MGE ENGINEERING, INC.
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August 6, 2024

Mr. Steve Wiesner, PE
Mr. Tim Bailey, PE
Santa Cruz County
701 Ocean Street, 4th Floor,
Santa Cruz County, California 95060

SUBJECT: GEOTECHNICAL REPORT
Mountain Charlie Road Storm Damage PM 1.63
Santa Cruz County, California

Dear Messrs. Wiesner and Bailey:

As requested, transmitted herewith is our geotechnical report for the Mountain Charlie Storm Damage PM 1.63 project in accordance with your request. This report presents field exploration details and results along with our geotechnical interpretation of this information. MGE also reviewed photographs of the site to evaluate slope movement extent and temporal changes in the road conditions. We prepared this report in accordance with the task order agreement notification between Santa Cruz County and MGE Engineering (MGE) dated March 26, 2024. The notification was via e-mail correspondence.

The purpose of this study is to evaluate the slipout geometry by investigating site conditions, identifying likely failure mechanisms, and collecting instrumentation data. By using site observations, boring information, and instrumentation data, MGE evaluated the slipout geometry, failure mechanisms, slipout failure plane depth, and extent of potential repairs that can be made.

MGE completed a geotechnical investigation in May 2023 and previously submitted a report titled, "Geotechnical Report," dated October 6, 2023, for a separate shallow storm damage area on the same roadway that is downslope and adjacent to the 2024 damage. Three borings were drilled for that study and the data from that study was also used for this study. Exploration for this study is described below and supplemented the data that MGE had in hand. The winter storms in 2024 created a new damaged area along Mountain Charlie Road with a different and separate failure mechanism that will be described later in this report.

SITE DESCRIPTION

At the storm damage site, Mountain (Mt.) Charlie Road is a narrow winding asphalt roadway that provides access to Summit Road, State Route 17, Glenwood Drive, and private residences in the area. The private residences are located east of the site and are connected by a driveway that creates a wye-intersection with Mt. Charlie Road. Residents are currently cut off from driving to their homes. Only pedestrian access on makeshift foot trails is available for residents. This is presenting an imminent threat to public safety should evacuations be required during fire season or subsequent storms. The locations of nearby homes are generally on the upslope side of the road. Overhead and underground utilities are present at the site including underground water, and overhead electric and communication lines.

County Survey

The County sent a survey team to install three topographic monitoring points of the slipout on March 7, 2024. Monitoring point 1 is located at the intersection of the private driveway with Mt. Charlie Rd while monitoring points 2 and 3 are located near the center of the slipout. Figure 1 Survey Monitoring Points shows the locations of the County installed monitoring points on the slope. Prior to setting the monitoring points, the site had already moved horizontally 10.85 feet and vertically 6.86 feet. The monitoring points were surveyed eleven times between March 11 and June 24, 2024. The measurements showed:

Monitoring Point No. 1	7.28 feet horizontal,	5.61-feet vertical;
Monitoring Point No. 2	8.56 feet horizontal,	4.72-feet vertical;
Monitoring Point No. 3	9.71 feet horizontal,	4.66-feet vertical.

Using the average of the monitoring point data for horizontal and vertical movement, and the recorded movement prior to setting the monitoring points, gives a total movement of 19.4 feet horizontally and 11.6 feet vertically.

See Figure 2 Survey Monitoring for the locations, dates of readings, and measurements and the cumulative totals for each monitoring point. The survey team performed a topographic survey of the site on May 3, 2024. MGE used the topographic survey information and compared it with previous topographic survey information from 2023. MGE also performed site observations and geologic reconnaissance in the damaged area to evaluate the limits of the storm damage debris and slipout scarp extent. By combining the differences in topographic information along with site observations in the field, MGE was able to approximate and compare the lateral extents of the two slipouts which are shown in Figure 3 Site Map.

Exhibit 1 Scarp on Mountain Charlie Road, Looking North at PM 1.63

Exhibit 2 Scarp and Damage on Mountain Charlie Road, Looking South at PM 1.63

Site Observations

Observations of the driveway reveal that the top of the scarp is generally aligned with the inboard edge of the driveway and follows the edge of the driveway drainage path. See Exhibit 2. The scarp geometry encompasses a 100-foot segment of Mt Charlie Road and extends 80 feet east towards the driveway from the edge of pavement. The scarp extends about 100 feet from the Mt. Charlie Road pavement edge downslope to the west. The toe of the slipout was characterized as an area with saturated soils that exhibited seepage and showed moderate relief compared to the surroundings, see Figure 3 Site map.

Exhibit 3 Scarp on Driveway, Looking North at PM 1.63

Mt. Charlie Road has multiple longitudinal tension cracks that vary in width up to approximately 1 foot wide that generally extend to the boundary of the slipout extents. See Exhibit 3.

Exhibit 4 PM 1.63 Looking South, Seepage Area Shown Above Road

Surface and Groundwater

Surface drainage along the private driveway is collected within a drainage ditch that flows to a culvert near the base of the wye intersection. Seepage was observed on the edge of driveway scarp. A corrugated metal pipe culvert is located beneath the roadway approximately 10 feet from a 24-inch north scarp face. The culvert diverts water from three locations: water from a creek uphill and east of the road, water from the drainage ditch north on Mt. Charlie Road, and the drainage ditch on the driveway. An approximate location of the culvert is shown on Figure 3 Site Map.

Exhibit 5 Northside of Scarp, Looking Southwest

Near Monitoring Point No. 1at the base of the driveway failure there are multiple locations where water is ponded in this area as shown on Figure 3 Site Map. The largest area of ponded water is located directly at the base of the driveway. The water depths of the ponding areas ranged from 5 inches to 1-foot of water. Water was still present at the locations during a site visit on May 2, 2024. At the top of the driveway at the southerly damage limits, the soil was generally firm and unyielding but near the bottom of the driveway the soil is saturated and soft when walked upon. Stepping on exposed portions of soil resulted in 3 to 4 inches of penetration.

The presence of ponded water on May 2, 2024, weeks after a small 0.5-inch rainfall event on April 13, 2024, illustrates a delay of groundwater movement and interaction within the soil and geologic rock unit. This delay between rainfall event, soil saturation, and movement is seen in the storm events. The location of the rain gauge is shown on Exhibit 6.

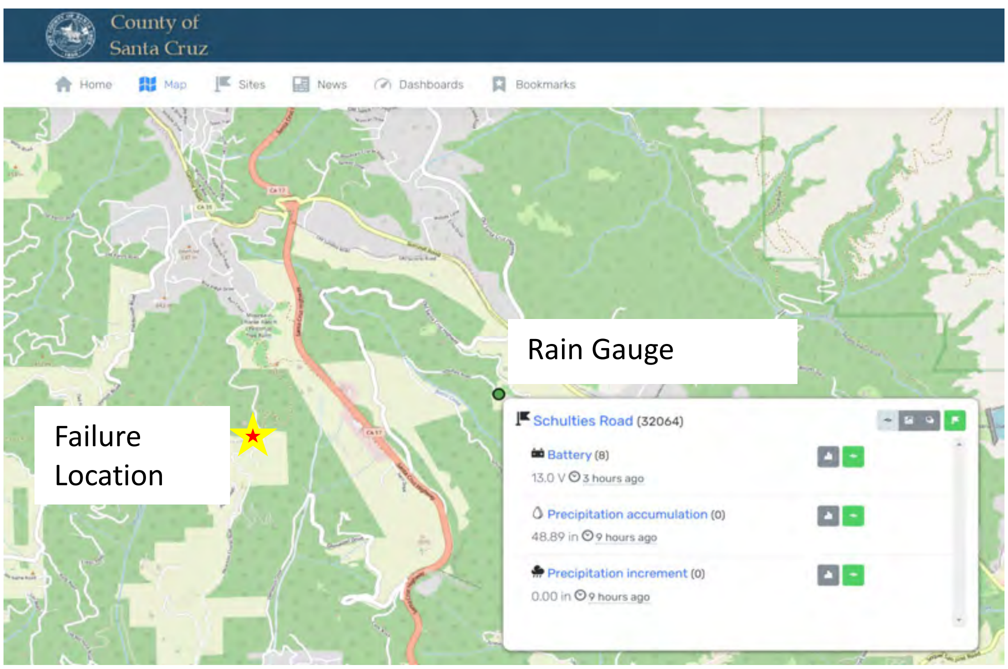

Exhibit 6 Rain Gauge Location

In 2024, rainfall impacted the slope by infiltrating the soil and allowing the soil to saturate between rain events. The infiltration was gradual and led to slope movement that was reported in February. Nineteen inches of rain had accumulated over the period of the storm events in early 2024. Eight inches had fallen within the declared disaster event that started the damage and soil creep before reaching critical saturation causing a catastrophic failure.

