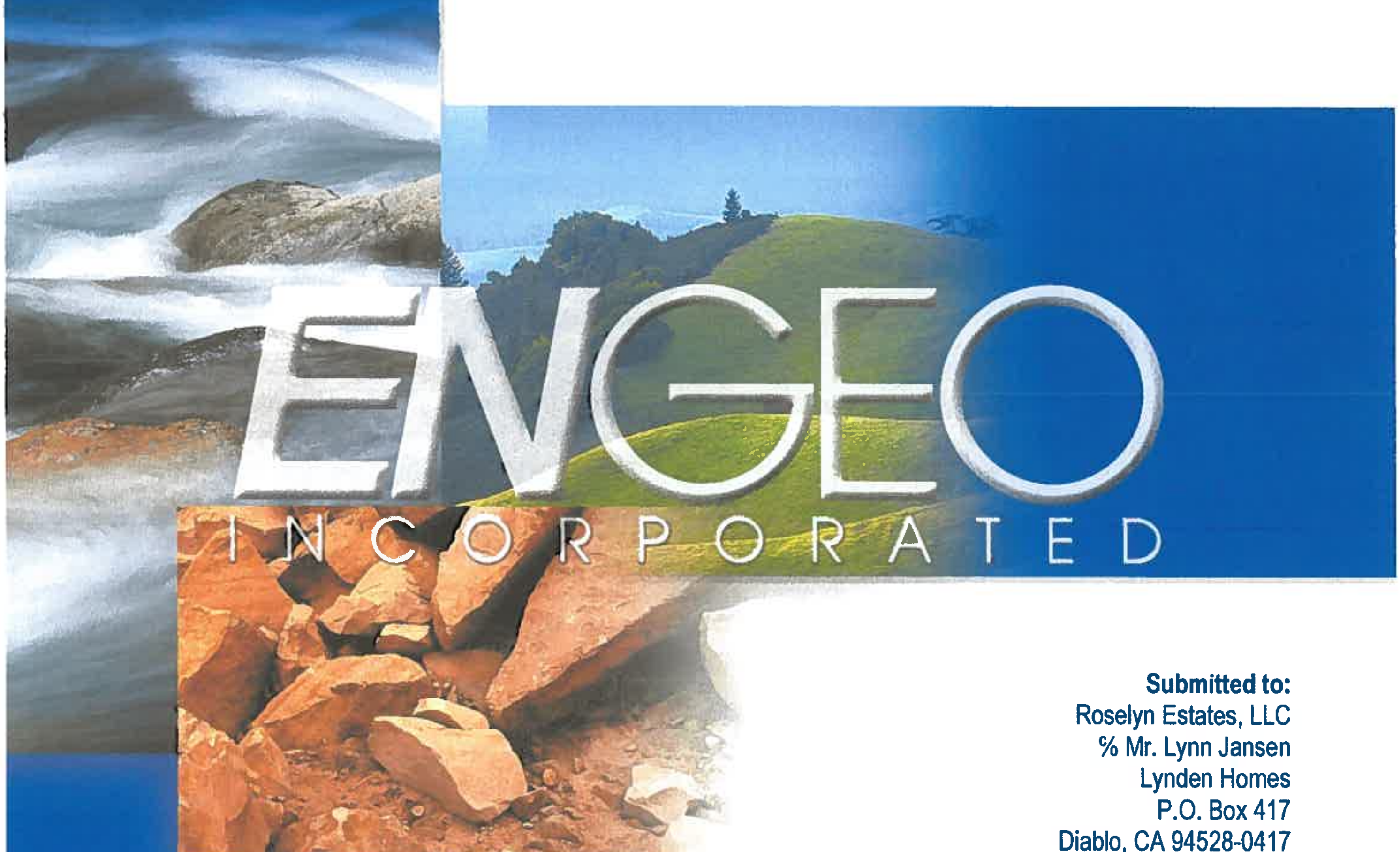
HYDRAULIC EVALUATION AND BANK EROSION ANALYSIS OF ARROYO DEL VALLE

ROSELYN ESTATES II PROPERTY
1623 CINDY WAY – PARCEL B
PLEASANTON, CALIFORNIA



Submitted to:
Roselyn Estates, LLC
% Mr. Lynn Jansen
Lynden Homes
P.O. Box 417
Diablo, CA 94528-0417

