Appendix I

Hydrology and Water Quality Assessments

ESA

I-1 Castellina Water Management Plan

CASTELLINA WATER MANAGEMENT PLAN



Prepared For:

Kimley-Horn and Associates
1300 Clay Street, Suite 325
Oakland, CA 94612
Contact: Mr. Sandy Vance, ASLA, RLA
(510) 350-0244

Prepared By:

House Moran Consulting, Inc.
(dba as HMC Engineering, Inc.)
846 Centerville Road
Ferndale, CA 95536
Contact: Ms. Annjanette Dodd, PhD, PE
(707) 845-1340

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1 INTRODUCTION

The Castellina Water Management Plan (CWMP) has been prepared at the request of Kimley-Horn and Associates to support the Drainage and Water Balance sections of the Infrastructure Master Plan for the proposed Castellina Development as described in the Castellina Specific Plan.

1.1 Castellina Water Management Plan Purpose

The purpose of this CWMP is to document the hydrologic setting, water management objectives, existing and proposed drainage, and floodplain impacts. An evaluation and assessment of stormwater quality measures is also provided. The key objectives are to develop a conceptual level backbone drainage master plan for the proposed Castellina development and determine impacts the new development would have on existing infrastructure. Since this is a planning level analysis, only conceptual level pipe and inlet geometry and basin design is provided. Final design will be conducted at a later date as each phase of the development moves forward in the design process.

1.2 Proposed Project Location and Description

The proposed project is an approximately 792-acre development located within the east-central San Joaquin Valley, approximately 1-mile north of the City of Madera and 3 miles east of Highway 99 within the Madera County's (County) jurisdiction (Exhibit 1). The project area is bounded by the proposed Avenue 18 alignment in the north, Road 28½ in the east, the proposed Avenue 17 alignment in the south, and Road 27 and the Burling Northern Santa Fe (BNSF) Railroad (RR) to the west. Specifically, the project is located in Sections 5 and 6 of Township 11 South, Range 18 East on the Madera and Kismet USGS 7.5-minute topographic quadrangles.

The proposed project includes 3,072 residential units, comprised of single- and multi-family, and mixed-use residential units along with commercial mixed-uses, an employment park, recreational facilities, parks, and open space areas. The proposed land uses for Castellina are summarized in Figure 1.

Development of the proposed project will occur over multiple phases, with Phase 1 of the project moving forward first. The proposed Phase 1 Conceptual Plan is summarized in Figure 2.

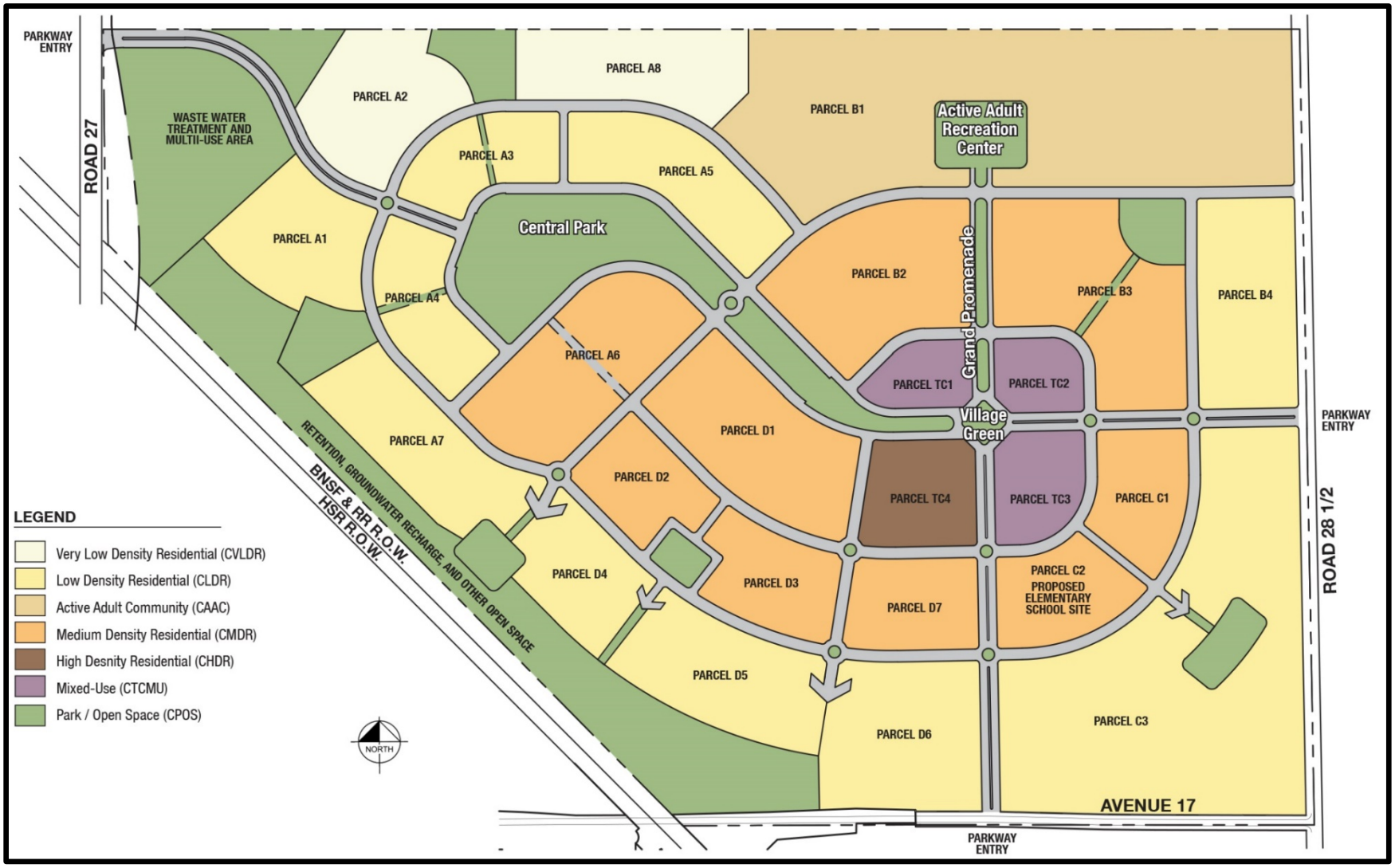


Figure 1. Castellina Proposed Land Use Plan

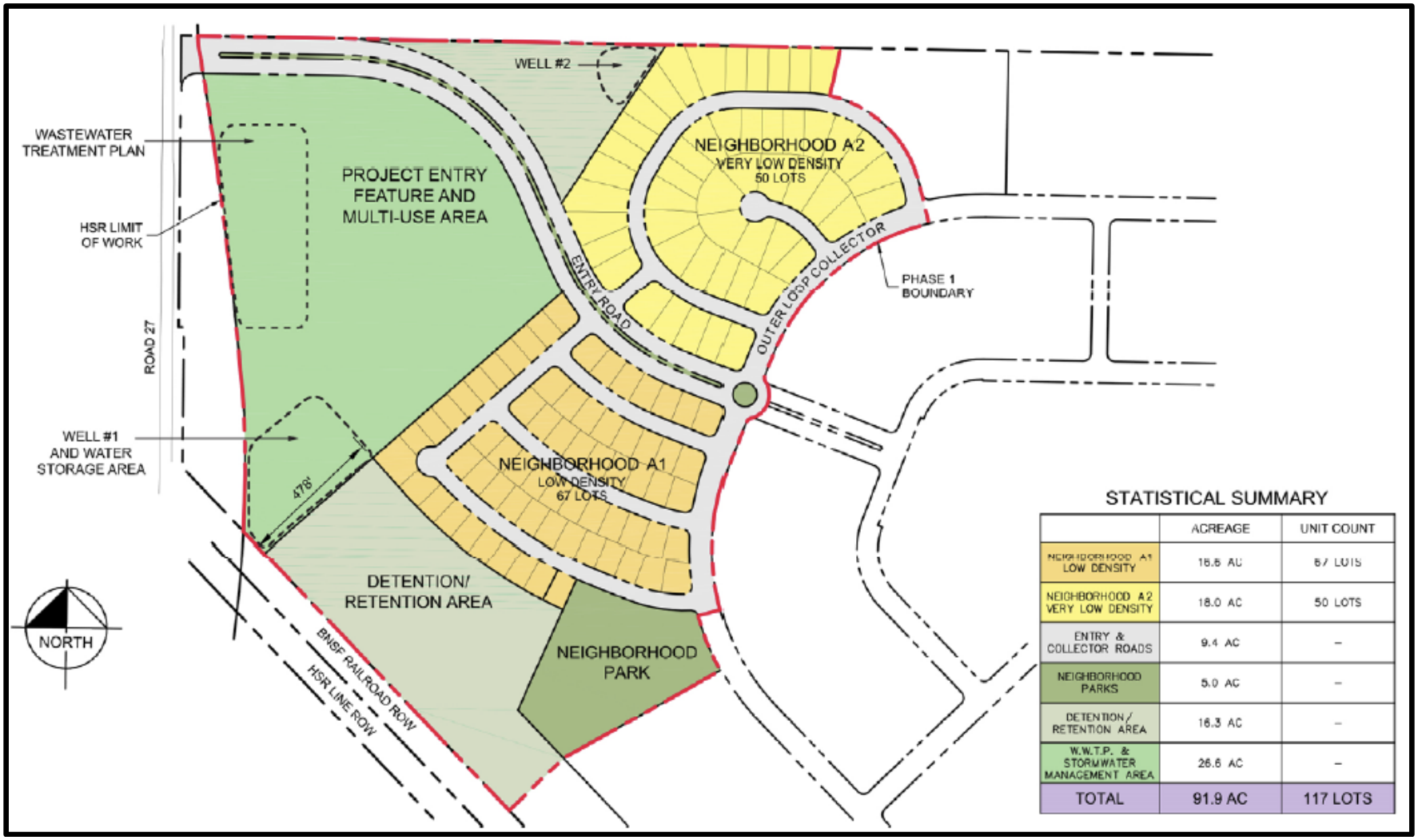


Figure 2. Castellina Phase 1 Conceptual Plan

1.3 Existing Conditions

The project area is comprised of existing fig and almond orchards. Offsite drainage, approximately 3.1 square-miles, enters the site from the north at three locations, one of these is the Schmidt Creek Tributary which flows through the northwest corner of the site. The northern section of the proposed project area drains towards the west and the southern portion drains towards and along the railroad tracks, where it passes through two culverts under the tracks, the remaining drainage ultimately ends up in the Schmidt Creek Tributary (Exhibits 1 and 2). The Schmidt Creek Tributary flows into Schmidt Creek approximately 1.3 miles west of the site. Schmidt Creek confluences with the Fresno River approximately 6.8 miles southwest of the site.

As shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) number 06039C0920E and illustrated on Exhibit 2, the northwest corner of the site is located in a FEMA Zone A. Zone A areas are subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Base Flood Elevations (BFEs) or flood depths are not provided in Zone A areas.

1.4 Drainage and Stormwater Criteria

1.4.1 Conceptual Drainage Plan

The County does not have formal drainage design standards. Most communities in the central valley have adopted policies for drainage and flood protection from major storm events. The County Municipal Code 17.28.030 states that, "*(subdividers) shall provide flood control or drainage systems within his land division to carry storm runoff both tributary to and originating within the land division in accordance with the flood control practices established by the county. Post development drainage flow shall be limited to the predevelopment rate*". Typical collection facilities are designed to handle more frequently occurring events, typically 2-year to 25-year, depending on land use and type of facilities.

The Master Drainage Plan for the Madera Ranchos, Bonadelle Ranchos, and Root Creek Areas prepared for the County in 1984 (Madera County, 1984) provides design criteria for evaluation of drainage alternatives which include:

- Sizing detention basins sufficient to contain a volume of storage equal to that produced by the 100-year runoff produced by two, three-hour, 100-year rainfall storms; and
- All roadway culverts shall be designed to pass the 25-year design storm without overtopping the roadway.

The California Department of Transportation Highway Design Manual Section 830 provides roadway drainage guidelines. The recommended design storm is the 25-year storm for low volume, rural roads with speeds over 45 miles per hour (mph) and the 10-year storm for frontage roads and rural roads with speeds less than 45 mph.

A purpose of the CWMP is to provide a conceptual backbone drainage plan, which represents the major trunklines for the entire Castellina development, thus, to be conservative, a 25-year design storm is used here to size the backbone drainage infrastructure.

So that post development flows leaving the site do not exceed predevelopment rates, detention basins are sized to contain a volume of storage equal to that provided by the 100-year runoff produced by two, three-hour, 100-year rainfall storms as was done in the 1984 Master Drainage Plan, to be conservative. The 1984 Master Drainage Plan is a regional drainage plan developed for areas much larger than Castellina, thus, a single 100-year volume of detention, with appropriate freeboard, should be sufficient.

Note that the system presented here is conceptual and that final design will be conducted as each phase of the development moves forward. The location, sizing and final configuration of the drainage system for future phases will be determined during design. Also, during design, the developer should get agreement from the County on what they want used for the backbone design storm and detention volume.

Since all future drainage will ultimately flow to the Phase 1 areas, it was decided here to choose the conservative values for the Phase 1 elements.

1.4.1 Groundwater Balance Requirements

County Municipal Code 13.110, Large Scale Development Groundwater Balance, requires large scale developments to demonstrate a groundwater balance for the development. The groundwater balance is provided in the Water Supply Assessment (WSA) for Castellina (Tully & Young, 2018). A project meets the County's balance requirements if the project demand, less recharge credits, does not exceed the sustainable yield of the groundwater basin. Recharge credits reflect stormwater recharge of groundwater. In the WSA it was estimated that 309 acre-feet per year (af/yr) of stormwater recharge is required to meet the groundwater balance requirements with a surplus of 25 af/yr. Thus, at least 284 af/yr of recharge is required to meet the groundwater balance requirements with a surplus of zero acre-feet per year.

The collection and recharge of stormwater is the primary approach to achieving a groundwater balance for the project. The proposed detention basins are sized to meet both the County detention requirements as well as the stormwater recharge requirements. Throughout this document, these basins are referred to as Managed Aquifer Recharge (MAR) basins. The MARs provide an integrated stormwater collection system that captures, retains, and infiltrates stormwater collected from the site.

1.4.1 Floodplain Development Requirements

Development within a floodplain is regulated by the Flood Damage and Prevention County Municipal Code 14.60 which provides specific development requirements for both residential and non-residential development. When a development encroaches in a Zone A without a regulatory floodway, as shown in Exhibit 2, the development must demonstrate that it will not increase the base flood elevation more than 1-foot and assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained.

1.4.2 Stormwater Quality Considerations

Development projects in the County are required to comply with two separate storm water National Pollutant Discharge Elimination System (NPDES) permits:

- Phase II Small Municipal Separate Storm Sewer System (MS4) General Permit (Phase II MS4 Permit); and
- General Permit for Discharges of Stormwater Associated with Construction Activity (Construction General Permit) (Order 2009-0009-DWQ).

The Phase II MS4 Permit (currently Order 2013-0001-DWQ) provides Waste Discharge Requirements for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s). The State Water Resources Control Board (SWRCB) is in the process of amending the 2013 Order, the amended Order was adopted by the SWRCB on December 19, 2018, however, the amended Order is not official until the State Water Board clerk certifies the amended Order; which was not done by the time of this report. However, it is anticipated that the amended Order will be certified before final design, thus the requirements of the draft amended Order are used here (SWRCB, 2018).

The Phase II MS4 Permit provides post-construction Low Impact Development (LID) Design Standards for development projects and provides numeric sizing criteria for stormwater retention and treatment (Section E.12.e). Developments are required, among other things, to evapotranspire, infiltrate, harvest/use, and biotreat stormwater to meet at least one of the MS4's hydraulic sizing criteria, implement Site Design Measures, implement Source Controls, and meet baseline hydromodification management measures. Developments in this location are also required to provide hydromodification management.

Stormwater requirements, along with site design measures, include, but are not limited to, the following:

- Implement Site Design Measures designed to infiltrate, evapotranspire, and/or harvest/reuse (i.e., prevent runoff of) the local 85th percentile, 24-hour runoff event;
- After the implementation of Site Design Measures, treat the remaining runoff with LIDS that meet the following design parameters;
    - Maximum surface loading rate of 5 inches per hour, based on the flow rates calculated. A sizing factor of 4% of tributary impervious area may be used.
    - Minimum surface reservoir volume equal to surface area times a depth of 6 inches.
    - Minimum planting medium depth of 18 inches. The planting medium must sustain a minimum infiltration rate of 5 inches per hour throughout the life of the project and must maximize runoff retention and pollutant removal. A mixture of sand (60%-70%) meeting the specifications of American Society for Testing and Materials (ASTM) C33 and compost (30%-40%) may be used.
    - Subsurface drainage/storage (gravel) layer with an area equal to the surface area and having a minimum depth of 12 inches.
    - Underdrain with discharge elevation at top of gravel layer.
    - No compaction of soils beneath the facility, or ripping/loosening of soils if compacted.

  - No liners or other barriers interfering with infiltration.
  - Appropriate plant palette for the specified soil mix and maximum available water use.
- Implement hydromodification management such that the post-project runoff does not exceed estimated pre-project flow rates for the 2-year, 24-hour storm.

LID practices and guiding principles are discussed in the County of Madera Stormwater Resource Plan (Madera County, 2017), however, the County does not currently provide specific design guidance for the sizing of LID facilities to meet the Phase II MS4 permit requirements. Typically LID facilities are distributed throughout a development. The facilities are sized on a site-by-site case. LIDs will be sited and designed during the design phase of the project and are not discussed further in this document.

The Construction General Permit applies to construction of the project. Measures to meet the requirements are prepared and designed as part of the final design phase and are not discussed further in this document.

2 OFFSITE HYDROLOGY

Offsite drainage from the north drains onto the site at three locations as shown in Exhibits 2 through 4. Drainage from the east drains towards Road 28½ where it flows south and away from the project area.

2.1 Methods

Offsite hydrologic analysis was conducted using the U.S. Army Corps of Engineers' HEC-HMS 4.2.1. This model utilizes NOAA Atlas 14 rainfall estimates, NRCS Curve Numbers to estimate watershed losses, Madera County S-Curve Unit Hydrograph (Appendix B), and Muskingum channel routing. The flows determined by the HEC-HMS model are used as inflows to the onsite hydrologic and hydraulic analysis discussed later in this report.

2.1.1 Subbasin Characterization

The offsite contributing drainage areas are illustrated in Exhibits 1 and 3. A total of three subbasins contribute to the offsite drainage (Exhibit 3). The basins were delineated using USGS topography (10-meter resolution). GIS software was used to aid in the basin delineation and development of model input parameters, such as subbasin area, curve numbers, and percent impervious. GIS layers representing subbasin boundaries, soil data, and land use data were used to calculate area-weighted averages for each desired parameter for each subbasin.

2.1.2 Precipitation

The design storm precipitation distribution was obtained from the County of Madera Master Drainage Plan (Madera County, 1984 – excerpts from the plan are provided in Appendix B). The Madera County design storm is based on a three-hour duration. Three-hour rainfall depths were obtained from NOAA Atlas 14 rainfall estimates (Appendix B). The design storms for multiple return periods are summarized in Table 1.

Table 1. Three-Hour Design Storm Distribution for Madera County

Time (hrs)	% of Total Precipitation	Precipitation (inches)	
		25-Year Event	100-Year Event
0	0	0.000	0.000
0.25	3.1	0.033	0.045
0.5	1.8	0.019	0.026
0.75	6.2	0.065	0.091
1	4	0.042	0.058
1.25	7.7	0.081	0.112
1.5	10	0.105	0.146
1.75	5.4	0.057	0.079
2	6.2	0.065	0.091
2.25	10	0.105	0.146
2.5	11.8	0.124	0.172
2.75	27.7	0.291	0.404
3	6.1	0.064	0.089
Total Precipitation (inches)		1.05	1.46

2.1.3 Watershed Abstractions and Percent Impervious

Watershed abstractions were estimated based on runoff Curve Numbers (NRCS, 1986) and percent of impervious area. Curve Numbers (CNs) are determined based on land use and Hydrologic Soil Group (HSG). General land use was obtained from Madera County and is summarized in Exhibit 3. The agricultural areas were assigned, using aerial imagery, as either Open Space in Fair Condition or as Orchard in Fair Condition and residential areas as 1-acre or 2-acre Residential. Soils are classified into four HSGs (A, B, C, and D) from low runoff potential (HSG A) to high runoff potential (HSG D). HSGs were obtained from the NRCS Web Soil Survey (NRCS, 2018) and are summarized in Exhibit 3. Percent impervious values were estimated based on the average percent impervious provided in the NRCS Technical Release 55 (NRCS, 1986). The percent impervious values used were 12% and 0% for rural residential and agricultural/open space, respectively. Watershed abstraction parameters are summarized in Table 2.

