PRELIMINARY HYDROLOGY STUDY

PREPARE FOR:

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FOR THE PROJECT:

COTTONWOOD RESIDENTIAL DEVELOPMENT
MORENO VALLEY, CA

PREPARED BY:

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PREPARED UNDER THE SUPERVISION OF:

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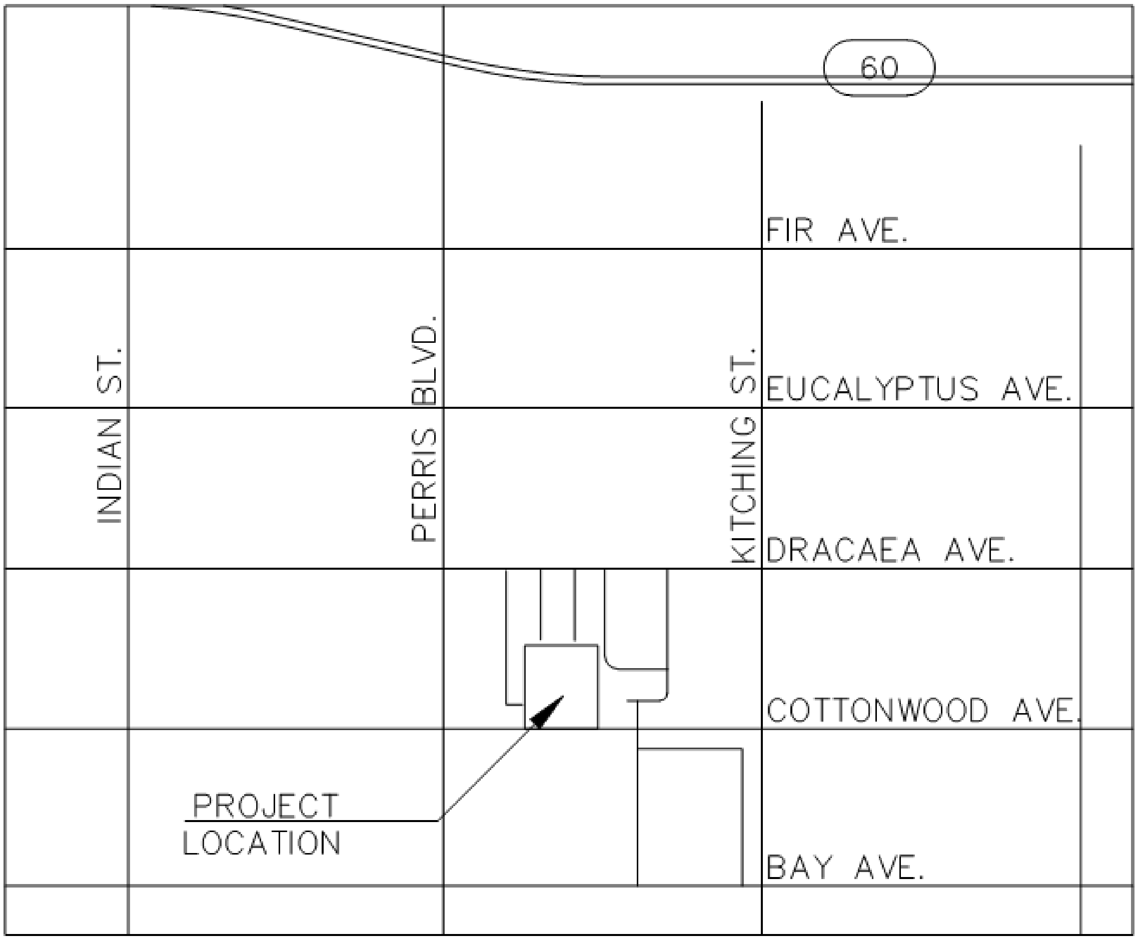
January, 2022

INDEX:



VICINITY MAP
N.T.S.

I. INTRODUCTION

The project Cottonwood Multi-family Residential Development is an approximately 9.4 acres site located approximately 600 feet east of the intersection of Perris Blvd and Cottonwood on the north side of Cottonwood Avenue in the City of Moreno Valley, Riverside County, California (see attached vicinity map). The site is bordered to the west by single family homes that have a chain linked fence along the boundary , to the south by Cottonwood Avenue, to the north by single family homes that contain a chain linked fence and single family residential home to the east with a block wall.

II. DESCRIPTION OF THE ONSITE CONDITIONS

The subject site consists of an almost square shaped parcel, approximately 9.4 acres in size. The site is currently undeveloped and appears to have been graded in the past. Ground surface cover consists of exposed soil.

The site topography appears to have a low spot at the southeast corner of the property. There is an estimated 6 foot of elevation differential across the site. The existing flows drains into an existing inlet that is in the public right of way just north of Cottonwood Avenue. This inlet is the ultimate outfall of the site and is connected into the Riverside County Flood Control District Sunnymead Line P.

The site will be developed into attached multi-family homes. The site will contain twenty-three residential building a multi-purpose building and pool, and two recreational areas. Each residential building will contain 4 units. Each unit will have approximately 1,045 sq ft foot print.

III. OFFSITE HYDROLOGY

Cottonwood residential development will receive offsite flows. Along the northerly property line where the two streets of Bencliff Avenue and Tacoma Dr end. Topography appears to have those two streets drain north to south.   A third street Birchwood Dr. flows north to south as well. The project is proposing to connect Birchwood Dr to Cottonwood Ave. so drainage will continue through. Patricia Lane along the northeast property line is fully developed with curb and gutter with block walls being along the easterly property line. The HGL line in the existing 96" storm drain pipe in Cottonwood Avenue according to the as-builts appears to be above the pipe itself but not protruding above the ground. The offsite flow before development naturally flows through the site to the two existing catch basins along Cottonwood Ave. The current HGL line shown in the as-builts take this flow into consideration already. The post mitigation development flow entering the existing storm drain line will be less than or equal to the current flow entering the system therefore, the HGL line will not change and no back water will occur.

IV. ONSITE HYDROLOGY

The project is proposed to use multiple biofiltration basins throughout the project, to mitigate added flows generated by the additional impervious surface. The project will use minimal inlets and storm drainpipes where needed to direct the flow to the basin. To calculate the flows that will be generated by the project site, CivilD software was used. The tables below summaries the calculations:

Pre-Development Calculations				Post-Development Calculations			
Drainage area	Area (ac)	Frequency	Q (cfs)	Drainage area	Area (ac)	Frequency	Q (cfs)
DA-1	9.32	2 yr	4.959	DA-1	2.10	2 yr	1.723
				DA-2	1.42	2 yr	1.152
				DA-3	4.81	2 yr	3.834
						TOTAL	6.708
				DA-4	0.51	2 yr	0.528
				DA-5	0.02	2 yr	0.021
						TOTAL	0.549
DA-1	9.32	10 yr	9.942	DA-1	2.10	10 yr	2.856
OS-1	4.12	10 yr	5.43	DA-2	1.42	10 yr	1.912
OS-2	3.99	10 yr	5.367	DA-3	4.81	10 yr	6.382
OS-3	4.07	10 yr	5.747			TOTAL	11.151
OS-4	5.76	10 yr	13.153	DA-4	0.51	10 yr	0.869
				DA-5	0.02	10 yr	0.034
						TOTAL	0.903
DA-1	9.32	100 yr	16.211	DA-1	2.10	100 yr	4.458
0S-1	4.12	100 yr	8.73	DA-2	1.42	100 yr	2.988
OS-2	3.99	100 yr	8.617	DA-3	4.81	100 yr	9.989
OS-3	4.07	100 yr	9.254			TOTAL	17.436
OS-4	0.27	100 yr	21.179	DA-4	0.51	100 yr	1.344
				DA-5	0.02	100 yr	0.053
						TOTAL	1.397

V. CONCLUSION

The project will increase the post Q amount. To mitigate the increase of flow coming from the project, multipe biofiltration basin with the capacity to store up to a volume of 9,795 c.f. During final engineering, CivilD Routing software will be used to determine if more volume will be required to match and reduce the maximum Q exiting the site. Per the attached geotechnical report, infiltration is not feasible for this project.

The project offsite from areas OS-1 and OS-2 will routed through the project site and into Sunnymead Line P in Cottonwood Avenue.

OS-3 and OS-4 will also go into Sunnymead Line P in the proposed new connection to Sunnymead Line P in Watson Way. The offsite flow will enter the proposed catch basins being proposed on Watson Way, into the proposed 24” storm drain line and then tie into the existing 96” storm drain line. The flows from the addition to Watson Way and the leasing building will drain towards the proposed catch basins on Watson Way. The existing offsite flow and flow from Watson Way would naturally drain to the existing catch basin along Cottonwood Avenue that leads into the existing 96" SD line. Therefore, the existing SD system already accounts for these flows and the HGL line will not change or be effected by the potential slight increase in flow from the areas now being developed.

APPENDIX

CIVILD Rational Method Calculations
- Pre-Development 2 yr
- Pre-Development 10 yr
- Pre-Development 100 yr
- Post Development 2 yr
- Post Development 10 yr
- Post Development 100 yr
- Offsite 10 yr
- Offsite 100 yr

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                Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
        Rational Hydrology Study        Date: 10/18/20  File:Cottonwood.out
------------------------------------------------------------------------
Cottonwood Residential Development
2 yr Pre Development




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 *********   Hydrology Study Control Information **********

 English (in-lb) Units used in input data file

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Program License Serial Number 6471

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Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) =    2.00 Antecedent Moisture Condition = 1

Standard intensity-duration curves data (Plate D-4.1)
For the [ Sunnymead-Moreno ] area used.
10 year storm 10 minute intensity =  2.010(In/Hr)
10 year storm 60 minute intensity =  0.820(In/Hr)
100 year storm 10 minute intensity =  2.940(In/Hr)
100 year storm 60 minute intensity =  1.200(In/Hr)

Storm event year =   2.0
Calculated rainfall intensity data:
1 hour intensity =  0.554(In/Hr)
Slope of intensity duration curve = 0.5000





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Process from Point/Station      101.000 to Point/Station      102.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   903.390(Ft.)
Top (of initial area) elevation =  1587.850(Ft.)
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Bottom (of initial area) elevation =  1581.000(Ft.)
Difference in elevation =     6.850(Ft.)
Slope =    0.00758  s(percent)=       0.76
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   21.412 min.
Rainfall intensity =      0.928(In/Hr) for a     2.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.573
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  71.60
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =      4.959(CFS)
Total initial stream area =       9.320(Ac.)
Pervious area fraction = 1.000
End of computations, total study area =            9.32 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged RI index number =  86.0
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                Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
        Rational Hydrology Study        Date: 10/18/20  File:Cottonwood.out
------------------------------------------------------------------------
Cottonwood Residential Development
10 yr Pre Development




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 *********   Hydrology Study Control Information **********

 English (in-lb) Units used in input data file

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Program License Serial Number 6471

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Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) =   10.00 Antecedent Moisture Condition = 2

Standard intensity-duration curves data (Plate D-4.1)
For the [ Sunnymead-Moreno ] area used.
10 year storm 10 minute intensity =  2.010(In/Hr)
10 year storm 60 minute intensity =  0.820(In/Hr)
100 year storm 10 minute intensity =  2.940(In/Hr)
100 year storm 60 minute intensity =  1.200(In/Hr)

Storm event year =  10.0
Calculated rainfall intensity data:
1 hour intensity =  0.820(In/Hr)
Slope of intensity duration curve = 0.5000





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Process from Point/Station      101.000 to Point/Station      102.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   903.390(Ft.)
Top (of initial area) elevation =  1587.850(Ft.)
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Bottom (of initial area) elevation =  1581.000(Ft.)
Difference in elevation =     6.850(Ft.)
Slope =    0.00758  s(percent)=       0.76
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   21.412 min.
Rainfall intensity =      1.373(In/Hr) for a    10.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.777
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  86.00
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =      9.942(CFS)
Total initial stream area =       9.320(Ac.)
Pervious area fraction = 1.000
End of computations, total study area =            9.32 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged RI index number =  86.0
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                Riverside County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
        Rational Hydrology Study        Date: 10/18/20  File:Cottonwood.out
------------------------------------------------------------------------
Cottonwood Residential Development
100 yr pre development




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 *********   Hydrology Study Control Information **********

 English (in-lb) Units used in input data file

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Program License Serial Number 6471

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Rational Method Hydrology Program based on
Riverside County Flood Control & Water Conservation District
1978 hydrology manual

Storm event (year) =  100.00 Antecedent Moisture Condition = 3

Standard intensity-duration curves data (Plate D-4.1)
For the [ Sunnymead-Moreno ] area used.
10 year storm 10 minute intensity =  2.010(In/Hr)
10 year storm 60 minute intensity =  0.820(In/Hr)
100 year storm 10 minute intensity =  2.940(In/Hr)
100 year storm 60 minute intensity =  1.200(In/Hr)

Storm event year = 100.0
Calculated rainfall intensity data:
1 hour intensity =  1.200(In/Hr)
Slope of intensity duration curve = 0.5000




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Process from Point/Station      101.000 to Point/Station      102.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   903.390(Ft.)
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Top (of initial area) elevation =  1587.850(Ft.)
Bottom (of initial area) elevation =  1581.000(Ft.)
Difference in elevation =     6.850(Ft.)
Slope =    0.00758  s(percent)=       0.76
TC = k(0.530)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   21.412 min.
Rainfall intensity =      2.009(In/Hr) for a   100.0 year storm
UNDEVELOPED (poor cover) subarea
Runoff Coefficient = 0.866
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  94.40
Pervious area fraction =  1.000; Impervious fraction =  0.000
Initial subarea runoff =     16.211(CFS)
Total initial stream area =       9.320(Ac.)
Pervious area fraction = 1.000
End of computations, total study area =            9.32 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 1.000
Area averaged RI index number =  86.0
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                        Riverside County Rational Hydrology Program

        CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
                Rational Hydrology Study        Date: 10/20/21
File:postcottonwood.out
        ------------------------------------------------------------------------
        Cottonwood Residential Development
        Post 2 yr



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         *********   Hydrology Study Control Information **********

         English (in-lb) Units used in input data file

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        Program License Serial Number 6481

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        Rational Method Hydrology Program based on
        Riverside County Flood Control & Water Conservation District
        1978 hydrology manual

        Storm event (year) =    2.00 Antecedent Moisture Condition = 1

        Standard intensity-duration curves data (Plate D-4.1)
        For the [ Sunnymead-Moreno ] area used.
        10 year storm 10 minute intensity =  2.010(In/Hr)
        10 year storm 60 minute intensity =  0.820(In/Hr)
        100 year storm 10 minute intensity =  2.940(In/Hr)
        100 year storm 60 minute intensity =  1.200(In/Hr)

        Storm event year =   2.0
        Calculated rainfall intensity data:
        1 hour intensity =  0.554(In/Hr)
        Slope of intensity duration curve = 0.5000




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        Process from Point/Station      201.000 to Point/Station      202.000
        **** INITIAL AREA EVALUATION ****
        ______________________________________________________________________
        Initial area flow distance =   852.420(Ft.)
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Top (of initial area) elevation =  1586.570(Ft.)
Bottom (of initial area) elevation =  1579.970(Ft.)
Difference in elevation =     6.600(Ft.)
Slope =    0.00774  s(percent)=       0.77
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.544 min.
Rainfall intensity =      1.126(In/Hr) for a     2.0 year storm
CONDOMINIUM subarea type
Runoff Coefficient = 0.729
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      1.723(CFS)
Total initial stream area =        2.100(Ac.)
Pervious area fraction = 0.350


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Process from Point/Station      202.000 to Point/Station      204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.970(Ft.)
Downstream point/station elevation =  1579.650(Ft.)
Pipe length  =    63.85(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.723(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     1.723(CFS)
Normal flow depth in pipe =    7.28(In.)
Flow top width inside pipe =   11.72(In.)
Critical Depth =    6.70(In.)
Pipe flow velocity =      3.46(Ft/s)
Travel time through pipe =    0.31 min.
Time of concentration (TC) =    14.85 min.