Prepared by:
ENGEO Incorporated

August 1, 2012

Project No:
4425.000.000

- Expect Excellence -

PUD-94
EXHIBIT B

ENGEO INCORPORATED

GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
4425.000.000

August 1, 2012

Roselyn Estates, LLC
% Mr. Lynn Jansen
Lynden Homes
P.O. Box 417
Diablo, CA 94528-0417

Subject: Roselyn Estates II Property
1623 Cindy Way – Parcel B
Pleasanton, California

HYDRAULIC EVALUATION AND BANK EROSION ANALYSIS OF ARROYO DEL VALLE

Dear Mr. Jansen:

With your authorization, we have evaluated the fluvial hydraulic characteristics and bank erosion potential of Arroyo del Valle specifically for the reach that is located at 1623 Cindy Way – Parcel B. The purpose of this report is to provide design recommendations for the proposed project.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you. We look forward to working with you to successfully complete your project. We are pleased to be of service for this study and will continue to consult with you and your design team as project planning progresses.

Sincerely,

ENGEO Incorporated

Sean Cleary, PE
sc/jb/rs/jf

Jonathan Buck, GE

REGISTERED PROFESSIONAL ENGINEER
JONATHAN BUCK
No. 2958
Exp. 9/30/2012
GEOTECHNICAL
STATE OF CALIFORNIA

Attachments: List of References
Figures
Appendix A – HEC-RAC Output Tables

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1.0 INTRODUCTION

The proposed project is a seven single-family residential lot development on a 4-acre site that is located at 1623 Cindy Way – Parcel B. The site is immediately adjacent to Arroyo Del Valle and is located east of Cindy Way and Lynn Drive, north of Rose Avenue and the Alameda County Fairgrounds, and south of the creek as shown on the Vicinity Map, Figure 1.

The site topography is relatively level at approximately 339 feet above mean sea level (msl). The creek bank is approximately 30 feet high in most locations. The creek bank and slopes contain dense vegetation and a significant amount of accumulated debris, including concrete, wood, and old fencing materials.

The upstream boundary of the hydraulic model begins approximately at the upstream property line of the project parcel and ends approximately 60 feet downstream of the subject parcel. It is our understanding that the purpose of this study is twofold:

1. Estimate the velocity and water surface profile of Arroyo Del Valle within the limits of the study reach for various peak hydrologic flow rates, as requested by the City of Pleasanton.

2. Assess the current condition and estimate the erosion potential of the southerly creek bank of Arroyo Del Valle within the limits of your project and validate the structural setback zones recommended in the previous studies, including the property immediately to the east of this study (References 1, 2, and 3).

It should be noted that a structural setback zone is required along the creek by Alameda County Flood Control and Water Conservation District (ACFC and WCD) Zone 7. The intent of the setback zone is to mitigate potential structural hazards posed by potential bank failure.

2.0 HYDRAULIC MODELING

The fluvial hydraulic analysis of this portion of Arroyo Del Valle was performed using the HEC-RAS Version 4.1.0 computer program published by the United States Army Corps of Engineers (USACE). HEC-RAS performs one-dimensional hydraulic analyses for natural channels and is intended for calculating water surface profiles and velocities in steady, gradually varied flow conditions. The basic HEC-RAS computational procedure is based on the solution of the one-dimensional energy equation. Energy losses consist of friction losses (based on Manning's equation), as well as expansion and contraction losses, where applicable. The development of the HEC-RAS models specific to this study is described in detail below.

2.1 Boundary Conditions

The hydraulic model is based on 'normal depth' boundary conditions, whereby HEC-RAS calculates an initial water surface profile based on the bedslope of the creek. The 'normal depth' HEC-RAS model was through the project parcel. An estimated bed slope for the Arroyo del Valle of 0.003 ft/ft was used as the upstream and downstream boundary conditions for

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computational purposes. Further discussion about the creek bed slope is found in this report. The extension of the HEC-RAS model at this particular length is a general standard of practice in cases where there is no known water surface elevation which can be used as a tailwater boundary condition within the actual study reach itself. The portion of Arroyo Del Valle through which the HEC-RAS model has been extended can be characterized as a relatively flat reach with little sign of instability and fairly consistent cross sectional area.