Table 2. Offsite Hydrologic Parameters

Subbasin	Area (acres)	% Impervious	CN
A	1742	1.8	75
B	90	0	69
C	145	0	75

2.1.4 Madera S-Curve – Hydrograph Transformation

The transformation method used is based on the S-Curve Unit Hydrograph method County from the Madera Master Drainage Plan (Madera County, 1984 – excerpts from the plan are provided in Appendix B). The method requires subbasin lag time. Lag times were estimated using the U.S. Bureau of Reclamation (USBR) Snyder lag time (Cudworth, 1989):

$$Lg = 26K_n\left(\frac{LL_C}{\sqrt{S}}\right)^{0.33},$$

where

K_n = an average Manning's n roughness coefficient for the principal watercourse of the watershed set to reflect hydraulic conditions during flood events,

L = Length of longest watercourse, in miles,

Lc = Length along L to a point opposite the centroid of the drainage basin, in miles, and

S = overall or average slope of the longest watercourse of the watershed reflecting average conditions (feet/mile).

ArcGIS tools were used to determine Snyder UH parameters. The USBR published a series of Snyder UH lag time relationship tables and plots for different regions in the United States, including southwest desert areas in California; the minimum *Kn* (USBR Exhibit 4-8, see Appendix B) was chosen as a conservative value. The results are summarized in Table 3.

Table 3. Offsite Lag Times

Subbasin	L (miles)	Lc (miles)	S (ft/mile)	Lag Time (hrs)
A	6.0	2.7	31.2	1.5
B	0.6	0.4	61.0	0.3
C	0.5	0.7	6.9	0.5

2.2 Offsite Hydrology Results

Offsite flows were determined for the 25-year and 100-year, 3-hour design storm events. The peak flows for these events are summarized in Table 4. Additional offsite hydrologic model information is provided in Appendix B.

Table 4. Offsite Peak Flows

Basin	Peak Flows (cfs)	
	25-Year	100-year
A	48	155
B	1	28
C	8	11

3 ONSITE HYDROLOGIC AND HYDRAULIC MODELING

Hydrologic and hydraulic modelling for the proposed project site was conducted using Computational Hydraulics, Inc's (CHI) PCSWMM version 7.2. PCSWMM is an interface used to set up and run the U.S. Environmental Protection Agency (USEPA) Stormwater Management Model (SWMM). SWMM is used for single events (design storms) or long-term simulations of water runoff to design drainage systems. SWMM utilizes the dynamic wave method, which solves the one-dimensional Saint-Venant equations for continuity and momentum for model conduits. This method enables the simulation of pressurized flow in closed conduits. Dynamic wave routing accounts for channel storage, backwater, entrance/exit losses, flow reversal, and pressurized flow.

3.1 Subbasin Characterization

The proposed drainage areas and model layout of the backbone system were designed based on proposed grading and land use provided by Kimley-Horn and Associates. The proposed drainage system has been designed to mimic existing flow directions where possible. Under proposed conditions, the majority of the drainage flows towards the open space area along the railroad tracks and into MAR #1, #2, and #3. Overflow from these MARs flows along the railroad tracks, towards the northwest, ultimately ending up in the Schmidt Creek Tributary. The remaining northern section drains towards the west into MAR #4. Overflow from MAR #4 drains towards the northwestern corner of the site into the Schmidt Creek Tributary.

3.2 Peak Flow Calculations

Parameters used to estimate onsite peak flows for each drainage area are runoff Curve Numbers (NRCS, 1986), percent of impervious area, overland Manning's roughness (*n*), and depression storage in inches. Curve Numbers (CNs) are determined based on land use and HSG. Proposed land use is shown in Figures 1 and 2. HSGs were obtained from the NRCS Web Soil Survey (NRCS, 2018) and are summarized in Exhibit 3. Percent impervious, Manning's *n*, and

depression storage values were estimated based values provided in the NRCS Technical Release 55 (NRCS, 1986) for each of the land use types. The parameters used are summarized in Table 5. These parameters were weighted within each subbasin. Physical characteristics of the subbasins that are used include area, overland flow length, and subbasin slope. Parameters, subbasin characteristics, and subbasin layouts for existing and proposed conditions are provided in Appendix C and on Exhibits 2 and 4. Phase 1 is a combination of existing and proposed conditions (Exhibit 5).

Precipitation for the onsite 25-year and 100-year events were determined the same as for offsite hydrology (Section 2.1.2).

Table 5. Onsite Hydrology Parameters

Land Use	Curve Number				Impervious (%)	Manning's *n*	Depression Storage (in)
	A	B	C	D			
Very Low Density	54	70	80	85	30	0.045	0.35
Low Density	57	72	81	86	35	0.045	0.33
Active Adult Area	57	72	81	86	35	0.040	0.33
Medium Density	61	75	83	87	41	0.040	0.30
High Density	77	85	90	92	75	0.035	0.17
Multi Use	89	92	94	95	85	0.030	0.11
School	77	85	90	92	65	0.030	0.17
New Open Space	39	61	74	80	5	0.060	0.50
Park	39	61	74	80	5	0.060	0.50
Treatment	89	92	94	95	85	0.030	0.11
Road	98	98	98	98	95	0.020	0.11
Existing Orchard	43	65	76	82	5	0.060	0.38
Existing Open Space	49	69	79	84	5	0.060	0.38

A Manning's *n* value of 0.013 is used for culverts and pipes (reinforced concrete pipes, RCPs) and 0.035 for ditches. For offsite and flow paths in the northwest corner, Manning's *n* ranges between 0.045 and 0.05.

3.3 Proposed Backbone Drainage Layout

Existing and proposed conditions models were developed. The existing conditions layout is shown in Exhibit 2 and Appendix C, including natural cross sections used. The proposed backbone system for the full buildout of the development and for Phase 1 were developed based on the proposed land uses (Figure 1 and 2) and the 25-year storm event, except in the northwestern corner. Since the northwestern corner is a FEMA Zone A, the 100-year storm event was used. The system has been designed mostly using Reinforced Concrete Pipes (RCPs), with some box culverts where slopes flatten out, and grass lined ditches. See Exhibits 4 and 5 and Appendices C and D for system details and model results.

County code requires that the development demonstrate that it will not increase the base flood elevation more than 1-foot and assure that the flood carrying capacity within the altered portion of Schmidt Creek Tributary is maintained. There is an existing 6'x3' corrugated metal culvert under Road 27

Ultimately, as with existing conditions, all flows are routed via existing culverts or to the Schmidt Creek Tributary. MARs (aka detention basins) have been incorporated into the proposed drainage network to mitigate post-project peak flows to pre-project levels and allow for stormwater recharge.

3.4 MAR Design

The County requires that post development flows be limited to the predevelopment rate. The MARs have been sized to contain a volume of storage equal to the runoff from two, three-hour, 100-year rainfall storms. As discussed above, this is in accordance with the 1984 Master Drainage Plan (Madera County, 1984).

MAR depths are based on the depth needed to allow for groundwater recharge. A letter from Kenneth D. Schmidt and Associates dated March 19, 2018 describes the subsurface geologic conditions of the site (Appendix E). The area along the HSR tracks is most ideal for recharge. There is a surficial hardpan layer or fine-grained deposits within the uppermost 10 to 20 feet. Beneath this surficial material is an extensive thick sand layer. Water recharged into this sand layer will readily reach the groundwater. Soil borings (Appendix E) in this area indicate the sand layer is reached between approximately 10 to 25 feet below the ground surface. Three MARs are sited in the open space area along the HSR tracks (Exhibit 4). Since the majority of Castellina drains to MAR #1 and MAR #2, these have been sized at a depth of 25-feet to allow for stormwater recharge into the groundwater. MAR #3 is 8-feet deep and is not assumed to recharge groundwater. The water that drains to MAR #3 could be routed and drained to MAR #1 if wanted. MAR #4 is not in an ideal location to recharge groundwater and has been designed to be 11-feet deep to allow for enough drop in the system.

MAR infiltration rates are estimated from the soil type at depth. For MARs #1, #2, and #4, the boring logs indicate sandy soil. For MAR #3, the soil type at depth is loamy sand. PCSWMM models infiltration using the Green and Ampt method. Infiltration parameters are the saturated hydraulic conductivity, suction head, and initial moisture deficit (

Table 6). These parameters were obtained from the gsshawiki.com for sand and loamy sand (Appendix E). A factor-of-safety of six (6) was used on the saturated hydraulic conductivity. In-situ soil testing will be required to validate infiltration rates for final design.

Table 6. Green and Ampt Infiltration Parameters

MAR	Saturated Hydraulic Conductivity (in/hr)	Suction Head (in)	Initial Moisture Deficit
1	1.54	1.95	0.437
2	1.54	1.95	0.437
3	0.195	2.41	0.437
4	1.54	1.95	0.437

Source: Infiltration Parameter Estimates. www.gsshawiki.com/Infiltration:Parameter_Estimates

An iterative process was done to size the MARs so that the maximum percent full for each MAR is approximately 50% during the 100-year, three-hour storm event. All runoff from the project area, except the Project Entry and Multi-Use Area shown on Figure 2, is routed to one of the four MARs. The MAR details are summarized in Table 7 and Table 8 and Appendix F.

Table 7. Phase 1 MAR Details

MAR[1] #	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Shape	Top Length[2] (ft)	Top Width[2] (ft)	Surface Area[2] (AC)	Volume (AC-FT)	Max % Full
1	280	290	10	Rectangle	150	150	0.52	1.9	36
4	279	290	11	Rectangle	130	130	0.39	1.2	54

[1]All basins sized using 3:1 side slopes
[2]Includes 30-ft buffer

Table 8. Full Buildout MAR Details

MAR[1] #	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Shape	Top Length[2] or Height (ft)	Top Width[2] or Base (ft)	Surface Area[2] (AC)	Volume (AC-FT)	Max % Full
1	265	290	25	Rectangle	420	325	3.13	40.9	54
2	271	296	25	Rectangle	380	300	2.62	31.9	52
3	278	286	8	Rectangle	255	185	1.08	4.9	50
4	279	290	11	Triangle	282	375	1.21	8.7	51

[1]All basins sized using 3:1 side slopes
[2]Includes 30-ft buffer

The MAR sizing is conceptual only. Detailed soil borings would need to be done to estimate in-situ infiltration rates, depth of hardpan layer, and depth to the thick sand layer.

3.5 Results

3.5.1 Impacts on Existing Infrastructure

The entire backbone system has been sized to pass the 25-year design storm. The MARs have been sized to detain two, 100-year, three-hour events for all areas except the Project Entry and Multi-Use Area on Figure 2. The onsite peak flows are summarized in Table 9 for Phase 1 and

full buildout. With detention, the project does not cause an increase in peak flows compared to the predevelopment condition.

Table 9. Summary of Existing and Proposed Onsite Peak Flows

Location	Existing Peak Flow (cfs)		Phase 1 Peak Flow (cfs)		Full Buildout Peak Flow (cfs)	
	100-year	25-year	100-year	25-year	100-year	25-year
J-K3	84	36	59	20	70	20
Sub-E	9	3	9	3	0	0
Sub-F	27	9	27	9	0	0
Sub-G	21	6	21	6	0	0

3.5.2 Impacts to the Floodplain

The County requires that the development demonstrate that it will not increase the base flood elevation more than 1-foot and assure that the flood carrying capacity within the altered portion of Schmidt Creek Tributary is maintained. In addition, the project will need to connect to the proposed HSR culvert under Road 27. This culvert routes Schmidt Creek Tributary flows under Road 27.

Offsite flows occur at three locations (Exhibit 2). The offsite HEC-HMS hydrology model resulted in a 100-year peak flow of 155 cfs for the Schmidt Creek Tributary entering the site. This is less than the FEMA effective flow reported in the Flood Insurance Study (FIS) for Madera County (FEMA, 2008) which uses the flow at the confluence of Schmidt Creek, over 1.3 miles downstream of Castellina. The hydrology model presented here is more detailed than what was used by FEMA and is more representative of the flows in the Schmidt Creek Tributary as it enters Castellina. The hydrographs generated by the offsite HEC-HMS hydrology model were the used to size the culvert under the entrance road. All offsite flows are routed via a ditch and wide flow path along the northern edge of the property and then into a 10’x3’ reinforced concrete box culvert under the entrance road. The flows are then routed through a wide flow path between the entrance road and the 6’x3’ CMP arch culvert under Road 27 (Figure 3).

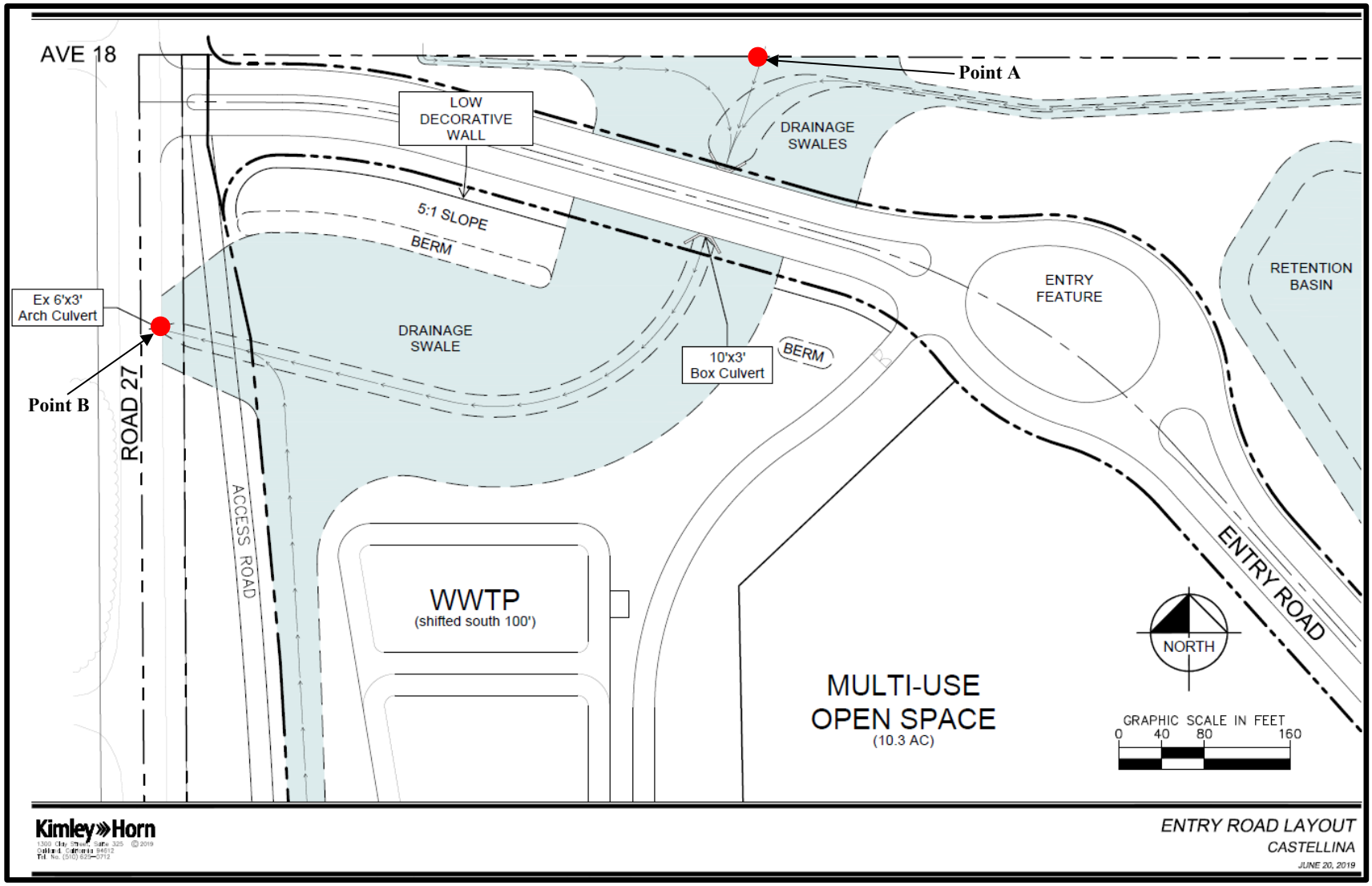


Figure 3. Drainage at Northwestern Corner of Project Area (See Appendix C and D for Model Details)

The 100-year event is contained within the wide flow paths shown in Figure 3 (cross sections are provided in Appendix C). Low flow ditches recommended along the centerline. The proposed base flood elevations do not increase by more than 1-foot (Table 10).

Table 10. 100-Year Water Surface Elevations

Location		Elevation (ft)			Difference from Existing (ft)	
Figure 3	PCSWMM Model Node	Existing	Phase 1	Full Buildout	Phase 1	Full Buildout
Point A	J-ASchTrib	281.6	282.2	282.4	+0.6	+0.8
Point B	J-K3	281.6	281.9	282.1	+0.3	+0.5

3.5.1 Groundwater Balance Impacts

The WSA estimated that 309 af/yr of stormwater recharge is required to meet the groundwater balance requirements with a surplus of 25 af/yr. Thus, at least 284 af/yr of recharge is required to meet the groundwater balance requirements with a surplus of zero acre-feet per year. To estimate the amount of recharge from MAR #1 and MAR #2, a long term simulation was created to model the average annual infiltration using the design presented above. MAR #3 and MAR #4 are not designed for stormwater recharge. The long term simulation utilizes daily average precipitation and evaporation and models the system over an average year.

Average daily precipitation was obtained for Madera County from the Western Regional Climate Center (WRCC, 2018a) and is summarized in

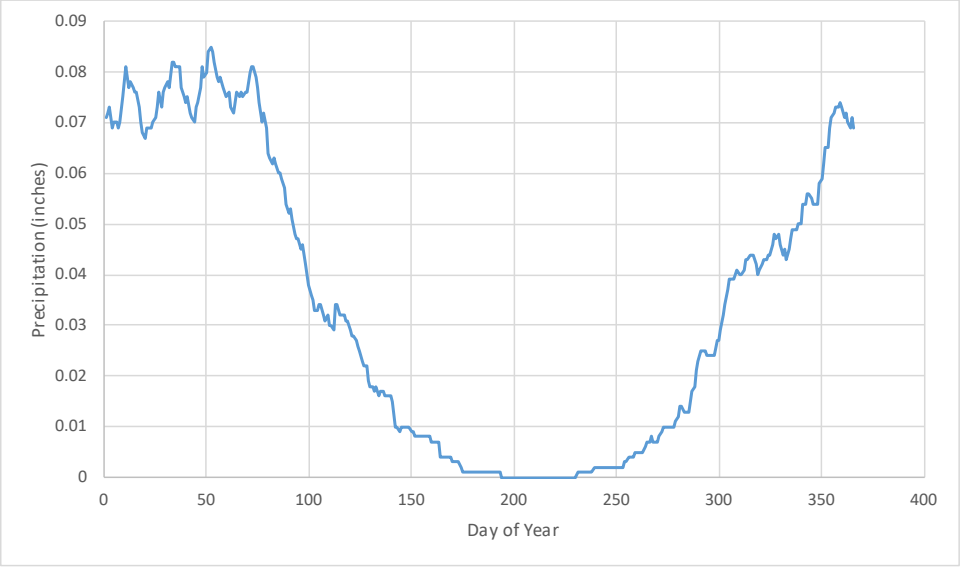


Figure 4. Daily evaporation rates were also obtained from the WRCC (WRCC, 2018b). The closest evaporation station is located at Friant, CA, approximately 20 mile to the east of Castellina. The daily evaporation rates are summarized in Table 11.

