

December 20, 2019
Revised February 17, 2020

Mr. Aaron Brusatori, PE
R.E.Y. Engineers, Inc.
905 Sutter Street, Suite 200
Folsom, CA 95630



Subject: Full Depth Reclamation Using Cement (FDR-C) Technical Memorandum

Project: Mosquito Road Rehabilitation Project, City of Placerville, California

Mr. Brusatori,

This letter report presents Twining Inc.'s (Twining) FDR-C Study Report for the subject project in the City of Placerville, El Dorado County, California. Our understanding of the project site, scope of work performed for this study, and engineering recommendations are described in detail below.

SCOPE OF SERVICES

Our proposed scope of services for this study consisted of the following:

- Review readily available data, including previous studies, available City as-built data, published geological studies, and maintenance records.
- Visit the site to mark out in white paint the proposed boring locations and call USA North 811 a minimum of 48 hours prior to the start of field investigation work to identify potential underground utility conflicts.
- Submit and obtain a (no fee) encroachment permit from the City.
- At five (5) locations, core the existing asphalt concrete pavement to measure the existing asphalt concrete (AC) thickness and aggregate base (AB) thickness, as well as collect bulk samples of the existing native materials.
- Visually classify bulk soil samples using the Caltrans Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition.
- Backfill all boring locations with Class 2 aggregate base and patch the roadway surface with SET 45 grout dyed black.
- Transported the samples to our certified lab for testing and mix design.
- Prepare this FDR-C Study Report to discuss the recommended depth of FDR and percent Portland cement admixture to rehabilitate the existing roadway section.

PROJECT DESCRIPTION

The Mosquito Road Pavement Evaluation and Rehabilitation project proposed to rehabilitate the existing asphalt concrete roadway from Clay Street to the City limits just east of Wildlife Way. Based upon communications with REY Engineers, Inc., the portion of Mosquito Road from Clay Street to Dimity Lane is classified as a Minor Arterial with a design Traffic Index (TI) of 8.0. The remaining portion of Mosquito Road up to the City limits is a two lane rural road with no shoulder and no design TI was provided at this time. There is an abundance of utilities, both underground and exposed, extending throughout the project area. The current condition of the roadway surface ranges from minor up to severe deterioration with alligator cracking, block cracking, longitudinal cracking, transverse cracking, shoved surface pavement, base failures, and potholes all present in multiple locations.

FIELD INVESTIGATION AND LABORATORY TESTING

The pavement coring was performed by Twining using a 6 inch diameter thin wall core barred to core the existing asphalt concrete to obtain five (5) representative pavement



cores for visual observations and use in the FDR-C study. Any base material identified beneath the asphalt concrete was measured and the thickness recorded. Representative subgrade collected for visual classification and laboratory testing.

Twining also coordinated with the City of Placerville to perform seven (7) shallow potholes along the section of Mosquito Road between Dimity Lane and the city limits to better quantify the limits of the Portland cement concrete identified in Pavement Core Location No. 5. The results of this were that no Portland cement concrete was identified anywhere within the roadway limits and it appears that the Portland cement concrete identified in Pavement Core Location No. 5 was an isolated occurrence of Portland cement concrete under the existing asphalt concrete.

The collected asphalt concrete and base/subgrade samples were proportioned (by volume and mix depth) to represent the approximate FDR-C construction proportions in the field. Once proportioned, the retrieved sample materials were completely mixed homogeneously to mimic the mixing action of the construction equipment. Per the Caltrans Highway Design Manual, Chapter 630, the optimum moisture content of each of the representative samples was determined by ASTM D1557 and a copy of the moisture/density curve is attached to this letter report. Using the optimum moisture content plus two percent (2%) to account for cement hydration, the samples were prepared with 4 and 6 percent Portland cement (by mass) mix and prepared in general accordance with ASTM D1633 and ASTM D1557, Method B. The prepared samples were then twice wrapped in 4-mil plastic and duct tape and placed in an oven where they were cured for seven (7) days at 100 degrees Fahrenheit following the Caltrans test specimen curing requirements. The samples were then removed and broken to determine the unconfined compressive strength of the FDR-C material.