2.2 Channel Geometry

In order to model the channel geometry of the fluvial system, cross sections were drawn perpendicular to the direction of flow in Arroyo Del Valle at approximately 100-foot intervals along the project reach. Representative elevations and locations were entered into the HEC-RAS program at these stations. Elevation data used in the model was obtained from a combination of sources. A survey completed for the area dated October 20, 1998, by Aero-Geodetic Survey, Inc., was merged with topographic data from Debolt Engineering 2011. Confirmation of the current valid applicability of that survey data was provided by two field survey performed on November 23, 2004, and January 19, 2005, by Alexander and Associates, the Project Surveyor. Respective locations of cross-sectional stations are shown on Figure 2. In general, the geometry of the creek bottom is based on survey shots performed by Alexander and Associates in 2004 through 2005. Since the channel is fairly consistent in shape, this cross sectional geometry was assumed to represent the channel shape in areas lacking detailed survey data. The creek banks are modeled using the Aero-Geodetic survey from 1998.

2.3 Input of Channel Flow Rate

Flow rates for the 100-year and 15-year events, of 7,000 and 4,600 cubic feet per second (cfs), respectively, were used to model peak hydrologic flow rates through the channel in the HEC-RAS model. These flow rates were furnished by ACFCWCD Zone 7 for this reach of Arroyo del Valle based on hydrologic modeling prepared by others.

2.4 Input of Hydraulic Coefficients

The value of the Manning's roughness coefficient (*n*) establishes frictional resistance in the channel and is thus related to the modeling of channel velocity and water surface profile by the HEC-RAS program. In accordance with Table 3.1 of the USACE HEC-RAS Hydraulic Manual (Reference 4), an '*n*' value was selected that typified the hydraulic roughness created by vegetation and other factors encountered throughout the study reach. This value is based on recommended minimum, maximum and normal values developed for a variety of vegetative and morphological conditions similar to those found in the channel and banks of the study creek. The following table summarizes the use of the coefficient in the modeling.

TABLE 2.4-1

Manning's 'n' value	Description
0.07 (banks)	Scattered brush, heavy weeds (maximum condition) Very weedy reaches with heavy stands of timber (minimum condition)
0.04 (active channel)	Clean winding channel, some pools and shoals (normal condition)

With the exception of the active creek channel, the selected '*n*' value of 0.07 is consistent with hydraulic modeling performed by Ruggeri-Jensen-Azar for Arroyo Del Valle upstream of the subject property and approved by ACFCWCD Zone 7 in Reference 5.

The limits of the active channel, and corresponding Manning's 'n' values, are shown on Figure 1 and are based on survey information collected by Alexander and Associates in November 2004 and observation work conducted by ENGEO during a November 2011 reconnaissance visit.

Photographs of the Arroyo are presented in Figure 2 that depict the types of established ri arian vegetative growth and fluvial morphology found within the subject reach.

In conformance with USACE guidelines, dimensionless channel expansion and contraction energy losses were computed using the following coefficients.

TABLE 2.4-2

Expansion (channel)	0.3
Contraction (channel)	0.1

2.5 Flow Regime

Based on the preliminary results of the modeling, no supercritical flows were encountered in the study reach for the analyses. Therefore, the final results of the study are based on a subcritical flow regime analysis.

3.0 RESULTS OF MODELING

The following tables summarize the results of the studies.

TABLE 3.0-1
Results of Fluvial Hydraulic Analysis

15-YEAR NORMAL HYDRAULIC ANALYSIS						
Station	Q (cfs)	Water Surface El. (ft)	Total Velocity (fps)	Left Bank Velocity (fps)	Total Shear (lb/sqft)	Left Bank Shear (lb/sqft)
17+39	4,600	320.3	6.6	4.4	2.3	1.3
17+92	4,600	320.7	6.9	1.8	1.4	0.3
18+81	4,600	320.6	8.4	3.6	2.2	1.1
20+02	4,600	321.4	6.5	3.2	1.5	0.8
20+71	4,600	321.6	6.1	2.7	1.4	0.6
21+53	4,600	321.7	6.4	2.8	1.4	0.6
22+55	4,600	321.4	7.4	5.4	3.7	2.1
22+90	4,600	322.0	7.1	3.2	2.0	0.8
23+95	4,600	322.4	6.6	3.3	1.9	0.8
24+62	4,600	322.5	6.8	3.9	2.1	1.1
25+94	4,600	322.8	6.9	3.9	2.1	1.1