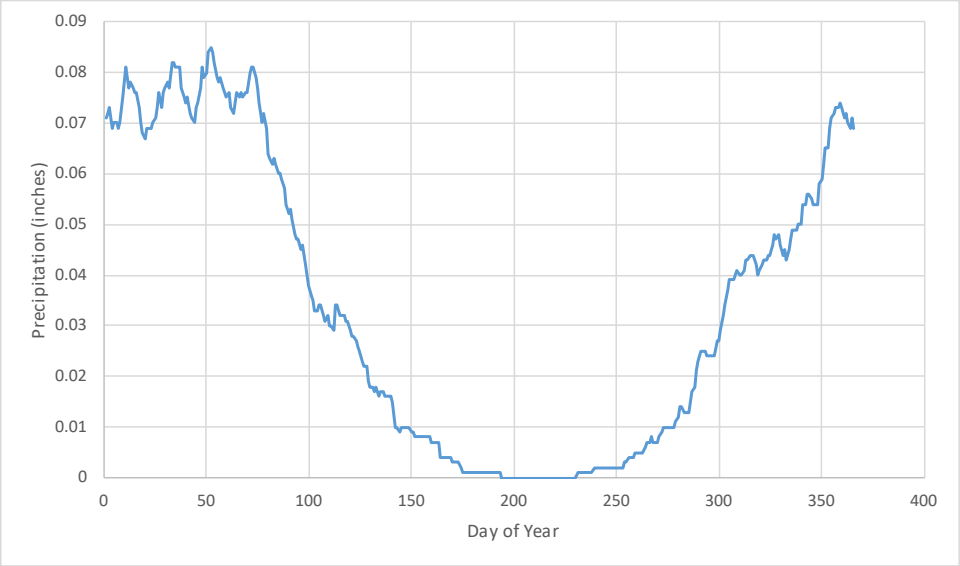


Figure 4. Average Daily Precipitation, Madera County, CA (starts January 1st and ends December 31st).

Table 11. Daily Evaporation Rates by Month

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rate (in)	0.035	0.057	0.092	0.147	0.228	0.302	0.338	0.302	0.225	0.139	0.065	0.033

The total stormwater recharge over an average year from MAR #1 and MAR #2 is 403 af/yr (Table 12), which meets the groundwater balance requirements of the County.

Table 12. Summary of Stormwater Recharge

MAR #	Total Inflow (af/yr)	Evaporated (af/yr)	Infiltrated (af/yr)
1	265	29	236
2	188	21	167
Total	453	50	403

4 SUMMARY

The CWMP has been developed to support the Drainage and Water Balance sections of the Infrastructure Master Plan for the proposed Castellina Development. On and offsite hydrologic and hydraulic modeling has been done to develop a conceptual level backbone system and evaluate the impacts the proposed project has on existing infrastructure, the Schmidt Creek Tributary floodplain, and groundwater balance requirements. The development is proposed in

phases, with Phase 1 moving forward first. The analyses include Phase 1 and full buildout scenarios.

The backbone system has been sized for the 25-year storm which is consistent with the Master Drainage Plan (Madera County, 1984). Since the Master Drainage Plan was a regional plan, this design storm may be excessive for Castellina. It is recommended that this be discussed with County staff to get concurrence on the design storm required. The portion of the system that routes the Schmidt Creek Tributary flows has been designed for the 100-year FEMA event to assure that the flood carrying capacity is maintained and base flood elevations do not increase by more than 1-foot.

The MARs (detention basins) have been sized to detain a volume approximately equal to two, three-hour, 100-year events, which is consistent with the Master Drainage Plan (Madera County, 1984). Since the Master Drainage Plan was a regional plan, this volume may be excessive for Castellina. It is recommended that this be discussed with County staff to get concurrence on the detention volume required. The MARs have been sized so that 1) the post project peak flows do not exceed the pre project peak flows and 2) the groundwater balance requirement is met.

Note, since this is a planning level analysis, only planning level pipe, inlet geometry, and storage basin design is provided here. Final design will be conducted at a later date as each development moves forward in the design process. In-situ soil and infiltration tests are required to validate the soil parameters and depth to the thick sand layer.

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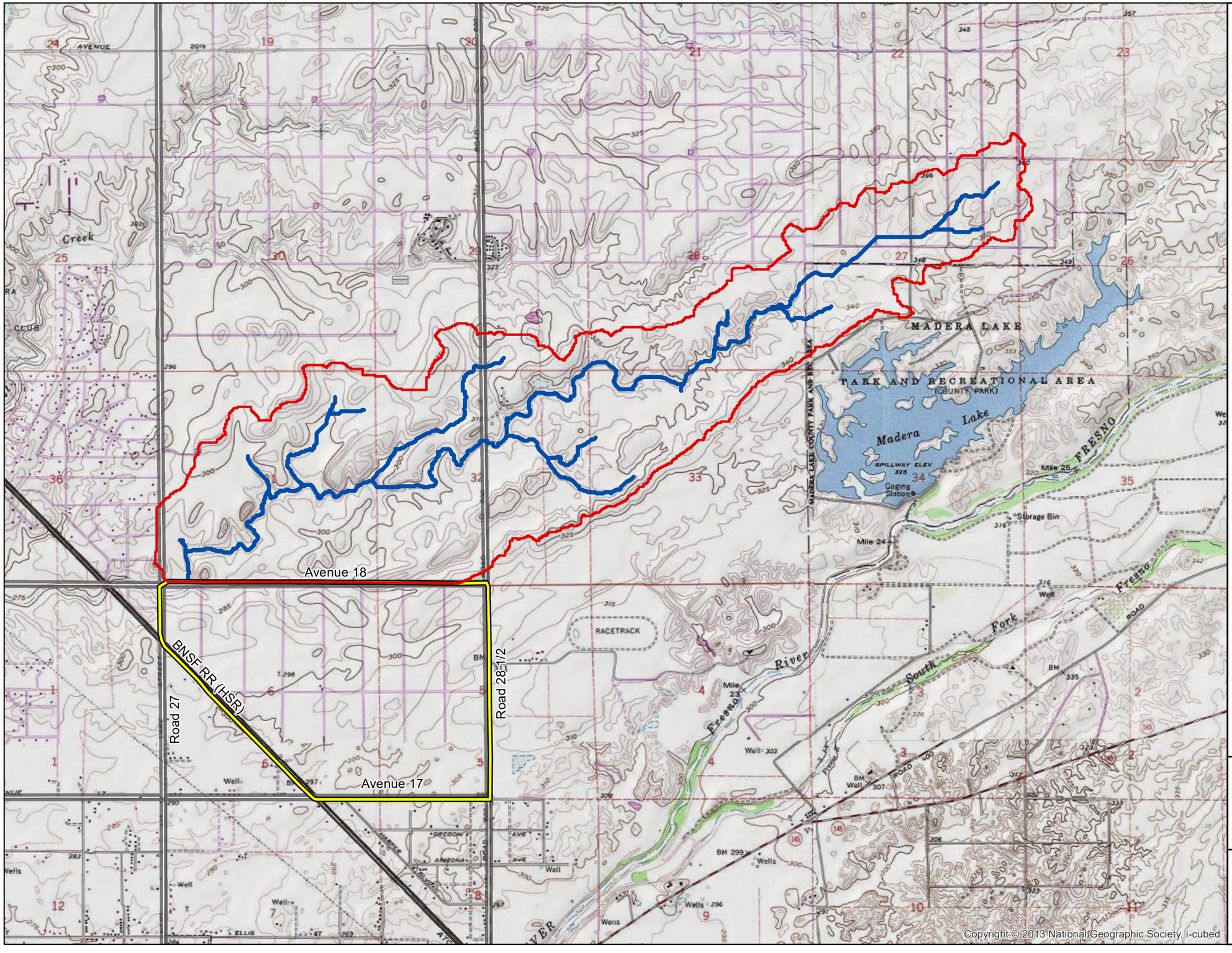
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WRCC. 2018b. Western U.S. Climatological Data Summaries (LCD) Summaries, Western Regional Climate Center (WRCC), https://wrcc.dri.edu/Climate/comp_table_show.php?stype=pan_evap_avg. Accessed August 15, 2018.

Appendix A – Exhibits





Legend

- Offsite Drainage
- Project Boundary
- Schmidt Creek Tributary

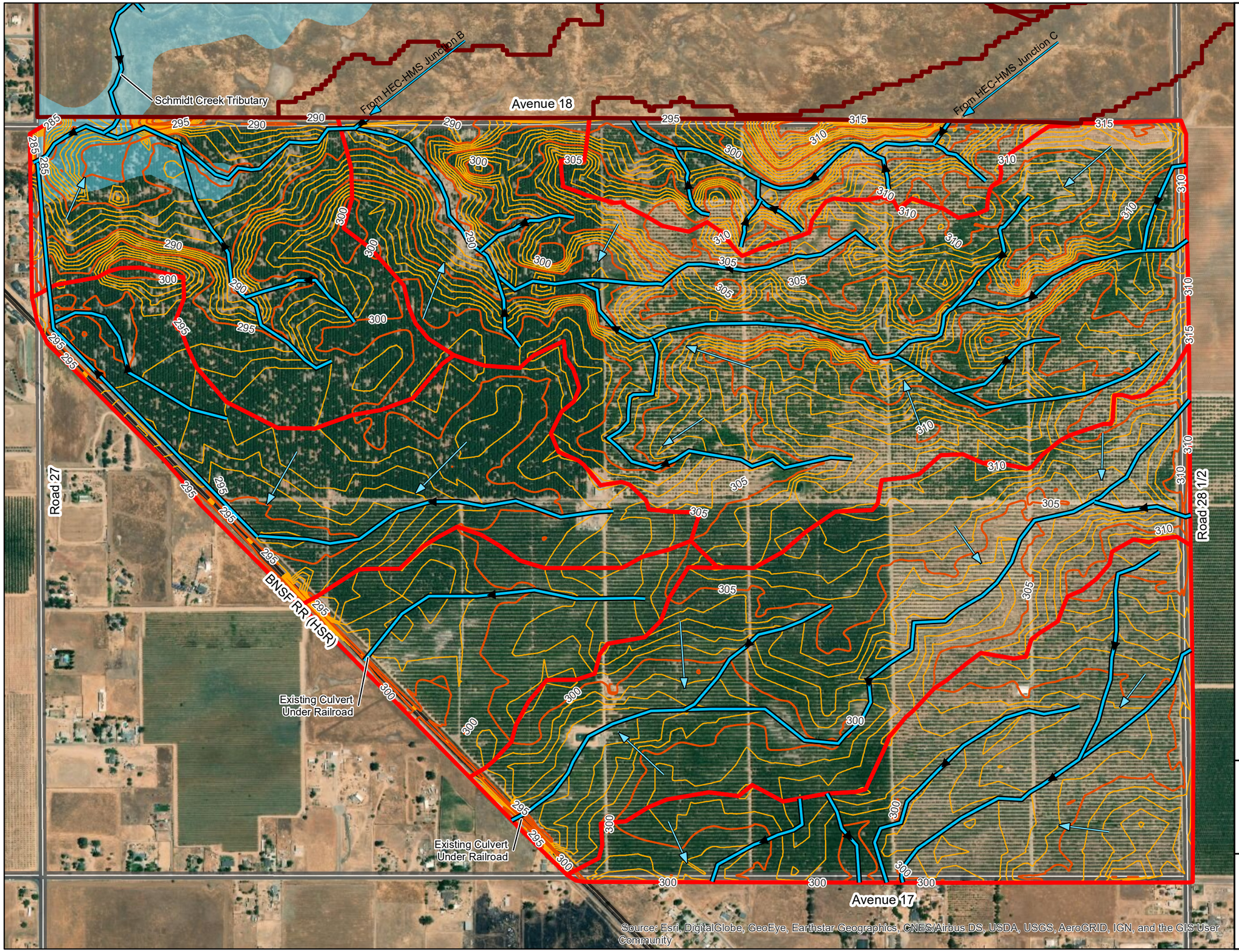
0 1,000 2,000

1 in = 4,000 ft

Exhibit 1
Castellina Water Management Plan
Vicinity Map

Prepared By:
House Moran Consulting, Inc.
Water Resources and Environmental Engineering
10399 Double R Boulevard Suite 110
Reno, NV 89521
Office: (775) 293-4000

Prepared On: 4/3/2019



Legend

- Onsite Flow Path
- Flow Direction
- Minor Contour
- Major Contour
- Offsite Drainage Area
- Onsite Drainage Area
- FEMA Flood Zone A

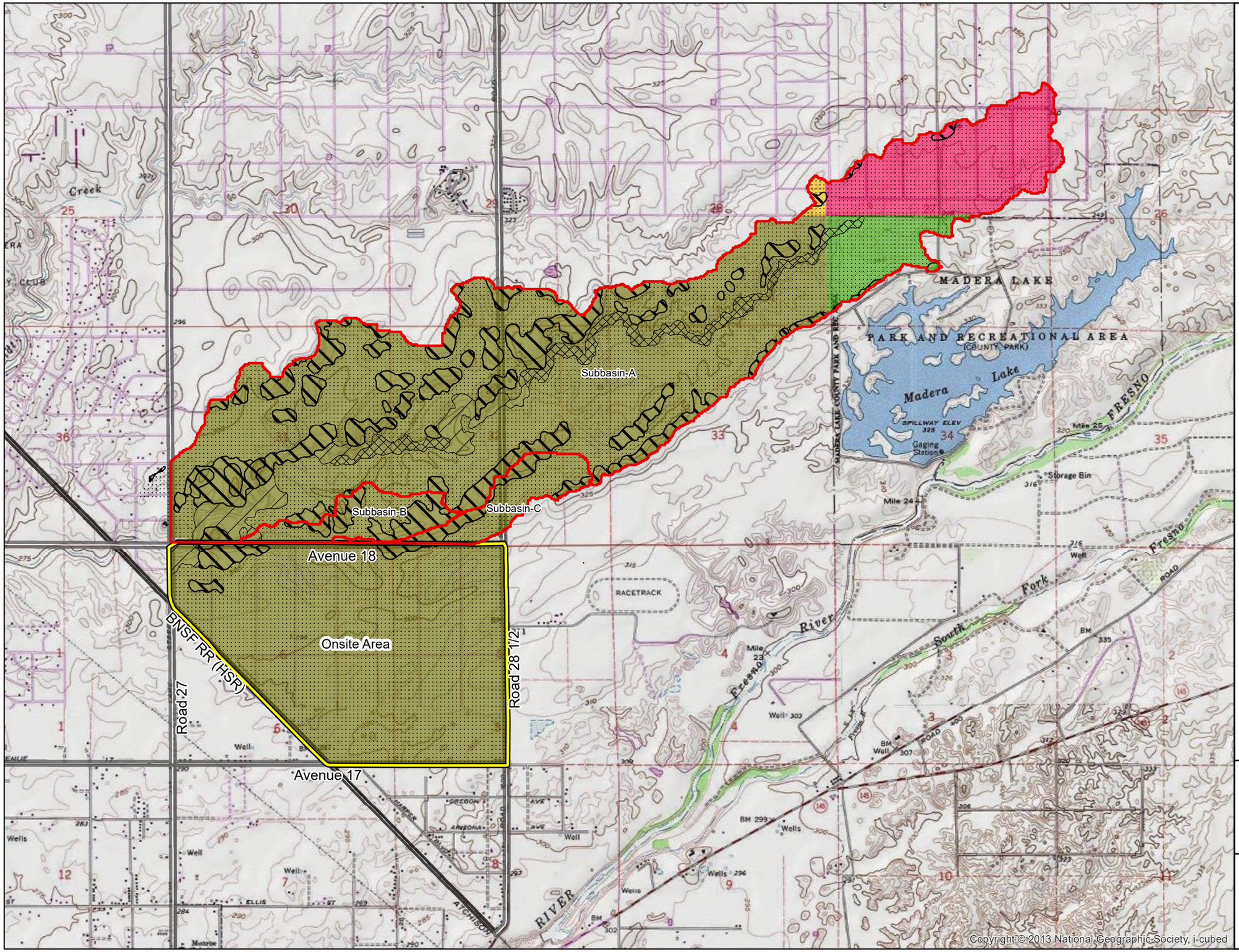
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1 in = 4,000 ft

Exhibit 2
Castellina Water Management Plan
Existing Drainage

Prepared By:
House Moran Consulting, Inc.
Water Resources and Environmental Engineering
10399 Double R Boulevard Suite 110
Reno, NV 89521
Office: (775) 293-4000

Prepared On: 6/20/2019



Legend

- Drainage Areas
- Project Boundary
- Hydrologic Soil Group A
- Hydrologic Soil Group B
- Hydrologic Soil Group C
- Hydrologic Soil Group D
- Agriculture
- Agricultural Exclusive
- Open Space
- Rural Residential

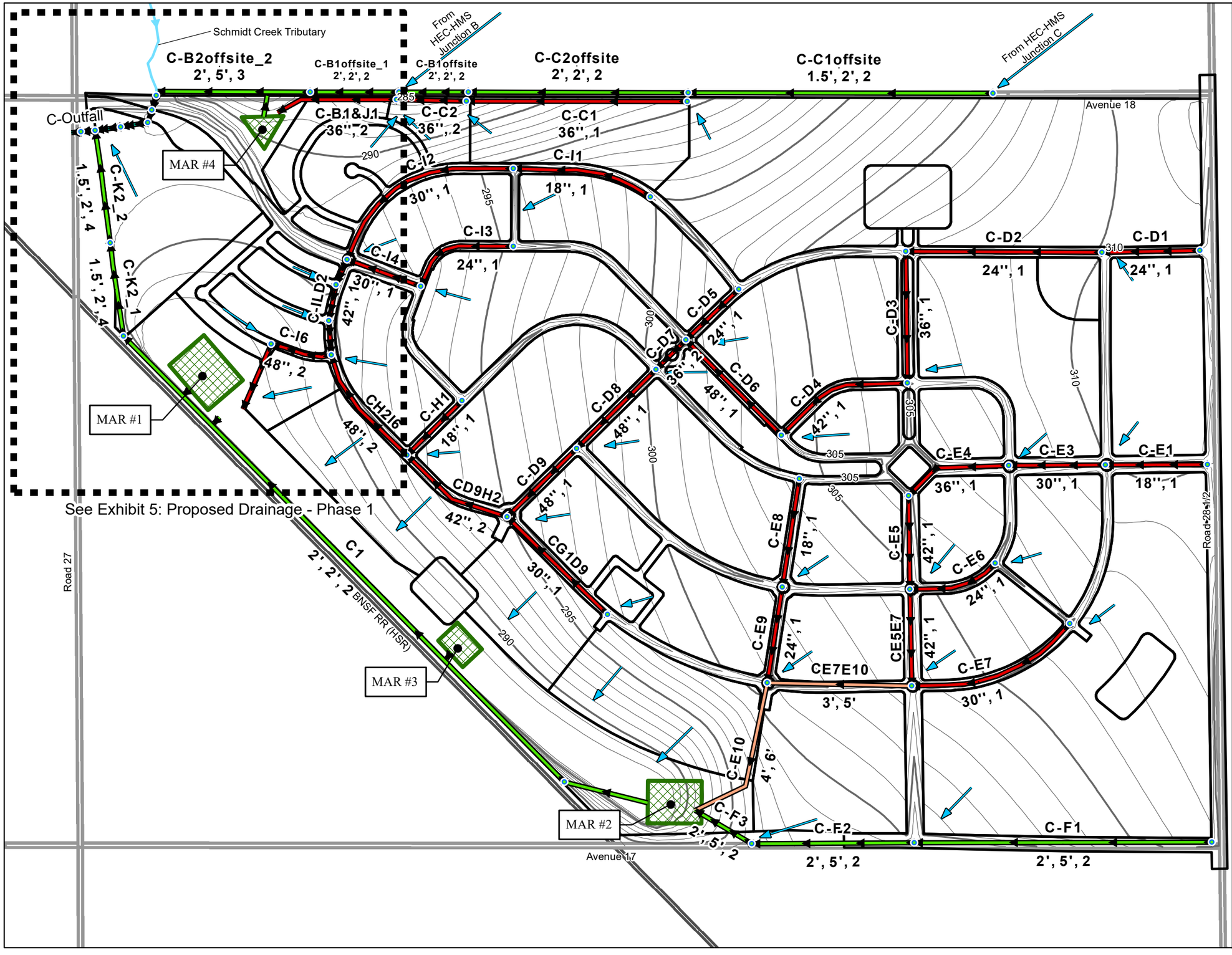
0 2,000 4,000

1 in = 4,000 ft

Exhibit 3
Castellina Water Management Plan
Offsite Model Layout and Existing Land Use

Prepared By:
House Moran Consulting, Inc.
Water Resources and Environmental Engineering
10399 Double R Boulevard Suite 110
Reno, NV 89521
Office: (775) 293-4000

Prepared On: 4/11/2019



Legend

- Natural Channel
- Circular Pipe - Diameter, Barrels
- Rectangular Closed Pipe - Dimensions
- Compacted Dirt Trapezoidal Channel - Depth, Bottom Width, SS
- Flow Direction
- Storage Basins
- Major Contour
- Minor Contour

Note: Drainage Layout is conceptual only.