LABORATORY TESTING RESULTS

R-value testing was performed on a composite sample of the site subgrade soils. R-value test results of the recovered subgrade soils indicate the site soils have an R-value in excess of 50, which is the maximum allowable value per the Caltrans Test Method 301. This is in good agreement with the R-value testing results from Spring Street and Upper Broadway Bike Lanes projects which also reported values of greater than 50. Copies of the R-value test results are included attached to this report.

As stated above, the samples were proportioned to represent how the proposed construction would be performed in the field. The following table, Table 1 Unconfined Compressive Strength Testing Results of FDR-C Mix Designs, provides a summary of the unconfined compressive strength test results for three samples by percent cement (by mass) design mixes.

Table 1. Unconfined Compressive Strength Testing Results of FDR-C Mix Designs

Sample ID	Unconfined Compressive Strength (psi)	
	4% Cement	6% Cement
Bulk Composite 1	380	540
Bulk Composite 2	430	570
Average	405	555

OBSERVATIONS AND CONCLUSIONS

FDR-C Laboratory Testing Results

The following statements can be made about the mix design study results regarding the unconfined compressive strengths:

- The FDR-C mixes all gained strength with increasing cement content.

- The increase of strength with increasing cement content is not a linear relation and the increase in percent cement added does not proportionally increase the unconfined compressive strength of the sample.

New FDR-C Pavement Sections



For the new FDR-C flexible pavement sections, Twining performed the analysis following the Caltrans Highway Design Manual, Chapter 630, and the Caltrans online software program CalFP, which computes flexible HMA pavement sections following the Gravel Equivalency Methodology prescribed in the Caltrans Highway Design Manual, Chapter 600. Design Traffic Indices (TI's) of 7.0 and 8.0 were provided by REY for use in the analysis. A design R-value of 50 was selected based upon the R-value testing results.

For the new FDR-C section, we analyzed several alternatives to allow flexibility in the rehabilitation strategies to account for shallow utilizes and the use of Rubbarized Hot Mix Asphalt. The following FDR-C structural sections are only valid for the portion of Mosquito Road from Dimity Lane to Wildlife Way/EI Dorado County Border. Using the design compressive strengths and the R-value testing results, new FDR-C/HMA structural sections for the were developed for the design unconfined compressive strengths to determine required treated depths with associated HMA cap sections. The following table, Table 4, shows the FDR-C unconfined compressive strength, design R-value, depth of FDR-C, and associated HMA cap thickness. Based upon discussions with the City and REY, the following FDR-C structural sections evaluated for use on the project segment discussed above.

Table 2. New FDR-C HMA Structural Pavement Sections

Design Traffic Index (TI)	FDR-C Unconfined Compressive Strength* (psi)	Design R-Value	HMA** Thickness (in)	FDR-C Thickness (in)
7.0	350	50	3	7
7.0	350	50	2 ½	8
7.0	350	50	2	10
8.0	350	50	3	8
8.0	350	50	2 ½	9
8.0	350	50	2	11

Notes:

* - Average Unconfined Compressive Strength based upon unconfined compressive testing results of FDR-C Mix Design.

** - HMA less than 2 ½ inches can consist of either Type A HMA, gap-graded RHMA-G, or a combination of both types of hot mix asphalt concrete. HMA greater than 3 inches cannot be only RHMA-G as RHMA-G is limited to a maximum of 2 ½ inches in thickness.

The proposed FDR-C structural sections will have an HMA cap section placed over the cement treated section. In areas where existing profile grades are to be maintained, the cement treated section should be left below finished grade to allow the placement of the HMA cap and maintain existing grades. The volume of cement treated materials which will need to be off hauled to achieve this grade will be the difference of the increased swelled height of the cement treated material (for quantity purposes use a 10 percent volumetric swell) to the bottom of the HMA section.

All pulverizing, mixing, admixture conformance, grading and compacting, applying any asphaltic emulsions, and quality control testing should conform to the requirements of Section 30-4 Full Depth Reclamation – Cement, of the latest Caltrans Standard Specifications.