Prior to the catastrophic collapse on February 29, 2024, photographs showed how the slope was gradually moving and tension cracks were opening in the driveway and slope above the road due to the groundwater water infiltration and groundwater rise from the storm.

Exhibit 7 February 26, 2024, Tension Cracks

Exhibit 8 Tension cracks, down-dropped road, tension crack in slope, February 26, 2024

GEOLOGIC CONDITIONS

This storm damage site is in the Santa Cruz Mountains which are generally underlain by Tertiary Period Marine Sedimentary rocks. The site is located approximately 0.9 miles of recently active breaks on the Butano Fault (north of the site at Summit Road) and less than 1.7 miles from the Santa Cruz Section of the San Andreas Fault. No faults are indicated on published mapping to pass through the project site.

The geologic map (Dibblee, 200b) shows surface geology, around the PM 1.63 storm damage, is mapped as the Oligocene to late Eocene San Lorenzo Formation (Tsl). The formation is described as micaceous gray clay shale or claystone. The overturned bedding strikes to the northwest and dips to the northeast at seventy degrees. Outcrop in the cut slopes at the site appears to be interbedded claystone and sandstone and appears consistent with the descriptions in the geologic mapping.

SUBSURFACE EXPLORATION

Drilling and Logging

The County constructed a ramp on the south side of the failure to enable site access for a drill rig. MGE performed the field logging at the site and Geo-Ex Subsurface Exploration (Geo-Ex) of Dixon, California drilled and sampled the borings on April 12, 2024. Geo-Ex drilled one boring, using a CME-75 track-mounted high torque drill rig. Drilling methods used included 5-inch solid flight auger drilling and mud rotary drilling using a 5-inch tri-cone bit. Table 1, Boring Exploration Data presents a summary of data for the completed boring. Refer to Figure 4 Boring Log, for details.

Table 1 Boring Exploration Data

Post Mile	Boring Designation	Ground Elevation (ft)	Depth (ft)	Groundwater Elevation (ft)	Rock Elevation (ft)	Tools
1.63	B4	≈1690.09	60	Not Encountered[1]	1660.09	Solid Flight Auger and Mud Rotary

1. Groundwater was not measured prior to switching to mud rotary drilling methods

The driller performed Standard Penetration Tests (SPTs) in accordance with ASTM International (ASTM) Designation 1586, Standard Method for Penetration Testing at 5-foot intervals until reaching a depth of 30 feet. At 30 feet depth the driller switched to mud rotary drilling techniques and drilled until reaching a depth of 60 feet where the boring was terminated due to refusal.

The driller backfilled the borings with neat cement grout mix upon completion of drilling and sampling.

Instrumentation Installation

The driller installed a 60-foot inclinometer pipe and a vibrating wire piezometer within the boring. The inclinometer pipe was positioned with the A-axis groove at 240° Southwest 6 inches above the ground surface.

The vibrating wire piezometer (VWP) was saturated prior to installation and taped to the bottom of the inclinometer pipe for installation. The VWP was approximately 6-inches up from the inclinometer bottom. Details and data are described in the instrumentation section.

A monitoring well cap was installed by the driller to cover the inclinometer pipe. The cover was approximately 6 inches above the ground surface of the roadway. Vertical movement of the slipout debris has caused the inclinometer pipe to tilt and raise the eastern half of the monitoring well cap 8 degrees and 3 inches, respectively from the ground surface.

SUBSURFACE CONDITIONS

Soil and Rock Units

Based on the borings and observations at the site, we interpreted the geology underlying the storm damage site. Interpreted geologic sections are appended as Figures 3, 6, and 7.

Unit 1 – Storm Damage Debris/Colluvium/Soil

We observed storm damage debris material or colluvium below the existing roadway elevation. We interpret the soil depth to extend from the existing roadway surface to the rock elevations presented in Table 1. The storm damage occurred within this unit.

The upper 30 feet of encountered soil is composed of soft sandy clay and was likely derived from nearby sources including weathered and decomposed rock.

Unit 2 –Moderately Weathered Rock

We encountered sedimentary rock resembling siltstone/sandstone below unit 1 within the boring at the elevations presented in Table 1. Based on the SPT sample acquired at 30 feet the rock was moderately weathered, moderately soft and very stiff per visual observations and based on the Caltrans Soil and Rock Logging Manual descriptors. This rock unit became progressively less decomposed and harder to drill with depth until the driller encountered complete refusal at 60 feet. In our opinion, the decomposed rock is below the failure plane.

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INSTRUMENTATION

Inclinometer

The 70 mm diameter slope inclinometer piping installed on April 12, 2024, was 60 feet deep. A monitoring well cap was used, and the pipe was filled with water during installation to counter buoyancy effects of the drill mud. The inclinometer model used is SGMCS-35E3B11.

MGE collected baseline inclinometer readings after the inclinometer was installed on April 12, 2024, along both the A0-axis as well as the A180-axis. Additional readings on both axes were collected on the day following installation (April 13, 2024). An attempt to collect a final round of data for the entire inclinometer depth for both axes was made on April 18, 2024. However, data collection beyond 28-feet deep was not possible due to deflection in the pipe not allowing for insertion of the inclinometer probe. A 100-foot tape measure was used to verify whether the inclinometer pipe had sheared. No pipe shear was encountered as the tape measure was able to reach the bottom and the pipe and the water level inside was maintained. DigiPro2 v2.12.4 software was used to process the inclinometer data. It is our interpretation that the slip plane is at 28 feet. Our interpreted data shows that the slip plane moved 2-inches in one day after the installation. See Figure 5 for inclinometer data.

Piezometer and Groundwater

The piezometer model used is a 4500S-350KPA-30M. It was attached near the base of the inclinometer. The data processing used is derived from the 2023 Model 4500 Series Vibrating Wire Piezometer Instruction Manual. The groundwater elevation readings peaked at 1676.40 feet after rainfall on April 13, 2024, but steadily dropped to Elevation 1671.48 during our final reading on May 2, 2024. From the piezometer data, it appears that the piezometer recorded the groundwater response during rainfall events and the groundwater elevation is likely above the soil:rock interface in the winter. Groundwater and surface water levels can fluctuate due to changes in precipitation, spring runoff, drought, and other factors. See Figure 8 Groundwater Elevations.

GEOLOGIC INTERPRETATION

Inclinometer Data in Boring B4 shows the depth of the failure plane at the B4 location is 28-feet deep. The scarp limits are defined by the obvious back scarp on the hillside and the toe of the storm damaged debris was observed and identified during walking traverse on the slope. These limits are shown on Figure 3 Site Map. In our opinion, the slipout failure plane is within the soil unit and not within the rock unit below 30-feet depth. MGE did not observe tension cracks upslope from the existing scarp limits. However, soft soil was observed above the scarp near the walking trail used by residents to access their property. This trail is within 20-feet of the upper scarp limits.

Below the road, seepage was emanating from the slipout debris and surface water was flowing on the north side of the debris in the natural channel depression. It appears that seepage is still emanating from the hillside and the origin of the seepage is unknown.