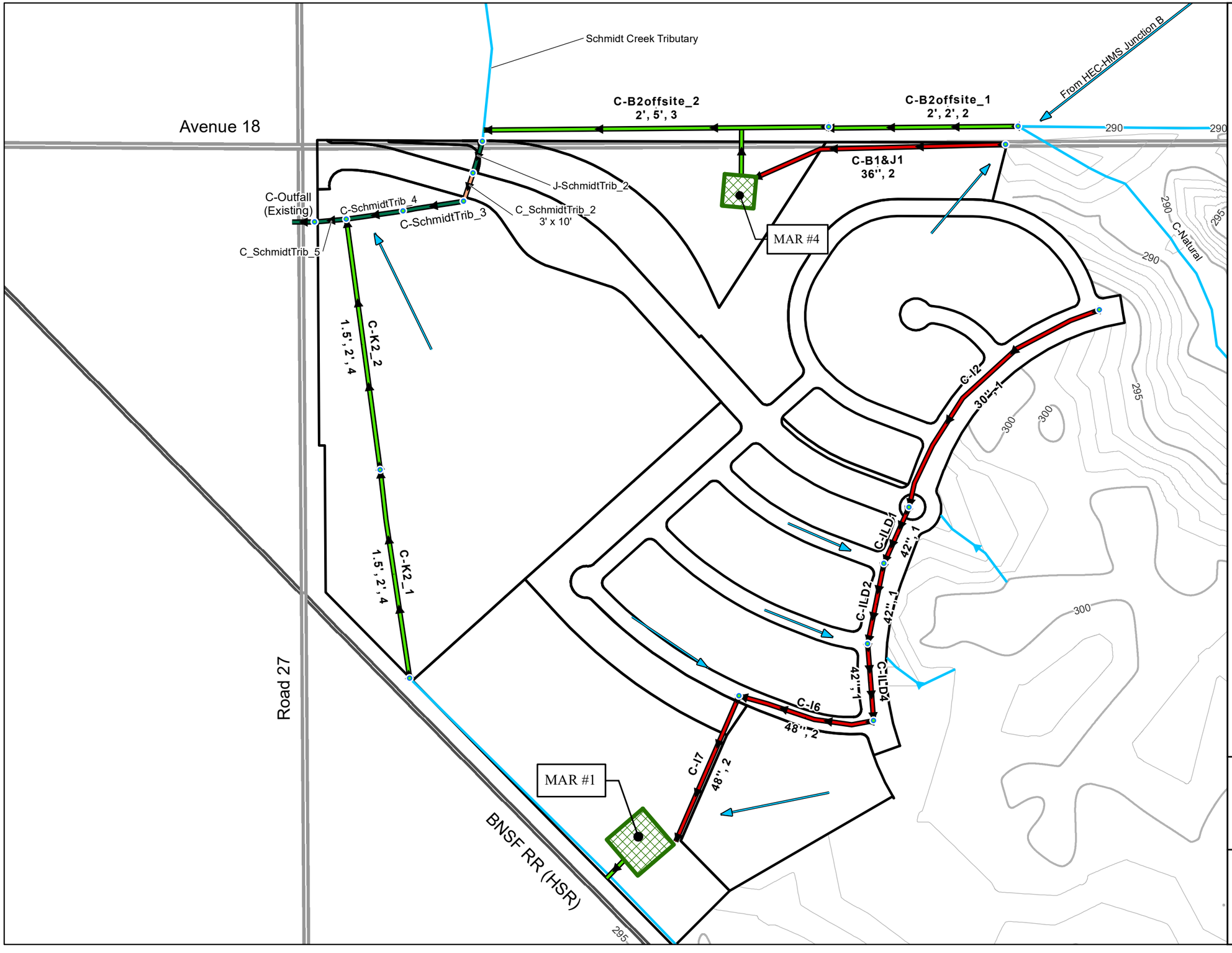
0 500 1,000

1 in = 4,000 ft

Exhibit 4
Castellina Water Management Plan
Proposed Drainage - Full Buildout

Prepared By:
House Moran Consulting, Inc.
Water Resources and Environmental Engineering
10399 Double R Boulevard Suite 110
Reno, NV 89521
Office: (775) 293-4000

Prepared On: 6/20/2019



Legend

- Storage Basins
- Proposed Flow Direction
- Circular Pipe - Diameter, Barrels
- Rectangular Closed Pipe - Dimensions
- Grass Trapezoidal Channel - Depth, Bottom Width, SS
- Natural Channel
- Flow Path
- Proposed Phase 1 Development
- Minor Contour
- Major Contour

Note: Drainage Layout is conceptual only.

0 200 400

1 in = 4,000 ft

Exhibit 5
Castellina Water Management Plan
Proposed Drainage - Phase 1

Prepared By:
House Moran Consulting, Inc.
Water Resources and Environmental Engineering
10399 Double R Boulevard Suite 110
Reno, NV 89521
Office: (775) 293-4000

Prepared On: 6/20/2019

Appendix B – HEC-HMS Model Inputs

EXCERPTS FROM MADERA 1984 MASTER DRAINAGE PLAN

COUNTY OF MADERA
CALIFORNIA

MASTER DRAINAGE PLAN
FOR
MADERA RANCHOS
BONADELLE RANCHOS
ROOT CREEK

GILL & PULVER ENGINEERS INC.
1300 ETHAN WAY, SUITE 675
SACRAMENTO, CALIFORNIA 95825

JUNE 1984
F I N A L

COUNTY OF MADERA

CALIFORNIA

MASTER DRAINAGE PLAN
FOR
MADERA RANCHOS
BONADELLE RANCHOS
ROOT CREEK

GILL & PULVER ENGINEERS INC.
1300 ETHAN WAY, SUITE 675
SACRAMENTO, CALIFORNIA 95825

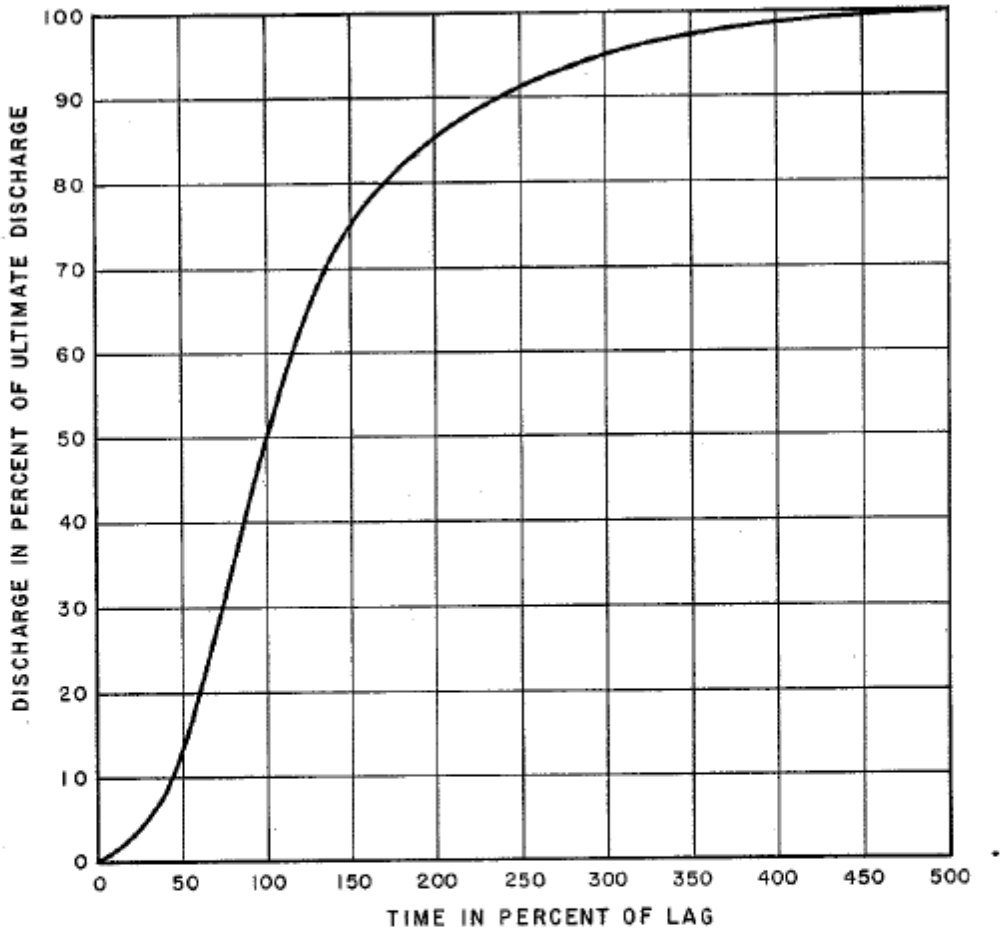
JUNE 1984
F I N A L

A unit hydrograph represents a volume of one inch of runoff from a specific basin from a rainstorm of a specified duration. The unit hydrograph can be used to help estimate the runoff from hypothetical storms and to reconstruct the runoff patterns from known historical storms.

A regional approach was used to develop unit hydrographs based on an s-curve unit hydrograph originally developed for Cottonwood Creek and successfully applied to streams in the area. Figure 3 shows the S-curve.

Rainfall-intensity-duration curves were developed from long term rainfall data, and are shown on Figure 4. A storm duration of three hours was selected for determining peak flow as historically, a storm of this duration, provides the highest peak flow in the Madera region. The adopted three hour depth-area-duration and rainfall distribution is shown in Figure 5.

Storms of four recurrence intervals were selected for study. The recurrence interval is the average interval in years between the occurrence of a specified size of storm and an equal or larger storm. For example, an event having a recurrence interval of 100 years has a probability of 1 percent of occurring in any one year.

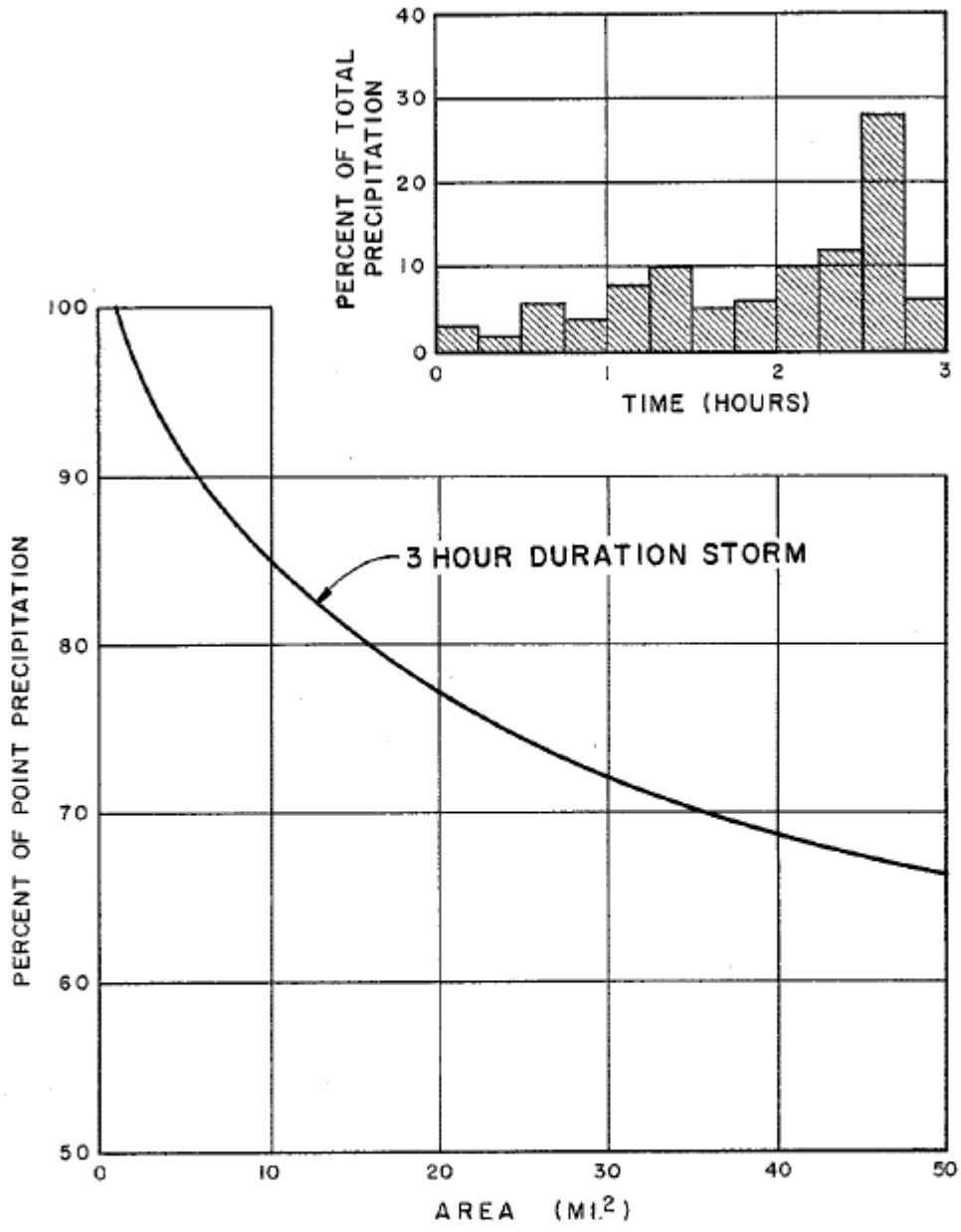


MADERA STORM DRAINAGE PLAN
ROOT CREEK AREA

S-CURVE

GILL & PULVER ENGINEERS INC.
Sacramento, California

FIGURE 3



MADERA STORM DRAINAGE PLAN
ROOT CREEK AREA

DEPTH–AREA–DURATION AND PRECIPITATION DISTRIBUTION CURVES

GILL & PULVER ENGINEERS INC.
Sacramento, California

FIGURE 5

CRITERIA

The following criteria were utilized in the selection and evaluation of drainage alternatives.

Detention Basins - Detention basins are water storage facilities located along the alignment of a waterway. A detention basin has the capability to store water during a period of high rainfall runoff which will reduce the maximum flow rate in the downstream channel by prolonging flow at a lower flow rate. Detention basin capacity shall be sufficient to contain a volume of storage equal to that produced by the 100-year runoff produced by two three hour 100-year rainfall storms. The detention basins should have the capability to be completely drained in 48 hours.

Roadway Culverts - All roadway culverts shall be designed to pass the 25-year flood without overtopping the roadway.

Channels - All channels shall be capable of passing the 25-year discharge in the banks with velocities less than five feet per second in unimproved channels.

SNYDER LAG TIME REFERENCE INFORMATION

Flood Hydrology Manual

A Water Resources Technical Publication

by
Arthur G. Cudworth, Jr.

Surface Water Branch
Earth Sciences Division

FIRST EDITION 1989



United States Department of the Interior
Bureau of Reclamation
Denver Office

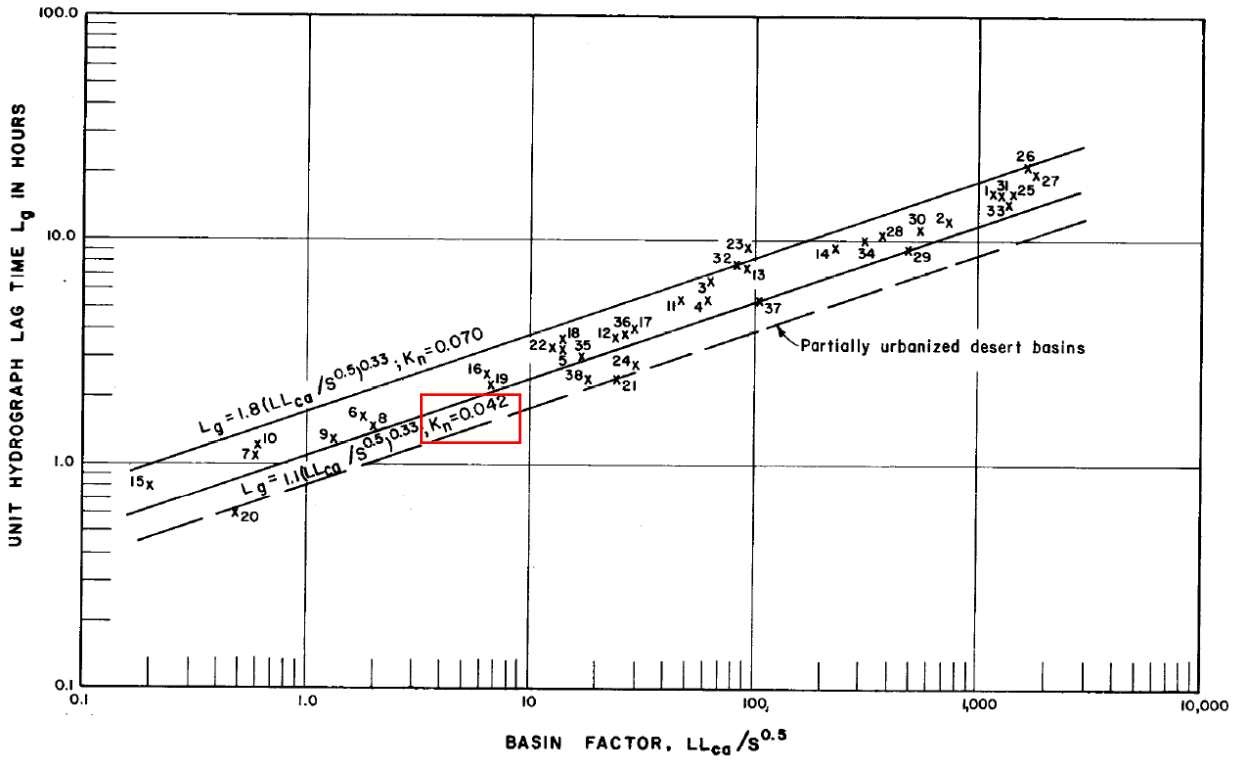


Figure 4-8.—Unit hydrograph lag relationships for the Southwest Desert, Great Basin, and Colorado Plateau. 103-D-1852.

Table 4-3.—Unit hydrograph lag data for the Southwest Desert, Great Basin, and Colorado Plateau.