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Process from Point/Station      203.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.728
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.350; Impervious fraction =  0.650
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Time of concentration =    14.85 min.
Rainfall intensity =      1.114(In/Hr) for a     2.0 year storm
Subarea runoff =      1.152(CFS) for      1.420(Ac.)
Total runoff =      2.874(CFS)  Total area =       3.520(Ac.)


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Process from Point/Station      204.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.650(Ft.)
Downstream point/station elevation =  1579.100(Ft.)
Pipe length  =   110.89(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.874(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     2.874(CFS)
Normal flow depth in pipe =    8.65(In.)
Flow top width inside pipe =   14.82(In.)
Critical Depth =    8.17(In.)
Pipe flow velocity =      3.92(Ft/s)
Travel time through pipe =    0.47 min.
Time of concentration (TC) =    15.32 min.


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Process from Point/Station      205.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.727
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =    15.32 min.
Rainfall intensity =      1.097(In/Hr) for a     2.0 year storm
Subarea runoff =      3.834(CFS) for      4.810(Ac.)
Total runoff =      6.708(CFS)  Total area =       8.330(Ac.)


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Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.100(Ft.)
Downstream point/station elevation =  1578.460(Ft.)
Pipe length  =   127.55(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     6.708(CFS)
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Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     6.708(CFS)
Normal flow depth in pipe =   13.36(In.)
Flow top width inside pipe =   15.75(In.)
Critical Depth =   12.02(In.)
Pipe flow velocity =      4.77(Ft/s)
Travel time through pipe =    0.45 min.
Time of concentration (TC) =    15.77 min.


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Process from Point/Station      801.000 to Point/Station      802.000
**** INITIAL AREA EVALUATION ****
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Initial area flow distance =   983.320(Ft.)
Top (of initial area) elevation =  1600.000(Ft.)
Bottom (of initial area) elevation =  1588.120(Ft.)
Difference in elevation =    11.880(Ft.)
Slope =    0.01208  s(percent)=       1.21
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.850 min.
Rainfall intensity =      1.114(In/Hr) for a     2.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.654
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      3.258(CFS)
Total initial stream area =        4.470(Ac.)
Pervious area fraction = 0.500


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Process from Point/Station      802.000 to Point/Station      803.000
**** SUBAREA FLOW ADDITION ****
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SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.654
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.500; Impervious fraction =  0.500
Time of concentration =    14.85 min.
Rainfall intensity =      1.114(In/Hr) for a     2.0 year storm
Subarea runoff =      4.198(CFS) for      5.760(Ac.)
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Total runoff =      7.455(CFS)  Total area =      10.230(Ac.)


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Process from Point/Station      804.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =     10.230(Ac.)
Runoff from this stream =      7.455(CFS)
Time of concentration =   14.85 min.
Rainfall intensity =     1.114(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        7.455     14.85                1.114
Largest stream flow has longer time of concentration
Qp =      7.455 + sum of
Qp =      7.455

Total of 1 main streams to confluence:
Flow rates before confluence point:
       7.455
Area of streams before confluence:
       10.230


Results of confluence:
Total flow rate =      7.455(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.230(Ac.)


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Process from Point/Station      208.000 to Point/Station      209.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   246.410(Ft.)
Top (of initial area) elevation =  1584.590(Ft.)
Bottom (of initial area) elevation =  1583.280(Ft.)
Difference in elevation =     1.310(Ft.)
Slope =    0.00532  s(percent)=       0.53
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.544 min.
Rainfall intensity =      1.390(In/Hr) for a     2.0 year storm
CONDOMINIUM subarea type
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Runoff Coefficient = 0.745
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      0.528(CFS)
Total initial stream area =        0.510(Ac.)
Pervious area fraction = 0.350


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Process from Point/Station      210.000 to Point/Station      209.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.745
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 1)  =  49.80
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =     9.54 min.
Rainfall intensity =      1.390(In/Hr) for a     2.0 year storm
Subarea runoff =      0.021(CFS) for      0.020(Ac.)
Total runoff =      0.549(CFS)  Total area =       0.530(Ac.)


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Process from Point/Station      803.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      0.530(Ac.)
Runoff from this stream =      0.549(CFS)
Time of concentration =    9.54 min.
Rainfall intensity =     1.390(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        7.455     14.85                 1.114
2        0.549      9.54                 1.390
Largest stream flow has longer time of concentration
Qp =      7.455 + sum of
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          Qb         Ia/Ib
           0.549 *    0.802 =      0.440
Qp =      7.896

Total of 2 main streams to confluence:
Flow rates before confluence point:
       7.455       0.549
Area of streams before confluence:
       10.230       0.530


Results of confluence:
Total flow rate =      7.896(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.760(Ac.)


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Process from Point/Station      209.000 to Point/Station      211.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1578.260(Ft.)
Downstream point/station elevation =  1572.350(Ft.)
Pipe length  =   224.28(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     7.896(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     7.896(CFS)
Normal flow depth in pipe =    9.71(In.)
Flow top width inside pipe =   14.33(In.)
Critical Depth =   13.32(In.)
Pipe flow velocity =      9.38(Ft/s)
Travel time through pipe =    0.40 min.
Time of concentration (TC) =    15.25 min.
End of computations, total study area =           19.09 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.430
Area averaged RI index number =  69.0
```

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                        Riverside County Rational Hydrology Program

        CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
                Rational Hydrology Study        Date: 10/20/21
File:postcottonwood.out
        ------------------------------------------------------------------------
        Cottonwood Residential Development
        Post 10 yr



        ------------------------------------------------------------------------
         *********   Hydrology Study Control Information **********

         English (in-lb) Units used in input data file

        ------------------------------------------------------------------------


        Program License Serial Number 6481

        ------------------------------------------------------------------------
        Rational Method Hydrology Program based on
        Riverside County Flood Control & Water Conservation District
        1978 hydrology manual

        Storm event (year) =   10.00 Antecedent Moisture Condition = 2

        Standard intensity-duration curves data (Plate D-4.1)
        For the [ Sunnymead-Moreno ] area used.
        10 year storm 10 minute intensity =  2.010(In/Hr)
        10 year storm 60 minute intensity =  0.820(In/Hr)
        100 year storm 10 minute intensity =  2.940(In/Hr)
        100 year storm 60 minute intensity =  1.200(In/Hr)

        Storm event year =  10.0
        Calculated rainfall intensity data:
        1 hour intensity =  0.820(In/Hr)
        Slope of intensity duration curve = 0.5000




        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        Process from Point/Station      201.000 to Point/Station      202.000
        **** INITIAL AREA EVALUATION ****

        Initial area flow distance =   852.420(Ft.)
```

```
Top (of initial area) elevation =  1586.570(Ft.)
Bottom (of initial area) elevation =  1579.970(Ft.)
Difference in elevation =     6.600(Ft.)
Slope =    0.00774  s(percent)=       0.77
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.544 min.
Rainfall intensity =      1.666(In/Hr) for a    10.0 year storm
CONDOMINIUM subarea type
Runoff Coefficient = 0.817
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      2.856(CFS)
Total initial stream area =        2.100(Ac.)
Pervious area fraction = 0.350


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.970(Ft.)
Downstream point/station elevation =  1579.650(Ft.)
Pipe length  =    63.85(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.856(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     2.856(CFS)
Normal flow depth in pipe =    8.59(In.)
Flow top width inside pipe =   14.84(In.)
Critical Depth =    8.14(In.)
Pipe flow velocity =      3.93(Ft/s)
Travel time through pipe =    0.27 min.
Time of concentration (TC) =    14.81 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.816
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.350; Impervious fraction =  0.650
```

```
Time of concentration =    14.81 min.
Rainfall intensity =      1.650(In/Hr) for a    10.0 year storm
Subarea runoff =      1.912(CFS) for      1.420(Ac.)
Total runoff =      4.769(CFS)  Total area =       3.520(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.650(Ft.)
Downstream point/station elevation =  1579.100(Ft.)
Pipe length  =   110.89(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     4.769(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     4.769(CFS)
Normal flow depth in pipe =   10.51(In.)
Flow top width inside pipe =   17.74(In.)
Critical Depth =   10.07(In.)
Pipe flow velocity =      4.45(Ft/s)
Travel time through pipe =    0.42 min.
Time of concentration (TC) =    15.23 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.815
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =    15.23 min.
Rainfall intensity =      1.628(In/Hr) for a    10.0 year storm
Subarea runoff =      6.382(CFS) for      4.810(Ac.)
Total runoff =     11.151(CFS)  Total area =       8.330(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.100(Ft.)
Downstream point/station elevation =  1578.460(Ft.)
Pipe length  =   127.55(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    11.151(CFS)
```

```
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    11.151(CFS)
Normal flow depth in pipe =   17.09(In.)
Flow top width inside pipe =   16.36(In.)
Critical Depth =   14.95(In.)
Pipe flow velocity =      5.32(Ft/s)
Travel time through pipe =    0.40 min.
Time of concentration (TC) =    15.63 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      801.000 to Point/Station      802.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   983.320(Ft.)
Top (of initial area) elevation =  1600.000(Ft.)
Bottom (of initial area) elevation =  1588.120(Ft.)
Difference in elevation =    11.880(Ft.)
Slope =    0.01208  s(percent)=       1.21
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.850 min.
Rainfall intensity =      1.648(In/Hr) for a    10.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.780
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      5.747(CFS)
Total initial stream area =       4.470(Ac.)
Pervious area fraction = 0.500


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      802.000 to Point/Station      803.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.780
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Time of concentration =    14.85 min.
Rainfall intensity =      1.648(In/Hr) for a    10.0 year storm
Subarea runoff =      7.406(CFS) for      5.760(Ac.)
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```
Total runoff =     13.153(CFS)  Total area =      10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      804.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =     10.230(Ac.)
Runoff from this stream =     13.153(CFS)
Time of concentration =   14.85 min.
Rainfall intensity =     1.648(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       13.153     14.85                1.648
Largest stream flow has longer time of concentration
Qp =     13.153 + sum of
Qp =     13.153

Total of 1 main streams to confluence:
Flow rates before confluence point:
      13.153
Area of streams before confluence:
       10.230


Results of confluence:
Total flow rate =     13.153(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      209.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   246.410(Ft.)
Top (of initial area) elevation =  1584.590(Ft.)
Bottom (of initial area) elevation =  1583.280(Ft.)
Difference in elevation =     1.310(Ft.)
Slope =    0.00532  s(percent)=       0.53
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.544 min.
Rainfall intensity =      2.056(In/Hr) for a    10.0 year storm
CONDOMINIUM subarea type
```

```
Runoff Coefficient = 0.829
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      0.869(CFS)
Total initial stream area =        0.510(Ac.)
Pervious area fraction = 0.350


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      210.000 to Point/Station      209.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.829
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =     9.54 min.
Rainfall intensity =      2.056(In/Hr) for a    10.0 year storm
Subarea runoff =      0.034(CFS) for      0.020(Ac.)
Total runoff =      0.903(CFS)  Total area =       0.530(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      803.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      0.530(Ac.)
Runoff from this stream =      0.903(CFS)
Time of concentration =    9.54 min.
Rainfall intensity =     2.056(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       13.153     14.85                 1.648
2        0.903      9.54                 2.056
Largest stream flow has longer time of concentration
Qp =     13.153 + sum of
```

```
          Qb         Ia/Ib
           0.903 *    0.802 =      0.724
Qp =     13.877

Total of 2 main streams to confluence:
Flow rates before confluence point:
      13.153       0.903
Area of streams before confluence:
       10.230        0.530


Results of confluence:
Total flow rate =     13.877(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.760(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      209.000 to Point/Station      211.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1578.260(Ft.)
Downstream point/station elevation =  1572.350(Ft.)
Pipe length  =   224.28(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    13.877(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =    13.877(CFS)
Normal flow depth in pipe =   12.33(In.)
Flow top width inside pipe =   16.72(In.)
Critical Depth =   16.52(In.)
Pipe flow velocity =     10.75(Ft/s)
Travel time through pipe =    0.35 min.
Time of concentration (TC) =    15.20 min.
End of computations, total study area =          19.09 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.430
Area averaged RI index number =  69.0
```

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                        Riverside County Rational Hydrology Program

        CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
                Rational Hydrology Study        Date: 10/20/21
File:postcottonwood.out
        ------------------------------------------------------------------------
        Cottonwood Residential Development
        Post 100 yr



        ------------------------------------------------------------------------
         *********   Hydrology Study Control Information **********

         English (in-lb) Units used in input data file

        ------------------------------------------------------------------------


        Program License Serial Number 6481

        ------------------------------------------------------------------------
        Rational Method Hydrology Program based on
        Riverside County Flood Control & Water Conservation District
        1978 hydrology manual

        Storm event (year) =  100.00 Antecedent Moisture Condition = 3

        Standard intensity-duration curves data (Plate D-4.1)
        For the [ Sunnymead-Moreno ] area used.
        10 year storm 10 minute intensity =  2.010(In/Hr)
        10 year storm 60 minute intensity =  0.820(In/Hr)
        100 year storm 10 minute intensity =  2.940(In/Hr)
        100 year storm 60 minute intensity =  1.200(In/Hr)

        Storm event year = 100.0
        Calculated rainfall intensity data:
        1 hour intensity =  1.200(In/Hr)
        Slope of intensity duration curve = 0.5000





        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        Process from Point/Station      201.000 to Point/Station      202.000
        **** INITIAL AREA EVALUATION ****
        ______________________________________________________________________
        Initial area flow distance =   852.420(Ft.)
```

```
Top (of initial area) elevation =  1586.570(Ft.)
Bottom (of initial area) elevation =  1579.970(Ft.)
Difference in elevation =     6.600(Ft.)
Slope =    0.00774  s(percent)=       0.77
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.544 min.
Rainfall intensity =      2.437(In/Hr) for a   100.0 year storm
CONDOMINIUM subarea type
Runoff Coefficient = 0.871
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      4.458(CFS)
Total initial stream area =        2.100(Ac.)
Pervious area fraction = 0.350


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1579.970(Ft.)
Downstream point/station elevation =  1579.650(Ft.)
Pipe length  =    63.85(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     4.458(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     4.458(CFS)
Normal flow depth in pipe =   11.98(In.)
Flow top width inside pipe =   12.04(In.)
Critical Depth =   10.27(In.)
Pipe flow velocity =      4.25(Ft/s)
Travel time through pipe =    0.25 min.
Time of concentration (TC) =    14.79 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.871
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.350; Impervious fraction =  0.650
```

```
Time of concentration =    14.79 min.
Rainfall intensity =      2.417(In/Hr) for a   100.0 year storm
Subarea runoff =      2.988(CFS) for      1.420(Ac.)
Total runoff =      7.447(CFS)  Total area =      3.520(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =  1579.650(Ft.)
Downstream point/station elevation =  1579.100(Ft.)
Pipe length  =   110.89(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     7.447(CFS)
Nearest computed pipe diameter  =     18.00(In.)
Calculated individual pipe flow  =     7.447(CFS)
Normal flow depth in pipe =   14.86(In.)
Flow top width inside pipe =   13.66(In.)
Critical Depth =   12.68(In.)
Pipe flow velocity =      4.77(Ft/s)
Travel time through pipe =    0.39 min.
Time of concentration (TC) =    15.18 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****

