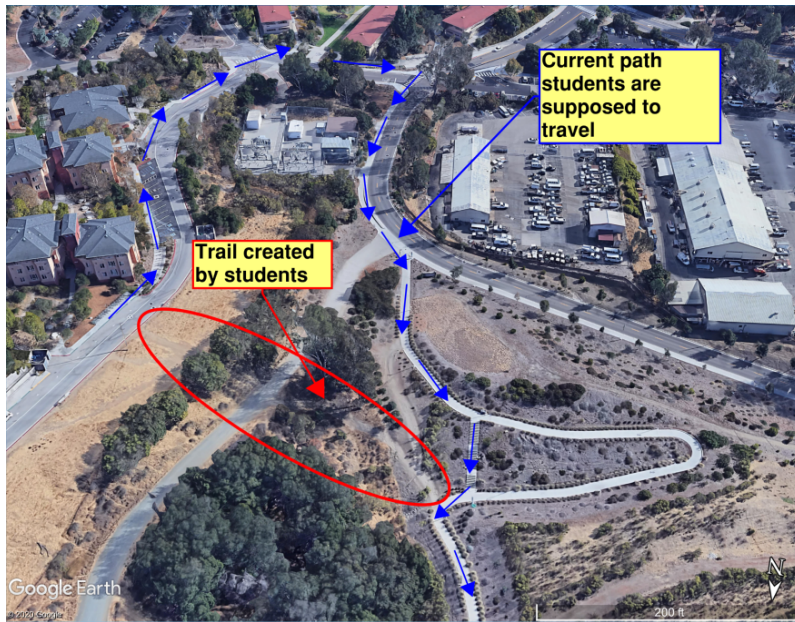


Figure 1. Existing Path vs. Student Trail

General Project Background

Having lived in the Cerro Vista Apartment Complex myself, I have traversed the student created trail many times and have experienced both its convenience and potential hazards. The convenience of this trail is unparalleled in comparison to the existing route that students are supposed to follow. The existing route doubled both the distance and time it took me to reach Poly Canyon Village, which was a common destination for myself along with many other residents of the Cerro Vista Apartment Complex. This is because Poly Canyon Village is home to many essential resources for residents of Cerro Vista including the post office where packages arrive, closest food and dining options, as well as the parking structures where we had to park our vehicles. As a result, most Cerro Vista residents, myself included, heavily traveled along this trail. I have also however seen the potential hazards to students that the trail poses. The trail is largely composed of loose soil and rock, with very steep slopes in some sections, as well as occasional tree roots sticking up. The combination of such hazards makes the trail a significant risk for trips, slips and falls, especially if one considers that many students walk up this trail with their hands full of groceries. I have personally witnessed and experienced my fair share of slips, trips, and falls on this trail which is why I decided to choose it as my senior project, as I hope to initiate the solution which will allow students the means to safely traverse up and down the hillside.

Important Project Design Considerations

Cal Poly 2035 Master Plan

California Polytechnic State University, San Luis Obispo, has already initiated a plan for how the campus is going to grow over the next 20 years from the plan's initial creation in 2015. This plan outlines what types of projects the school plans to construct, as well as their locations. This was an important document to investigate in order to determine whether or not the school was planning to use the land for any future expansion projects, as well as to see if they had already thought of a solution to this issue. Additionally, it was important to consider how the growth of the campus would affect the potential foot traffic of the project. According to the 2019 revision of the master plan, there are no proposed projects in the stairway's location. Furthermore, it is apparent that the school is planning on constructing more buildings directly west of the Cerro Vista Apartment Complex, which will result in even further foot traffic along the current trail. This means that the demand for the project will significantly increase over time.