Index No.	Station and location	Drainage area, mi^2	Basin factor, $LL_{ca}/S^{0.5}$	Lag time, L_g, hours	K_n	C_t
1	Salt River at Roosevelt, AZ	4341.0	1261.0	16.0	0.058	1.51
2	Verde R. above E. Verde and below Jerome, AZ	3190.0	760.0	12.0	.052	1.35
3	Tonto Cr. above Gun Cr., AZ	678.0	66.3	6.5	.063	1.64
4	Agua Fria R. nr. Mayor, AZ	590.0	63.2	5.4	.053	1.38
5	San Gabriel R. at San Gabriel Dam, CA	162.0	14.4	3.3	.053	1.38
6	West Fk. San Gabriel R. at Cogswell Dam, CA	40.4	1.8	1.6	.051	1.33
7	Santa Anita Cr. at Santa Anita Dam, CA	10.8	0.6	1.1	.050	1.30
8	Sand Dimas Cr. at San Dimas Dam, CO	16.2	2.0	1.5	.046	1.20
9	Eaton Wash at Eaton Wash Dam, CA	9.5	1.3	1.3	.046	1.20
10	San Antonio Cr. nr. Claremont, CA	16.9	0.6	1.2	.055	1.43
11	Santa Clara R. nr. Saugus, CA	355.0	48.2	5.6	.060	1.56
12	Temecula Cr. at Pauba Canyon, CA	168.0	24.1	3.7	.050	1.30
13	Santa Margarita R. nr. Fallbrook, CA	645.0	99.2	7.3	.062	1.61
14	Santa Margarita R. at Ysidora, CA	740.0	228.0	9.5	.061	1.59
15	Live Oak Cr. at Live Oak Dam, CA	2.3	0.2	0.8	.052	1.35
16	Tujunga Cr. at Big Tujunga Dam, CA	81.4	6.5	2.5	.052	1.35
17	Murrieta Cr. at Temecula, CA	220.0	28.9	4.0	.051	1.33
18	Los Angeles R. at Sepulveda Dam, CA	152.0	14.3	3.5	.056	1.46
19	Pacoima Wash at Pacoima Dam, CA	27.8	6.8	2.4	.049	1.27
20	East Fullerton Cr. at Fullerton Dam, CA	3.1	0.5	0.6	.029	0.75
21	San Jose Cr. at Workman Mill Rd. CA	81.3	24.8	2.4	.032	0.83
22	San Vincente Cr. at Foster, CA	75.0	12.8	3.2	.053	1.38
23	San Diego R. nr. Santee, CA	380.0	95.4	9.2	.078	2.03
24	Deep Cr. nr. Hesperia, CA	137.0	28.1	2.8	.036	0.94
25	Bill Williams R. at Planet, AZ	4730.0	1476.0	16.2	.056	1.46
26	Gila R. at Conner No. 4 Damsite, AZ	2840.0	1722.0	21.5	.071	1.85
27	San Francisco R. at Jct. with Blue R., AZ	2000.0	1688.0	20.6	.068	1.77
28	Blue R., nr. Clifton, AZ	790.0	352.0	10.3	.057	1.48
29	Moencopi Wash nr. Tuba City, AZ	2490.0	473.0	9.2	.046	1.20
30	Clear Cr. nr. Winslow, AZ	607.0	570.0	11.2	.053	1.38
31	Puerco R. nr. Admana, AZ	2760.0	1225.0	15.9	.058	1.51
32	Plateau Cr. nr. Cameo, CO	604.0	89.9	7.9	.069	1.79
33	White R. nr. Watson, UT	4020.0	1473.0	15.7	.054	1.40
34	Paria R. at Lees Ferry, AZ	1570.0	296.0	10.2	.060	1.56
35	New River at Rock Springs, AZ	67.3	16.5	3.1	.047	1.22
36	New River at New River, AZ	85.7	26.3	3.7	.048	1.25
37	New R. at Bell Road nr. Phoenix, AZ	187.0	108.0	5.3	.043	1.12
38	Skunk Cr. nr. Phoenix, AZ	64.6	18.7	2.4	.035	0.91

NOAA ATLAS 14 PRECIPITATION

7/31/2018

Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Madera, California, USA*
Latitude: 37.0041°, Longitude: -120.0417°
Elevation: 305.16 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.077 (0.069-0.088)	0.095 (0.085-0.108)	0.122 (0.108-0.139)	0.148 (0.130-0.171)	0.189 (0.158-0.229)	0.226 (0.183-0.282)	0.269 (0.210-0.347)	0.320 (0.241-0.429)	0.401 (0.285-0.570)	0.475 (0.322-0.708)
10-min	0.111 (0.099-0.126)	0.136 (0.121-0.155)	0.175 (0.155-0.200)	0.212 (0.186-0.245)	0.271 (0.226-0.328)	0.324 (0.262-0.404)	0.385 (0.302-0.498)	0.459 (0.345-0.616)	0.575 (0.408-0.818)	0.681 (0.462-1.01)
15-min	0.134 (0.120-0.152)	0.165 (0.147-0.187)	0.212 (0.188-0.242)	0.256 (0.225-0.296)	0.327 (0.273-0.396)	0.391 (0.317-0.488)	0.466 (0.365-0.602)	0.554 (0.417-0.744)	0.695 (0.494-0.989)	0.824 (0.558-1.23)
30-min	0.186 (0.166-0.211)	0.229 (0.204-0.260)	0.294 (0.261-0.335)	0.356 (0.312-0.411)	0.454 (0.379-0.550)	0.543 (0.440-0.677)	0.647 (0.506-0.835)	0.769 (0.579-1.03)	0.965 (0.685-1.37)	1.14 (0.775-1.70)
60-min	0.257 (0.229-0.291)	0.315 (0.280-0.358)	0.405 (0.359-0.462)	0.490 (0.429-0.565)	0.625 (0.522-0.757)	0.747 (0.605-0.932)	0.890 (0.696-1.15)	1.06 (0.797-1.42)	1.33 (0.943-1.89)	1.57 (1.07-2.34)
2-hr	0.366 (0.326-0.415)	0.447 (0.398-0.508)	0.571 (0.505-0.651)	0.686 (0.601-0.791)	0.868 (0.725-1.05)	1.03 (0.835-1.29)	1.22 (0.954-1.57)	1.44 (1.08-1.93)	1.79 (1.27-2.54)	2.10 (1.42-3.12)
3-hr	0.447 (0.399-0.507)	0.545 (0.485-0.619)	0.693 (0.614-0.790)	0.831 (0.727-0.958)	1.05 (0.873-1.27)	1.24 (1.00-1.54)	1.46 (1.14-1.88)	1.71 (1.29-2.30)	2.11 (1.50-3.00)	2.47 (1.67-3.68)
6-hr	0.612 (0.545-0.694)	0.743 (0.661-0.844)	0.940 (0.833-1.07)	1.12 (0.981-1.29)	1.40 (1.17-1.70)	1.65 (1.33-2.05)	1.93 (1.51-2.49)	2.25 (1.69-3.02)	2.75 (1.95-3.91)	3.19 (2.16-4.75)
12-hr	0.831 (0.741-0.942)	1.00 (0.894-1.14)	1.26 (1.12-1.44)	1.50 (1.31-1.73)	1.86 (1.55-2.26)	2.18 (1.77-2.72)	2.54 (1.99-3.28)	2.96 (2.22-3.97)	3.60 (2.55-5.11)	4.16 (2.82-6.20)
24-hr	1.12 (1.01-1.26)	1.35 (1.21-1.53)	1.69 (1.52-1.92)	2.00 (1.78-2.29)	2.47 (2.13-2.91)	2.87 (2.44-3.46)	3.33 (2.76-4.10)	3.85 (3.11-4.86)	4.64 (3.61-6.10)	5.33 (4.01-7.23)
2-day	1.35 (1.22-1.53)	1.65 (1.49-1.87)	2.07 (1.86-2.36)	2.44 (2.18-2.80)	2.99 (2.59-3.53)	3.45 (2.92-4.15)	3.94 (3.27-4.85)	4.49 (3.62-5.67)	5.29 (4.11-6.95)	5.96 (4.49-8.09)
3-day	1.51 (1.36-1.71)	1.86 (1.68-2.11)	2.35 (2.11-2.66)	2.76 (2.46-3.16)	3.36 (2.91-3.97)	3.85 (3.26-4.63)	4.37 (3.62-5.38)	4.93 (3.98-6.23)	5.74 (4.46-7.54)	6.40 (4.82-8.69)
4-day	1.66 (1.49-1.87)	2.05 (1.85-2.32)	2.59 (2.33-2.94)	3.05 (2.72-3.49)	3.70 (3.20-4.36)	4.22 (3.58-5.08)	4.77 (3.95-5.87)	5.36 (4.33-6.77)	6.20 (4.81-8.14)	6.88 (5.17-9.33)
7-day	1.99 (1.80-2.25)	2.48 (2.23-2.81)	3.14 (2.82-3.56)	3.69 (3.29-4.22)	4.46 (3.86-5.26)	5.07 (4.30-6.10)	5.71 (4.73-7.03)	6.39 (5.16-8.07)	7.33 (5.70-9.63)	8.09 (6.08-11.0)
10-day	2.21 (1.99-2.50)	2.76 (2.48-3.12)	3.49 (3.14-3.97)	4.11 (3.66-4.70)	4.96 (4.29-5.85)	5.63 (4.78-6.78)	6.33 (5.25-7.79)	7.07 (5.71-8.93)	8.08 (6.28-10.6)	8.90 (6.69-12.1)
20-day	2.85 (2.57-3.23)	3.59 (3.23-4.07)	4.56 (4.10-5.18)	5.36 (4.78-6.14)	6.46 (5.59-7.62)	7.31 (6.20-8.80)	8.18 (6.78-10.1)	9.08 (7.33-11.5)	10.3 (8.01-13.5)	11.3 (8.48-15.3)
30-day	3.47 (3.13-3.93)	4.39 (3.96-4.97)	5.59 (5.03-6.35)	6.57 (5.86-7.52)	7.90 (6.83-9.32)	8.92 (7.57-10.7)	9.96 (8.25-12.3)	11.0 (8.90-13.9)	12.5 (9.68-16.4)	13.6 (10.2-18.4)
45-day	4.28 (3.86-4.85)	5.44 (4.90-6.16)	6.94 (6.24-7.88)	8.15 (7.27-9.33)	9.79 (8.46-11.5)	11.0 (9.35-13.3)	12.3 (10.2-15.1)	13.5 (10.9-17.1)	15.2 (11.8-20.0)	16.6 (12.5-22.5)
60-day	5.08 (4.58-5.75)	6.47 (5.83-7.33)	8.27 (7.43-9.39)	9.71 (8.66-11.1)	11.6 (10.1-13.7)	13.1 (11.1-15.8)	14.6 (12.1-17.9)	16.0 (12.9-20.2)	18.0 (14.0-23.6)	19.5 (14.6-26.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

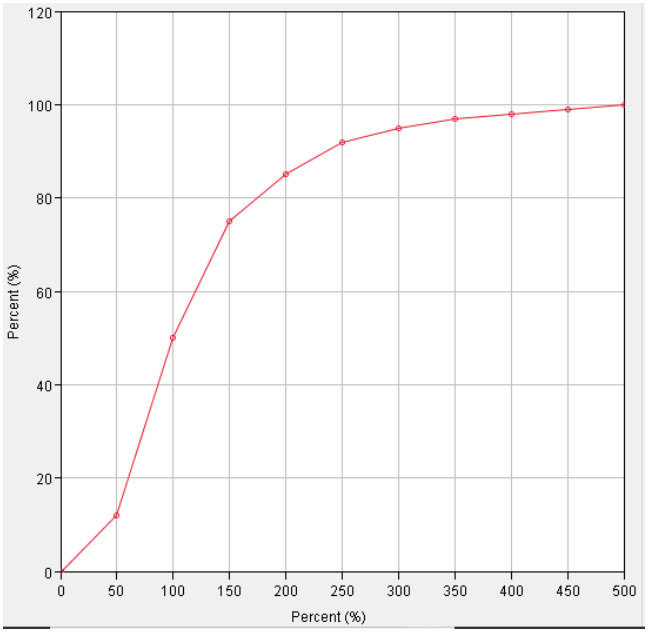
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

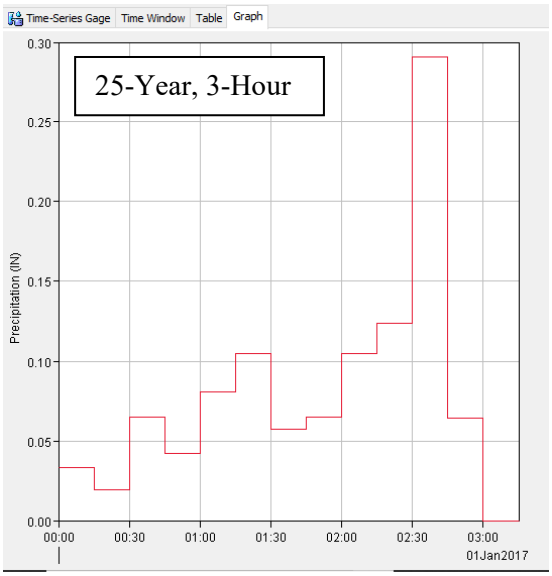
Back to Top

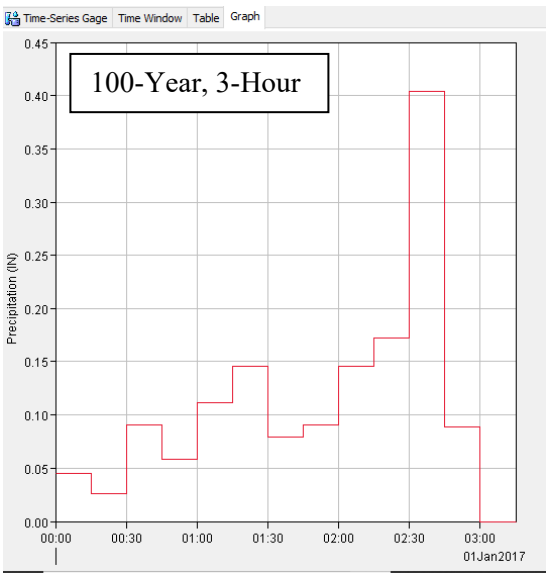
PF graphical

HEC-HMS DETAILS
MADERA S-CURVE



DESIGN STORMS





PARAMETER CALCULATIONS

Castellina
Offsite Parameters

SUMMARY

Basin	Area (mi2)	Area (AC)	CN	% Imp
A1	0.783	501.4	79.6	5.8
A2	1.939	1240.9	73.4	0.2
A total		1742.3	75.2	1.8
B	0.140	89.6	69.1	0.0
C	0.226	144.5	74.8	0.0

CN_A	CN_B	CN_C	CN_D	LAND_USE	IMP	HSG	Area (ft2)	Area (mi2)	CN	Area*CN	Area*Imp
OFFSITE SUBBASIN A1											
46	65	77	82	2 acre Residential	0.12	D	191115	0.0068553	82	0.562135	0.000823
46	65	77	82	2 acre Residential	0.12	A	120792	0.0043328	46	0.19931	0.00052
46	65	77	82	2 acre Residential	0.12	A	48582.6	0.0017427	46	0.080162	0.000209
46	65	77	82	2 acre Residential	0.12	D	1.03E+07	0.3682672	82	30.19791	0.044192
43	65	76	82	Orchard Fair	0	A	13940.6	0.0005001	43	0.021502	0
43	65	76	82	Orchard Fair	0	A	33287.8	0.001194	43	0.051344	0
43	65	76	82	Orchard Fair	0	A	139079	0.0049888	43	0.214517	0
43	65	76	82	Orchard Fair	0	A	57247.4	0.0020535	43	0.088299	0
43	65	76	82	Orchard Fair	0	B	701466	0.0251616	65	1.635506	0
43	65	76	82	Orchard Fair	0	A	83329.3	0.002989	43	0.128528	0
43	65	76	82	Orchard Fair	0	A	41001.9	0.0014707	43	0.063242	0
43	65	76	82	Orchard Fair	0	A	153358	0.005501	43	0.236541	0
43	65	76	82	Orchard Fair	0	A	366336	0.0131405	43	0.565041	0
43	65	76	82	Orchard Fair	0	A	10458.3	0.0003751	43	0.016131	0
43	65	76	82	Orchard Fair	0	D	74380.3	0.002668	82	0.218778	0
43	65	76	82	Orchard Fair	0	D	5312400	0.1905561	82	15.6256	0
49	69	79	84	Open Space - Fair	0	D	99534.7	0.0035703	84	0.299907	0
49	69	79	84	Open Space - Fair	0	A	54457.6	0.0019534	49	0.095716	0
49	69	79	84	Open Space - Fair	0	B	154612	0.0055459	69	0.38267	0
49	69	79	84	Open Space - Fair	0	D	409628	0.0146934	84	1.234244	0
49	69	79	84	Open Space - Fair	0	A	100169	0.0035931	49	0.17606	0
49	69	79	84	Open Space - Fair	0	D	3406960	0.1222079	84	10.26546	0
OFFSITE SUBBASIN A2											
49	69	79	84	Open Space - Fair	0	A	288294	0.0103411	49	0.506715	0
49	69	79	84	Open Space - Fair	0	A	450100	0.0161451	49	0.791111	0
49	69	79	84	Open Space - Fair	0	C	1492910	0.0535508	79	4.230511	0
49	69	79	84	Open Space - Fair	0	A	437226	0.0156833	49	0.768483	0
49	69	79	84	Open Space - Fair	0	A	155782	0.0055879	49	0.273808	0
49	69	79	84	Open Space - Fair	0	A	147583	0.0052938	49	0.259397	0
49	69	79	84	Open Space - Fair	0	A	99215.7	0.0035589	49	0.174385	0
49	69	79	84	Open Space - Fair	0	A	115526	0.0041439	49	0.203052	0
49	69	79	84	Open Space - Fair	0	D	744698	0.0267124	84	2.243839	0
49	69	79	84	Open Space - Fair	0	A	258860	0.0092853	49	0.454981	0
49	69	79	84	Open Space - Fair	0	C	1266580	0.0454323	79	3.589152	0
49	69	79	84	Open Space - Fair	0	D	98052.6	0.0035172	84	0.295441	0
49	69	79	84	Open Space - Fair	0	A	131599	0.0047205	49	0.231303	0
49	69	79	84	Open Space - Fair	0	D	45421.1	0.0016293	84	0.136858	0
49	69	79	84	Open Space - Fair	0	A	833093	0.0298831	49	1.464272	0
49	69	79	84	Open Space - Fair	0	A	450505	0.0161596	49	0.791823	0
49	69	79	84	Open Space - Fair	0	A	36092.2	0.0012946	49	0.063437	0
49	69	79	84	Open Space - Fair	0	A	88591.2	0.0031778	49	0.155711	0
49	69	79	84	Open Space - Fair	0	A	19123.1	0.0006859	49	0.033611	0
49	69	79	84	Open Space - Fair	0	A	398604	0.014298	49	0.7006	0
49	69	79	84	Open Space - Fair	0	A	256400	0.0091971	49	0.450657	0
49	69	79	84	Open Space - Fair	0	A	168475	0.0060432	49	0.296117	0

49	69	79	84 Open Space - Fair	0	A	155878	0.0055914	49	0.273976	0
49	69	79	84 Open Space - Fair	0	A	62273.4	0.0022338	49	0.109454	0
49	69	79	84 Open Space - Fair	0	D	49244.7	0.0017664	84	0.148378	0
49	69	79	84 Open Space - Fair	0	A	243044	0.008718	49	0.427182	0
49	69	79	84 Open Space - Fair	0	A	1088060	0.0390288	49	1.91241	0
49	69	79	84 Open Space - Fair	0	A	1361220	0.048827	49	2.392525	0
49	69	79	84 Open Space - Fair	0	D	67873.6	0.0024346	84	0.204509	0
49	69	79	84 Open Space - Fair	0	A	446626	0.0160205	49	0.785005	0
49	69	79	84 Open Space - Fair	0	D	36265.2	0.0013008	84	0.10927	0
49	69	79	84 Open Space - Fair	0	A	85381.6	0.0030626	49	0.15007	0
49	69	79	84 Open Space - Fair	0	C	338289	0.0121344	79	0.958621	0
49	69	79	84 Open Space - Fair	0	A	1513540	0.0542908	49	2.660248	0
49	69	79	84 Open Space - Fair	0	B	748437	0.0268465	69	1.852407	0
49	69	79	84 Open Space - Fair	0	A	203735	0.007308	49	0.358091	0
49	69	79	84 Open Space - Fair	0	A	282707	0.0101407	49	0.496895	0
49	69	79	84 Open Space - Fair	0	B	752111	0.0269783	69	1.861501	0
49	69	79	84 Open Space - Fair	0	A	206958	0.0074236	49	0.363756	0
49	69	79	84 Open Space - Fair	0	A	89649.3	0.0032157	49	0.157571	0
49	69	79	84 Open Space - Fair	0	D	2.19E+07	0.7871291	84	66.11884	0
43	65	76	82 Orchard Fair	0	A	192613	0.006909	43	0.297089	0
43	65	76	82 Orchard Fair	0	A	163433	0.0058624	43	0.252081	0
43	65	76	82 Orchard Fair	0	A	117298	0.0042075	43	0.180922	0
43	65	76	82 Orchard Fair	0	A	48712.3	0.0017473	43	0.075134	0
43	65	76	82 Orchard Fair	0	A	103555	0.0037145	43	0.159725	0
43	65	76	82 Orchard Fair	0	B	767574	0.0275329	65	1.78964	0
43	65	76	82 Orchard Fair	0	A	178783	0.006413	43	0.275757	0
43	65	76	82 Orchard Fair	0	A	17410.5	0.0006245	43	0.026854	0
43	65	76	82 Orchard Fair	0	D	5632640	0.2020432	82	16.56754	0
43	65	76	82 Orchard Fair	0	C	9364.01	0.0003359	76	0.025527	0
43	65	76	82 Orchard Fair	0	A	807265	0.0289566	43	1.245136	0
43	65	76	82 Orchard Fair	0	A	307.665	1.104E-05	43	0.000475	0
43	65	76	82 Orchard Fair	0	A	545190	0.019556	43	0.840908	0
43	65	76	82 Orchard Fair	0	D	2838500	0.1018172	82	8.349009	0
43	65	76	82 Orchard Fair	0	A	75840.3	0.0027204	43	0.116977	0
43	65	76	82 Orchard Fair	0	A	37305.8	0.0013382	43	0.057541	0
43	65	76	82 Orchard Fair	0	A	61791.3	0.0022165	43	0.095308	0
43	65	76	82 Orchard Fair	0	A	158197	0.0056745	43	0.244005	0
43	65	76	82 Orchard Fair	0	D	6960.74	0.0002497	82	0.020474	0
43	65	76	82 Orchard Fair	0	A	54630.1	0.0019596	43	0.084262	0
43	65	76	82 Orchard Fair	0	A	24907.2	0.0008934	43	0.038417	0
43	65	76	82 Orchard Fair	0	A	79472	0.0028507	43	0.122579	0
43	65	76	82 Orchard Fair	0	A	177137	0.0063539	43	0.273218	0
43	65	76	82 Orchard Fair	0	D	62227.9	0.0022321	82	0.183034	0
43	65	76	82 Orchard Fair	0	A	81287.4	0.0029158	43	0.125379	0
43	65	76	82 Orchard Fair	0	A	553820	0.0198656	43	0.854219	0
43	65	76	82 Orchard Fair	0	D	2991650	0.1073107	82	8.799476	0
51	68	79	84 1 acre Residential	0.2	A	4117.79	0.0001477	51	0.007533	2.95E-05
51	68	79	84 1 acre Residential	0.2	A	18806.1	0.0006746	51	0.034403	0.000135
51	68	79	84 1 acre Residential	0.2	D	586371	0.0210332	84	1.766786	0.004207
OFFSITE SUBBASIN B										
49	69	79	84 Open Space - Fair	0	C	70649.5	0.0025342	79	0.200202	0
49	69	79	84 Open Space - Fair	0	A	388150	0.013923	49	0.682225	0
49	69	79	84 Open Space - Fair	0	A	1061010	0.0380585	49	1.864866	0
49	69	79	84 Open Space - Fair	0	A	200842	0.0072042	49	0.353007	0
49	69	79	84 Open Space - Fair	0	D	2182510	0.0782868	84	6.576089	0
OFFSITE SUBBASIN C										
49	69	79	84 Open Space - Fair	0	A	200515	0.0071925	49	0.352432	0