Based on the locations of ponded water, seepage, and the groundwater level data from the piezometer, groundwater elevations are not confined to the soils:rock interface and are elevated above this level. Seepage areas may be present within the slipout debris mass near the back scarp and are likely contributing to the saturation in the slope.

DISCUSSION

Saturation of the local native soil appears to be the cause of the slipout damage. The failure of the embankment is a deep-seated circular failure. The failure plane is not within the underlying rock unit. This failure mechanism is different from the 2023 adjacent storm damage that was shallow on the outside of the road embankment. During the major storm disaster experienced by Santa Cruz County between January 31st and February 9, 2024, this location experienced approximately 8 inches of rainfall based on the rainfall gauge located nearest to the site. The groundwater elevation response to precipitation that we noted during our piezometer readings suggest the precipitation during the major storm disaster saturated the soil at the site. This led to the failure observed at PM 1.63 during the 2024 atmospheric river storms. The scarp limits noted along Mt. Charlie Road during the 2024 site visit coincided with the tension cracking observed in the photographs take on February 26, 2024. Isolated seepage appears above the original Mt. Charlie Road elevation and above the culvert inlet elevation at the road. In our opinion, the culvert is not the source of seepage in the slope, nor the cause of the existing soil saturation based on our observations of seepage and ponded water about the site.

Integral Ground

The failure of Mt. Charlie Road PM 1.66 in 2023, while adjacent to this failure, was a different failure mechanism (shallow on the outboard fill) and did not play a role in compromising the integral ground of Mt. Charlie Road PM 1.63.

The limits of integral ground to support the County Road infrastructure are from a 1:1 downward projected plane from 40-feet south and north outside of the existing north and south scarp limits. The failure plane approximately 30-feet below ground surface where the rock unit is located, is the integral ground foundation depth necessary for road repairs.

Restoration of the integral ground to support the road will be required to at least these limits for a long-term repair solution. Actual limits of integral may be greater than what is indicated here and will depend on the progression of the failure and monitoring of the scarp surface expressions in the road.

Storm Damage Repair

The scarp limits and failure plane depth would indicate that a soldier pile wall would be an effective repair for restoring Mt. Charlie Road given the right-of-way constraints and the anticipated height of a suitable repair. In our opinion, a wall height of 25 feet at the former roadway edge is likely. Given the wall height, tie-backs anchors may be required unless lightweight fill is used to reduce lateral earth pressures. Given that a portion of the slipout debris will require removal to restore the site, there is an opportunity to import lightweight fill and reduce the amount of or need for tie-back anchors.

Work to restore the storm damaged roadway will not be sufficient to restore the residential driveway above the County Road. The designer will need to consider any additional surcharge loads on the wall from placement of superadjacent fill.

Internal drainage for the wall and drainage near the backscarp should be considered in the design. Lightweight fill such as tire-derived aggregate can be used and serve as both a lightweight fill and an excellent drainage layer to relieve seepage pressures and control groundwater. Surface water will need to be controlled to maintain slope stability and reduce/eliminate any potential driving forces from water infiltration leading to saturated soil. Reconditioning and lining roadside ditches may be required to increase slope stability by preventing surface infiltration into the repaired road.

LIMITATIONS

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. We base our conclusions and recommendations on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil and rock samples from borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

This report was prepared for the exclusive use of Santa Cruz County Department of Public Works and the project design team for Mountain Charlie Road Storm Damage project. The data and report should be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report or as a baseline report.

The scope of our present services did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air, on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater should any be encountered.

MGE Engineering cannot be responsible for interpretations made by others regarding our report and the recommendations contained herein.

MGE Engineering, Inc. has prepared and included as an enclosure, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our report.

Sincerely,

MGE ENGINEERING, INC.

Martin W. McIlroy, CEG, PE
Senior Project Manager

MWM/mwm

Enc: References
- Figure 1 Survey Monitoring Points
- Figure 2 Survey Monitoring
- Figure 3 Site Map
- Figure 4 Boring Log
- Figure 5 Inclinometer Data
- Figure 6 Cross Section A
- Figure 7 Cross Section B
- Figure 8 Groundwater Elevations

Important Information About Your Geotechnical/Environmental Report

REFERENCES

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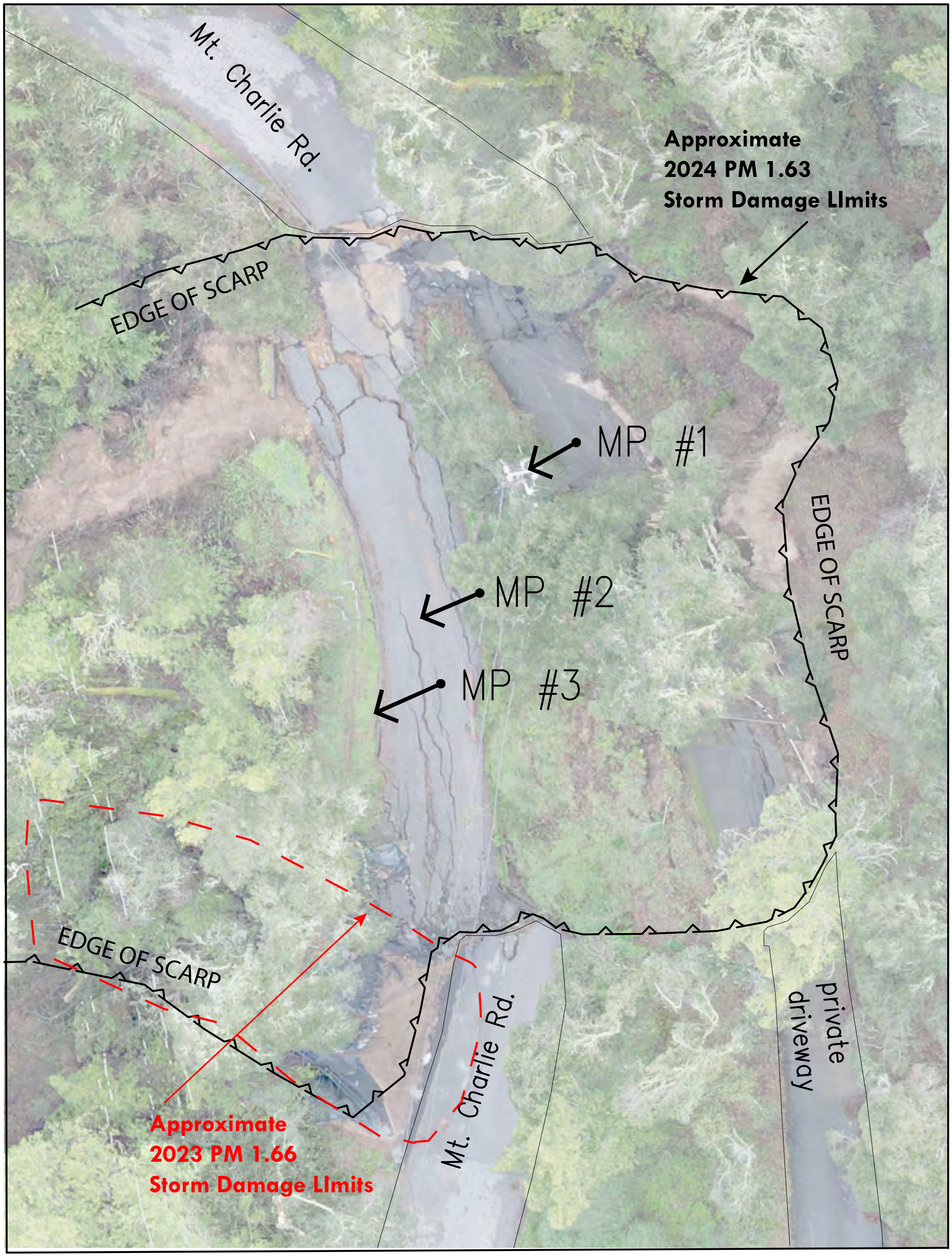