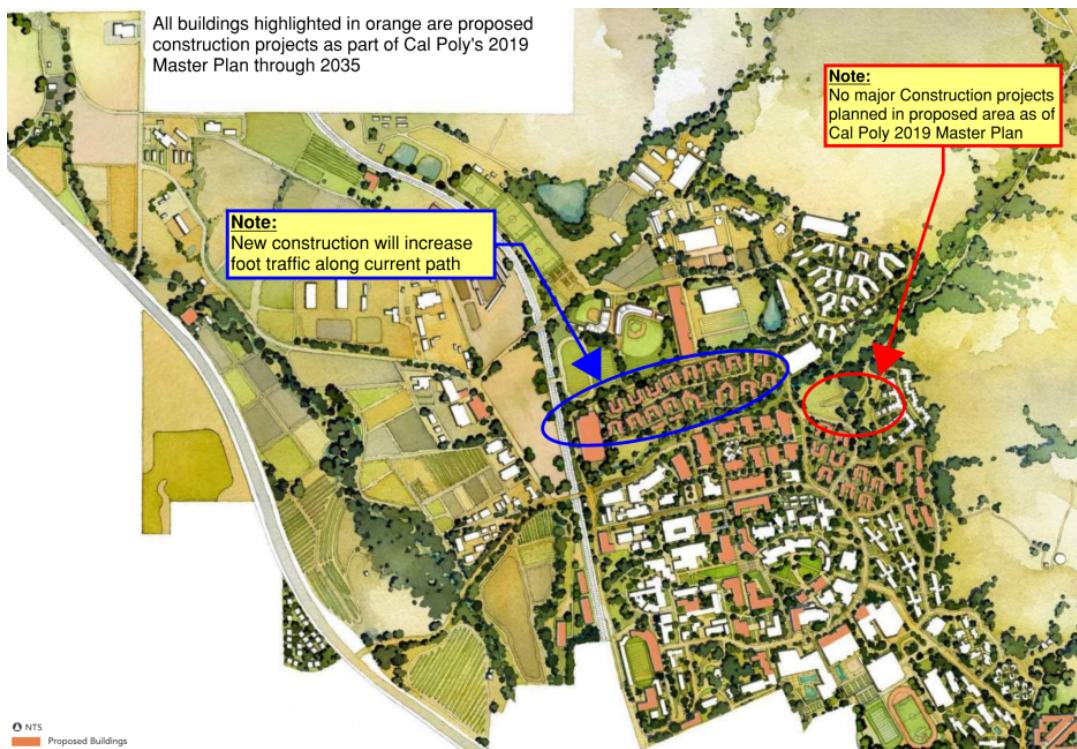


Figure 2. Cal Poly 2035 Master Plan Map

Cal Poly Zoning

In addition to the 2035 Master Plan, the design for the project also had to consider the zoning requirements on California Polytechnic State University's campus. According to zoning information provided by Cal Poly Facilities, the project is located in zone OS-1. This area is reserved for open space, passive recreational uses, and outdoor teaching and learning facilities or displays. It also notes that prior to installing any new facilities in the area, an analysis of soil compaction and suitability given the nature and size of the proposed project will be required. Therefore, prior to the start of any on site construction, the soil should be tested by a third-party geotechnical company. The proposed stairway is an open space design, similar to the existing stairway in this zone, so Cal Poly's zone requirements should not be an issue for the project.

Procedure

Site Survey

Prior to beginning the design of the stairs, I had to first determine the existing grade of the hillside. The first step was to find the construction plans for the existing pathway, which proved to be a bit of a struggle, as the path was part of a change order on the Poly Canyon Village project and was not initially found on those plans. However, after corresponding with Cal Poly Facilities I was able to locate them. This was crucial as there were no survey benchmarks in the area, and I was able to use the elevation from a stair landing found on the existing path's plans as my benchmark. Then I was able to borrow the Construction Management Department's total station to incrementally shoot the elevations of the existing grade. This was done in three sections down the centerline of the trail so I could determine the existing grade along the path that my stair design would follow. Using the survey data, I was able to determine the path of the stairway, as well as model the existing grade on Revit.