TABLE 3.0-2
Results of Fluvial Hydraulic Analysis

100-YEAR NORMAL HYDRAULIC ANALYSIS						
Station	Q (cfs)	Water Surface El. (ft)	Total Velocity (fps)	Left Bank Velocity (fps)	Total Shear (lb/sqft)	Left Bank Shear (lb/sqft)
17+39	7,000	323.62	7.5	5.1	3.0	1.7
17+92	7,000	324.22	7.4	2.4	1.6	0.5
18+81	7,000	323.96	9.0	4.3	2.6	1.3
20+02	7,000	324.83	7.1	3.8	1.9	1.0
20+71	7,000	325.06	6.8	3.2	1.7	0.7
21+53	7,000	325.22	7.0	3.3	1.8	0.8
22+25	7,000	324.91	7.9	6.0	4.2	2.4
22+90	7,000	325.28	8.1	3.9	2.6	1.1
23+95	7,000	325.9	7.2	3.9	2.3	1.1
24+62	7,000	326.01	7.4	4.6	2.5	1.4
25+94	7,000	326.3	7.4	4.6	2.5	1.4

4.0 BANK EROSION POTENTIAL

The following table summarizes the range of velocities calculated for the reach from the HEC-RAS modeling.

TABLE 4.0-1

RANGE OF CALCULATED VELOCITIES		
Model	Area	Velocity (ft./sec.)
15-yr. Normal Depth	Total Left Bank	6.1 - 8.4 2.7 – 3.9
100-yr. Normal Depth	Total Left Bank	6.8 – 9.0 2.4 – 6.0

Based on research published by the United States Army Corps of Engineers in Reference 8, which provides erosion threshold guidance for flood control channels, the allowable mean velocity for a channel comprised of a silty clay soil and vegetated with Bermuda grass is 8.0 feet per second. The soil boring furnished in Appendix B taken near the creek in Reference 1 characterized the soil horizon at the flowline of Arroyo Del Valle as a silty clay. The total velocity slightly exceeds 8 feet per second at two cross sections. The calculations indicate the total velocity at Section 18+81 during the 15-year peak flow is 8.4 ft/sec and 9.0 ft/sec during the 100-year peak flow. The total velocity Section 22+90 is approximately 9.0 during the 100-year peak.

It is our opinion that the root architecture of the plants found on the banks of Arroyo Del Valle will provide greater erosion protection than the roots of Bermuda grass. The banks of the creek are heavily vegetated with brush, shrubs, and trees. Additionally, it is our opinion that the actual velocities at the creek bottom and banks are substantially less than what is furnished in the HEC-RAS studies, since HEC-RAS calculates average velocities across a channel and the velocities are actually not uniformly distributed in the creek section. Studies performed by Chow (1959) indicate that due to friction along the walls and bottom of an open channel section, the actual velocity at the boundary of a creek channel is approximately one-half the calculated "average" velocity. Accordingly, actual maximum velocities likely approach only about 4.5 feet per second at the channel bottom where the water is in contact with the bed material. The calculations also indicate that velocities along the left bank, which is the project's side of the creek, is significantly less than 8 ft/sec.

Therefore, we conclude that the potential for erosion in Arroyo Del Valle is negligible based on average velocity calculations, since velocities do not significantly and consistently exceed published erosion threshold standards, especially in the heavily vegetated bank areas.

5.0 CHANNEL EROSION POTENTIAL

The potential for long-term degradation or downcutting of the creek bed has also been evaluated for this reach of Arroyo Del Valle as part of this study. A major indicator for the potential of long-term channel degradation in a fluvial system is the measurement of the system's bed slope which should be similar to that of other similar systems which are in a state of erosion/deposition equilibrium. The concept of an 'equilibrium' bed slope is based on basic principles of fluvial geomorphology and suggests that a creek will adjust its bed slope over the long term so that the system transports all of its sediment without net deposition or erosion. Based on field observations, it is apparent that the creek bed has formed a pool and riffle system in the channel bed since there are several undulations in the flowline as the creek progresses downstream. Since this is the case, the bed slope of the creek will be estimated by the slope of the Energy Grade Line (EGL) computed by HEC-RAS which provides a reasonable indicator of the overall creek slope.