Mt. Charlie Road PM 1.63
Storm Damage
Santa Cruz County, California

SURVEY MONITORING SITE PLAN

August 2024

Project No. 730

MGE Engineering, Inc
Civil, Structural, and Geotechnical Engineers

FIG 1

PRIOR TO SETTING MONITORING STATIONS MP#1, MP#2 & MP#3, THE SITE HAD ALREADY MOVED:

HORIZONTALLY 10.85'
VERTICALLY 6.86'

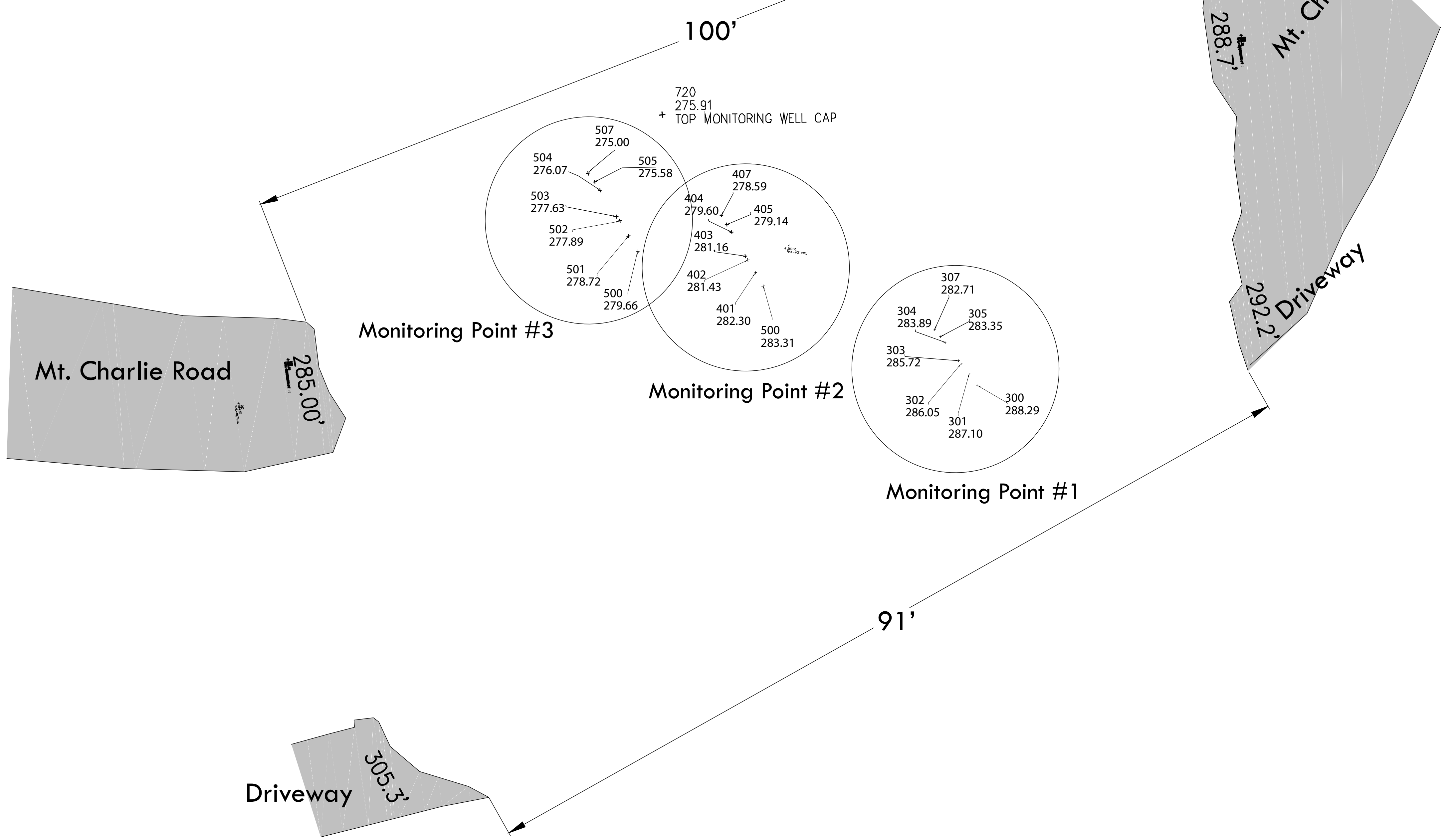
AFTER SETTING MONITORING ON 3/7/24, STATIONS MP#1, MP#2 & MP#3 HAVE MOVED AS FOLLOWS:

MP#1 HORIZONTALLY 7.28'
VERTICALLY 5.61'

MP#1 HORIZONTALLY 8.56'
VERTICALLY 4.72'

MP#1 HORIZONTALLY 9.71'
VERTICALLY 4.66'

TOTAL AVERAGE MOVEMENT
HORIZONTALLY 19.4'
VERTICALLY 11.6'



MONITORING PT #1

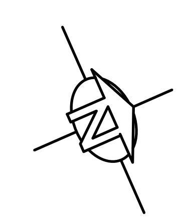
300	3-7-24	SET MONITORING PT
301	3-11-24	SHIFT 1.44' HOR, 1.19' VERT
302	3-18-24	SHIFT 1.34' HOR, 1.05' VERT
303	3-25-24	SHIFT 0.43' HOR, 0.33' VERT
304	4-4-24	SHIFT 2.37' HOR, 1.86' VERT
305	4-11-24	SHIFT 0.77' HOR, 0.54' VERT
307	4-19-24	SHIFT 0.93' HOR, 0.64' VERT

MONITORING PT #2

400	3-7-24	SET MONITORING PT
401	3-11-24	SHIFT 1.63' HOR, 1.01' VERT
402	3-18-24	SHIFT 1.52' HOR, 0.87' VERT
403	3-25-24	SHIFT 0.49' HOR, 0.27' VERT
404	4-4-24	SHIFT 2.88' HOR, 1.56' VERT
405	4-11-24	SHIFT 0.95' HOR, 0.46' VERT
407	4-19-24	SHIFT 1.09' HOR, 0.55' VERT

MONITORING PT #3

500	3-7-24	SET MONITORING PT
501	3-11-24	SHIFT 1.88' HOR, 0.94' VERT
502	3-18-24	SHIFT 1.80' HOR, 0.83' VERT
503	3-25-24	SHIFT 0.57' HOR, 0.26' VERT
504	4-4-24	SHIFT 3.23' HOR, 1.56' VERT
505	4-11-24	SHIFT 1.04' HOR, 0.49' VERT
507	4-19-24	SHIFT 1.19' HOR, 0.58' VERT