All placement of the HMA cap section should conform to Section 39-2 Hot Mix Asphalt of the latest Caltrans Standard Specifications.



To help in slowing the development of reflexive cracking propagation, the completed FDR-C section should be micro-cracked using a vibratory roller which “pre-cracks” the section and reduces strain cracking in the FDR-C section; this should reduce reflective cracking in the final wearing surface HMA. The microcracking is typically performed approximately two to three days after performing the FDR-C and usually consists of four passes of a roller which must be capable of at least 2,500 vibrations per minute and a gross static weight of at least 7.5 tons.

LIMITATIONS

This technical memorandum was performed in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made as to the conclusions and professional recommendations made in this report.

This technical memorandum is intended for use with the Mosquito Road Rehabilitation Project in the City of Placerville, and any changes in the design or location of the proposed new improvements, however slight, should be brought to our attention so that we may determine how they may affect our conclusions and recommendations. The conclusions and recommendations contained in this report are based upon the data relating only to this specific project and locations discussed herein.

The analyses and recommendations submitted herein are based upon the observations noted during the boring operations and field observations as to the local surficial geology. This report does not reflect or comment on any subsurface variations that may occur between the borings which may be encountered during construction. If conditions in the field differ with those described in this report, Twining should be notified immediately so we may adjust our recommendations based upon this new information.

Services performed by Twining were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under seismic conditions. No other representation, expressed or implied, and no warranty for guarantee is included or intended.

CONCLUDING REMARKS

Twining would like to thank R.E.Y. Engineers, Inc. and the City of Placerville for the opportunity to conduct this study. If you have any questions or wish to discuss the technical memorandum in greater detail, please contact us at (916) 649-9000.

Respectfully submitted,

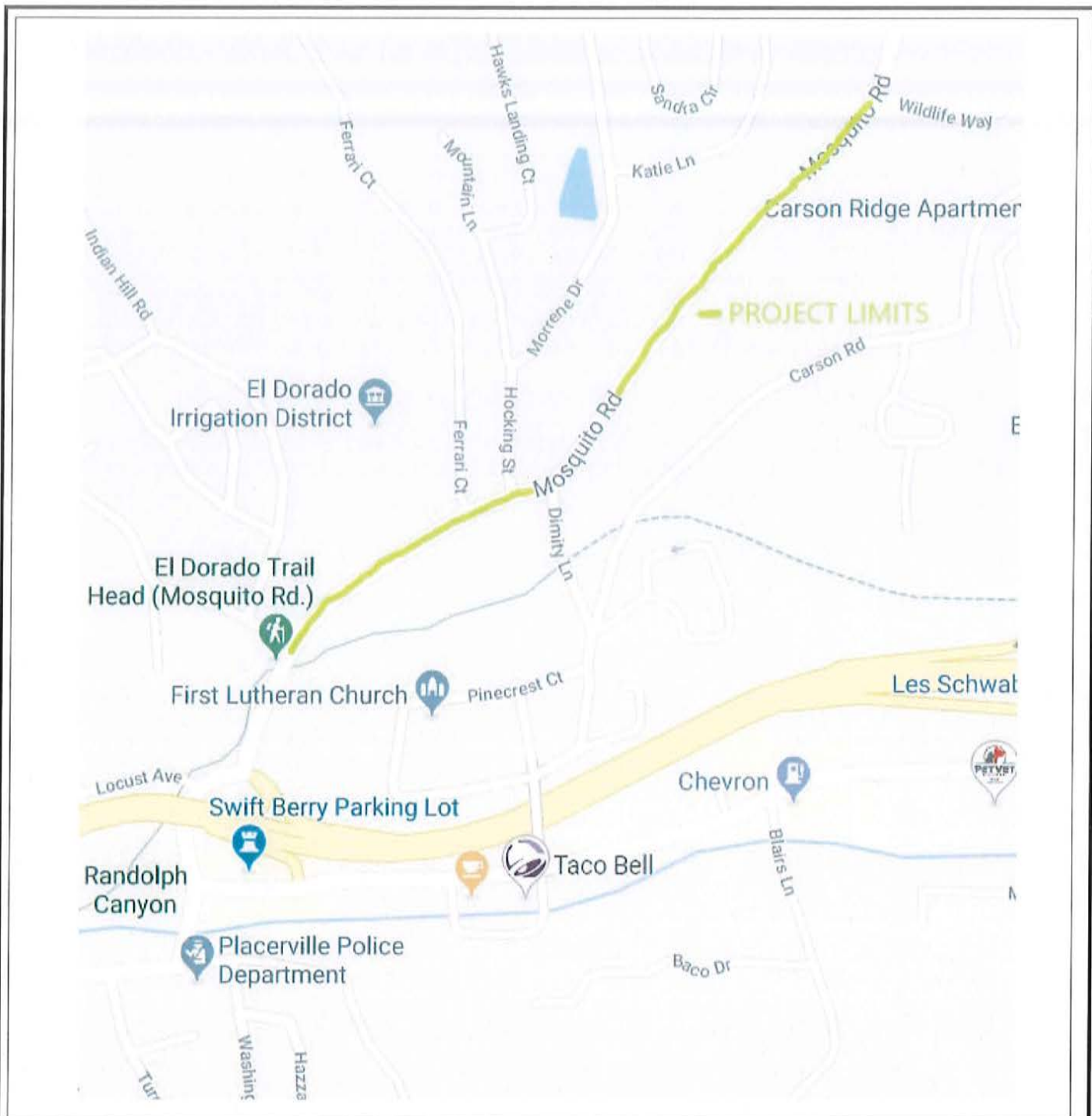
TWINING, INC.