The creek's EGL is between 0.0015 and 0.0040 ft./ft. for the 'normal depth' HEC-RAS model. Based on our experience with the geomorphology of other creeks in the San Francisco East Bay region, these values are actually slightly lower that the 'equilibrium' bed slope for a fluvial system with a 15-year discharge of 4,600 cfs such as Arroyo Del Valle (0.0033 – 0.00 45 ft./ft.).

Our opinion is that because the EGL slope is actually on average less than the range estimated for stable slopes for creeks of this size, the active creek channel may experience some deposition over the long term rather than erosion. Moreover, the creek has historically armored its channel and banks to withstand higher flows and velocities than currently anticipated, through deposition of larger colloidal material at greater velocities reducing the potential for channel erosion.

Thus, because the bed slope of the creek is slightly less than what one would expect for an 'equilibrium' slope condition for a fluvial system of this size, long-term erosion in the channel in this reach of Arroyo Del Valle is considered to be unlikely. The evaluation of erosion potential presented in this document, are based on existing conditions. Future modifications to the creek geometry upstream or downstream of the subject property may impact future erosion potential.

6.0 RECOMMENDATIONS

The following setbacks are recommended in Reference 1.

- 3:1 (horizontal:vertical) line of projection from the toe of the creek bank to the top of the bank plus an additional horizontal distance of 15 feet for habitable structures.
- 2.5:1 line of projection from the toe of the creek bank to the top of the bank for non-habitable improvements, including the proposed Lynn Drive if no reinforcement is used.
- 2:1 line of projection from the toe of the creek bank to the top of the bank for non-habitable improvements, including the proposed Lynn Drive if two layers of Tensar Ux1400HS or approved equivalent geogrid reinforcement is placed as indicated in Reference 1.

Rainfall runoff should be designed to drain away from the top of creek bank into the storm drain system that is proposed for the project, which will prevent the ponding of water on the relatively flat areas directly behind the creek bank in the setback area.

Based on the results of the fluvial hydraulic evaluation and the visual survey and slope stability analysis conducted for this report, the above-described setbacks recommended in References 1 and 2 should provide sufficient protection to the surrounding development from any creek-related hazard. Additionally, the recommendations for site development and assessment of creek bank stability provided in References 1 and 2 remain valid. Because of the extensive vegetation, no additional creek bank mitigation is recommended for this reach of creek.

7.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report is issued with the understanding that it is the responsibility of the owner to transmit the information and recommendations of this report to developers, contractors, buyers, architects, engineers, and designers for the project so that the necessary steps can be taken by the contractors and subcontractors to carry out such recommendations in the field. The conclusions and recommendations contained in this report are solely professional opinions.

The professional staff of ENGEO Incorporated strives to perform its services in a proper and professional manner with reasonable care and competence but is not infallible. There are risks of earth movement and property damages inherent in land development. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our work.

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SELECTED REFERENCES

1. ENGEO; Geotechnical Exploration, Roselyn Estates II Property, Pleasanton, California; August 2, 2012; Project No. 4425.000.000.

2. ENGEO; Creek Bank Erosion Assessment, 1635-1777-1851 Rose Avenue, Pleasanton, California; September 18, 1998.

3. ENGEO; Hydraulic Evaluation and Bank Erosion Analysis of Arroyo Del Valle. Roselyn Lane Project PUD #38 TRACT 7534, Pleasanton California; March 2005.