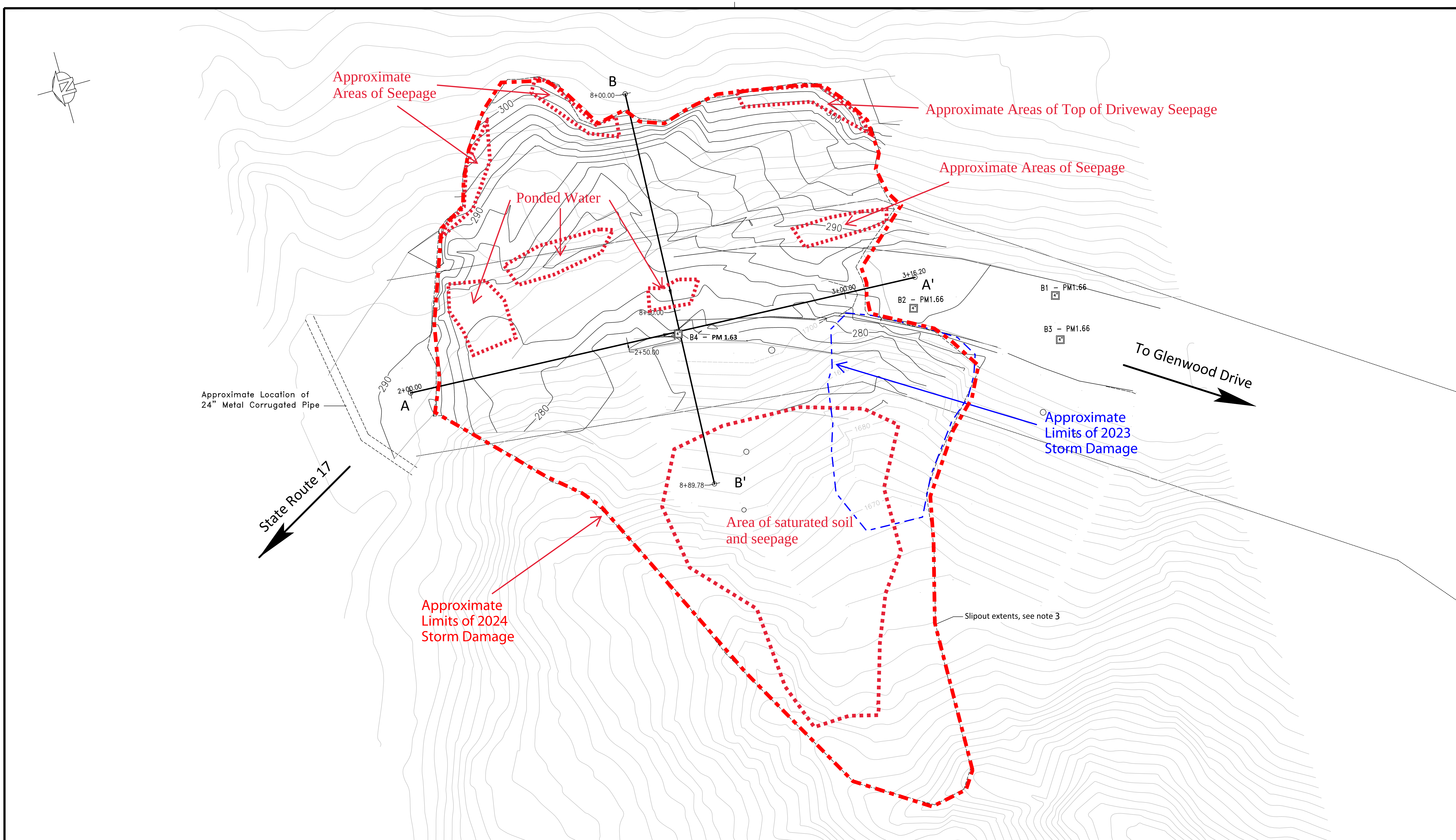
Mt. Charlie Road PM 1.63
Storm Damage
Santa Cruz County, California

Survey Monitoring

May 2024 Project No. 730

MGE Engineering, Inc.
Civil, Structural, and Geotechnical Engineers

FIG 2



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Plan

VERTICAL 1"=20'
HORIZONTAL 1"=20'

NOTE

1. The survey uses a control point with an assumed elevation of 300 feet. All survey points collected were relative to this control point. Survey conducted by Santa Cruz County from March 7, 2024.
2. Two topographic surveys are shown. Underlain is the pre-storm damage from 2023, provided by NCE. Overlain is the existing site conditions and topography of the road failure, provided by Santa Cruz County in May 2024.
3. Slip extent mapped in the field by M. McIlroy, CEG, PE on April 12, 2023; the 2024 damage resulting from DR-4683.

Cross Section Identification	PM 1.63 Site Map			
DIST. 5	COUNTY Santa Cruz	ROUTE	POSTMILE 1.63	PROJECT NUMBER 730
PROJECT OR BRIDGE NAME Santa Cruz Storm Damage				
FIGURE 3	PREPARED BY Edward Muro		DATE May 2024	SHEET 1 of 3

PROJECT OR BRIDGE NAME	BOREHOLE LOCATION (Lat/Long or North/East and Datum) (Offset, Station, Line)	HOLE ID
Mountain Charlie Road PM 1.63		**B4 - PM 1.63**

DRILL CONTRACTOR	DRILLER	DRILL RIG	DIRECTION OF BORING	DEG FROM VERTICAL	BEARING	SURFACE ELEVATION
GEO-EX	**D. Allatorre**	**CME 75 Track Rig**	☒ VERTICAL ☐ INCLINED	---	·	**1691.1 ft**

DRILLING METHOD	THICKNESS OF OVERBURDEN	DEPTH DRILLED INTO ROCK	BOREHOLE DIAMETER
Solid-Stem Auger/Mud Rotary Tri-Cone Bit	**30.0**	**30.0**	**5 in**

SAMPLER TYPE(S) AND SIZE(S) (ID)	SPT HAMMER TYPE AND EFFICIENCY, ERI	TOTAL SAMPLES
SPT	**Autohammer, 140 lb / ERi = ~85**	Disturbed **7** Undisturbed

BOREHOLE BACKFILL AND COMPLETION	GROUNDWATER READINGS	DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Grout backfill		**Not encounterd prior to rotary**		**60.0 ft**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	N60 per foot	Recovery (%)	RQD (%)	Laboratory: Gravel	Sand	Fines	LL	PI	MC	DD	ASTM Class	Drilling Method	Casing Depth	Remarks
	0		SANDY lean CLAY (CL); yellowish brown; moist; trace SAND ; mostly high plasticity, no dilatancy, high toughness fines ; orangish red oxidation.																		
	1																				
1689.1	2																				
	3																				
1687.1	4																				
	5			X	B4-1	3 3 4	**7**		100												P.P. = 1.75 tsf
1685.1	6																				
	7																				
1683.1	8																				
	9																				
1681.1	10			X	B4-2	3 3 3	**6**		100												P.P. = 2.5 tsf
	11																				
1679.1	12																				
	13																				
1677.1	14																				
	15			X	B4-3	3 4 7	**11**		100												P.P. = 2.25 tsf
1675.1	16																				
	17																				
1673.1	18																				
	19																				
1671.1	20			X	B4-4	5 3 5	**8**		100												Clayey Sand Lenses
	21																				
1669.1	22																				
	23																				
1667.1	24																				Possible transition of material
	25																				

(continued)

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LOGGED BY	REPORT TITLE				HOLE ID
EM	**BORING RECORD**				**B4 - PM 1.63**
BEGIN DATE	DIST.	COUNTY	ROUTE	POSTMILE	PROJECT ID
4-12-24	**4**	**SCR**		**1.661.7**	**730**
COMPLETION DATE	PROJECT OR BRIDGE NAME				
4-12-24	**Mountain Charlie Road PM 1.63**				
	BRIDGE NUMBER	PREPARED BY		DATE	SHEET
		Edward Muro		**5-9-24**	**1 of 3**

FIG 4

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	N60 per foot	Recovery (%)	RQD (%)	Gravel	Sand	Fines	LL	PI	MC	DD	ASTM Class	Drilling Method	Casing Depth	Remarks
	25		SANDY lean CLAY (CL) *(continued)*.		B4-5	3 3 4	**7**		100												
1665.1	26																				
	27																				Color transition to greenish color at 27'
1663.1	28																				
	29																				
1661.1	30		Poorly graded SAND with SILTY CLAY (SP-SC); dense to very dense; greenish black; moist; medium dry strength fines ; (SEDIMENTARY ROCK, SANDSTONE, moderately hard to hard, fine grained, cemented.).		B4-6	11 13 54	**67**		100												Transition to mud rotary, 5-in tricone bit. No groundwater encountered before switching to mud rotery
	31																				
1659.1	32																				
	33																				
1657.1	34																				
	35																				
1655.1	36																				
	37																				
1653.1	38																				
	39																				
1651.1	40																				Hard Drilling
	41																				
1649.1	42																				
	43																				
1647.1	44																				
	45																				
1645.1	46																				
	47																				Hard Drilling
1643.1	48																				
	49																				
1641.1	50																				
	51																				
1639.1	52																				
	53																				Very Hard Drilling, Drill rig started to lift off ground
1637.1	54																				
	55																				