Robert Lawrence, RCE 63076, GE 2785
Senior Geotechnical Engineer



Attachments:

- Figure 1 – Site Location Plan
- Figures 2 & 3 – Pavement Core Location Plan
- Laboratory Testing Results



REFERENCE: GOOGLE MAPS (2019)



TWINING

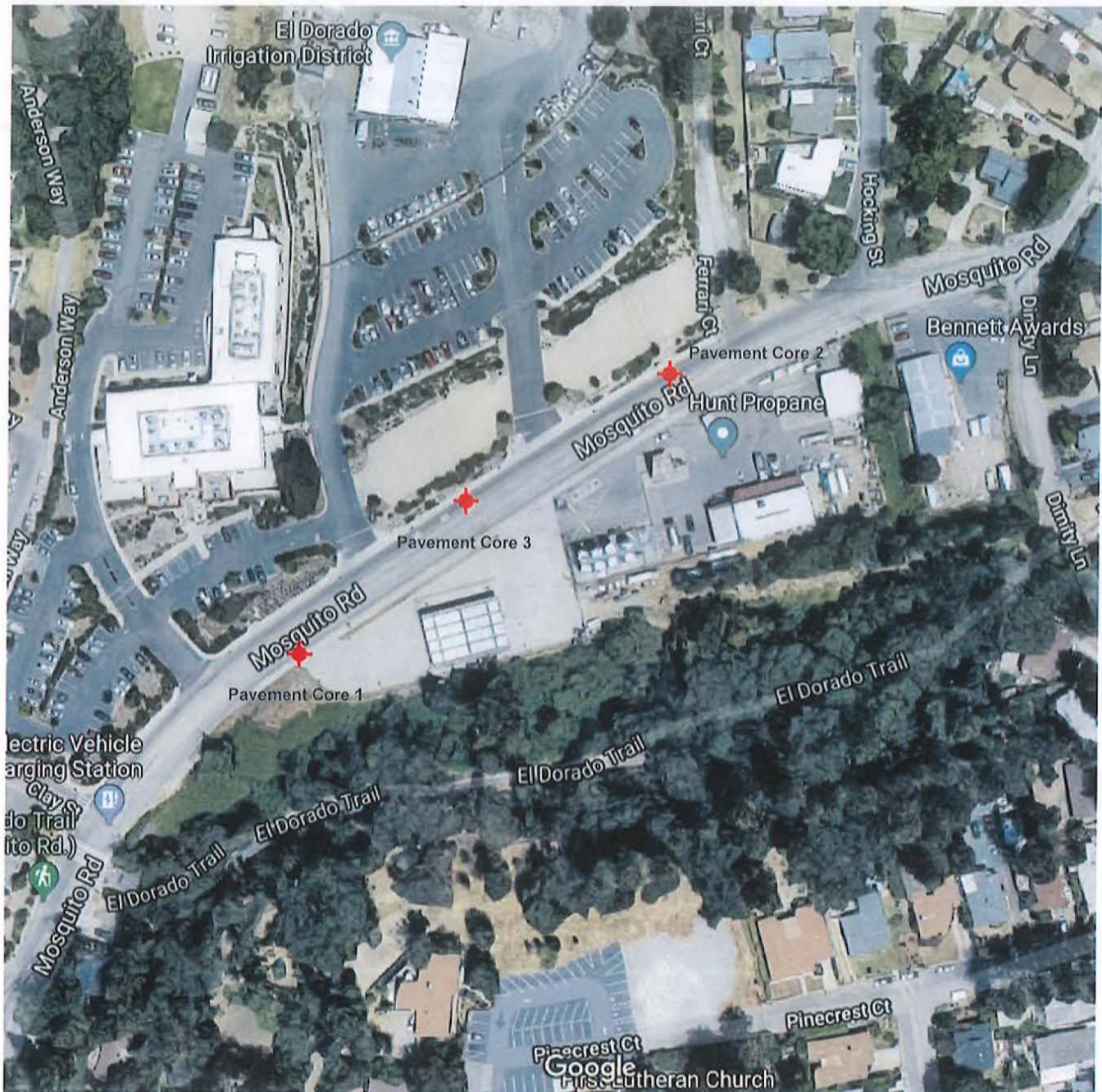
SITE LOCATION MAP