4. United States Army Corps of Engineers; HEC-RAS Version 3.01, Hydraulic Reference Manual; Davis, California; 2003.

5. Ruggeri-Jensen-Azar, Inc.; Nolan Farms TR 7143; April 28, 2000; Job No. 981117EX.

6. Chow, V.T. Open Channel Hydraulics, McGraw Hill, New York, 1959.

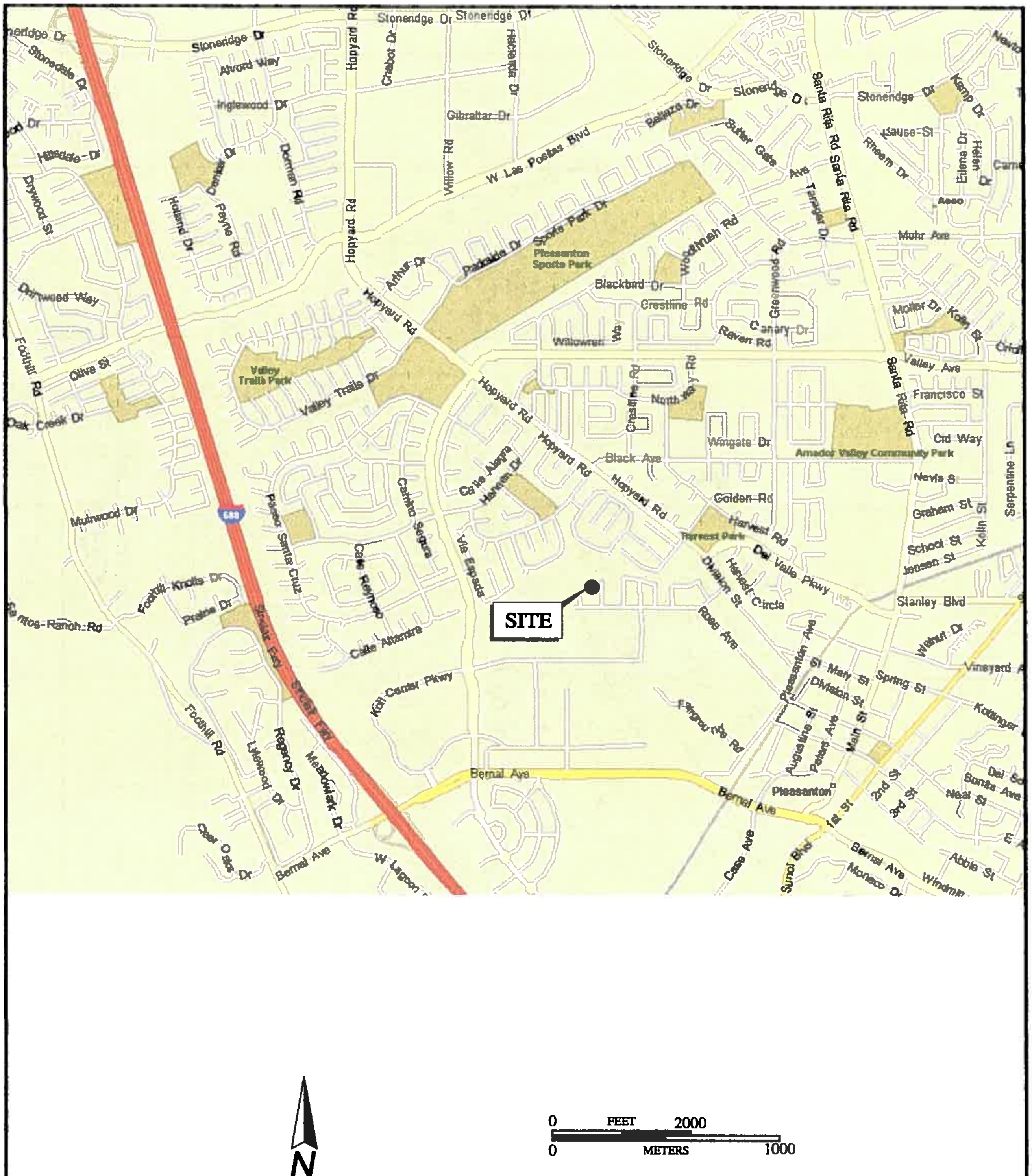
7. Federal Emergency Management Agency; FIRM Flood Insurance Rate Map, City of Pleasanton California, Community Panel No. 0600120004 D, Revised September 19, 1984.

8. United States Army Corps of Engineers, Hydraulic Stability of Natural Channels EM 1110-2-1418, 1994.

9. International Erosion Control Association. Design Procedures for Channel Protection and Streambank Stabilization, 1996.

10. California Geological Survey. Seismic Mapping Program Special Publication 117, Guidelines for Evaluation and Mitigating Seismic Hazards in California, March 1997.