CONDOMINIUM subarea type
Runoff Coefficient = 0.871
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =    15.18 min.
Rainfall intensity =      2.386(In/Hr) for a   100.0 year storm
Subarea runoff =      9.989(CFS) for      4.810(Ac.)
Total runoff =     17.436(CFS)  Total area =      8.330(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =  1579.100(Ft.)
Downstream point/station elevation =  1578.460(Ft.)
Pipe length  =   127.55(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    17.436(CFS)
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```
Nearest computed pipe diameter  =     27.00(In.)
Calculated individual pipe flow  =    17.436(CFS)
Normal flow depth in pipe =   18.19(In.)
Flow top width inside pipe =   25.32(In.)
Critical Depth =   17.49(In.)
Pipe flow velocity =      6.12(Ft/s)
Travel time through pipe =    0.35 min.
Time of concentration (TC) =    15.53 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      801.000 to Point/Station      802.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   983.320(Ft.)
Top (of initial area) elevation =  1600.000(Ft.)
Bottom (of initial area) elevation =  1588.120(Ft.)
Difference in elevation =    11.880(Ft.)
Slope =    0.01208  s(percent)=       1.21
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.850 min.
Rainfall intensity =      2.412(In/Hr) for a   100.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.858
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      9.254(CFS)
Total initial stream area =        4.470(Ac.)
Pervious area fraction = 0.500


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      802.000 to Point/Station      803.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.858
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Time of concentration =    14.85 min.
Rainfall intensity =      2.412(In/Hr) for a   100.0 year storm
Subarea runoff =     11.925(CFS) for      5.760(Ac.)
```

```
Total runoff =     21.179(CFS)  Total area =      10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      804.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****

The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =     10.230(Ac.)
Runoff from this stream =     21.179(CFS)
Time of concentration =   14.85 min.
Rainfall intensity =     2.412(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       21.179     14.85                 2.412
Largest stream flow has longer time of concentration
Qp =     21.179 + sum of
Qp =     21.179

Total of 1 main streams to confluence:
Flow rates before confluence point:
      21.179
Area of streams before confluence:
       10.230


Results of confluence:
Total flow rate =     21.179(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      209.000
**** INITIAL AREA EVALUATION ****

Initial area flow distance =   246.410(Ft.)
Top (of initial area) elevation =  1584.590(Ft.)
Bottom (of initial area) elevation =  1583.280(Ft.)
Difference in elevation =     1.310(Ft.)
Slope =    0.00532  s(percent)=       0.53
TC = k(0.370)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =    9.544 min.
Rainfall intensity =      3.009(In/Hr) for a   100.0 year storm
CONDOMINIUM subarea type
```

```
Runoff Coefficient = 0.876
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.350; Impervious fraction =  0.650
Initial subarea runoff =      1.344(CFS)
Total initial stream area =        0.510(Ac.)
Pervious area fraction = 0.350


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      210.000 to Point/Station      209.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
CONDOMINIUM subarea type
Runoff Coefficient = 0.876
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.350; Impervious fraction =  0.650
Time of concentration =     9.54 min.
Rainfall intensity =      3.009(In/Hr) for a   100.0 year storm
Subarea runoff =      0.053(CFS) for      0.020(Ac.)
Total runoff =      1.397(CFS)  Total area =       0.530(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      803.000 to Point/Station      209.000
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area =      0.530(Ac.)
Runoff from this stream =      1.397(CFS)
Time of concentration =    9.54 min.
Rainfall intensity =     3.009(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1       21.179     14.85                 2.412
2        1.397      9.54                 3.009
Largest stream flow has longer time of concentration
Qp =     21.179 + sum of
```

```
          Qb         Ia/Ib
           1.397 *    0.802 =      1.120
Qp =     22.299

Total of 2 main streams to confluence:
Flow rates before confluence point:
      21.179       1.397
Area of streams before confluence:
       10.230       0.530


Results of confluence:
Total flow rate =     22.299(CFS)
Time of concentration =    14.850 min.
Effective stream area after confluence  =     10.760(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      209.000 to Point/Station      211.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =  1578.260(Ft.)
Downstream point/station elevation =  1572.350(Ft.)
Pipe length  =   224.28(Ft.)   Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =    22.299(CFS)
Nearest computed pipe diameter  =     21.00(In.)
Calculated individual pipe flow  =    22.299(CFS)
Normal flow depth in pipe =   15.09(In.)
Flow top width inside pipe =   18.88(In.)
Critical Depth =   19.73(In.)
Pipe flow velocity =     12.04(Ft/s)
Travel time through pipe =    0.31 min.
Time of concentration (TC) =    15.16 min.
End of computations, total study area =           19.09 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.430
Area averaged RI index number =  69.0
```

```
                        Riverside County Rational Hydrology Program

        CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
                Rational Hydrology Study        Date: 10/18/20
File:CottonwoodOffsite.out
        -------------------------------------------------------------------------
        Cottonwood Residential Development
        Offsite 10 yr



        -------------------------------------------------------------------------
         *********   Hydrology Study Control Information **********

         English (in-lb) Units used in input data file

        -------------------------------------------------------------------------


        Program License Serial Number 6471

        -------------------------------------------------------------------------
        Rational Method Hydrology Program based on
        Riverside County Flood Control & Water Conservation District
        1978 hydrology manual

        Storm event (year) =   10.00 Antecedent Moisture Condition = 2

        Standard intensity-duration curves data (Plate D-4.1)
        For the [ Sunnymead-Moreno ] area used.
        10 year storm 10 minute intensity =  2.010(In/Hr)
        10 year storm 60 minute intensity =  0.820(In/Hr)
        100 year storm 10 minute intensity =  2.940(In/Hr)
        100 year storm 60 minute intensity =  1.200(In/Hr)

        Storm event year =  10.0
        Calculated rainfall intensity data:
        1 hour intensity =  0.820(In/Hr)
        Slope of intensity duration curve = 0.5000




        +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        Process from Point/Station      801.000 to Point/Station      802.000
        **** INITIAL AREA EVALUATION ****
        _______________________________________________________________________
        Initial area flow distance =   983.320(Ft.)
```

```
Top (of initial area) elevation =  1600.000(Ft.)
Bottom (of initial area) elevation =  1588.120(Ft.)
Difference in elevation =    11.880(Ft.)
Slope =    0.01208  s(percent)=       1.21
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.850 min.
Rainfall intensity =      1.648(In/Hr) for a    10.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.780
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      5.747(CFS)
Total initial stream area =        4.470(Ac.)
Pervious area fraction = 0.500


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      802.000 to Point/Station      803.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.780
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Time of concentration =    14.85 min.
Rainfall intensity =      1.648(In/Hr) for a    10.0 year storm
Subarea runoff =      7.406(CFS) for      5.760(Ac.)
Total runoff =     13.153(CFS)  Total area =      10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      804.000 to Point/Station      805.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   882.790(Ft.)
Top (of initial area) elevation =  1598.000(Ft.)
Bottom (of initial area) elevation =  1587.260(Ft.)
Difference in elevation =    10.740(Ft.)
Slope =    0.01217  s(percent)=       1.22
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.203 min.
Rainfall intensity =      1.685(In/Hr) for a    10.0 year storm
```

```
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.782
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      5.430(CFS)
Total initial stream area =        4.120(Ac.)
Pervious area fraction = 0.500


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      806.000 to Point/Station      807.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   885.190(Ft.)
Top (of initial area) elevation =  1599.000(Ft.)
Bottom (of initial area) elevation =  1586.000(Ft.)
Difference in elevation =    13.000(Ft.)
Slope =    0.01469  s(percent)=       1.47
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   13.693 min.
Rainfall intensity =      1.716(In/Hr) for a    10.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.784
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 2)  =  69.00
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      5.367(CFS)
Total initial stream area =        3.990(Ac.)
Pervious area fraction = 0.500
End of computations, total study area =           18.34 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.500
Area averaged RI index number =  69.0
```

```
                        Riverside County Rational Hydrology Program

        CIVILCADD/CIVILDESIGN Engineering Software,(c) 1989 - 2018 Version 9.0
                Rational Hydrology Study        Date: 10/18/20
File:CottonwoodOffsite.out
        ------------------------------------------------------------------------
        Cottonwood Residential Development
        Offsite 100 yr



        ------------------------------------------------------------------------
         *********   Hydrology Study Control Information **********

         English (in-lb) Units used in input data file

        ------------------------------------------------------------------------


        Program License Serial Number 6471

        ------------------------------------------------------------------------
        Rational Method Hydrology Program based on
        Riverside County Flood Control & Water Conservation District
        1978 hydrology manual

        Storm event (year) =  100.00 Antecedent Moisture Condition = 3

        Standard intensity-duration curves data (Plate D-4.1)
        For the [ Sunnymead-Moreno ] area used.
        10 year storm 10 minute intensity =  2.010(In/Hr)
        10 year storm 60 minute intensity =  0.820(In/Hr)
        100 year storm 10 minute intensity =  2.940(In/Hr)
        100 year storm 60 minute intensity =  1.200(In/Hr)

        Storm event year = 100.0
        Calculated rainfall intensity data:
        1 hour intensity =  1.200(In/Hr)
        Slope of intensity duration curve = 0.5000




        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
        Process from Point/Station      801.000 to Point/Station      802.000
        **** INITIAL AREA EVALUATION ****
        ______________________________________________________________________
        Initial area flow distance =   983.320(Ft.)
```

```
Top (of initial area) elevation =  1600.000(Ft.)
Bottom (of initial area) elevation =  1588.120(Ft.)
Difference in elevation =    11.880(Ft.)
Slope =    0.01208  s(percent)=       1.21
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.850 min.
Rainfall intensity =      2.412(In/Hr) for a   100.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.858
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      9.254(CFS)
Total initial stream area =       4.470(Ac.)
Pervious area fraction = 0.500


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      802.000 to Point/Station      803.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.858
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Time of concentration =    14.85 min.
Rainfall intensity =      2.412(In/Hr) for a   100.0 year storm
Subarea runoff =     11.925(CFS) for      5.760(Ac.)
Total runoff =     21.179(CFS)  Total area =      10.230(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      804.000 to Point/Station      805.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Initial area flow distance =   882.790(Ft.)
Top (of initial area) elevation =  1598.000(Ft.)
Bottom (of initial area) elevation =  1587.260(Ft.)
Difference in elevation =    10.740(Ft.)
Slope =    0.01217  s(percent)=       1.22
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.203 min.
Rainfall intensity =      2.466(In/Hr) for a   100.0 year storm
```

```
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.859
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      8.730(CFS)
Total initial stream area =        4.120(Ac.)
Pervious area fraction = 0.500

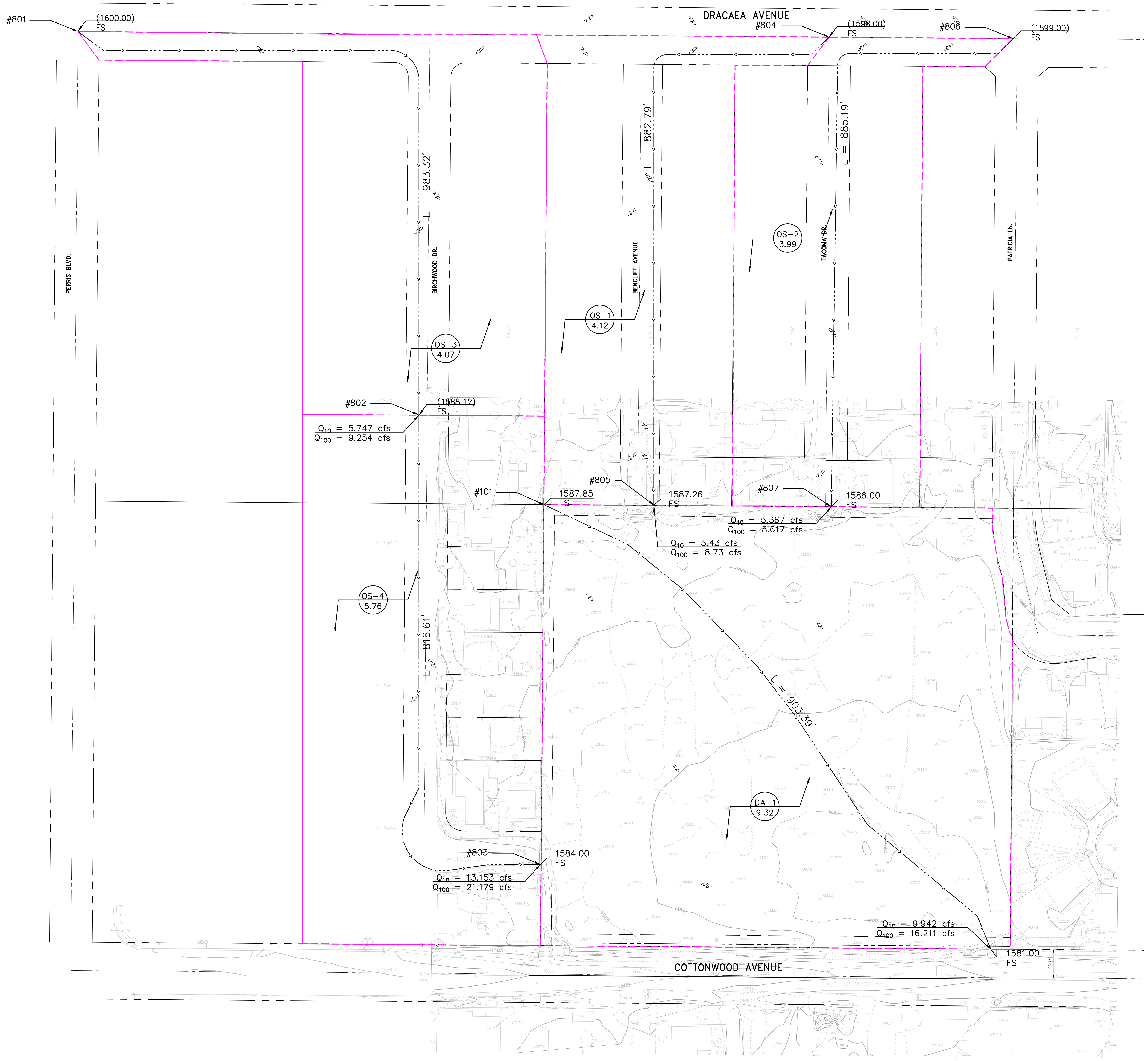

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      806.000 to Point/Station      807.000
**** INITIAL AREA EVALUATION ****

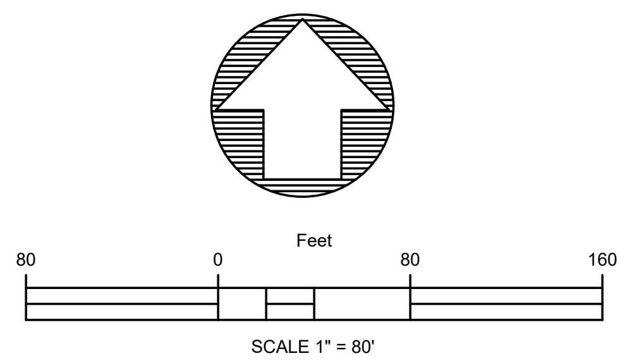
Initial area flow distance =   885.190(Ft.)
Top (of initial area) elevation =  1599.000(Ft.)
Bottom (of initial area) elevation =  1586.000(Ft.)
Difference in elevation =    13.000(Ft.)
Slope =    0.01469  s(percent)=       1.47
TC = k(0.390)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   13.693 min.
Rainfall intensity =      2.512(In/Hr) for a   100.0 year storm
SINGLE FAMILY (1/4 Acre Lot)
Runoff Coefficient = 0.860
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
RI index for soil(AMC 3)  =  84.40
Pervious area fraction =  0.500; Impervious fraction =  0.500
Initial subarea runoff =      8.617(CFS)
Total initial stream area =        3.990(Ac.)
Pervious area fraction = 0.500
End of computations, total study area =           18.34 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.