Figure 3. Site Surveying

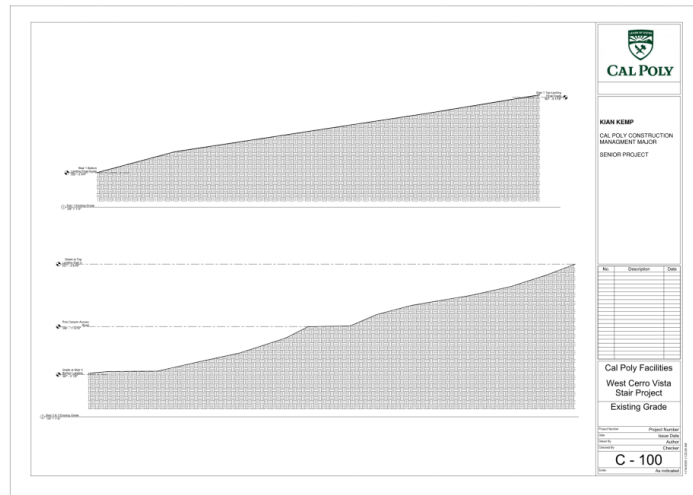


Figure 4. Existing Grade Revit Section

Design

After the site survey was completed, I used the data to model the existing grade of the trail along with the rest of the stairway design using Autodesk Revit. The existing grade model proved to be very valuable as I was able to overlay the stair design with the existing grade to determine an appropriate design that met both state and county codes, as well as Cal Poly standards. The stairway steps have a universal vertical rise of 7 inches and a horizontal run of 12 inches, and all landings have at least 4 feet of dimension in the direction of travel. The handrail height is 36 inches tall, and all handrails extend more than 1 foot minimum onto the landing, as required by code. Additionally, the model overlay allowed the design to stay as close to existing grade as possible in order to minimize the amount of grading required during construction.

For the design process I decided to split the stairways into 3 major sections: Stair 1, Stair 2 and Stair 3. Stair 1 is the smallest section of stairs and it connects the stairway to the existing path. Stair 1 is

approximately 70 foot 6 inches of horizontal run, rises approximately 12 feet in elevation, and has a total of 22 steps, and 8 landings. Stair 2 shares Stair 1's top landing but takes a 51 degree turn towards Cerro Vista. Stair 2 has approximately 107 foot 6 inches of horizontal run, and rises approximately 23 feet in elevation over the course of 39 steps and 7 risers. The top landing of Stair 2 ends on the west edge of Poly Canyon Road and shares an equal elevation with the road. Stair 3 is not connected to stair 1 or 2. Stair 3's bottom landing is offset 20 feet, 1 and 5/8 inches from the closest point to Stair 2's top landing. Stair 3 takes a 12 degree turn south of stair 2 to ensure that its top landing arrives square to Cerro Vista Circle Road. Stair 3 has approximately 109 feet of horizontal run and rises approximately 30 feet in elevation through 52 steps and 10 risers.

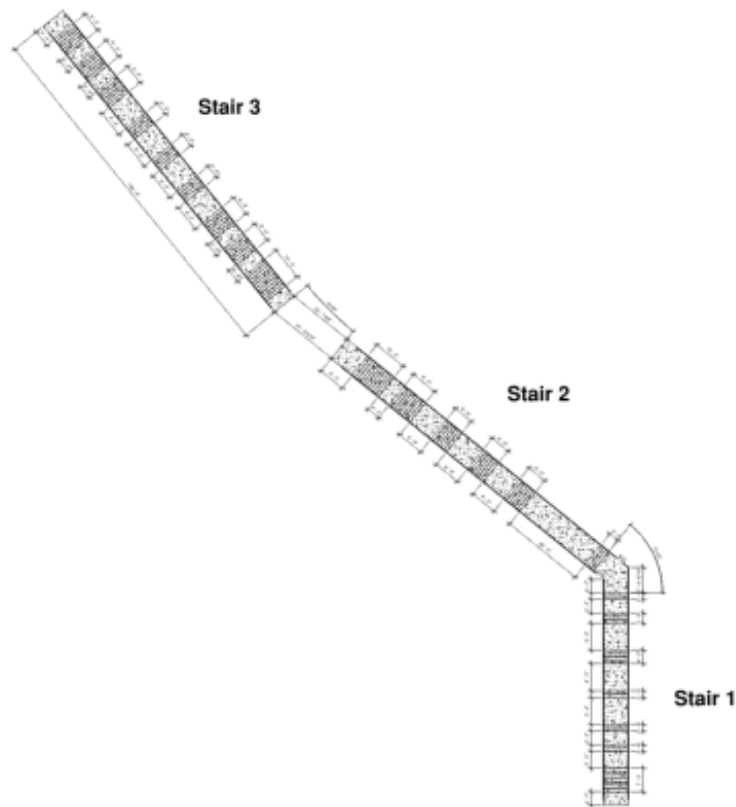


Figure 5. Stairs 1, 2, and 3

The project was designed as a monolithic reinforced concrete stairway to not only resemble the similar stairs in the area, but to ensure that it is a permanent solution to the safety concern. Additionally, the handrails are designed to be 1 and ½ inch galvanized steel pipe, and the stair tread grips are anchored black anti-slip strips in order to fit in with similar staircases along the existing path. That way the staircase does not look out of place in its environment.