Castellina
Offsite Parameters

49	69	79	84 Open Space - Fair	0	A	1114840	0.0399894	49	1.95948	0
49	69	79	84 Open Space - Fair	0	D	2797750	0.1003555	84	8.42986	0
43	65	76	82 Orchard Fair	0	A	196893	0.0070626	43	0.30369	0
43	65	76	82 Orchard Fair	0	D	1231100	0.0441596	82	3.62109	0
43	65	76	82 Orchard Fair	0	D	33036.9	0.001185	82	0.097173	0
43	65	76	82 Orchard Fair	0	D	720755	0.0258535	82	2.119989	0

HEC-HMS
SUMMARY OF RESULTS

Global Summary Results for Run "25 Year"

Project: Castellina Offsite Hydrology Simulation Run: 25 Year

Start of Run: 01Jan2017, 00:00
End of Run: 02Jan2017, 01:00
Compute Time: 15May2019, 15:16:12

Basin Model: Offsite - Schmidt Crk @ Cast
Meteorologic Model: 25yr3hr
Control Specifications: Control 3hr

Show Elements: Initial Selection Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-A	2.722	48.367	01Jan2017, 03:54	0.06
Subbasin C	0.226	7.961	01Jan2017, 03:08	0.04
Subbasin-B	0.140	0.902	01Jan2017, 03:06	0.01

Global Summary Results for Run "100 year"

Project: Castellina Offsite Hydrology Simulation Run: 100 year

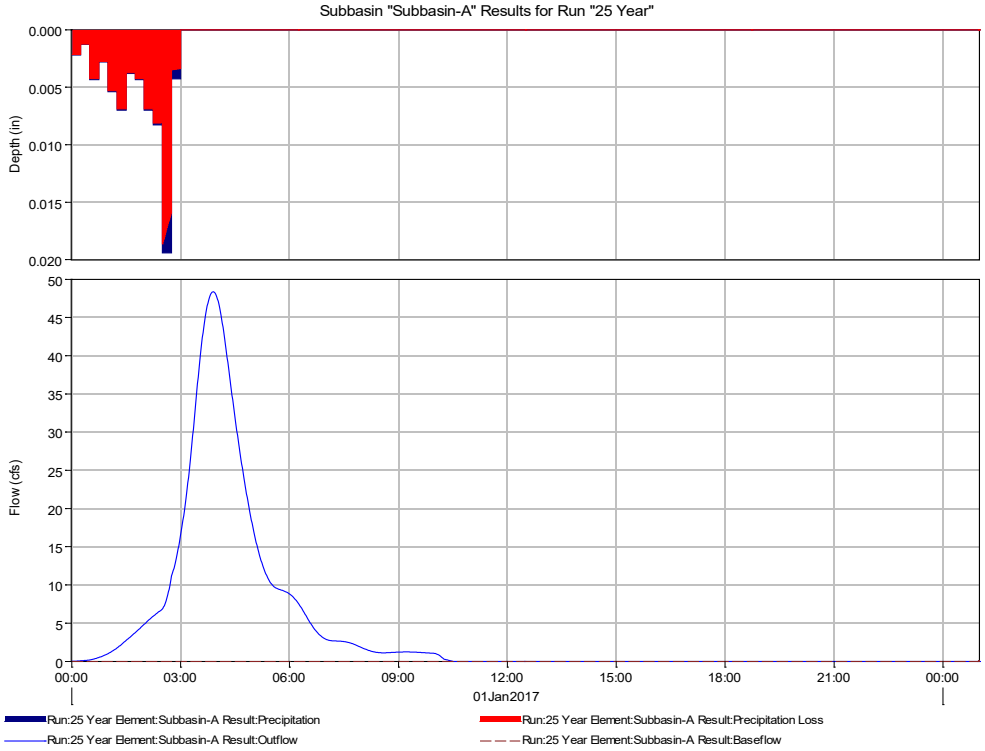
Start of Run: 01Jan2017, 00:00
End of Run: 02Jan2017, 01:00
Compute Time: 15May2019, 15:12:22

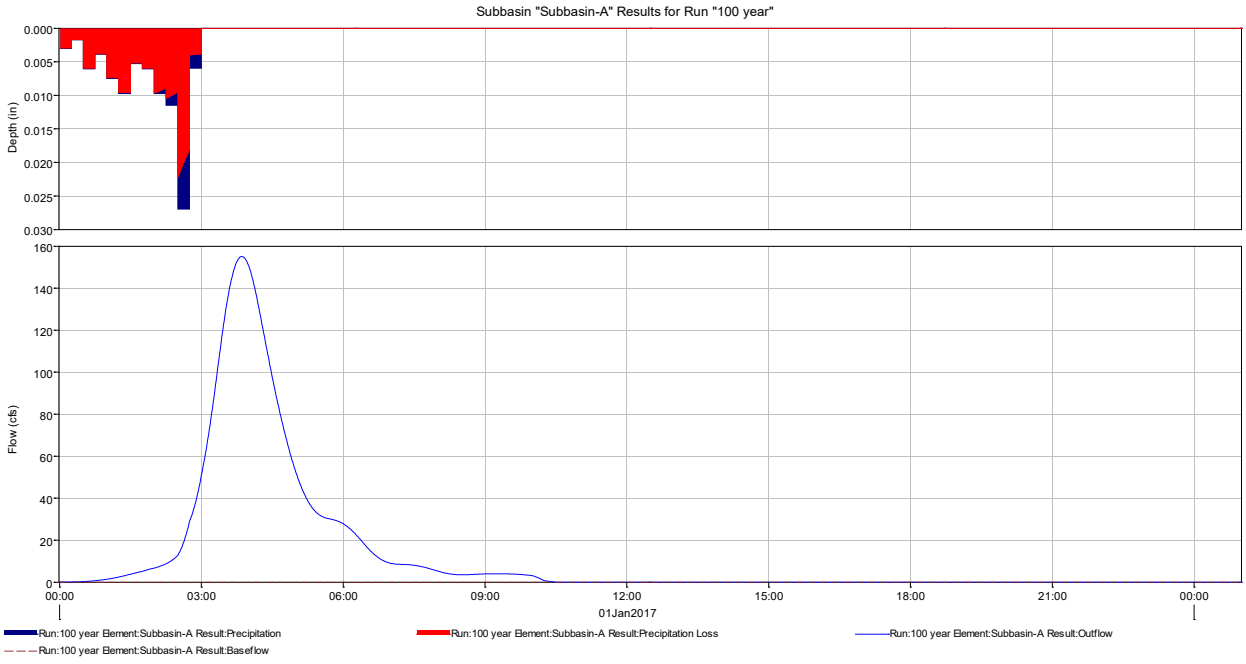
Basin Model: Offsite - Schmidt Crk @ Cast
Meteorologic Model: 100yr3hr
Control Specifications: Control 3hr

Show Elements: Initial Selection Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

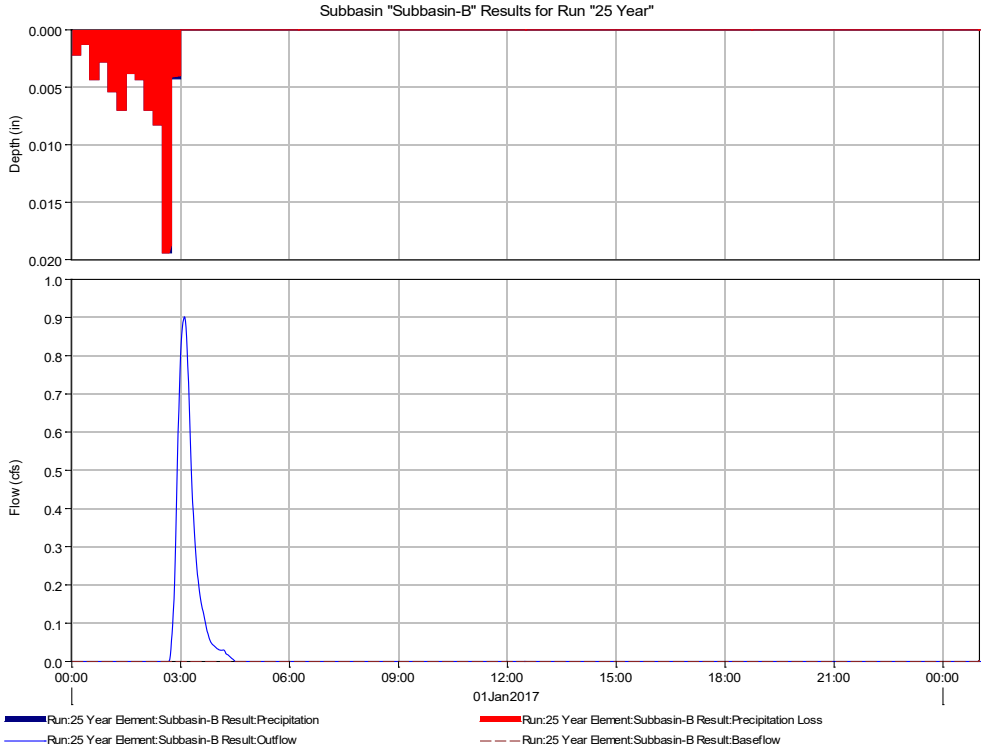
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-A	2.722	155.097	01Jan2017, 03:51	0.18
Subbasin C	0.226	28.065	01Jan2017, 03:04	0.15
Subbasin-B	0.140	10.599	01Jan2017, 02:56	0.06