(continued)

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LOGGED BY **EM**	REPORT TITLE **BORING RECORD**			HOLE ID **B4 - PM 1.63**
BEGIN DATE **4-12-24**	DIST. **4**	COUNTY **SCR**	ROUTE / POSTMILE **1.661.7**	PROJECT ID **730**
COMPLETION DATE **4-12-24**	PROJECT OR BRIDGE NAME **Mountain Charlie Road PM 1.63**			
	BRIDGE NUMBER	PREPARED BY **Edward Muro**	DATE **5-9-24**	SHEET **2 of 3**

FIG 4

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	N60 per foot	Recovery (%)	RQD (%)	Laboratory: Gravel	Sand	Fines	LL	PI	MC	DD	ASTM Class	Drilling Method	Casing Depth	Remarks
	55		Poorly graded SAND with SILTY CLAY (SP-SC) *(continued)*.																		
1635.1	56																				
	57																				
1633.1	58																				Very Hard Drilling, Drill rig shaking and lifting.
	59																				
1631.1	60		Bottom of borehole at 60.0 ft bgs Terminate boring at 60'. Inclinometer and Piezometer installed to 60'. End Drilling 1420 Hrs This Boring Record was developed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010) except as noted on the Soil or Rock Legend or below.																		
	61																				
1629.1	62																				
	63																				
1627.1	64																				
	65																				
1625.1	66																				
	67																				
1623.1	68																				
	69																				
1621.1	70																				
	71																				
1619.1	72																				
	73																				
1617.1	74																				
	75																				
1615.1	76																				
	77																				
1613.1	78																				
	79																				
1611.1	80																				
	81																				
1609.1	82																				
	83																				
1607.1	84																				
	85																				

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LOGGED BY	REPORT TITLE				HOLE ID	
EM	**BORING RECORD**				**B4 - PM 1.63**	
BEGIN DATE **4-12-24**	DIST. **4**	COUNTY **SCR**	ROUTE	POSTMILE **1.661.7**	PROJECT ID **730**	
COMPLETION DATE **4-12-24**	PROJECT OR BRIDGE NAME **Mountain Charlie Road PM 1.63**					
	BRIDGE NUMBER	PREPARED BY **Edward Muro**			DATE **5-9-24**	SHEET **3 of 3**

FIG 4

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names	Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166) Unconfined Compression - Rock (ASTM D 7012)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler (2.5" I.D.)
- Modified California Sampler (2.0" I.D.)
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

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PROJECT NAME Mountain Charlie Road PM 1.63		
DATE 5-9-24		SHEET 1 of 3

FIG 4

CONSISTENCY OF COHESIVE SOILS

Descriptor	Unconfined Compressive Strength (tsf)	Pocket Penetrometer (tsf)	Torvane (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	0.25 - 0.50	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	0.50 - 1.0	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	1.0 - 2.0	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	2.0 - 4.0	1.0 - 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60} - Value (blows / foot)
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Descriptor	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE

Descriptor		Size
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CEMENTATION

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

<u>NOTE</u>: This legend sheet provides descriptors and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), Section 2, for tables of additional soil description components and discussion of soil description and identification.

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REPORT TITLE: EXPLORATION RECORD LEGEND		
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FIG 4

ROCK GRAPHIC SYMBOLS

⊠	IGNEOUS ROCK
☰	SEDIMENTARY ROCK
⬚	METAMORPHIC ROCK

BEDDING SPACING

Descriptor	Thickness or Spacing
Massive	> 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8 inches to 1 ft
Thinly bedded	1-1/4 to 3-5/8 inches
Very thinly bedded	3/8 inch to 1-1/4 inches
Laminated	< 3/8 inch

WEATHERING DESCRIPTORS FOR INTACT ROCK

	Diagnostic Features					
	Chemical Weathering-Discoloration-Oxidation		Mechanical Weathering and Grain Boundary Conditions	Texture and Solutioning		
Descriptor	Body of Rock	Fracture Surfaces		Texture	Solutioning	General Characteristics
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy"	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation (refer to grain boundary conditions)	All fracture surfaces are discolored or oxidized; surfaces are friable	Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated	Altered by chemical disintegration such as via hydration or argillation	Leaching of soluble minerals may be complete	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened.
Decomposed	Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay		Complete separation of grain boundaries (disaggregated)	Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes".

Note: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

RELATIVE STRENGTH OF INTACT ROCK

Descriptor	Uniaxial Compressive Strength (psi)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

CORE RECOVERY CALCULATION (%)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

RQD CALCULATION (%)

$$\frac{\Sigma \text{ Length of intact core pieces > 4 in.}}{\text{Total length of core run (in.)}} \times 100$$

ROCK HARDNESS

Descriptor	Criteria
Extremely Hard	Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows
Very hard	Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows
Hard	Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows
Moderately Soft	Specimen can be grooved 1/6 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure
Soft	Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure
Very Soft	Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light hand pressure

FRACTURE DENSITY

Descriptor	Criteria
Unfractured	No fractures
Very Slightly Fractured	Lengths greater 3 ft
Slightly Fractured	Lengths from 1 to 3 ft, few lengths outside that range
Moderately Fractured	Lengths mostly in range of 4 in. to 1 ft, with most lengths about 8 in.
Intensely Fractured	Lengths average from 1 in. to 4 in. with scattered fragmented intervals with lengths less than 4 in.
Very Intensely Fractured	Mostly chips and fragments with few scattered short core lengths

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REPORT TITLE EXPLORATION RECORD LEGEND		
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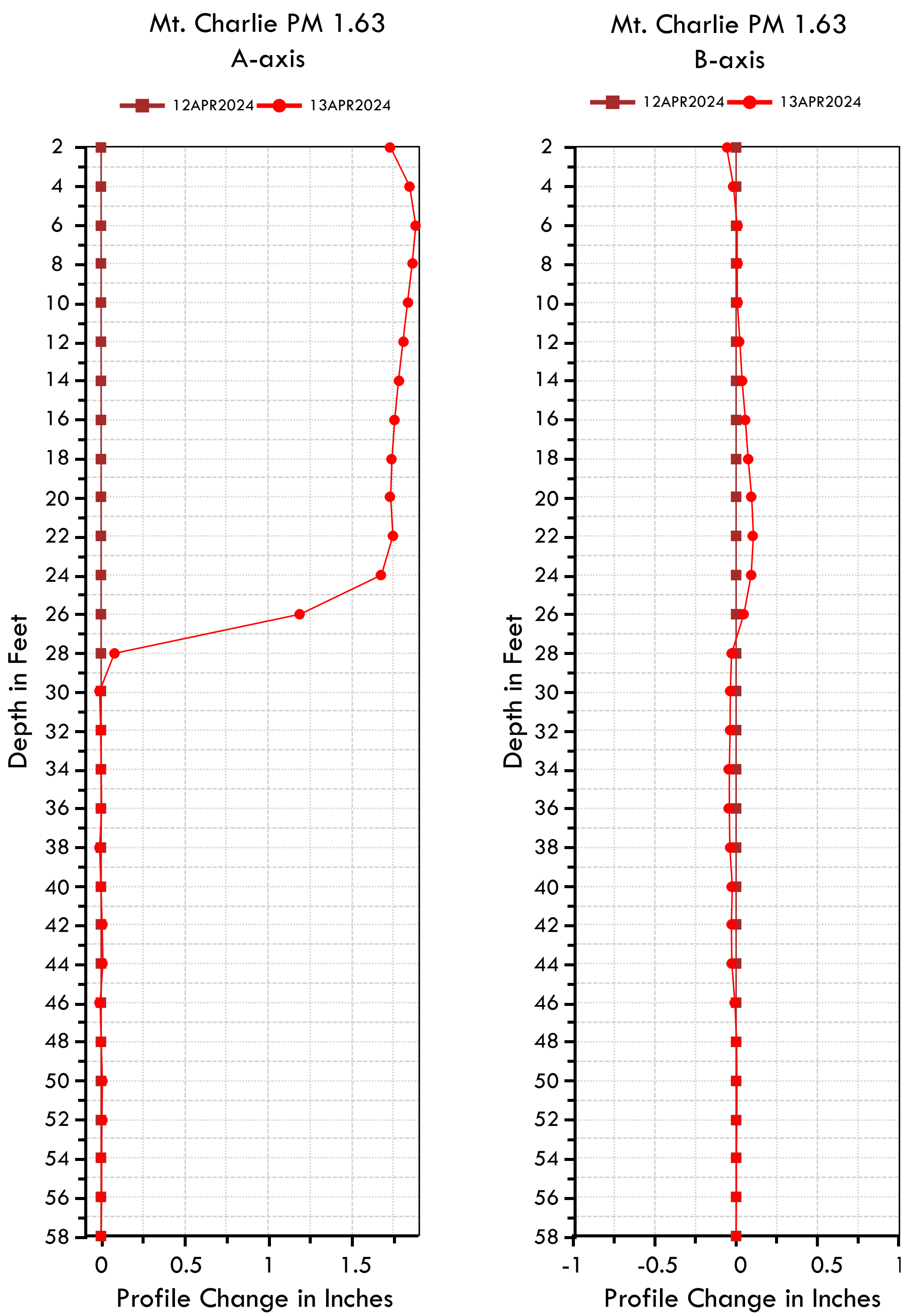
FIG 4