Quantity Takeoffs

Earthwork

After completion of the stairway plans, the quantity takeoff and estimate phase could begin. Because I was both the designer and estimator of the project, the quantity take-off phase was relatively smooth. I was able to overlay the final and existing grades in the model which made for fairly simple earthwork takeoff. There was a 6 inch layer of compacted crushed stone layer that accounted for the majority of the cut, and much of the excavated soil was able to be reused as fill in areas that required it. As a result, the site was relatively balanced and after all cut and fill calculations were completed, the project only required approximately 21 bank cubic yards of soil to be off hauled. The total amount of crushed stone to be imported is approximately 39 bank cubic yards. It is important to note that the earthwork quantities will need to be adjusted following a soils report, as their respective swell factors and compaction factors are unknown at this time.

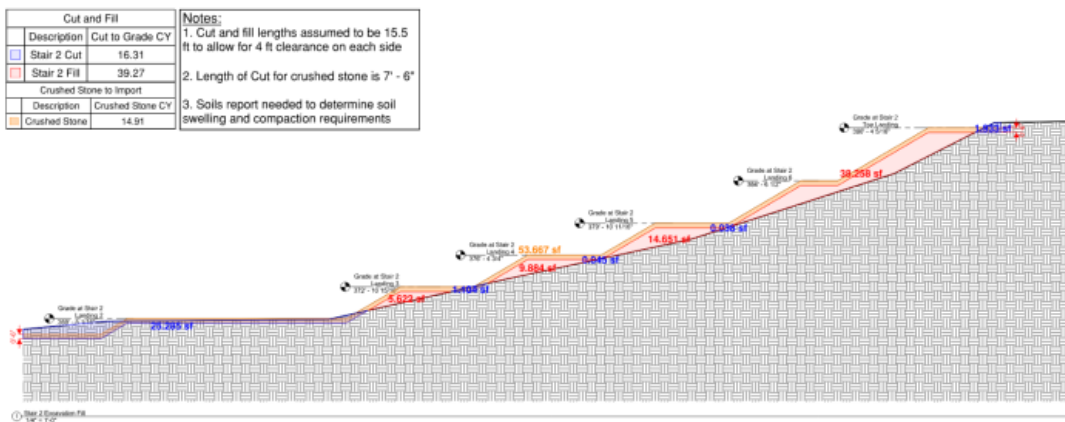


Figure 6. Stair 3 Cut and Fill Quantity Takeoff

Steel Reinforcement

The stairs all require #4 rebar reinforcement for longitudinal bar, traverse bar, and stair nosing bars. The longitudinal bar running lengthwise along the long span of the stairs have a top and bottom bar vertically offset 2 inches from one another. The longitudinal bar is to be offset 12 inches on center. Additionally, along the top longitudinal bar, there are traverse bars set 12 inches on center. Furthermore, each stair has a nose bar with a minimum 1 inch concrete cover. The project calls for approximately 8691 linear feet of #4 rebar after considering lap factor and estimated waste. Therefore approximately 2.91 tons of #4 rebar should be ordered. It is also recommended that the rebar be prefabricated in order to save time and labor costs during the construction process.