Area averaged pervious area fraction(Ap) = 0.500
Area averaged RI index number =  69.0
```

HYDROLOGY MAP

Pre-Development Exhibit
Post Development Exhibit





NO WORK SHALL BE DONE ON THIS SITE UNTIL BELOW AGENCY IS NOTIFIED OF INTENTION TO GRADE OR EXCAVATE.

DIGALERT

CALL
811 or
1-800-422-4133
2 Working Days Before You Dig
WWW.CALL811.COM

DATE OF PREPARATION MARCH 11, 2021
PEN21-0147

ANGEL CESAR
No. 87222

BLUE Engineering & Consulting, Inc

UNDER THE SUPERVISION OF:

ANGEL CESAR
RCE 87222

DATE

CITY OF MORENO VALLEY

PRE DEVELOPMENT EXHIBIT

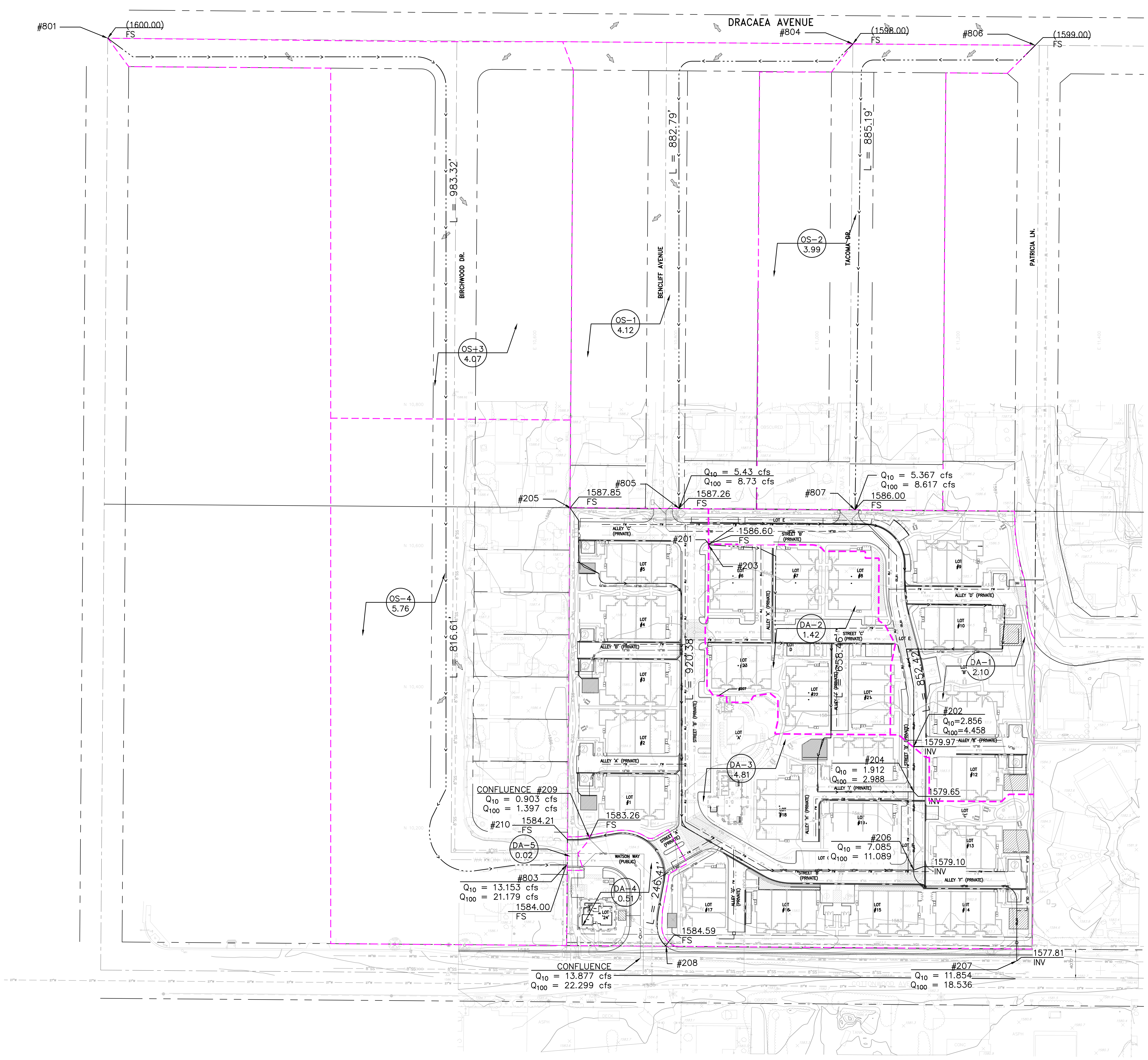
COTTONWOOD VILLAGE
TTM 34544

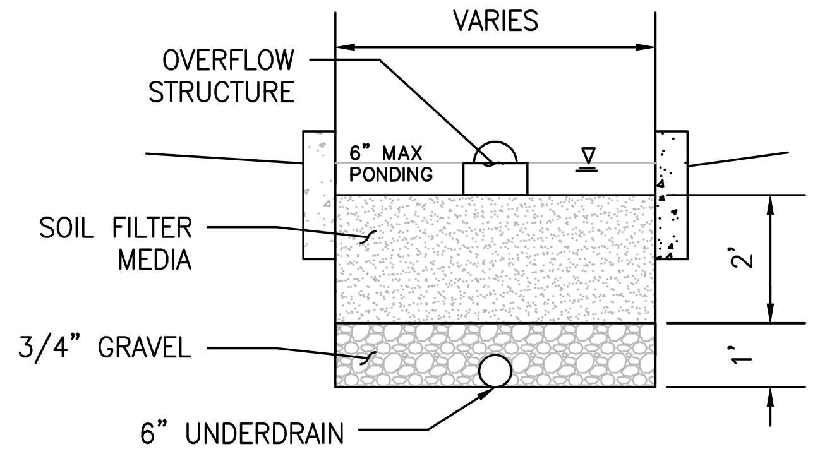
APN. 479-140-022

DATE PREPARED MARCH 11, 2021

SHEET 7 OF 10

CITY ID No





BIOFILTRATION BASIN DETAIL (TYP)
SCALE 1" = 3'

LEGEND

- ▬ ▪ ▬ DRAINAGE AREA
- SEWER MAIN
- DOMESTIC WATER
- 18"SD STORM DRAIN
- CENTERLINE
- FLOW LINE
- ○ MANHOLE
- DIRECTIONAL FLOW ARROW
- ▨ BIOFILTRATION TRENCH

NO WORK SHALL BE DONE ON THIS SITE UNTIL BELOW AGENCY IS NOTIFIED OF INTENTION TO GRADE OR EXCAVATE.

DIGALERT

CALL
811 or
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2 Working Days Before You Dig
WWW.CALL811.COM

DATE OF PREPARATION MARCH 11, 2021
PEN21-0147

No. 87222

BLUE Engineering & Consulting, Inc

UNDER THE SUPERVISION OF:

ANGEL CESAR
RCE 87222

DATE

CITY OF MORENO VALLEY

POST DEVELOPMENT EXHIBIT
COTTONWOOD VILLAGE
TTM 34544

APN. 479-140-022

DATE PREPARED MARCH 11, 2021

SHEET 8 OF 10

CITY ID No

GEOTECHNICAL EVALUATION

FOR

PROPOSED SINGLE- FAMILY RESIDENTIAL DEVELOPMENT
APN 479-140-022
CITY OF MORENO VALLEY, RIVERSIDE COUNTY, CALIFORNIA

PREPARED FOR

FRONTIER ENTERPRISES
8300 UTICA AVENUE, SUITE 300
RANCHO CUCAMONGA, CALIFORNIA 91730

PREPARED BY

GEOTEK, INC.
710 EAST PARKRIDGE AVENUE, SUITE 105
CORONA, CALIFORNIA 92879

PROJECT NO. 1165-CR3 APRIL 10, 2014

GEOTEK

GeoTek, Inc.
710 E. Parkridge Avenue, Suite 105, Corona, California 92879-1097
(951) 710-1160 Office (951) 710-1167 Fax www.geotekusa.com

April 10, 2014
Project No. 1165-CR3

Frontier Enterprises
8300 Utica Avenue, Suite 300
Rancho Cucamonga, California 91730

Attention: Mr. Daniel Pocius

Subject: Geotechnical Evaluation
Proposed Single-Family Residential Development
APN 479-140-022
City of Moreno Valley, Riverside County, California

Dear Mr. Pocius:

We are pleased to provide herein the results of our Geotechnical Evaluation for the subject project located in the City of Moreno Valley, Riverside County, California. This report presents the results of our evaluation and discussion of our findings. In our opinion, site development appears feasible from a geotechnical viewpoint. Site development and grading plans should be reviewed by this firm as they become available, as it will be necessary to provide appropriate recommendations for intended specific site development as those plans become refined.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
GeoTek, Inc.

EDWARD H. LaMONT
No. 1892
Exp.

EDMOND VARDEH
No. 56992
Exp.

Edward H. LaMont
CEG 1824, Exp. 07/31/14
Principal Geologist

Edmond Vardeh
RCE 56992, Exp. 06/30/15
Project Engineer

Distribution: (1) Addressee via email
G:\Projects\1151 to 1200\1165CR3 Frontier Enterprises Moreno Valley 79\Geo\1165CR3 Geotechnical Evaluation APN 479-140-022 Moreno Valley.doc

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ENCLOSURES

Figure 1 – Site Location Map
Figure 2 – General Site Topography Map
Figure 3 – Boring Location Map

Appendix A – Logs of Exploratory Borings
Appendix B – Results of Laboratory Testing
Appendix C – General Earthwork Grading Guidelines

1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to evaluate the general geotechnical conditions on the site. Services provided for this study included the following:

- Research and review of available geologic and geotechnical data, and general information pertinent to the site,
- Site exploration consisting of the excavation, logging and sampling of four (4) exploratory borings by a geologist from our firm,
- Laboratory testing of soil samples collected during the field investigation,
- Review and evaluation of site seismicity, and
- Compilation of this geotechnical report which presents our findings and a general summary of pertinent site geotechnical conditions relevant for site development.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The subject project site is located north of Cottonwood Avenue, west of Patricia Lane and south of the terminus of Tacoma Drive and Bencliff Drive in the City of Moreno Valley, Riverside County, California (see Figure 1). The square-shaped property is comprised of roughly 9.39 acres of vacant land. The property is bounded by existing residential development to the north and west, Cottonwood Avenue to the south and Patricia Lane and residential development to the east.

The site is relatively flat with total relief across the site on the order of roughly five (5) feet, with surface drainage generally directed toward the south. Topographically, the property ranges from approximately 1,588 to approximately 1,593 feet above mean sea level (msl). Figure 2, to the rear of the text of this report, shows historic topographic contours of the site and site area.

2.2 PROPOSED DEVELOPMENT

It is our understanding that proposed development will consist of single-family residential structures and associated streets. For this evaluation it was assumed that the structures will be one (1)- to two (2)-story, wood-framed residences situated atop slab-on-ground foundations. As site development planning progresses and plans become available, the plans should be provided to GeoTek for review and comment.

3. FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

Field exploration was conducted on March 24, 2014 and consisted of excavating four (4) exploratory borings, one (1) to a maximum depth of approximately 50 feet. Approximate locations of the exploratory borings are shown on the Boring Location Map (see Figure 3). A geologist from our firm logged the excavations and collected samples for use in the laboratory testing. The logs of the exploratory borings are included in Appendix A.

3.2 LABORATORY TESTING

Laboratory testing was performed on selected soil samples collected during the field exploration. The purpose of the laboratory testing was to help confirm the field classification of the soil materials encountered and to evaluate their physical and chemical properties for use in the engineering design and analysis. Results of the laboratory testing program, along with a brief description and relevant information regarding testing procedures, are included in Appendix B.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and northeasterly adjacent the Transverse Ranges geomorphic province to the tip of Baja California. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zones trend northwest-southeast and are found in the near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, the site is located in an area geologically mapped to be underlain by Quaternary age alluvium (Dibblee, 2003). No faults are shown in the immediate site vicinity on the maps reviewed for the area.

4.2 GENERAL SOIL CONDITIONS

A brief description of the earth materials encountered during our subsurface exploration is presented in the following section. Based on our site reconnaissance, field observations, our exploratory excavations and review of published geologic maps the subject site area is locally underlain by alluvial deposits. Although not encountered during our subsurface exploration, localized accumulations of undocumented artificial fill materials may exist onsite.

4.2.1 Alluvium

Alluvial deposits were observed to underlie the project site at the explored locations. The alluvial deposits encountered generally consist of sand, silty sand and clayey sand, which is mostly gray brown to red brown, dry to slightly moist, and medium dense to dense (see logs in Appendix A).

Based on the results of the laboratory testing performed on a sample of the near surface onsite materials, these near surface alluvial materials indicated a "low" expansion potential ($21 \leq EI \leq 50$) when tested and classified in accordance with ASTM D 4829. It is likely that most of the onsite materials encountered during grading and construction will have a "very low" to "low" expansion potential. Test results are shown in Appendix B.

4.3 SURFACE WATER AND GROUNDWATER

4.3.1 Surface Water

Surface water was not observed during our site visit. If encountered during earthwork construction, surface water on this site is the result of precipitation or possibly some minor surface run-off from immediately surrounding properties. Overall site area drainage is generally in a southerly direction, as directed by site topography. Provisions for surface drainage will need to be accounted for by the project civil engineer.

4.3.2 Groundwater

Groundwater was encountered in one (1) of our exploratory excavations (Boring B-1) at a depth of approximately 31 feet below ground surface (bgs) (see logs in Appendix A). Perched groundwater or localized seepage can occur due to variations in rainfall, irrigation practices, and other factors not evident at the time of this investigation

4.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone or a Special Studies Zone (CGS, 1974; Bryant and Hart, 2007). No faults are identified on geologic maps readily available and reviewed by this firm for the immediate study area. The County of Riverside has designated the site as having a "low" potential for liquefaction, as being "susceptible" to subsidence and not within ½ mile of a Riverside County designated fault zone.

4.4.1 Seismic Design Parameters

The site is located at approximately 33.9255 Latitude and -117.2231 Longitude. Site spectral accelerations (S_s and S_1), for 0.2 and 1.0 second periods for a Class "D" site, were determined from the USGS Website, Earthquake Hazards Program, U.S. Seismic Design Maps for Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Response Accelerations for the Conterminous 48 States by Latitude/Longitude. The results are presented in the following table:

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_S	1.663g
Mapped 1.0 sec Period Spectral Acceleration, S_1	0.724g
Site Coefficient for Site Class "D", F_a	1.0
Site Coefficient for Site Class "D", F_v	1.5
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	1.663g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	1.087g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.109g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	0.724g

4.5 LIQUEFACTION/SEISMIC SETTLEMENT

Liquefaction describes a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in relatively cohesionless soils. These soils may thereby acquire a high degree of mobility, which can lead to lateral movement, sliding, consolidation and settlement of loose sediments, sand boils and other damaging deformations. This phenomenon occurs only below the water table, but, after liquefaction has developed, the effects can propagate upward into overlying non-saturated soil as excess pore water dissipates.

The factors known to influence liquefaction potential include soil type and grain size, relative density, groundwater level, confining pressures, and both intensity and duration of ground shaking. In general, materials that are susceptible to liquefaction are loose, saturated granular soils having low fines content under low confining pressures.