Note:

1. A-Axis is oriented at 240 degrees which is the downslope direction.

Mt. Charlie Road PM 1.63
Storm Damage
Santa Cruz County, California

Inclinometer Data

May 2024 | Project No. 730

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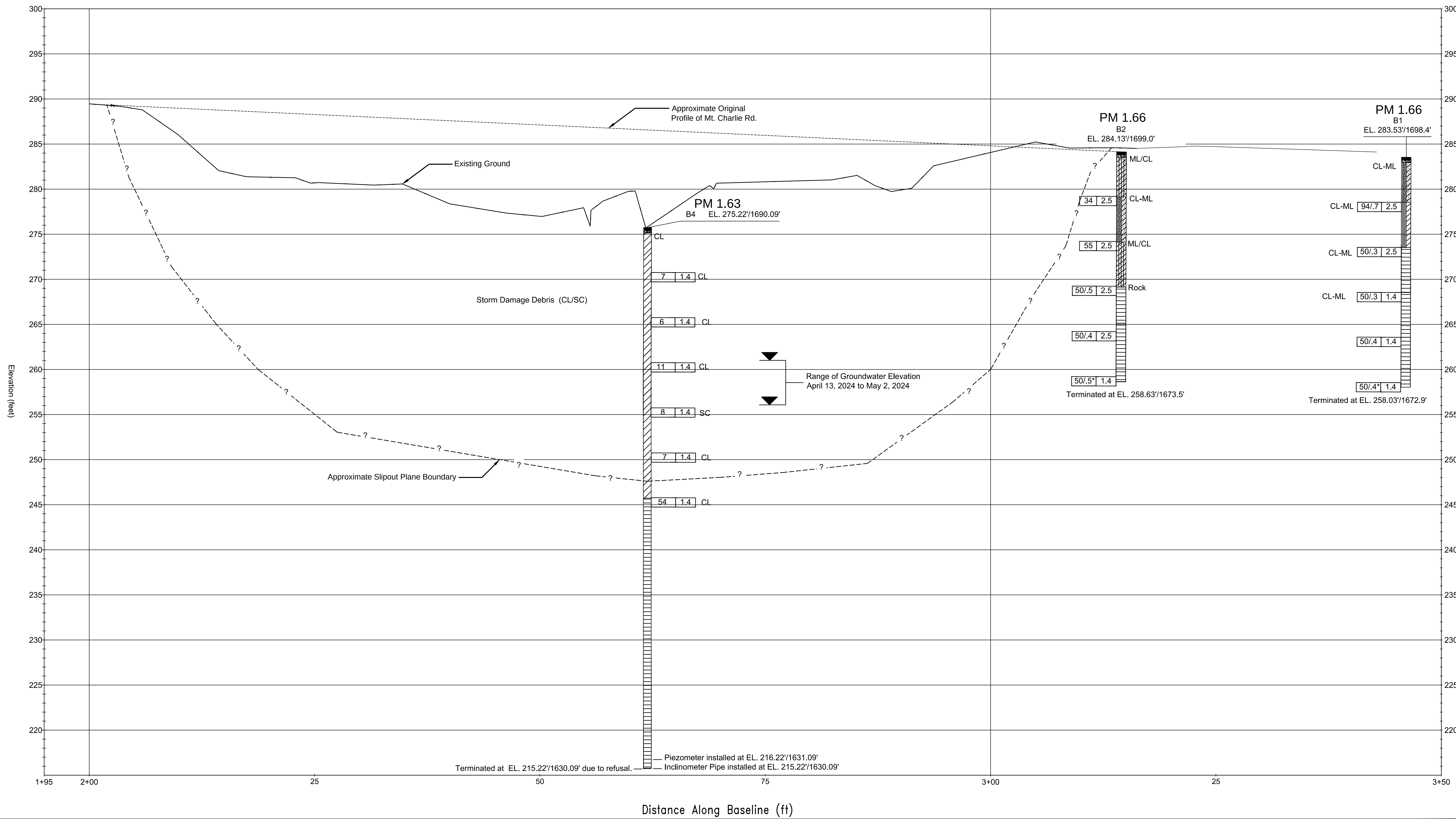
FIG 5

CROSS SECTION A PROFILE

A (NORTH) A' (SOUTH)