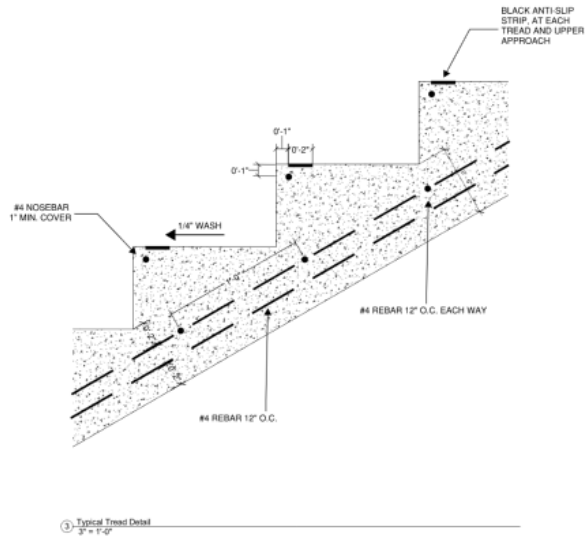


Figure 7. Reinforcing Steel Typical

Concrete & Formwork

The concrete formwork for the project was estimated using *RSMMeans Heavy Construction Cost Data 2013*. *RSMMeans* specified that this take off was determined using the horizontal run and width of stairs to calculate square footage of stairs as per section 03 11 23. The concrete required for the project was very straight forward to takeoff by taking the surface area of the stair cut sections and multiplying it by the 7 foot 6 inch width of the stairs. Stair 1 requires approximately 13.07 cubic yards, Stair 2 requires approximately 20.41 cubic yards, and Stair 3 requires approximately 22.61 cubic yards, for a total of 56.09 cubic yards. All three stairs are scheduled to be poured in the same day utilizing a concrete pump and 6 incrementally timed concrete trucks.

Description	CY Concrete
Stair 3 Concrete	21.88

NOTES:
 1. INSTALL HANDRAILS ON BOTH SIDES OF ALL STAIRS
 2. HANDRAIL EXTENSIONS BEYOND TOP AND BOTTOM RISERS SHALL CONTINUE IN DIRECTION OF TRAVEL AT ALL STAIRS

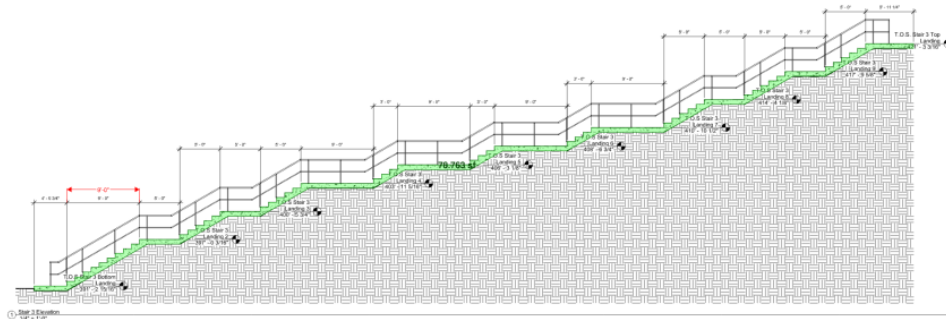


Figure 8. Concrete Quantity Takeoff

Estimates

Project cost estimates were determined using a combination of average industry crew output and activity costs from *RSMMeans Heavy Construction Cost Data 2013*, local equipment rental quotes, as well as local material quotes. Labor crews, activity outputs, and costs were determined using *RSMMeans*. Industry price quotes from manufacturers and rental companies were used to determine all equipment costs, crushed stone import and delivery cost, concrete material and delivery cost, trucking off haul rates, as well as stair tread grip cost. The remainder of material costs were pulled from *RSMMeans*. Bare cost of the project came out to \$105,545.55, with a total estimated project cost of \$137,209.22 which includes both a conservative 10% contingency, and an estimated 20% for project overhead and profit.

ACTIVITY		SUBTOTAL
Site Clearing and Grubbing		\$ 8,115.15
Site Grading		
Location	Cost	
Stair 1	\$ 4,239.18	
Stair2	\$ 6,500.96	
Stair 3	\$ 6,693.93	\$ 17,434.07
Stair Formwork		
Location	Cost	
Stair 1	\$ 7,673.99	
Stair2	\$ 11,700.91	
Stair 3	\$ 11,863.08	\$ 31,237.98
Stair Rebar		
Location	Cost	
Stair 1	\$ 1,659.47	
Stair2	\$ 2,167.02	
Stair 3	\$ 2,221.97	\$ 6,048.46
Stair Concrete		
Location	Cost	
Stair 1	\$ 1,843.16	
Stair2	\$ 2,859.66	
Stair 3	\$ 3,134.36	\$ 7,837.18
Stair Handrail and Tread		
Handrail	\$ 18,058.31	
Tread	\$ 16,814.40	\$ 34,872.71
Project Cost Subtotal		\$ 105,545.55
Project Contingency 10%		\$ 10,554.56
Project O&P 20%		\$ 21,109.11
TOTAL PROJECT COST		\$ 137,209.22