The liquefaction potential on this site is considered to be low due to the dense nature of the underlying materials and overall material types.

4.6 OTHER SEISMIC HAZARDS

Evidence of ancient landslides or slope instabilities at this site was not observed during our investigation as the topography of the site is relatively flat. Thus, the potential for landslides is considered negligible.

The potential for secondary seismic hazards such as seiche and tsunami are considered to be remote due to site elevation and distance from an open body of water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

Development of the site appears feasible from a geotechnical viewpoint. Specific recommendations for site development provided herein will need to be further evaluated when development plans are provided for our review.

5.2 EARTHWORK CONSIDERATIONS

5.2.1 General

Earthwork and grading should be performed in accordance with the applicable grading ordinances of City of Moreno Valley, the 2013 California Building Code (CBC), and recommendations contained in this report. The Grading Guidelines included in Appendix C outline general procedures and do not anticipate all site specific situations. In the event of conflict, the recommendations presented in the text of this report should supersede those contained in Appendix C.

5.2.2 Site Clearing and Preparation

Site preparation should start with demolition/razing of any existing improvements and removal of deleterious materials and vegetation. These materials should be properly disposed of offsite. Any existing underground improvements, utilities and trench backfill should also be removed or be further evaluated as part of site development operations.

5.2.3 Remedial Grading

Prior to placement of fill materials, the upper loose and compressible materials should be removed for structural site areas. Additionally, all undocumented artificial fill materials should be removed for structural site areas (if encountered). The lateral extent of removals beyond the outside edge of all settlement sensitive structures/foundations should minimally be equivalent to that vertically removed. Depending on actual field conditions encountered during grading, locally deeper and/or shallower areas of removal may be necessary.

Removal depths a minimum of four (4) feet across the site are recommended. At a minimum, removal bottoms in alluvial areas should extend down to relatively uniform material which is not visibly porous. Removal bottoms should also be tested to have a minimum in-place relative compaction of at least 85%.

At a minimum, any proposed cut lots and the cut portion(s) of any transition building pad areas should be overexcavated a minimum of three (3) feet below existing grades or a minimum of one (1) foot below the bottom of the deepest proposed footing, whichever is deeper, if not already mitigated by the removal recommendations provided above. Overexcavations should extend a minimum of five (5) feet outside the proposed building envelope(s), or at a 1:1 projection to a suitable removal bottom. The intent of the recommended overexcavation is to support the improvements on engineered fill with relatively uniform engineering characteristics and decrease the potential for future differential settlement.

The bottom of all removals should be scarified to a minimum depth of eight (8) inches, brought to at or above optimum moisture content, and then compacted to minimum project standards prior to fill placement. The remedial excavation bottoms of should be observed by a GeoTek representative prior to scarification. The resultant voids from remedial grading/overexcavation should be filled with materials placed in accordance with Section 5.2.4 Engineered Fill of this report.

5.2.4 Engineered Fill

Onsite materials are generally considered suitable for reuse as engineered fill provided they are free from vegetation, roots, and rock/concrete or hard lumps greater than six (6) inches in maximum dimension. The earthwork contractor should have the proposed excavated and stockpiled materials to be used as engineered fill at this project approved by the soils engineer prior to placement.

Engineered fill materials should be moisture conditioned to above optimum moisture content and compacted in horizontal lifts not exceeding eight (8) inches in loose thickness to a minimum relative compaction of 90% as determined in accordance with laboratory test procedure ASTM D 1557.

If fill is being placed on slopes steeper than 5:1 (h:v), the fill should be properly benched into the existing slopes and a sufficient size keyway shall be constructed in accordance with the recommendations of the soils engineer.

5.2.5 Excavatability and Oversized Materials

The alluvial materials should excavate easily using conventional heavy equipment in good working condition and modern earthmoving methods. Oversized materials (larger than six (6) inches in dimension) were not encountered during this investigation and are not anticipated to be encountered during rough grading. If encountered, placement of such materials may require special handing. No oversized rocks should be placed within the building footprint or street areas. Oversized materials may be placed in open space, landscape areas, if acceptable to the local agency. Alternatively, the rocks should be reduced in size, removed from the site, or handled as discussed in Appendix C.

Additional recommendations may be necessary based on exposed conditions during earthwork construction. General grading guidelines are included in Appendix C at the back of this report.

5.2.6 Shrinkage and Subsidence

Several factors will impact earthwork balancing on the site, including shrinkage, subsidence, trench spoil from utilities and footing excavations, as well as the accuracy of topography.

Shrinkage and subsidence are primarily dependent upon the degree of compactive effort achieved during construction, depth of fill and underlying site conditions. For planning purposes, a shrinkage factor of up to 5 to 10 percent may be considered for the materials requiring removal and recompaction. Subsidence on the order of approximately 0.1 foot may occur. Site balance areas should be available in order to adjust project grades, depending on actual field conditions at the conclusion of site earthwork construction.

5.2.7 Trench Excavations and Backfill

Temporary excavations within the onsite materials should be stable at 1:1 inclinations for short durations during construction, and where cuts do not exceed 10 feet in height. Temporary cuts to a maximum height of 4 feet can be excavated vertically.

Trench excavations should conform to Cal-OSHA regulations. The contractor should have a competent person, per OSHA requirements, on site during construction to observe conditions and to make the appropriate recommendations.

Utility trench backfill should be compacted to at least 90% relative compaction (as determined per ASTM D 1557). Under-slab trenches should also be compacted to project specifications. Where applicable, based on jurisdictional requirements, the top 12 inches of backfill below subgrade for road pavements should be compacted to at least 95 percent relative compaction. Onsite materials may not be suitable for use as bedding material, but should be suitable as backfill provided particles larger than 6± inches are removed.

Compaction should be achieved with a mechanical compaction device. Ponding or jetting of trench backfill is not recommended. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

5.3 DESIGN RECOMMENDATIONS

5.3.1 Foundation Design Criteria

Preliminary foundation design criteria, in general conformance with the 2013 CBC, are presented herein. These are typical design criteria and are not intended to supersede the design by the structural engineer.

Based on the results of our recent testing, the anticipated onsite soils near subgrade may be preliminary classified as having an expansion potential "low" ($21 \leq EI \leq 50$) in accordance with ASTM D 4829. Presented below are foundation design parameters for the proposed single-family residences.

Foundations should be designed in accordance with the *2013 California Building Code* (CBC).

Additional testing of the soils should be performed during construction to evaluate the as-graded conditions. Final foundation recommendations will be based on the as-graded soils conditions.

MINIMUM DESIGN REQUIREMENTS

DESIGN PARAMETER	0≤EI≤20	21≤EI≤50
Foundation Depth or Minimum Perimeter Beam Depth (inches below lowest adjacent grade)	One-Story Exterior Footing – 12” One-Story Interior Footing – 12” Two-Story Exterior Footing – 18” Two-Story Interior Footing – 18”	One-Story Exterior Footing – 12” One-Story Interior Footing – 12” Two-Story Exterior Footing – 18” Two-Story Interior Footing – 18”
Minimum Foundation Width	One-Story - 12” Two-Story – 15”	One-Story - 12” Two-Story – 15”
Minimum Slab Thickness (actual)	4”	4”
Minimum Slab Reinforcing	No. 3 rebar 24” on-center, placed in the middle 1/3 of the slab	No. 3 rebar 24” on-center, placed in the middle 1/3 of the slab
Minimum Footing Reinforcement	Two (2) No. 4 Reinforcing Bars-one (1) top and one (1) bottom	Two (2) No. 4 Reinforcing Bars-one (1) top and one (1) bottom
Effective Plasticity Index	N/A	10
Presaturation of Subgrade Soil (Percent of Optimum/Depth in Inches)	100% to a depth of 12 inches	110% to a depth of 12 inches

It should be noted that the above recommendations are based on soil support characteristics only. The structural engineer should design the slab and beam reinforcement based on actual loading conditions. If it is desired to utilize post-tensioned foundations, then those recommendations can be provided at the appropriate time.

5.3.1.1 An allowable bearing capacity of 1500 pounds per square foot (psf) may be used for design of continuous and perimeter footings 12 inches deep and 12 inches wide, and pad footings 24 inches square and 12 inches deep. This value may be increased by 200 pounds per square foot for each additional 12 inches in depth and 100 pounds per square foot for each additional 12 inches in width to a maximum value of 2000 psf. Additionally, an increase of one-third may be applied when considering short-term live loads (e.g. seismic and wind loads).

5.3.1.2 Based on our experience in the area, foundations may experience a total settlement of approximately one (1) inch as a result of structural loading. Differential settlement of up to one-half of the total settlement over a horizontal distance of 40 feet could result from structural loading. The foundation engineer should incorporate these settlement estimates from the structural loads into the design of the slab, as appropriate.

5.3.1.3 The passive earth pressure may be computed as an equivalent fluid having a density of 150 psf per foot of depth, to a maximum earth pressure of 2,000 psf for footings founded on engineered fill. A coefficient of friction between soil and concrete of 0.30 may be used with dead load forces. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

5.3.1.4 A grade beam, a minimum of 12 inches wide and 12 inches deep, should be utilized across large entrances. The base of the grade beam should be at the same elevation as the bottom of the adjoining footings.

5.3.1.5 A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these are provided in the 2013 California Green Building Standards Code (CALGreen) Section 4.505.2 and the 2013 CBC Section 1907.1 It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as a result of construction related punctures (e.g. stake penetrations, tears, punctures from walking on the aggregate layer, etc.). These occurrences should be limited as much as possible during construction.