MOSQUITO ROAD REHABILITATION PROJECT
City of Placerville, California

PROJECT NO.
190339.5

REPORT DATE
June 2019

FIGURE 1



REFERENCE: GOOGLE EARTH (2019)



★ Pavement Core Locations



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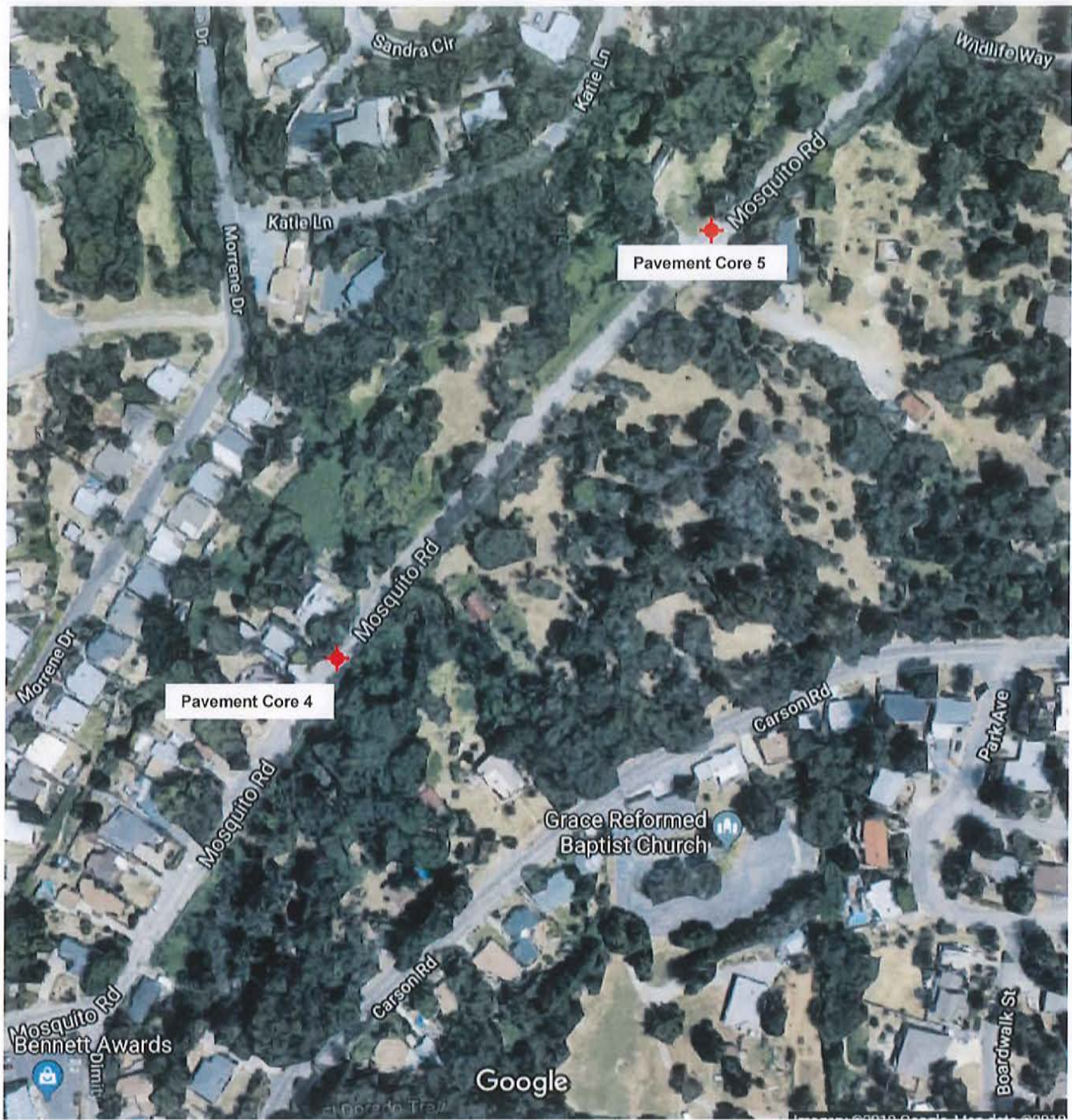
PAVMENT CORE LOCATION MAP (1 of 2)