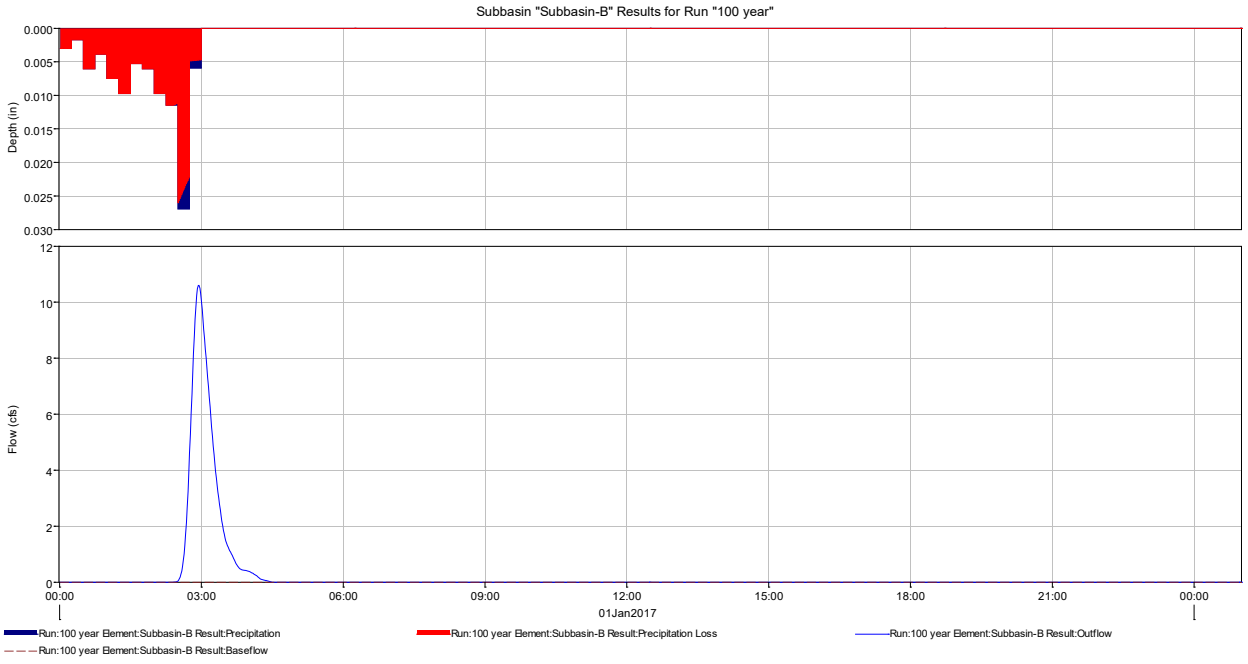
BASIN "A" HYDROGRAPHS



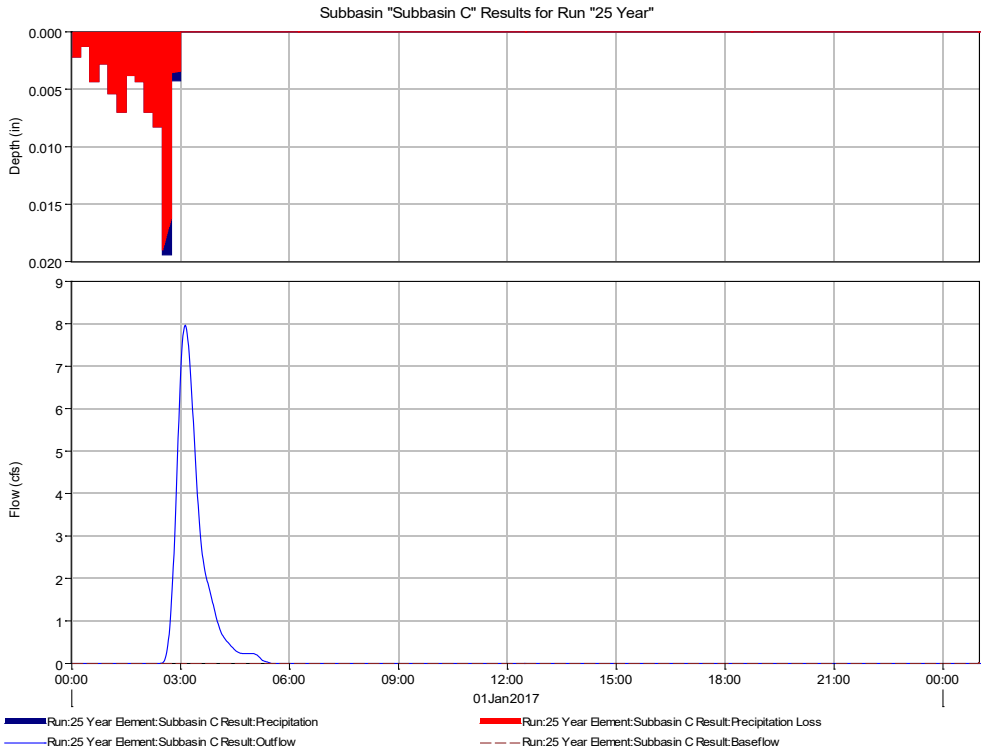


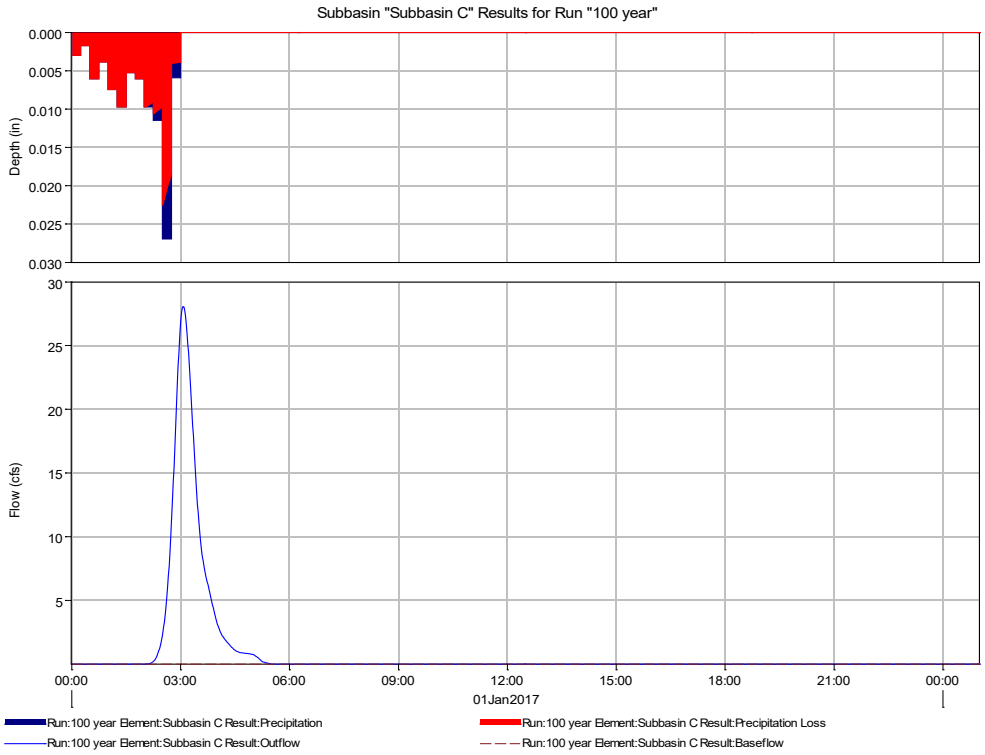
SUBBASIN "B" HYDROGRAPHS





SUBBASIN "C" HYDROGRAPHS





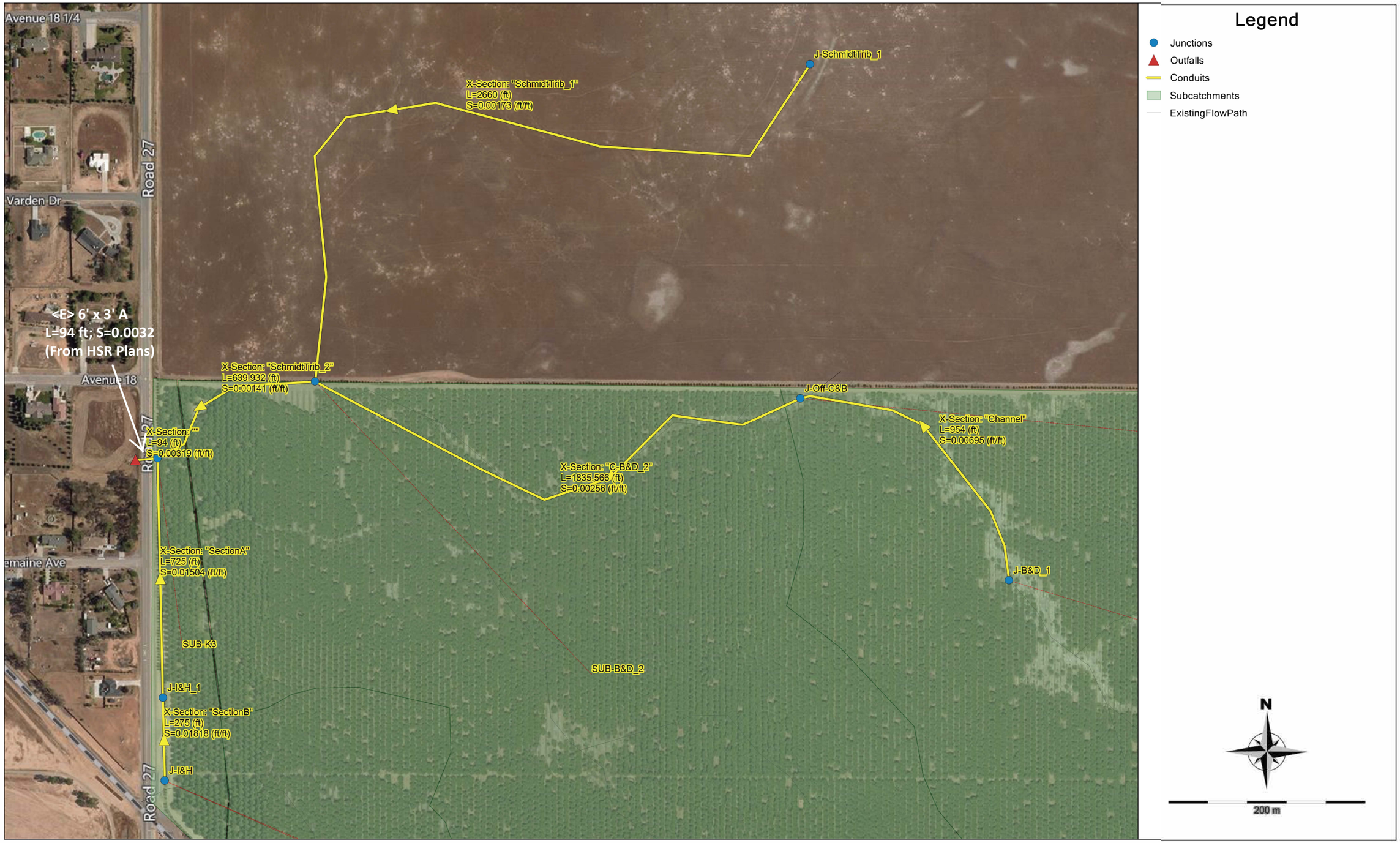
Appendix C – PCSWMM Model Inputs

Appendix C
Castellina Onsite Subbasin Parameters
Existing Conditions

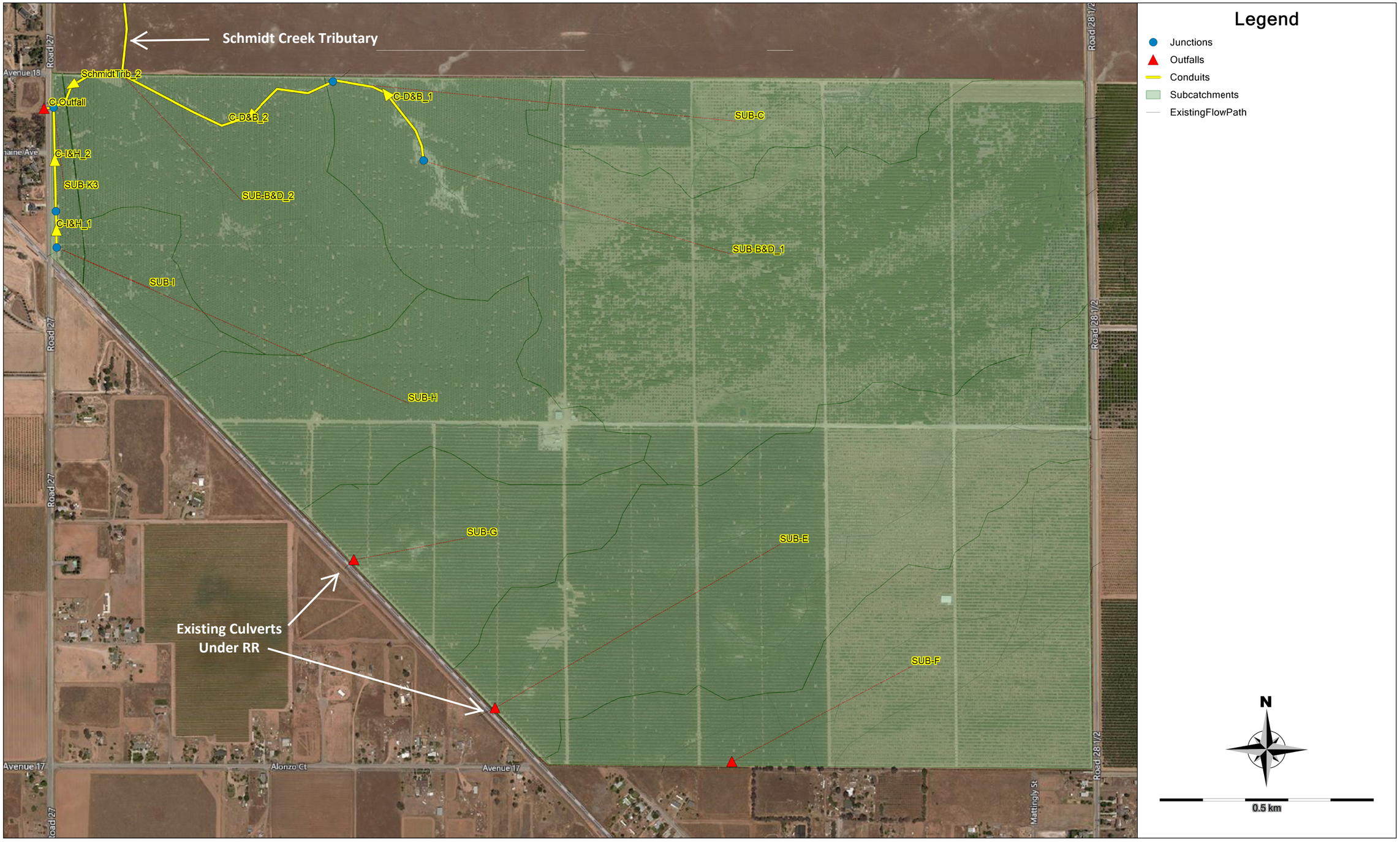
Name	Area (ac)	Width (ft)	Overland Flow Length (ft)	Slope (%)	Impervious Area (%)	Overland Manning's *n*		Dstore (in)		Curve Number
						Impervious Areas	Pervious Areas	Impervious Areas	Pervious Areas	
SUB-B&D_1	251.9	31339	350	0.32	5	0.01	0.06	0.05	0.38	82
SUB-B&D_2	85.8	10675	350	0.32	5	0.01	0.06	0.05	0.38	74
SUB-C	45.9	5713	350	0.55	5	0.01	0.06	0.05	0.38	69
SUB-E	153.7	19129	350	0.26	5	0.01	0.06	0.05	0.38	82
SUB-F	108.3	13479	350	0.35	5	0.01	0.06	0.05	0.38	82
SUB-G	50.1	6235	350	0.27	5	0.01	0.06	0.05	0.38	82
SUB-H	75.8	9434	350	0.34	5	0.01	0.06	0.05	0.38	82
SUB-I	20.1	2502	350	0.1	5	0.01	0.06	0.05	0.38	82
SUB-K3*	6	1525	200	0.5	10	0.01	0.06	0.05	0.38	82
Total	**798**									

*Represents offsite area

CASTELLINA EXISTING DRAINAGE



EXISTING ONSITE SUBBASINS



Appendix C
Castellina Onsite Subbasin Parameters
Proposed Conditions

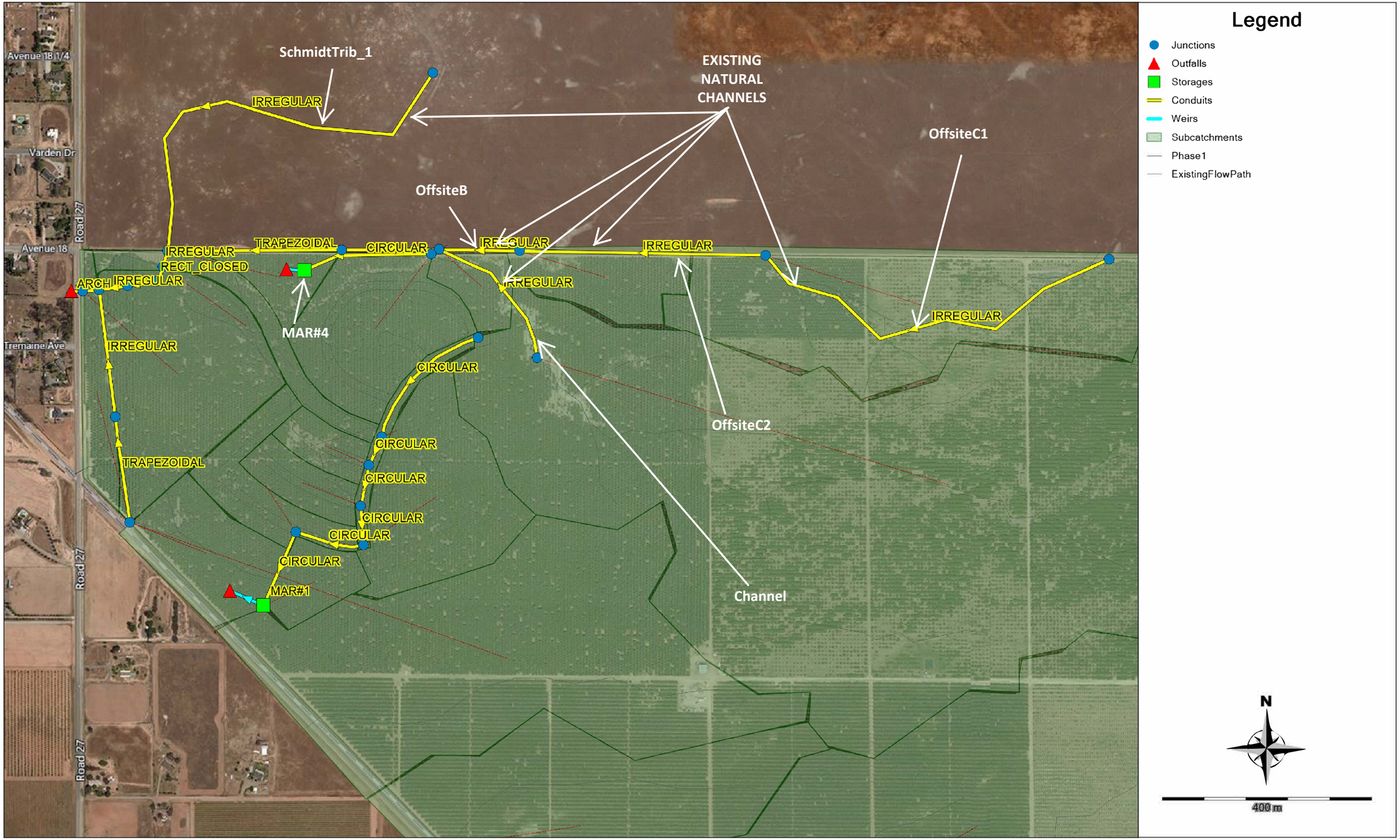
						Overland Manning's *n*		Dstore (in)		
Name	**Area (ac)**	**Width (ft)**	**Overland Flow Length (ft)**	**Slope (%)**	**Impervious Area (%)**	**Impervious Areas**	**Pervious Areas**	**Impervious Areas**	**Pervious Areas**	**Curve Number**
SUB-C1	59.5	300	8639	0.45	32.0	0.02	0.042	0.05	0.35	85.4
SUB-C2	17.9	300	2599	0.65	30.0	0.02	0.045	0.05	0.35	85.0
SUB-B1	4.7	300	682	0.11	5.0	0.02	0.060	0.05	0.50	80.0
SUB-D1	17.2	300	2497	0.33	39.2	0.02	0.039	0.05	0.31	86.8
SUB-D2	16.7	300	2425	0.36	44.0	0.02	0.037	0.05	0.30	87.8
SUB-D3	27.7	250	4826	0.31	36.3	0.02	0.044	0.05	0.32	86.3
SUB-D4	9.2	200	2004	0.22	88.3	0.02	0.027	0.05	0.11	96.0
SUB-D5	2.2	100	958	0.08	95.0	0.02	0.020	0.05	0.11	98.0
SUB-D6	28.2	250	4914	0.26	46.0	0.02	0.038	0.05	0.28	88.0
SUB-D7	8.7	350	1083	0.21	32.9	0.02	0.048	0.05	0.38	85.6
SUB-D8	28.0	250	4879	0.28	49.1	0.02	0.037	0.05	0.27	88.7
SUB-D9	13.4	250	2335	0.31	51.1	0.02	0.036	0.05	0.26	89.1
SUB-D10	10.2	300	1481	0.99	27.4	0.02	0.049	0.05	0.38	84.5
SUB-E1	25.6	300	3717	0.29	45.5	0.02	0.041	0.05	0.29	88.1
SUB-E2	26.1	300	3790	0.42	39.8	0.02	0.043	0.05	0.31	87.0
SUB-E3	12.3	250	2143	0.32	56.8	0.02	0.034	0.05	0.24	90.2
SUB-E4	9.7	200	2113	0.17	83.9	0.02	0.029	0.05	0.13	95.1
SUB-E6	14.4	250	2509	0.25	50.4	0.02	0.027	0.05	0.27	88.9
SUB-E5	10.9	200	2374	0.19	87.6	0.02	0.036	0.05	0.11	95.8
SUB-E7	15.9	200	3463	0.20	72.4	0.02	0.028	0.05	0.16	93.5
SUB-E8	2.2	350	274	0.19	45.9	0.02	0.042	0.05	0.32	88.2
SUB-E9	14.5	200	3158	0.22	78.6	0.02	0.032	0.05	0.16	93.1
SUB-E10	15.0	250	2614	0.26	51.8	0.02	0.036	0.05	0.26	89.2
SUB-F1	57.8	300	8393	0.32	36.0	0.02	0.045	0.05	0.33	86.2
SUB-F2	24.9	300	3615	0.34	38.1	0.02	0.044	0.05	0.32	86.6
SUB-G1	18.6	250	3241	0.29	49.0	0.02	0.038	0.05	0.28	88.7
SUB-G2	28.3	300	4109	0.67	35.0	0.02	0.045	0.05	0.33	86.0
SUB-H1	3.1	100	1350	0.28	95.0	0.02	0.020	0.05	0.11	98.0
SUB-H2	27.3	250	4757	0.38	45.9	0.02	0.038	0.05	0.28	88.0
SUB-H3	20.0	300	2904	0.72	35.0	0.02	0.045	0.05	0.33	86.0
SUB-I1	1.7	100	741	0.33	95.0	0.02	0.020	0.05	0.11	98.0
SUB-I2	20.3	300	2948	0.38	43.0	0.02	0.042	0.05	0.30	87.6
SUB-I3	2.7	100	1176	0.37	95.0	0.02	0.020	0.05	0.11	98.0
SUB-I4	26.5	350	3298	0.40	15.9	0.02	0.055	0.05	0.45	82.2
SUB-I5	15.6	300	2265	0.34	50.8	0.02	0.038	0.05	0.27	89.2
SUB-I6	15.6	300	2265	0.37	45.4	0.02	0.041	0.05	0.29	88.1
SUB-I8	5.0	350	622	0.44	5.0	0.02	0.060	0.05	0.50	80.0
SUB-J1	18.0	300	2614	0.10	30.0	0.02	0.045	0.05	0.14	75.0
SUB-J2	4.5	350	560	0.40	5.0	0.02	0.060	0.05	0.50	39.0
SUB-K1	6.4	250	1115	0.09	100.0	0.02	0.020	0.05	0.05	98.0
SUB-K2	26.6	350	3310	0.10	31.7	0.02	0.050	0.05	0.37	81.0
SUB-K3*	6.0	200	1307	0.50	10.0	0.02	0.060	0.05	0.38	82.0
SUB-LD-1	3.6	120	1307	0.10	35.0	0.02	0.045	0.05	0.33	86.0
SUB-LD-2	4.7	120	1706	0.10	35.0	0.02	0.045	0.05	0.33	86.0
SUB-LD-3	8.2	220	1624	0.10	35.0	0.02	0.045	0.05	0.33	86.0
SUB-Tracks	62	350	7766	0.12	5.0	0.02	0.060	0.05	0.50	80.0
Total	798.0									