Thicker membranes are generally more resistant to accidental puncture that thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. Although the CBC specifies a 6 mil vapor retarder membrane, it is GeoTek's opinion that a minimum 10 mil membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional.

Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and environmental conditions. Ultimately, the vapor retarding system should be comprised of suitable elements to limit migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e. thickness, composition, strength and permeance) to achieve the desired performance level. Consideration should be given to consulting with an individual possessing specific expertise in this area for additional evaluation.

5.3.1.6 We recommend that control joints be placed in two directions spaced approximately 24 to 36 times the thickness of the slab in inches. These joints are a widely accepted means to control cracks and should be reviewed by the project structural engineer.

5.3.2 Miscellaneous Foundation Recommendations

5.3.2.1 To minimize moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.

5.3.2.2 Isolated exterior footings should be tied back to the main foundation system in two orthogonal directions.

5.3.2.3 Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.

5.3.2.4 Unsuitable soil removals along the property lines will likely be restricted due to adjacent improvements. Special considerations will be required for foundation elements in these areas. Such considerations may include deepening of foundations, reduced bearing capacity, or other measures. This issue should be further evaluated once site plans become available.

5.3.3 Foundation Set Backs

Where applicable, the following setbacks should apply to all foundations. Any improvements not conforming to these setbacks may be subject to lateral movements and/or differential settlements:

- The outside bottom edge of all footings should be set back a minimum of H/3 (where H is the slope height) from the face of any descending slope. The setback should be at least 7 feet and need not exceed 40 feet.
- The bottom of all footings for structures near retaining walls should be deepened so as to extend below a 1:1 projection upward from the bottom inside edge of the wall stem. This applies to the existing retaining walls along the perimeter, if they are to remain.
- The bottom of any existing foundations for structures should be deepened so as to extend below a 1:1 projection upward from the bottom of the nearest excavation.

5.3.4 Soil Corrosivity

The soil resistivity at this site was tested in the laboratory on a sample collected during the field investigation. The results of the testing indicate that the onsite soils are considered "moderately corrosive" to buried metal in accordance with current standards used by corrosion engineers. These characteristics are considered typical of soils commonly found in southern California. We recommend that a corrosion engineer be consulted to provide recommendations for protection of buried metal at this site.

5.3.5 Soil Sulfate Content

The sulfate content was determined in the laboratory for onsite soil sample. The results indicate that the water soluble sulfate range is less than 0.1 percent by weight, which is considered "not applicable" (negligible) as per Table 4.2.1 of ACI 318.

5.4 RETAINING WALL DESIGN AND CONSTRUCTION

5.4.1 General Design Criteria

Recommendations presented herein may apply to typical masonry or concrete vertical retaining walls to a maximum height of 10 feet. Additional review and recommendations should be requested for higher walls.

Retaining wall foundations embedded a minimum of 18 inches into engineered fill or dense formational materials should be designed using an allowable bearing capacity of 1500 psf. An increase of one-third may be applied when considering short-term live loads (e.g. seismic and wind loads). The passive earth pressure may be computed as an equivalent fluid having a density of 200 psf per foot of depth, to a maximum earth pressure of 2,000 psf. A coefficient of friction between soil and concrete of 0.25 may be used with dead load forces. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

An equivalent fluid pressure approach may be used to compute the horizontal active pressure against the wall. The appropriate fluid unit weights are given in the table below for specific slope gradients of retained materials.

Surface Slope of Retained Materials (H:V)	Equivalent Fluid Pressure (PCF) Select Backfill*
Level	35
2:1	55

*Select backfill should consist of imported sand other approved materials with an SE>30 and an EI≤20.

The above equivalent fluid weights do not include other superimposed loading conditions such as expansive soil, vehicular traffic, structures, seismic conditions or adverse geologic conditions.

Additional lateral forces can be induced on retaining walls during an earthquake. For level backfill and a Site Class "D", the minimum earthquake-induced force (F_{eq}) should be $20H^2$ (lbs/linear foot of wall) for cantilever walls. This force can be assumed to act at a distance of 0.6H above the base of the wall, where "H" is the height of the retaining wall measured from the base of the footing (in feet).

5.4.2 Wall Backfill and Drainage

Wall backfill should include a minimum one (1) foot wide section of ¾ to 1-inch clean crushed rock (or approved equivalent). The rock should be placed immediately adjacent to the back of wall and extend up from the backdrain to within approximately 12 inches of finish grade. The upper 12 inches should consist of compacted onsite materials. If the walls are designed using the "select" backfill design parameters, then the "select" materials shall be placed within the active zone as defined by a 1:1 (H:V) projection from the back of the retaining wall footing up to the retained surface behind the wall. Presence of other materials might necessitate revision to the parameters provided and modification of wall designs.

The backfill materials should be placed in lifts no greater than eight (8) inches in thickness and compacted at 90% relative compaction in accordance with ASTM Test Method D 1557. Proper surface drainage needs to be provided and maintained. Water should not be allowed to pond behind retaining walls. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

Retaining walls should be provided with an adequate pipe and gravel back drain system to reduce the potential for hydrostatic pressures to develop. A 4-inch diameter perforated collector pipe (Schedule 40 PVC, or approved equivalent) in a minimum of one cubic foot per lineal foot of 3/8 to one inch clean crushed rock or equivalent, wrapped in filter fabric should be placed near the bottom of the backfill and be directed (via a solid outlet pipe) to an appropriate disposal area. Maximum horizontal spacing between drain outlets should be 100 feet.

Walls from two (2) to four (4) feet in height may be drained using localized gravel packs behind weep holes at 10 feet maximum spacing (e.g. approximately 1.5 cubic feet of gravel in a woven plastic bag). Weep holes should be provided or the head joints omitted in the first course of block extended above the ground surface. However, nuisance water may still collect in front of the wall.

Drain outlets should be maintained over the life of the project and should not be obstructed or plugged by adjacent improvements.

5.4.3 Restrained Retaining Walls

Any retaining wall that will be restrained prior to placing backfill or walls that have male or reentrant corners should be designed for at-rest soil conditions using an equivalent fluid pressure of 60 pcf (select backfill), plus any applicable surcharge loading. For areas having male or reentrant corners, the restrained wall design should extend a minimum distance equal to twice the height of the wall laterally from the corner, or as otherwise determined by the structural engineer.

5.5 CONCRETE CONSTRUCTION

5.5.1 General

Concrete construction should follow the 2013 CBC and ACI guidelines regarding design, mix placement and curing of the concrete. If desired, we could provide quality control testing of the concrete during construction.

5.5.2 Concrete Mix Design

As indicated in Section 5.3.5, no special concrete mix design is required by Code to resist sulfate attack based on the existing test results. However, additional testing should be performed during grading so that specific recommendations can be formulated based on the as-graded conditions.

5.5.3 Concrete Flatwork

Exterior concrete flatwork (patios, walkways, driveways, etc.) is often some of the most visible aspects of site development. They are typically given the least level of quality control, being considered “non-structural” components. Cracking of these features is fairly common due to various factors. While cracking is not usually detrimental, it is unsightly. We suggest that the same standards of care be applied to these features as to the structure itself.

Flatwork may consist of 4 inch thick concrete and the use of reinforcement is suggested. The project structural engineer should provide final design recommendations.

5.5.4 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 1/8 inch in width. Most cracks in concrete while unsightly do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete undergoes chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, also is subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

5.6 POST CONSTRUCTION CONSIDERATIONS

5.6.1 Landscape Maintenance and Planting

Water has been shown to weaken the inherent strength of soil, and slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from graded slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Controlling surface drainage and runoff, and maintaining a suitable vegetation cover can minimize erosion. Plants selected for landscaping should be lightweight, deep-rooted types that require little water and are capable of surviving the prevailing climate.

Overwatering should be avoided. The soils should be maintained in a solid to semi-solid state as defined by the materials Atterberg Limits. Care should be taken when adding soil amendments to avoid excessive watering. Leaching as a method of soil preparation prior to planting is not recommended. An abatement program to control ground-burrowing rodents should be implemented and maintained. This is critical as burrowing rodents can decreased the long-term performance of slopes.

It is common for planting to be placed adjacent to structures in planter or lawn areas. This will result in the introduction of water into the ground adjacent to the foundation. This type of landscaping should be avoided. If used, then extreme care should be exercised with regard to the irrigation and drainage in these areas. Waterproofing of the foundation and/or subdrains may be warranted and advisable. We could discuss these issues, if desired, when plans are made available.

5.6.2 Drainage

The need to maintain proper surface drainage and subsurface systems cannot be overly emphasized. Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond or seep into the ground. Pad drainage should be directed toward approved area(s) and not be blocked by other improvements.