LIST OF FIGURES

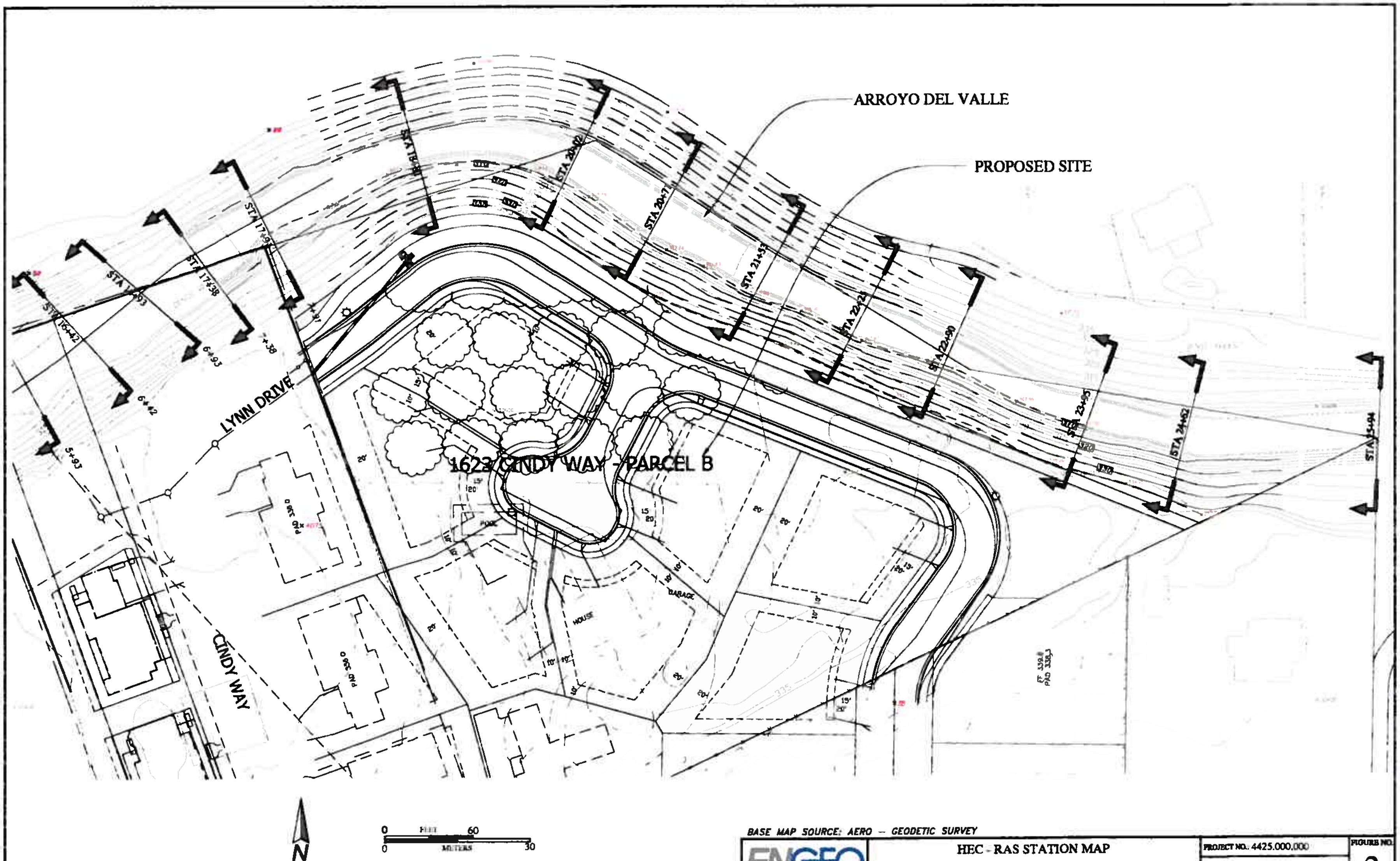


BASE MAP SOURCE: MS STREETS AND TRIPS

ENGEO Expect Excellence	VICINITY MAP ROSELYN ESTATES II PROPERTY PLEASANTON, CALIFORNIA	PROJECT NO.: 4425.000.000 SCALE: AS SHOWN DRAWN BY: SRP CHECKED BY: RPS	FIGURE NO. 1

G:\Drafting\DRAFTING2_Dwg\4425\000\HydroEval\4425000000-HydroEval-1-VicinityMap-0112.dwg Plot Date: 8-01-12 dborde