MOSQUITO ROAD REHABILITATION PROJECT
City of Placerville, California

PROJECT NO.
190339.5

REPORT DATE
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FIGURE 2



REFERENCE: GOOGLE EARTH (2019)



◆ Pavement Core Locations



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PAVMENT CORE LOCATION MAP (2 of 2)

MOSQUITO ROAD REHABILITATION PROJECT
City of Placerville, California

PROJECT NO.
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June 2019

FIGURE 3



Proctor Report

Twining, Inc. - Sacramento Lab
1572 Santa Ana Avenue, Sacramento, CA 95838
Ph: 916-649-9000
Fax: 916-921-8532
www.twininginc.com

Report No: PTR:W05-19-01614-S1

Customer: REY Engineers, Inc
905 Sutter St.
Folsom, CA, 95630
Project: Mosquito Road Rehab Project
Mosquito Road
Placerville, ,

Project No.: 190399.5
Permit No.:
OSHDP:
DSA File #:
DSA AP #:

Jurisdiction:
Distribution:

Sample Details

Sample ID: W05-19-01614-S1

Field Sample ID: Composite Bulk 1

Date Sampled: 6/6/2019

Sampled By: R. Lawrence

Source:

Material:

Specification:

Sampling Method:

Sampling Location:

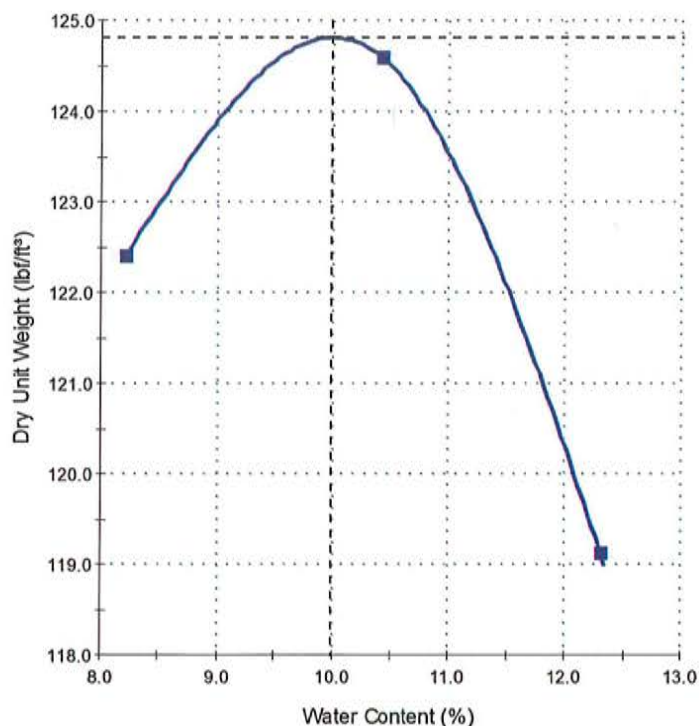
Sampling Depth:

Material Description: Brown Silty SAND

Tested By:

Date Tested: June 13, 2019

Dry Unit Weight - Water Content Relationship



Test Results

ASTM D 1557

Maximum Dry Unit Weight (lb/ft³): 124.8

Optimum Water Content (%): 10.0

Method:

Preparation Method:

Tested By:

Date Tested: June 13, 2019

Remarks:

The Material Tested
With the Project Requirements

Complies ☐ Does Not Comply



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 Fax: 916-921-8532
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R Value Report

Report No: RV:W05-19-01720-S1

Customer: REY Engineers, Inc
 905 Sutter St.
 Folsom, CA, 95630
 Project: Mosquito Road Rehab Project
 Mosquito Road
 Placerville, ,

Project No.: 190399.5
 Permit No.:
 OSHPD:
 DSA File #:
 DSA AP #:

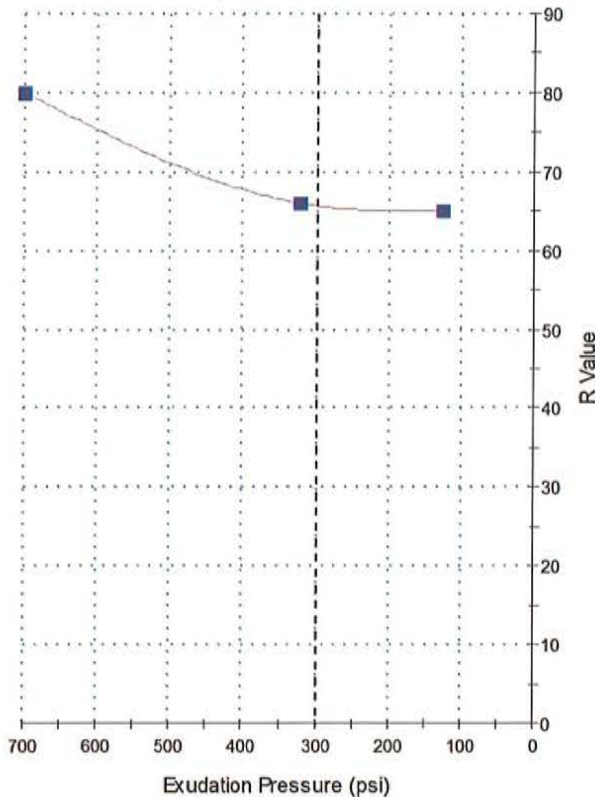
Jurisdiction:
 Distribution:

Sample Details

Sample ID: Composite Bulk 1
 Sampling Method: ASTM D-75
 Material: Subgrade - Brown Silty Sand (SM)
 Location: Mosquito Road
 Date Tested:

Date Sampled: 5/23/2019
 Source: Native
 Specification:
 Tested By: T Van-Y

R Value



Test Results

ASTM D 2844

R Value at 300 psi Exudation: 66

Specimen Results

Moisture Content (%)	13.4	12.5	11.6
Dry Density (lb/ft³)	124.5	124.8	126.8
Exudation Pressure (psi)	127	323	699
R Value	65	66	80
Expansion Pressure (psi)	0.0	0.0	0.0

Remarks:

The Material Tested
 With the Project Requirements

Complies ☐ Does Not Comply