It is the owner's responsibility to maintain and clean drainage devices on or contiguous to their lot. In order to be effective, maintenance should be conducted on a regular and routine schedule and necessary corrections made prior to each rainy season.

5.7 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

We recommend that site grading, specifications, retaining wall plans and foundation plans be reviewed by this office prior to construction to check for conformance with the recommendations of this report. Additional recommendations may be necessary based on these reviews. We also recommend that GeoTek representatives be present during site grading and foundation construction to check for proper implementation of the geotechnical recommendations. The owner/developer should have GeoTek's representative perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of on-site and import materials for fill placement, and collect soil samples for laboratory testing when necessary.
- Observe the fill for uniformity during placement including utility trenches.

- Test the fill for field density and relative compaction.
- Observe and probe foundation excavations to confirm suitability of bearing materials.

If requested, a construction observation and compaction report can be provided by GeoTek, which can comply with the requirements of the governmental agencies having jurisdiction over the project. We recommend that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

6. LIMITATIONS

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in Section 5 of this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of our evaluation is limited to the area explored that is shown on the Boring Location Map (Figure 2). This evaluation does not and should in no way be construed to encompass any areas beyond the specific area of proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our proposal (Proposal No. P3-0302114) dated March 14, 2014 and geotechnical engineering standards normally used on similar projects in this region.

The materials observed on the project site appear to be representative of the area; however, soil and bedrock materials vary in character between excavations and natural outcrops or conditions exposed during site construction. Site conditions may vary due to seasonal changes or other factors. GeoTek, Inc. assumes no responsibility or liability for work, testing or recommendations performed or provided by others.

Since our recommendations are based on the site conditions observed and encountered, and laboratory testing, our conclusions and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty is expressed or implied. Standards of practice are subject to change with time.

7. SELECTED REFERENCES

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California Code of Regulations, Title 24, 2013 "California Building Code," 3 volumes.

Dibblee, Jr., T.W., 2003, "Geologic Map of the Sunnymead/South ½ of Redlands Quadrangles, San Bernardino and Riverside Counties, California," Dibblee Geology Center Map #DF-110, map scale 1:24000.

GeoTek, Inc., In-house proprietary information.

Seismic Design Values for Buildings (http://geohazards.usgs.gov/designmaps/us/application.php).

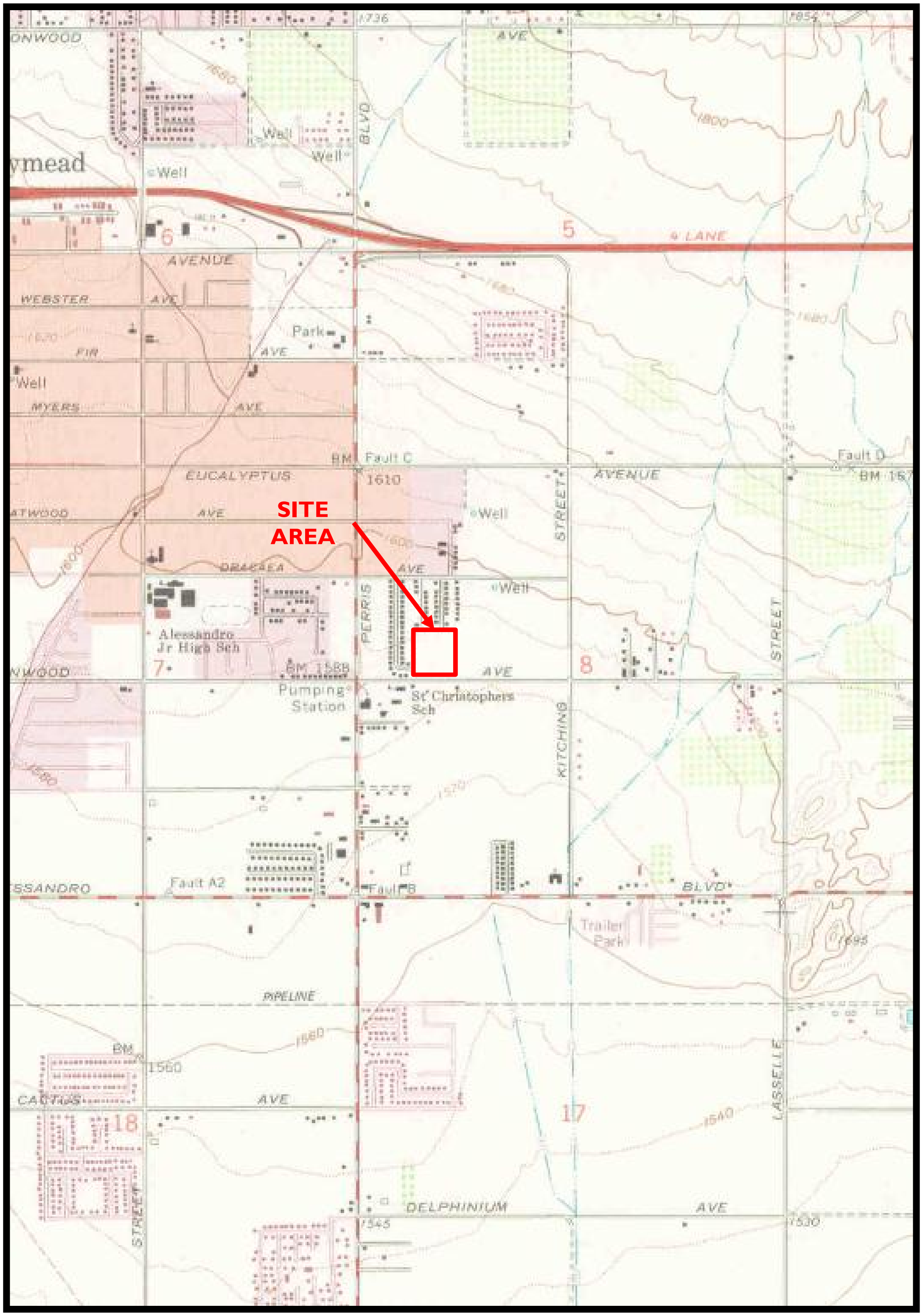
Frontier Enterprises
APN 479-140-022
City of Moreno Valley
Riverside County, California

GeoTek Project No. 1165-CR3

Figure 1

Site Location Map

GEOTEK



Frontier Enterprises
APN 479-140-022
City of Moreno Valley
Riverside County, California

GeoTek Project No. 1165-CR3

Modified from USGS
7.5 Topographic Map

Figure 2

General Site Topography Map

GEOTEK

Frontier Enterprises
APN 479-140-022
City of Moreno Valley
County of Riverside, California

GeoTek Project No. 1165-CR3

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Figure 3

Boring Location Map

GEOTEK

APPENDIX A

LOGS OF EXPLORATORY BORINGS

APN 479-140-022
City of Moreno Valley, County of Riverside, California
Project No. 1165-CR3

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)

The Ring sampler is driven into the ground in accordance with ASTM Test Method D 3550. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the log of boring. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)

These samples are normally large bags of representative earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

B - BORING LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the logs of borings:

SOILS	
USCS	Unified Soil Classification System
f-c	Fine to coarse
f-m	Fine to medium
GEOLOGIC	
B: Attitudes	Bedding: strike/dip
J: Attitudes	Joint: strike/dip
C:	Contact line
………..	Dashed line denotes USCS material change
———	Solid Line denotes unit / formational change
———	Thick solid line denotes end of boring

(Additional denotations and symbols are provided on the log of boring)

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	Frontier Enterprises	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	APN 479-140-022	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1165-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	3/24/2014

BORING NO.: B-1

Depth (ft)	SAMPLES Sample Type	 Blows/ 6 in	 Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing Water Content (%)	 Dry Density (pcf)	 Others
0	☒			SM	**Alluvium:** 0': Silty f-m SAND with some clay, red brown, slightly moist, loose to medium dense			SH, EI, MD, SR
5	■	35 50-4.5"	B1-1		5': Silty f-m SAND with some clay, red brown, slightly moist, dense	5.0	130.9	HC
10	■	50	B1-2		10': SAME	6.8	112.1	
15	■	11 19 22	B1-3		15': SAME	18.1	109.4	
20	■	50	B1-4		20': SAME	8.7	119.7	
25	■	43 50-5.5"	B1-5		25': Silty f-c SAND, gray brown to red brown, slightly moist, dense			
30	■	40 50-4.5"	B1-6	SP	30': m-c SAND with gravel, gray brown, wet, dense			
▽								

LEGEND

Sample type: ■ ---Ring ▮ ---SPT ⧄ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ▽ ---Water Table

Lab testing:

AL = Atterberg Limits	EI = Expansion Index	SA = Sieve Analysis	RV = R-Value Test
SR = Sulfate/Resisitivity Test	SH = Shear Test	HC= Consolidation	MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT: Frontier Enterprises
PROJECT NAME: APN 479-140-022
PROJECT NO.: 1165-CR3
LOCATION: See Boring Location Map

DRILLER: 2R Drilling
DRILL METHOD: 8" Hollow Stem
HAMMER: Auto 140#/30"

LOGGED BY: AMS
OPERATOR: Jerry
RIG TYPE: CME 75
DATE: 3/24/2014

BORING NO.: B-1 (continued)

Depth (ft)	SAMPLES			USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing		
	Sample Type	Blows/ 6 in	Sample Number			Water Content (%)	Dry Density (pcf)	Others
					Alluvium (continued)			
35								
40	■	18 50-5.5"	B1-7	SM	40': Silty f-c SAND, gray brown to red brown, wet, dense			
45	■	36 50-5"	B1-8		45': SAME			
50	■	18 50-2.5"	B1-9		50': Silty f-c SAND with trace gravel, red brown to gray brown, wet, dense			
					BORING TERMINATED AT 50 FEET No groundwater encountered Boring backfilled with cuttings			
55								
60								

LEGEND

Sample type: ■ ---Ring ▮ ---SPT ⧄ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ▽ ---Water Table

Lab testing:
AL = Atterberg Limits
SR = Sulfate/Resisitivity Test
EI = Expansion Index
SH = Shear Test
SA = Sieve Analysis
HC= Consolidation
RV = R-Value Test
MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Frontier Enterprises	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	APN 479-140-022	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1165-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	3/24/2014

	SAMPLES				**BORING NO.: B-2**	Laboratory Testing		
Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	**MATERIAL DESCRIPTION AND COMMENTS**	Water Content (%)	Dry Density (pcf)	Others
					Alluvium:			
				SM	0': Silty f-m SAND with some clay, red brown, slightly moist, loose to medium dense			
5	■	22 24 18	B2-1		5': Clayey silty f-c SAND, red brown, slightly moist, dense	7.9	130.0	
10	■	33 46 48	B2-2		10': Silty f-c SAND, gray to red brown, slightly moist, dense	10.7	127.9	
15	■	13 27 33	B2-3	SC	15': Clayey f-c SAND, red, slightly moist, dense	13.8	122.5	
20	■	16 22 25	B2-4		20': SAME	9.1	126.1	
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ■ ---Ring ■ ---SPT ◩ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ≚ ---Water Table

Lab testing:

AL = Atterberg Limits
EI = Expansion Index
SA = Sieve Analysis
RV = R-Value Test
SR = Sulfate/Resisitivity Test
SH = Shear Test
HC= Consolidation
MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT: Frontier Enterprises
PROJECT NAME: APN 479-140-022
PROJECT NO.: 1165-CR3
LOCATION: See Boring Location Map

DRILLER: 2R Drilling
DRILL METHOD: 8" Hollow Stem
HAMMER: Auto 140#/30"

LOGGED BY: AMS
OPERATOR: Jerry
RIG TYPE: CME 75
DATE: 3/24/2014

BORING NO.: B-3

	SAMPLES					Laboratory Testing		
Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
				SM	**Alluvium:** 0': Silty f-m SAND with some clay, red brown, slightly moist, loose to medium dense			
5	■	15 14 16	B3-1		5': Silty fine SAND, medium brown, slightly moist, dense	9.6	109.7	
10	■	20 50-4.5"	B3-2		10': Silty fine SAND, orange brown mottled, slightly moist, dense	12.5	124.2	HC
15	■	24 47 50-5"	B3-3	SC	15': Silty clayey f-c SAND, red, slightly moist, dense	14.8	120.2	
20	■	21 50	B3-4		20': SAME	13.2	122.2	
					BORING TERMINATED AT 20 FEET No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ■ ---Ring ▮ ---SPT ◩ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ▽ ---Water Table

Lab testing:

AL = Atterberg Limits
EI = Expansion Index
SA = Sieve Analysis
RV = R-Value Test
SR = Sulfate/Resisitivity Test
SH = Shear Test
HC= Consolidation
MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT: Frontier Enterprises
DRILLER: 2R Drilling
LOGGED BY: AMS
PROJECT NAME: APN 479-140-022
DRILL METHOD: 8" Hollow Stem
OPERATOR: Jerry
PROJECT NO.: 1165-CR3
HAMMER: Auto 140#/30"
RIG TYPE: CME 75
LOCATION: See Boring Location Map
DATE: 3/24/2014

	SAMPLES				**BORING NO.: B-4**	Laboratory Testing		
Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	**MATERIAL DESCRIPTION AND COMMENTS**	Water Content (%)	Dry Density (pcf)	Others
					Alluvium:			
				SM	0': Silty f-m SAND with some clay, red brown, slightly moist, loose to medium dense			
5	▨	18 27 28	B4-1		5': Silty fine SAND, medium brown, slightly moist, dense	12.1	125.1	
10	▨	24 43 50-5.5"	B4-2	SC	10': Silty clayey f-c SAND, red brown, slightly moist, dense	10.4	128.1	
15	▨	43 50-3"	B4-3		15': SAME	13.1	122.0	
20	▨	12 23 42	B4-4		20': SAME	12.3	124.3	
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ▨ ---Ring ▮ ---SPT ⧄ ---Small Bulk ☒ ---Large Bulk ☐ ---No Recovery ▽ ---Water Table

Lab testing:
AL = Atterberg Limits
EI = Expansion Index
SA = Sieve Analysis
RV = R-Value Test
SR = Sulfate/Resisitivity Test
SH = Shear Test
HC= Consolidation
MD = Maximum Density

APPENDIX B

RESULTS OF LABORATORY TESTING

APN 479-140-022
City of Moreno Valley, County of Riverside, California
Project No. 1165-CR3

GEOTEK

SUMMARY OF LABORATORY TESTING

Classification

Soils were classified visually in general accordance to the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications are shown on the logs of exploratory test borings in Appendix A.

Moisture-Density Relations

Laboratory testing was performed on a selected sample collected during the recent subsurface exploration. The laboratory maximum dry density and optimum moisture content for the sample tested was determined in general accordance with test method ASTM Test Method D 1557. The results are included herein.

Expansion Index

Expansion Index testing was performed in general accordance with ASTM Test Method D 4829. The test results are included herein.

Consolidation