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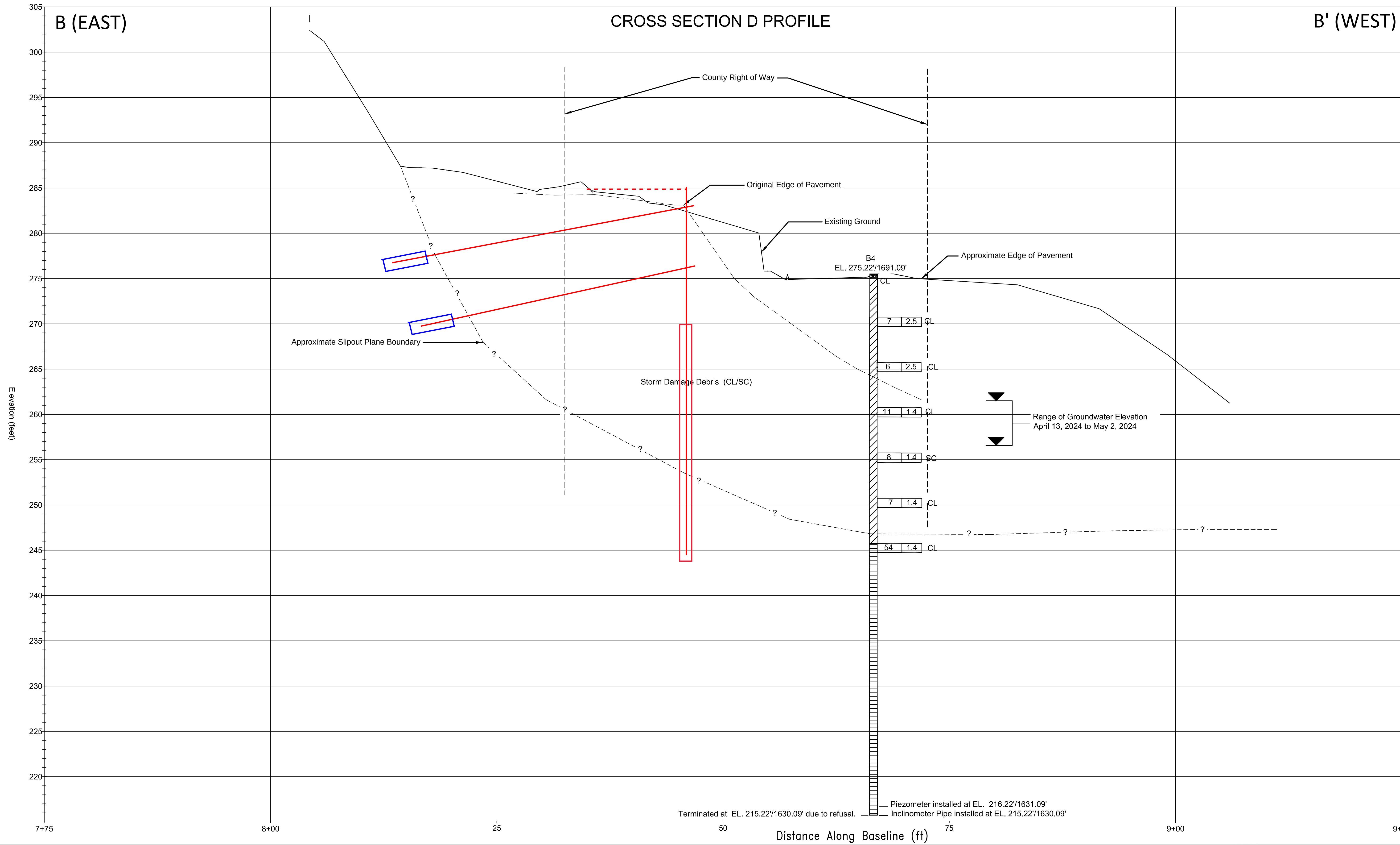
PROFILE

VERTICAL 1"=10' HORIZONTAL 1"=10'

NOTE

1. The survey uses a control point with an assumed elevation of 300 feet. All survey points collected were relative to this control point. Survey conducted by Santa Cruz County from March 7, 2024. True elevations are approximately 1415 feet above the control point.
2. Survey was provided to MGE by Santa Cruz County in May 2024. Relative and True elevations are shown on the sheet.
3. Slip extent maoped in the field by M. McIlroy, CEG, PE on April 12, 2023; the 2024 damage resulted from DR-4683.

Cross Section Identification	Cross Section A			
DIST. 5	COUNTY Santa Cruz	ROUTE	POSTMILE 1.63	PROJECT NUMBER 730
PROJECT OR BRIDGE NAME Santa Cruz Storm Damage				
FIGURE 6	PREPARED BY Edward Muro		DATE May 2024	SHEET 2 of 3



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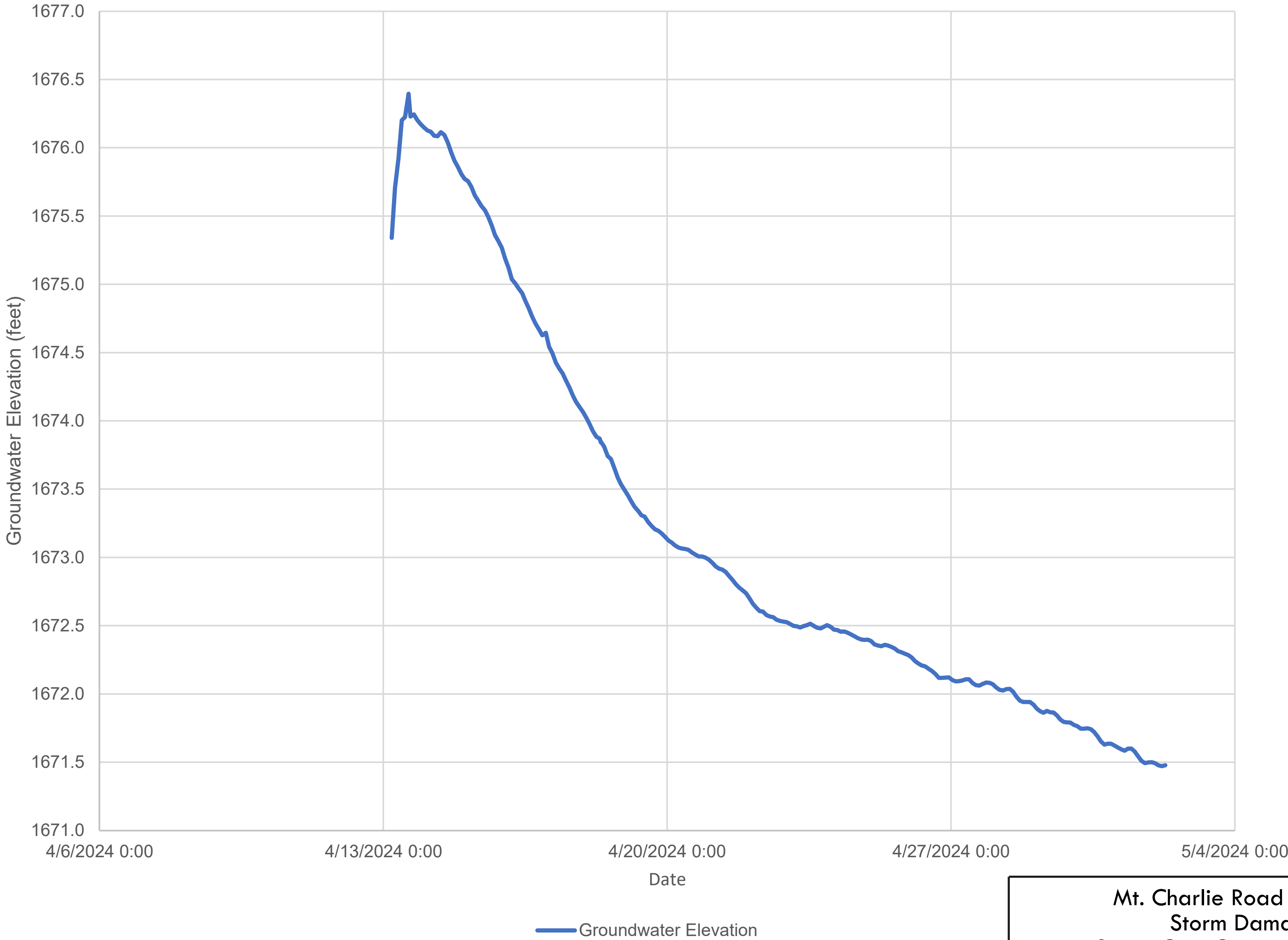
PROFILE

VERTICAL 1"=10' HORIZONTAL 1"=10'

NOTE

1. The survey uses a control point with an assumed elevation of 300 feet. All survey points collected were relative to this control point. Survey conducted by Santa Cruz County from March 7, 2024. True elevations are approximately 1415 feet above the control point.
2. Survey was provided to MGE by Santa Cruz County in May 2024.
3. Slip extent maoped in the field by M. McIlroy, CEG, PE on April 12, 2023; the 2024 damage resulted from DR-4683.

Cross Section Identification	Cross Section B			
DIST. 5	COUNTY Santa Cruz	ROUTE	POSTMILE 1.63	PROJECT NUMBER 730
PROJECT OR BRIDGE NAME Santa Cruz Storm Damage				
FIGURE 7	PREPARED BY Edward Muro		DATE May 2024	SHEET 3 of 3



Mt. Charlie Road PM 1.63
Storm Damage
Santa Cruz County, California

Groundwater Elevation

May 2024

Project No. 730

MGE Engineering, Inc.
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FIG 8