ORIGINAL FIGURE PRINTED IN COLOR



BASE MAP SOURCE: AERO – GEODETIC SURVEY

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HEC - RAS STATION MAP ROSELYN ESTATES II PROPERTY PLEASANTON, CALIFORNIA	PROJECT NO.: 4425.000.000 SCALE: AS SHOWN DRAWN BY: SRP CHECKED BY: RPS	FIGURE NO. 2

APPENDIX A

HEC-RAS Output

HEC-RAS Plan FEMA WSE bou Locations, User Defined Profile 100-yr

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Vel Left	Shear Chan	Shear LOB
				(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft/s)	(lb/sq ft)	(lb/sq ft)
Arroyo Del Valle	1	2594	100-yr	4600.00	306 49	322 84	324.13	0.002554	6 85	871.09	3 91	2.12	1.11
Arroyo Del Valle	1	2462	100-yr	4600.00	306.09	322.52	323.79	0.002498	6 80	676.78	3 89	2.08	1 09
Arroyo Del Valle	1	2395	100-yr	4600.00	308.24	322 44	323.60	0.002229	6 55	702.01	3 31	1.88	0 84
Arroyo Del Valle	1	2290	100-yr	4600 00	307 91	322.02	323.34	0 002410	7 14	644.08	3.24	1 97	0 82
Arroyo Del Valle	1	2225	100-yr	4600.00	307.24	321.42	323.10	0.004316	7.41	620.38	5.41	3.66	2.06
Arroyo Del Valle	1	2153	100-yr	4600.00	307 74	321.73	322.70	0.001695	6 35	724 87	2 81	1.41	0.61
Arroyo Del Valle	1	2071	100-yr	4600.00	307.10	321 58	322.52	0.001654	6 10	753.95	2.70	1 42	0 57
Arroyo Del Valle	1	2002	100-yr	4600 00	307 24	321.35	322.39	0.001839	6.45	712 68	3.19	1.54	0 75
Arroyo Del Valle	1	1881	100-yr	4600.00	306.87	320.56	322.06	0.003155	6.36	550.25	3 64	2 19	1 05
Arroyo Del Valle	1	1791.9	100-yr	4600.00	306 45	320 71	321.67	0.002051	6 88	668.24	1 82	1.40	0.33
Arroyo Del Valle	1	1738 72	100-yr	4600.00	305.59	320.27	321 52	0.002633	6.62	694 42	4.40	2 31	1 33

HEC-RAS Plan: FEMA WSE bou Locations: User Defined Profile: 100-yr

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Total	Flow Area	Vel Left	Shear Chan	Shear LOB
				(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft/s)	(lb/sq ft)	(lb/sq ft)
Arroyo Del Valle	1	2584	100-yr	7000.00	308.49	326.29	327.86	0.002442	7.45	939.64	4.60	2.53	1.40
Arroyo Del Valle	1	2462	100-yr	7000.00	308.09	325.98	327.53	0.002390	7.39	947.28	4.57	2.49	1.38
Arroyo Del Valle	1	2395	100-yr	7000.00	308.24	325.89	327.35	0.002162	7.20	972.84	3.92	2.30	1.07
Arroyo Del Valle	1	2290	100-yr	7000.00	307.91	325.43	327.09	0.002383	7.74	904.04	3.78	2.43	1.04
Arroyo Del Valle	1	2225	100-yr	7000.00	307.24	324.91	326.86	0.003990	7.94	681.96	6.02	4.23	2.37
Arroyo Del Valle	1	2153	100-yr	7000.00	307.74	325.22	326.47	0.001689	7.02	996.59	3.33	1.76	0.79
Arroyo Del Valle	1	2071	100-yr	7000.00	307.10	325.06	326.29	0.001679	6.91	1027.35	3.15	1.79	0.72
Arroyo Del Valle	1	2002	100-yr	7000.00	307.24	324.83	326.16	0.001616	7.11	985.05	3.79	1.91	0.97
Arroyo Del Valle	1	1881	100-yr	7000.00	306.87	323.98	325.83	0.002981	9.04	774.47	4.32	2.62	1.34
Arroyo Del Valle	1	1791.9	100-yr	7000.00	306.45	324.22	325.42	0.001848	7.44	941.33	2.42	1.64	0.50
Arroyo Del Valle	1	1738.72	100-yr	7000.00	305.59	323.62	325.26	0.002714	7.47	937.58	5.09	2.95	1.67