Figure 9. Project Cost Summary

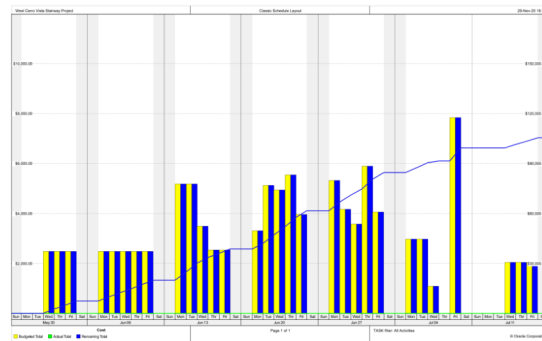


Figure 10. Project Cost Forecast

Results

At the end of this senior project, I was able to successfully translate skills that I have learned through my courses at Cal Poly to create a complete design and preconstruction plan for the proposed stairway. An engineering surveying course enabled me to successfully survey the existing grade to begin my design. Then I was able to successfully design the stairway on AutoCAD Revit through knowledge obtained in various BIM and structures courses. Nearly every construction management lab course covered how to execute quantity take offs and estimates of required materials and labor in order to complete the estimate. Additionally, I was able to accomplish the estimate using knowledge learned in those courses, as well as gained skills on Revu Bluebeam and *RSMMeans* interpretation. Furthermore, the advanced scheduling course enabled me to create a cost loaded critical path schedule and project cost forecast using Primavera P6 scheduling software. Ultimately, I was able to combine

the skills learned in the above courses, as well as the rest of the construction management curriculum to successfully produce my final deliverables which included: A preliminary design, equipment and material takeoff, labor estimate, critical path schedule, cost loaded schedule, site logistics plan, traffic control plan, risk hazard analysis, as well as a land acquisition and permitting plan.

Additional Resource

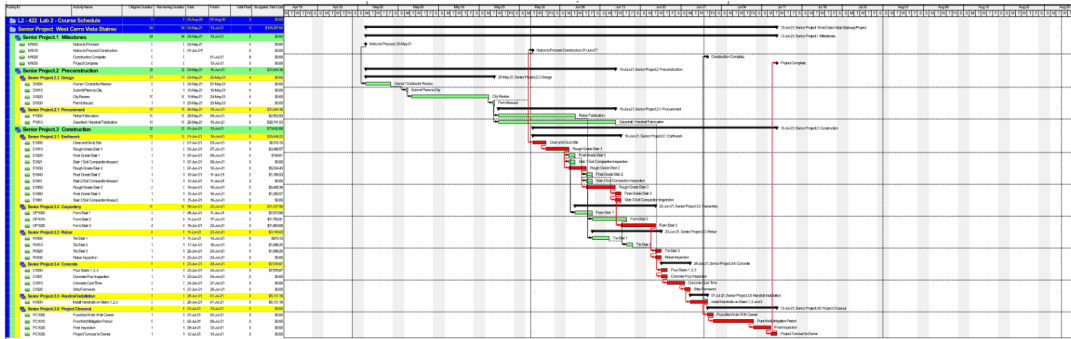


Figure 11. Project Schedule

Conclusion

This project aimed to propose a solution to an existing safety concern where students have created an unsafe foot path west of the Cerro Vista Apartment Complex. The objective of the paper is to bring awareness to the safety concern with the existing trail as well as to initiate the mitigation of the issue through a preconstruction plan which includes the design of a potential solution to the problem. This project was a successful first step in the process to create a permanent solution to the issue. The deliverables of the project will allow Cal Poly Facilities to determine that there is indeed a demand for such a project, as well as allow them to analyze the potential cost of construction, potential risks, and duration of the project. In order to ensure the goal of this project, which is for Cal Poly Facilities to pursue the construction of the proposed stairway, I will contact Cal Poly Facilities and provide them with all project deliverables.

References

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