Consolidation testing was performed on selected samples of the site soils according to ASTM Test Method D 2435. The results of this testing is presented herein.

Direct Shear Test

Shear testing was performed on a remolded sample of the site soil materials in general accordance with ASTM Test Method D 3080. The test results are included herein.

Sulfate Content, Resistivity and Chloride Content

Testing to determine the water-soluble sulfate content was performed by others in general accordance with California Test No. 417. Resistivity testing was completed by others in general accordance with California Test 643. Testing to determine the chloride content was performed by others in general accordance with California Test No. 422. The results of the testing are included herein.

Atterberg Limits

Laboratory testing to determine the liquid and plastic limits was performed in general accordance with ASTM D4318. The results of the testing are included herein.

GEOTEK

MOISTURE/DENSITY RELATIONSHIP

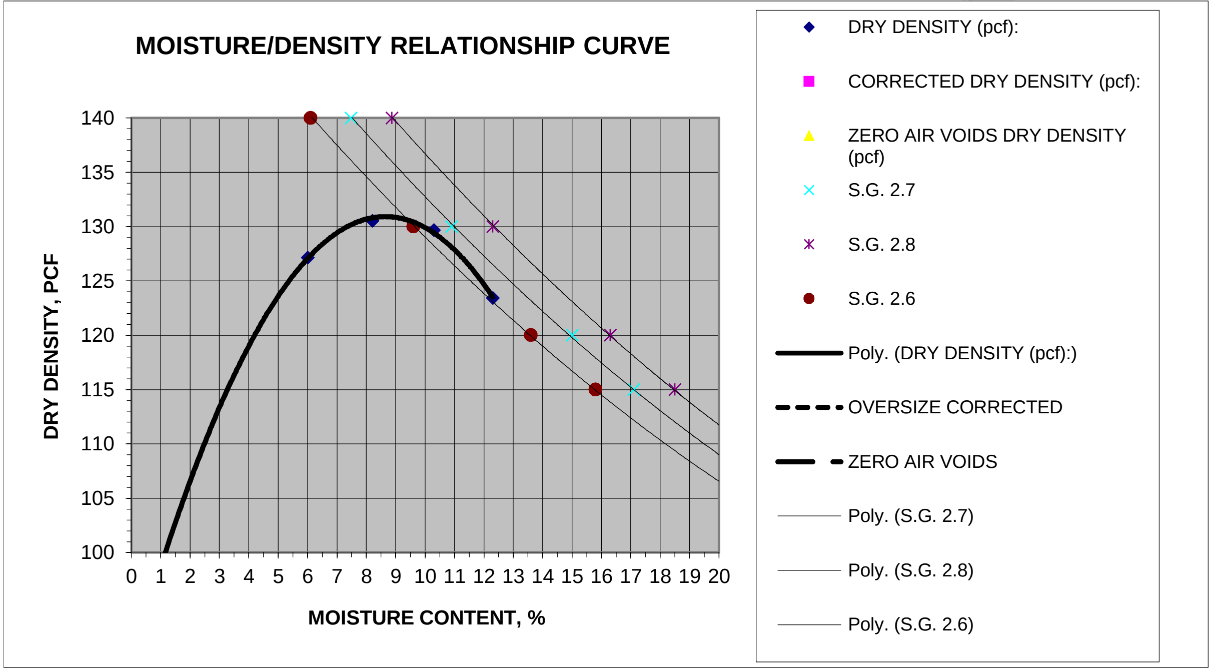
Client: Frontier Enterprises
Project: APN 479-140-022
Location: Moreno Valley
Material Type: Red Brown Silty Sand
Material Supplier:
Material Source:
Sample Location: B-1 @ 0-5'

Job No.: 1165-CR3
Lab No.: Corona

Sampled By: AMS
Received By: DI
Tested By: DI
Reviewed By:

Date Sampled: 24-Mar-14
Date Received: 24-Mar-14
Date Tested: 29-Mar-14
Date Reviewed: 8-Apr-14

Test Procedure: ASTM 1557
Method: A
Oversized Material (%): 0.0
Correction Required: ☐ yes ☒ no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf 131.0 @ **Optimum Moisture, %** 9.0
Corrected Maximum Dry Density, pcf @ **Optimum Moisture, %**

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification:
AASHTO Soils Classification:

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client: Frontier Enterprises

Project Number: 1165-CR3

Project Location: APN 479-140-022, Moreno Valley

Tested/ Checked By: DI Lab No Corona

Date Tested: 3/31/2014

Sample Source: B-1 @ 0-5'

Sample Description: Silty Clayey Sand

Ring #:______ Ring Dia. : 4.01" Ring Ht.1"

Loading weight: 5516. grams

DENSITY DETERMINATION

A	Weight of compacted sample & ring (gm)	778.3
B	Weight of ring (gm)	369.1
C	Net weight of sample (gm)	409.2
D	Wet Density, lb / ft3 (C*0.3016)	123.4
E	Dry Density, lb / ft3 (D/1.F)	**114.0**

SATURATION DETERMINATION

F	Moisture Content, %	8.2
G	Specific Gravity, assumed	2.64
H	Unit Wt. of Water @ 20°C, (pcf)	62.3
I	% Saturation	**48.9**

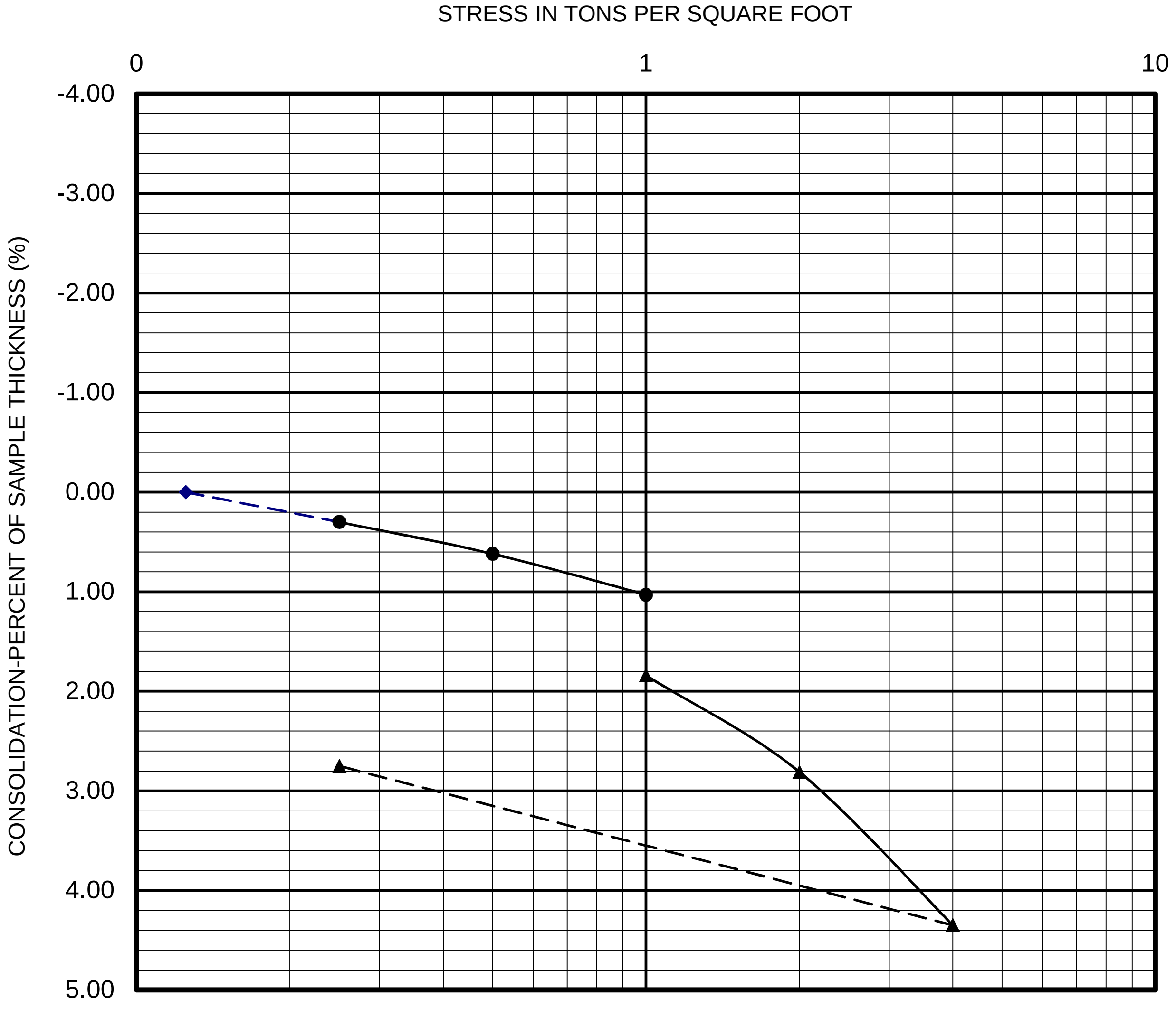
READINGS

DATE	TIME	READING	
3/31/2014	9:00	0.3270	Initial
	9:10	0.3270	10 min/Dry
	10:20	0.3510	
	12:10	0.3530	
4/1/2014	5:05	0.3540	Final

FINAL MOISTURE

Weight of wet sample & tare	Weight of dry sample & tare	Tare	% Moisture
555.5	494.8	150.1	**17.6%**

EXPANSION INDEX = 27



- - -●- - -	Seating Cycle
——●——	Loading Prior to Inundation
——▲——	Loading After Inundation
- - -▲- - -	Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

GEOTEK

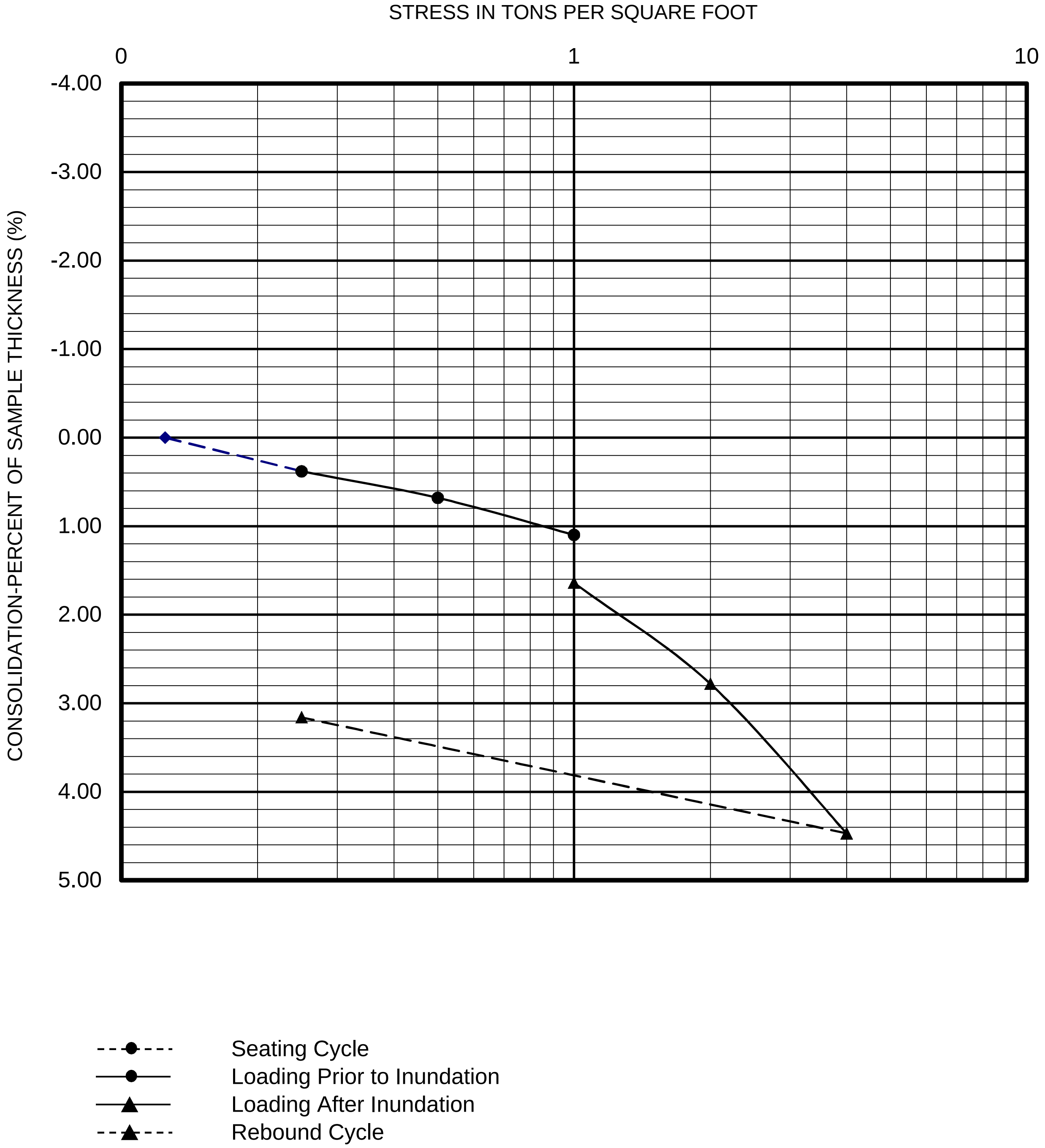
CONSOLIDATION REPORT

Sample: B-1 @ 5'

APN 479-140-022
Moreno Valley, California

Plate C-1

CHECKED BY: EHL
Lab: DI
PROJECT NO.: 1165-CR3
Date: 04/14



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

GEOTEK

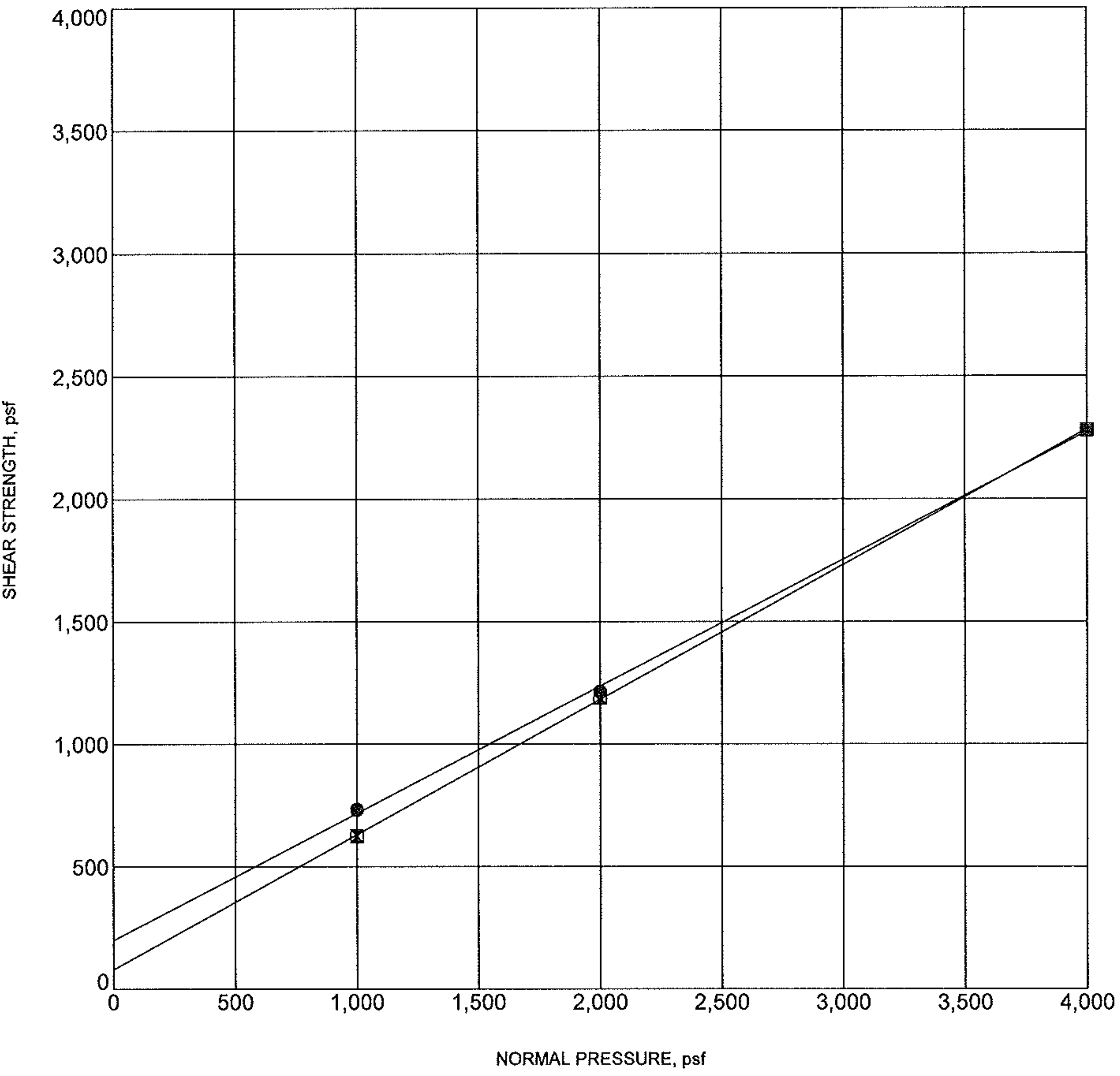
CHECKED BY: EHL	Lab: DI
PROJECT NO.: 1165-CR3	Date: 04/14

CONSOLIDATION REPORT

Sample: B-3 @ 10'

APN 479-140-022
Moreno Valley, California

Plate C-2



	Specimen Identification		Classification	γ_d	MC%	c	ϕ
●	**B-1; 1165 CR-3**	**0.0**	**0-5 ft, Remolded, Peak Stress**			**198**	**27**
☒	**B-1; 1165 CR-3**	**0.1**	**0-5 ft, Remolded, Ultimate Stress**			**78**	**29**

TGR GEOTECHNICAL, INC.

3037 S. Harbor Blvd.
Santa Ana, CA
Telephone:
Fax:

DIRECT SHEAR TEST

Project Number: 10-2700
Project Name: GeoTek (1165-CR3)

Cal Land Engineering, Inc.
dba Quartech Consultants
Geotechnical, Environmental, and Civil Engineering

GeoTek, Inc.
710 East Parkridge Avenue, Suite 105
Corona, California 92879

Date: April 4, 2014
QCI Project No.: 14-167-04h
Summarized by: ABK

Client: Frontier
W.O.: 1165-CR3
Project: Moreno Valley

Corrosivity Test Results

Sample ID	Depth (Feet)	pH CT-532 (643)	Chloride CT-422 (ppm)	Sulfate CT-417 (% By Weight)	Resistivity CT-532 (643) (ohm-cm)
B-1	0-5’	7.33	98	0.0035	2,900

APPENDIX C

GENERAL EARTHWORK GRADING GUIDELINES

APN 479-140-022
City of Moreno Valley, County of Riverside, California
Project No. 1165-CR3

GEOTEK

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the Uniform Building Code, CBC (2013) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor’s overall level of efforts during grading. The contractor’s personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor’s responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.
4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.

5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.
6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
    a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
    b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.

2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).
2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
   a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
   b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
   a) They are not placed in concentrated pockets;
   b) There is a sufficient percentage of fine-grained material to surround the rocks;
   c) The distribution of the rocks is observed by, and acceptable to, our representative.
5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable

methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors’ methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that “worked” on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.

2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
    a) shallow (12 + inches) under slab interior trenches and,
    b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.
3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

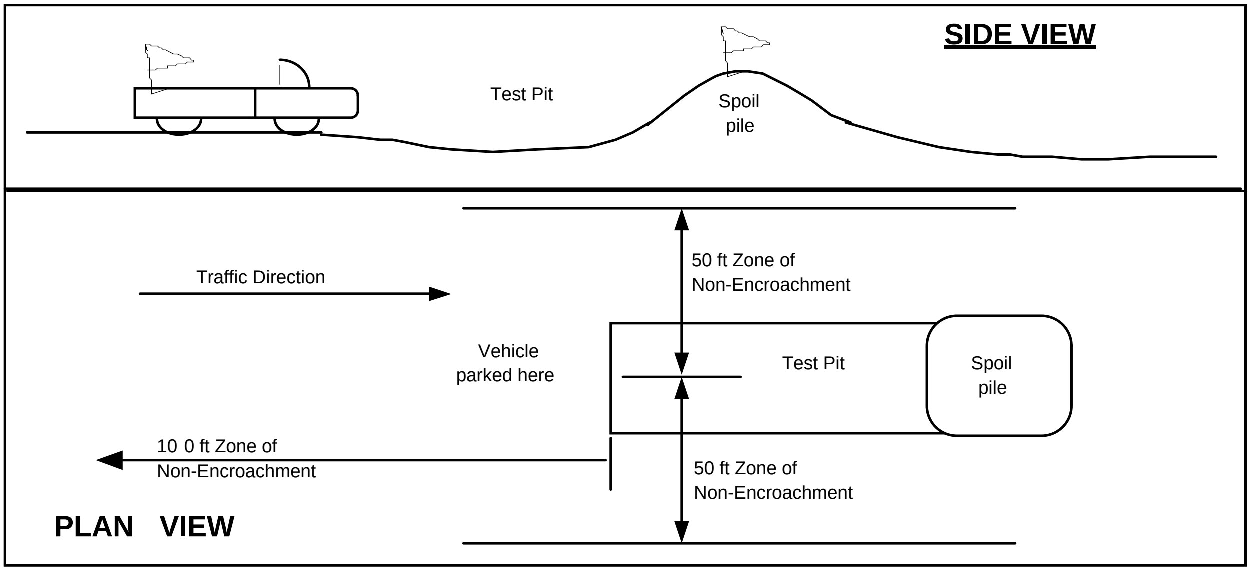
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or
4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

GeoTek, Inc.
710 E. Parkridge Avenue, Suite 105, Corona, California 92879-1097
(951) 710-1160 Office (951) 710-1167 Fax www.geotekusa.com

June 30, 2014
Project No. 1165-CR3

Frontier Enterprises
8300 Utica Avenue, Suite 300
Rancho Cucamonga, California 91730

Attention: Mr. Daniel Pocius

Subject: Infiltration Evaluation
Proposed Residential Development
Tentative Tract Map No. 34544
City of Moreno Valley, Riverside County, California

Reference: *Riverside County Flood Control and Water Conservation District (RCFCWCD), 2011, "Design Handbook for Low Impact Development Best Management Practices."*

Dear Mr. Pocius:

As requested and authorized, GeoTek, Inc. (GeoTek) has performed an infiltration evaluation at the subject property. This report presents the results of the double-ring infiltrometer testing, and provides recommendations from a geotechnical standpoint for a design infiltration rate.

The subject project site (Tentative Tract Map No. 34544) is located adjacent to and to the north of Cottonwood Avenue, approximately 1,000 feet east of Perris Boulevard, in the City of Moreno Valley, Riverside County, California. The project site is currently vacant land.

One (1) excavation was dug with a backhoe, to a depth of about five (5) feet below existing grade in the area of the proposed basin in the southeastern portion of the project site area (see Figure 1). A double-ring infiltrometer test was performed within the excavation (I-1) by a representative from our firm on June 28, 2014 in general conformance with ASTM D 3385 and the *Riverside County Flood Control and Water Conservation District Design Handbook for Low Impact Development Best Management Practices* (RCFCWCD, 2011).

The double-ring infiltrometer test resulted in an infiltration rate of 0.3 inches per hour after the infiltration rate had generally stabilized. The attached Figure 1 shows the approximate location of the infiltration test. A copy of the double-ring infiltrometer test field data is included at the back of this report.

Over the lifetime of the storm water disposal areas, the infiltration rates may be affected by silt build up and biological activities, as well as local variations in near surface soil conditions. An appropriate factor of safety no less than 2.0 should be applied to the measured infiltration rate based on the suitability of the underlying soils for infiltration and the infiltration design.

LIMITATIONS

The materials observed on the project site appear to be representative of the area; however, soil materials vary in character between excavations and natural outcrops or conditions exposed during site construction. Site conditions may vary due to seasonal changes or other factors. GeoTek, Inc. assumes no responsibility or liability for work, testing or recommendations performed or provided by others.

Our conclusions and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty is expressed or implied. Standards of practice are subject to change with time.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
GeoTek, Inc.

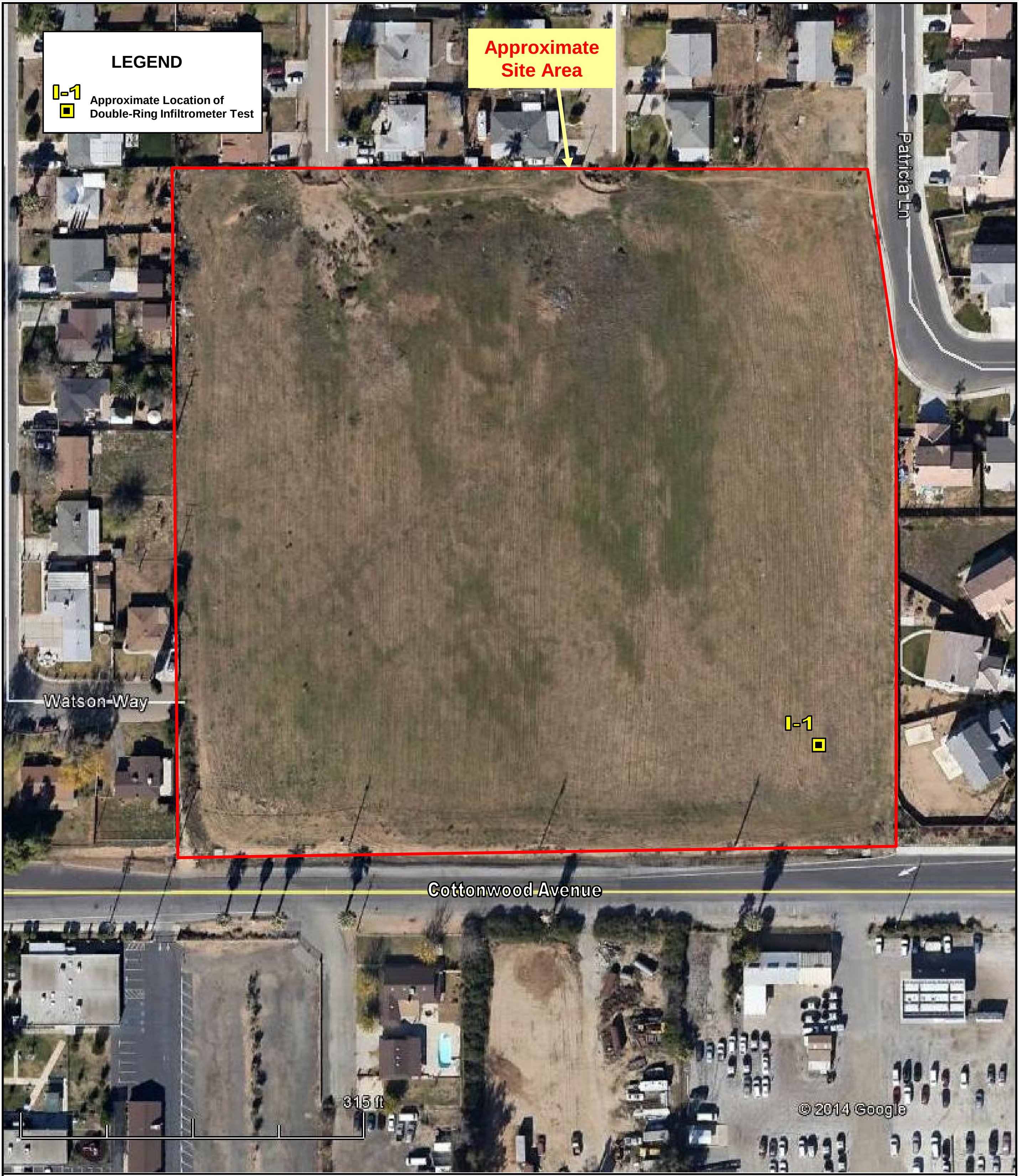
REGISTERED GEOLOGIST
EDWARD H. LaMONT
No. 1892
Exp._____
Certified Engineering Geologist
STATE OF CALIFORNIA

Edward H. LaMont
CEG 1892, Exp. 07/31/16
Principal Geologist

Attachments: Figure 1 – Infiltration Test Location Map
Infiltration Test Field Data

Distribution: (1) Addressee via email

G:\Projects\1151 to 1200\1165CR3 Frontier Enterprises Moreno Valley 79\Infiltration\Infiltration Revised\1165CR3 Infiltration Evaluation TTM 34544.doc



Frontier Enterprises
Tentative Tract Map No. 34544
City of Moreno Valley
Riverside County, California

GeoTek Project No. 1165-CR3

Figure 1

Infiltration Test Location Map

GEOTEK

FRONTIER ENTERPRISES

DOUBLE RING INFILTROMETER TEST DATA

Project Name and Test Location: 1165-CR3 TTM 34544
Trench No.:
Tested by:
Date of Testing: 6/28/14
Water Table Depth: >50

Liquid Used: WATER
Ground Temperature:
Liquid Level Mainted by Using: HAND MEASUREMENTS
Penetration of Rings Into Soil (in.): 4 6
USCS Classification: SM

				FLOW READINGS					INFILTRATION RATE		
TRIAL NO.	START/END	TIME	ELAPSED TIME (Min.)	INNER RING (in.)	RING FLOW (water added in ml)	ANNULAR READING (in.)	SPACE FLOW (water added in ml)	LIQUID TEMP. (F)	INNER (in./hr.)	ANNULAR (in./hr.)	REMARKS
1	S	520	0	10	232	12	1390	74	0.8	1.5	
	E	530	10	9 7/8		11 3/4					
2	S	531	0	10	232	12	1390		0.8	1.5	
	E	541	10	9 7/8		11 3/4					
3	S	542	0	10	232	12	1390		0.8	1.5	
	E	552	10	9 7/8		11 3/4					
4	S	553	0	10	232	12	1390		0.8	1.5	
	E	603	10	9 7/8		11 3/4					
5	S	604	0	10	116	12	695		0.4	0.8	
	E	614	10	9 15/16		11 7/8					
6	S	615	0	10	116	12	695		0.4	0.8	
	E	625	10	9 15/16		11 7/8					
7	S	626	0	10	348	12	2085		0.4	0.8	
	E	656	30	9 13/16		11 5/8					
8	S	658	0	10	348	12	2085		0.4	0.8	
	E	728	30	9 13/16		11 5/8					
9	S	730	0	10	348	12	2085		0.4	0.8	
	E	800	30	9 13/16		11 5/8					
10	S	802	0	10	348	12	2085		0.4	0.8	
	E	832	30	9 13/16		11 5/8					
11	S	834	0	10	232	12	1043		0.3	0.6	
	E	904	30	9 7/8		11 11/16					
12	S	906	0	10	232	12	1043		0.3	0.6	
	E	936	30	9 7/8		11 11/16					
13	S	938	0	10	232	12	1043		0.3	0.6	
	E	1008	30	9 7/8		11 11/16					
14	S	1010	0	10	232	12	1043		0.3	0.6	
	E	1040	30	9 7/8		11 11/16					
15	S	1042	0	10	232	12	1043		0.3	0.6	
	E	1112	30	9 7/8		11 11/16					
16	S	1114	0	10	232	12	1043		0.3	0.6	
	E	1144	30	9 7/8		11 11/16					
17	S	1146	0	10	232	12	1043	74	0.3	0.6	
	E	1216	30	9 7/8		11 11/16					
18	S										
	E										
19	S										
	E										