*Represents offsite area

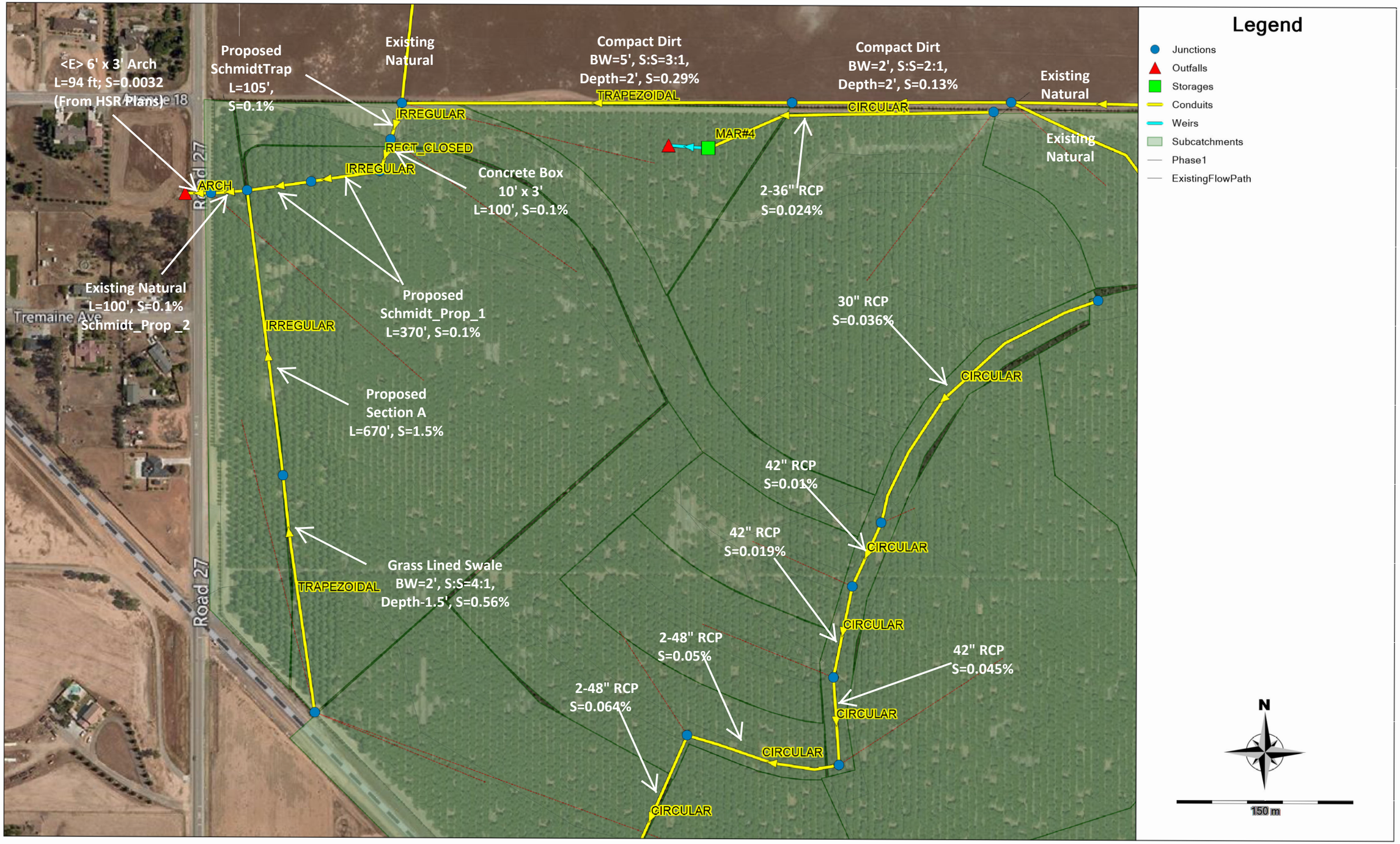
CASTELLINA PHASE I SUBBASINS



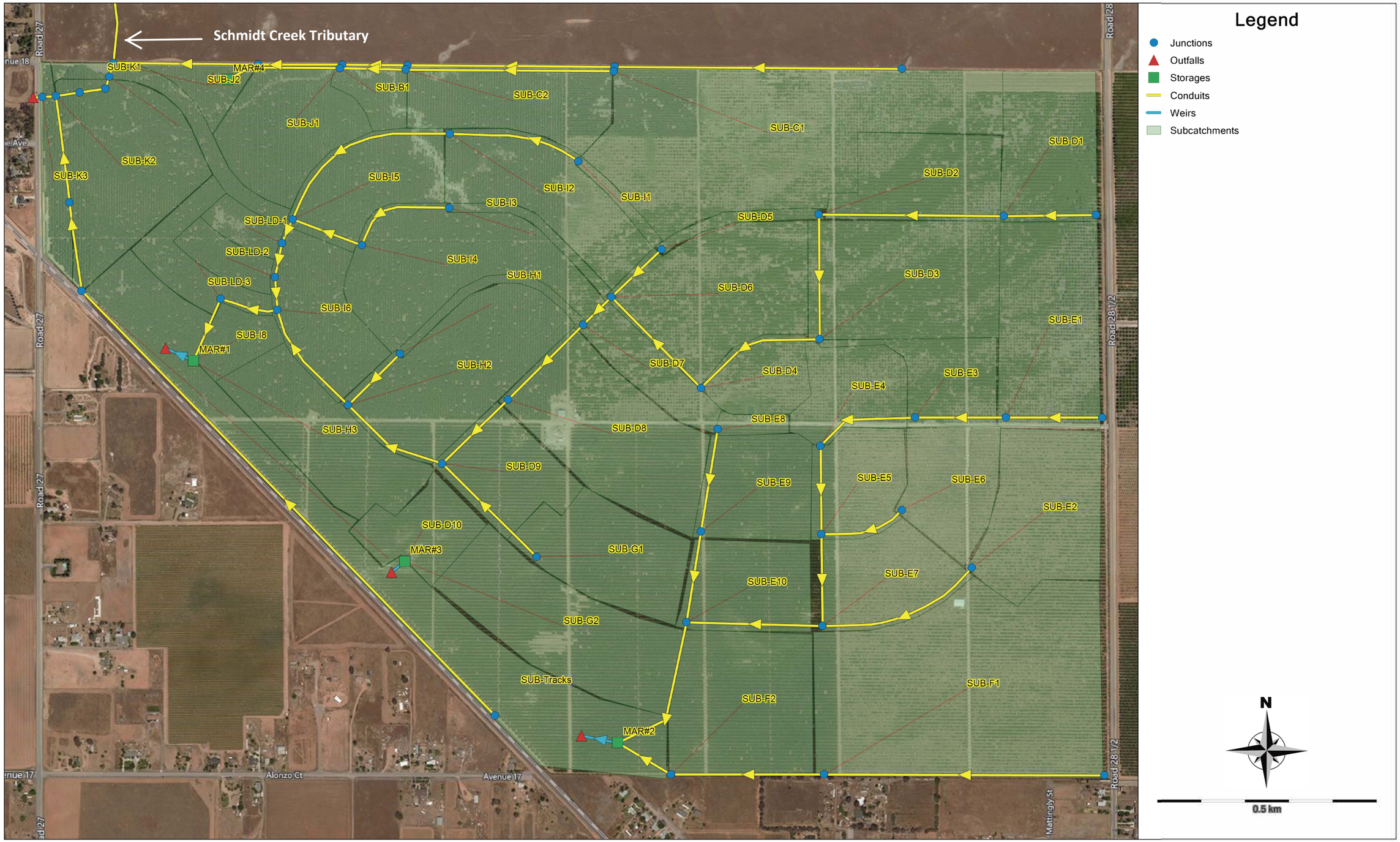
CASTELLINA PHASE I DRAINAGE LAYOUT



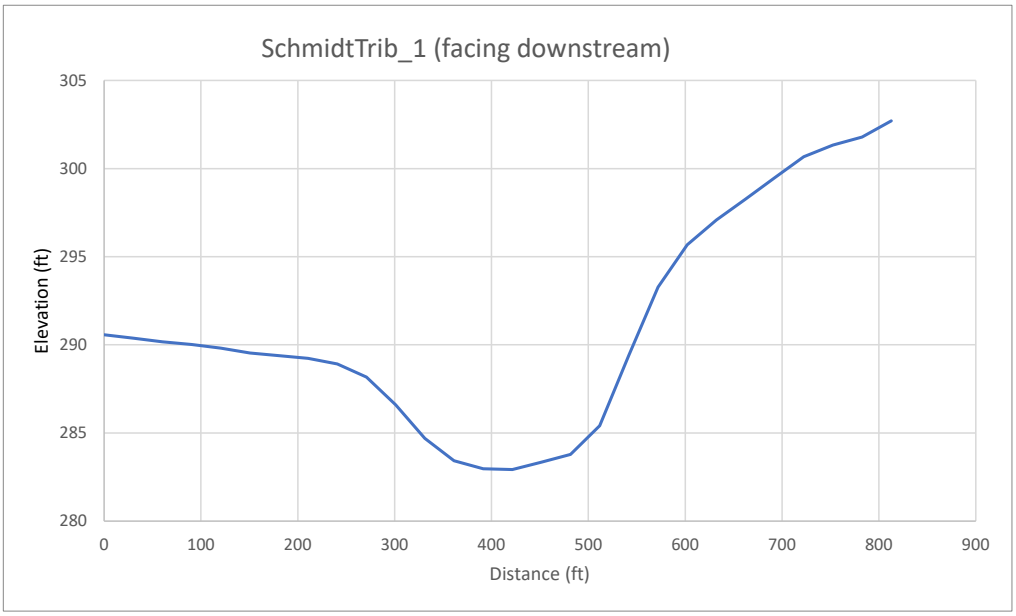
CASTELLINA PHASE I DRAINAGE LAYOUT



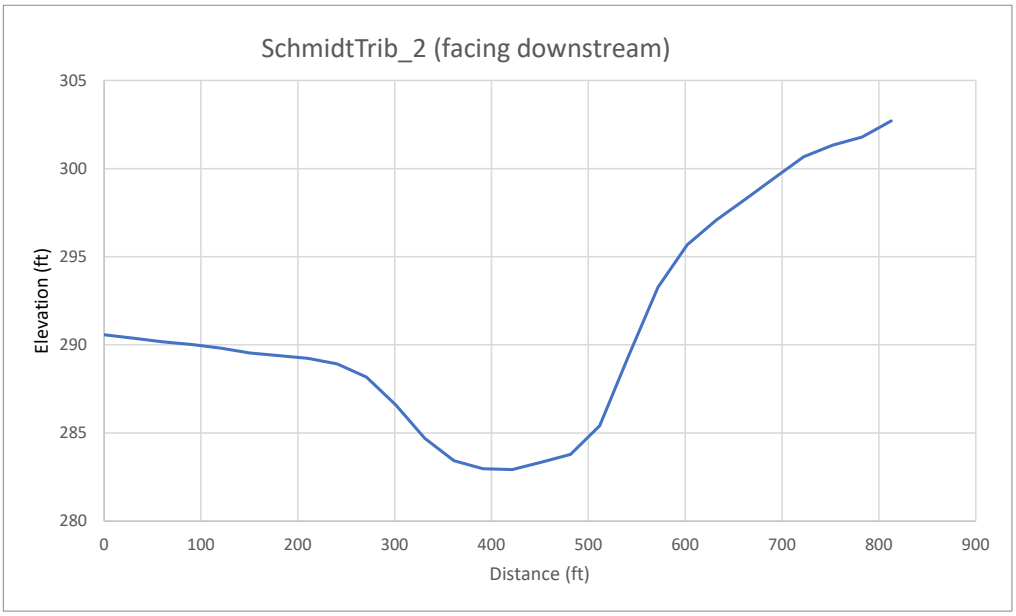
CASTELLINA FULL BUILDOUT SUBBASINS



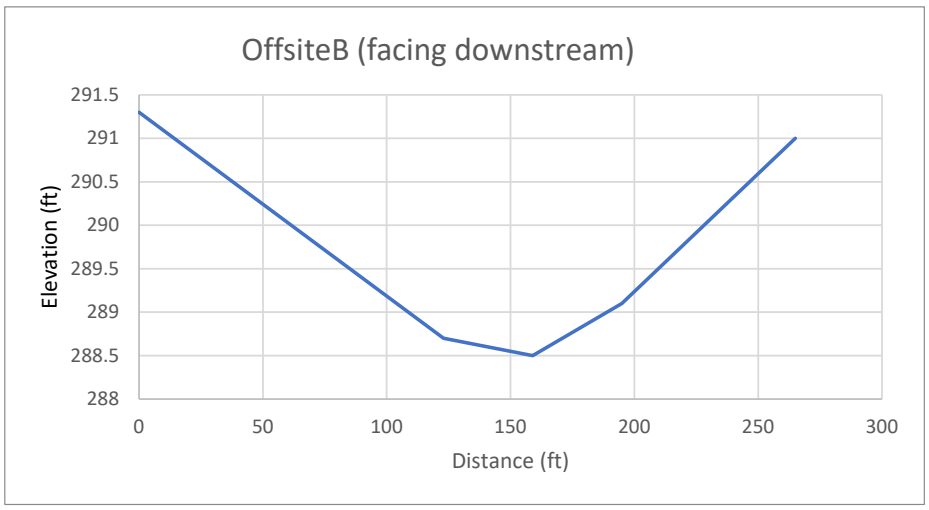
X (ft)	Y (ft)
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60.20497	290.1773
90.30745	290.0184
120.4099	289.8127
150.5124	289.5322
180.6149	289.3849
210.7174	289.2388
240.8199	288.9208
270.9224	288.1718
301.0248	286.5943
331.1273	284.6965
361.2298	283.4282
391.3323	282.975
421.4348	282.9254
451.5373	283.3463
481.6397	283.7838
511.7422	285.4176
541.8447	289.4149
571.9472	293.2784
602.0497	295.6777
632.1522	297.0893
662.2546	298.2679
692.3571	299.4885
722.4596	300.6658
752.5621	301.3366
782.6646	301.7931
812.7671	302.7064



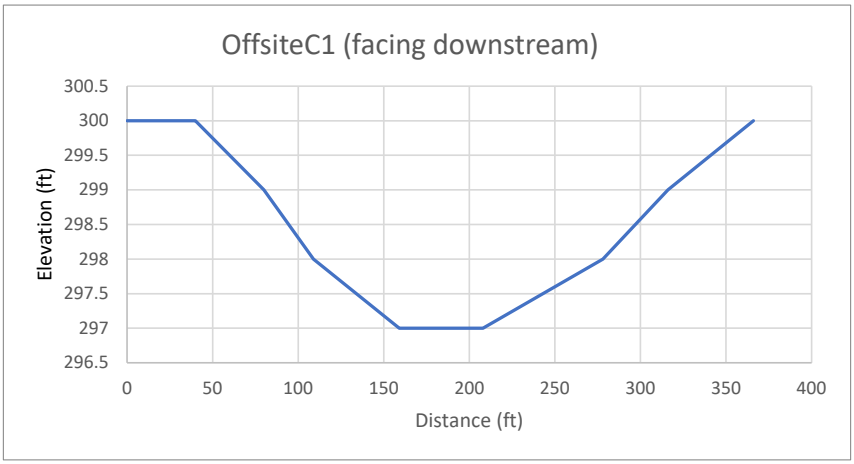
X (ft)	Y (ft)
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58.70118	285.461
88.05178	285.1124
117.4024	284.7752
146.753	284.6542
176.1036	284.3841
205.4541	284.0109
234.8047	283.5174
264.1553	282.7006
293.5059	281.5957
322.8565	280.6094
352.2071	280.0844
381.5577	279.9942
410.9083	280.0921
440.2589	280.1346
469.6095	280.7326
498.9601	281.9743
528.3107	283.2957
557.6612	284.3111
587.0118	285.0689
616.3624	285.7365
645.713	286.3664
675.0636	286.9496
704.4142	287.3946
733.7648	287.731
763.1154	287.968
792.466	288.958
821.8166	290.1561
851.1672	291.4543
880.5178	292.6147
909.8683	293.5866
939.2189	294.4808
968.5695	295.6121



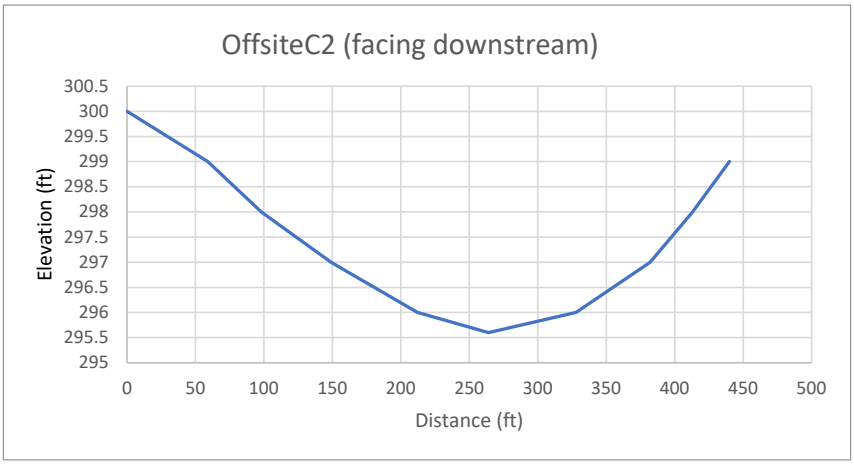
X (ft)	Y (ft)
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159	288.5
195	289.1
265	291



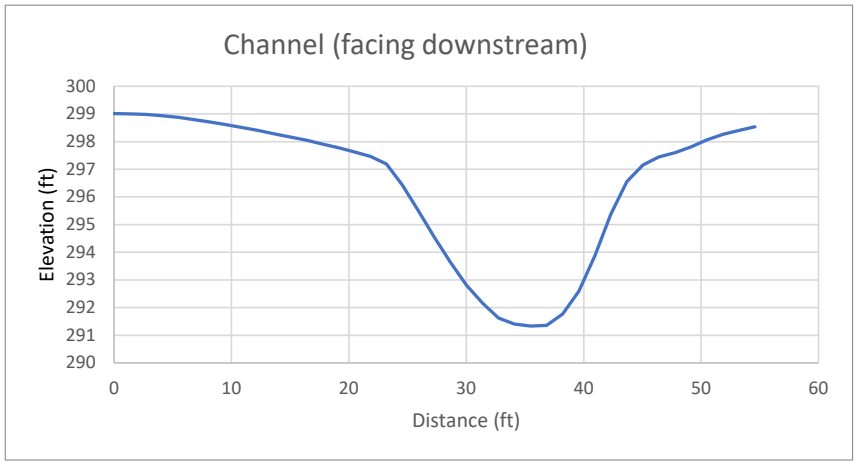
X (ft)	Y (ft)
0	300
40	300
80	299
109	298
159	297
208	297
278	298
316	299
366	300



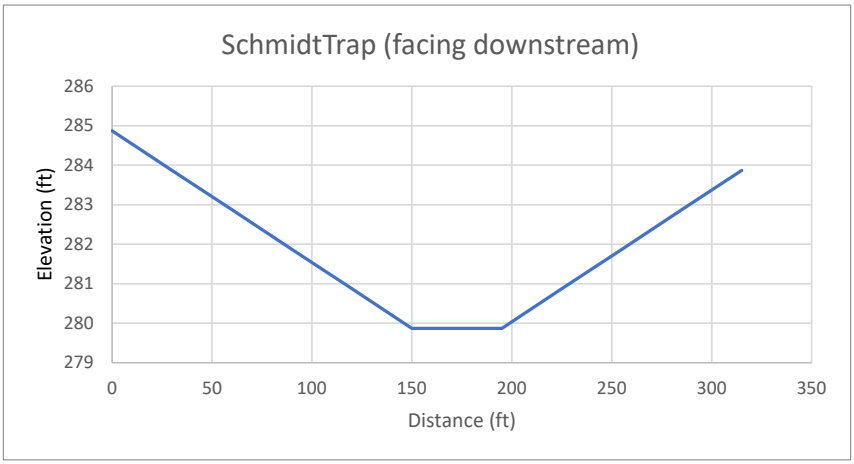
X (ft)	Y (ft)
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59	299
98	298
149	297
212	296
264	295.6
328	296
382	297
413	298
440	299



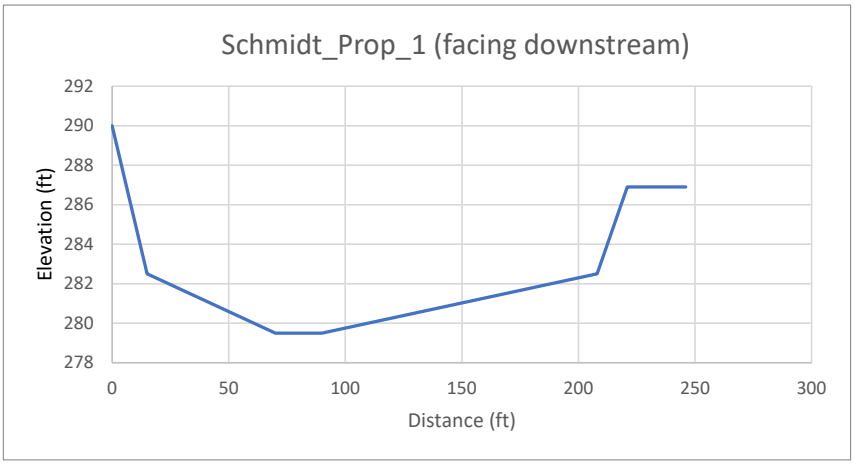
X (ft)	Y (ft)
0	299.0132
1.36	298.9977
2.729384	298.9811
4.094077	298.937
5.458769	298.8759
6.823461	298.7937
8.188153	298.7117
9.552846	298.6168
10.91754	298.5113
12.28223	298.4032
13.64692	298.2831
15.01161	298.1706
16.37631	298.0546
17.741	297.9133
19.10569	297.7749
20.47038	297.6221
21.83508	297.4657
23.19977	297.1935
24.56446	296.42
25.92915	295.4932
27.29384	294.5324
28.65854	293.6311
30.02323	292.8084
31.38792	292.1658
32.75261	291.6254
34.11731	291.3998
35.482	291.3336
36.84669	291.3569
38.21138	291.7638
39.57607	292.5886
40.94077	293.8703
42.30546	295.3799
43.67015	296.5502
45.03484	297.1532
46.39954	297.4433
47.76423	297.5972
49.12892	297.8036
50.49361	298.066
51.8583	298.2657
53.223	298.4003
54.58769	298.5328
55.95238	298.8778



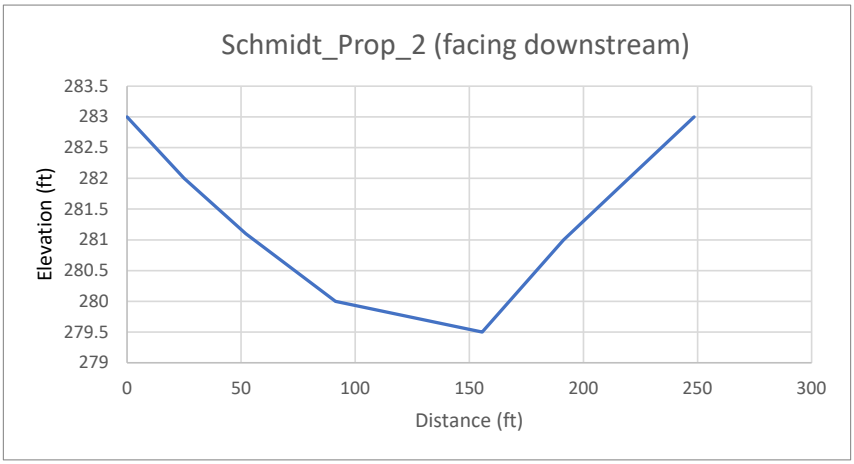
X (ft)	Y (ft)
0	284.87
30	283.87
60	282.87
90	281.87
120	280.87
150	279.87
180	279.87
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285	282.87
315	283.87



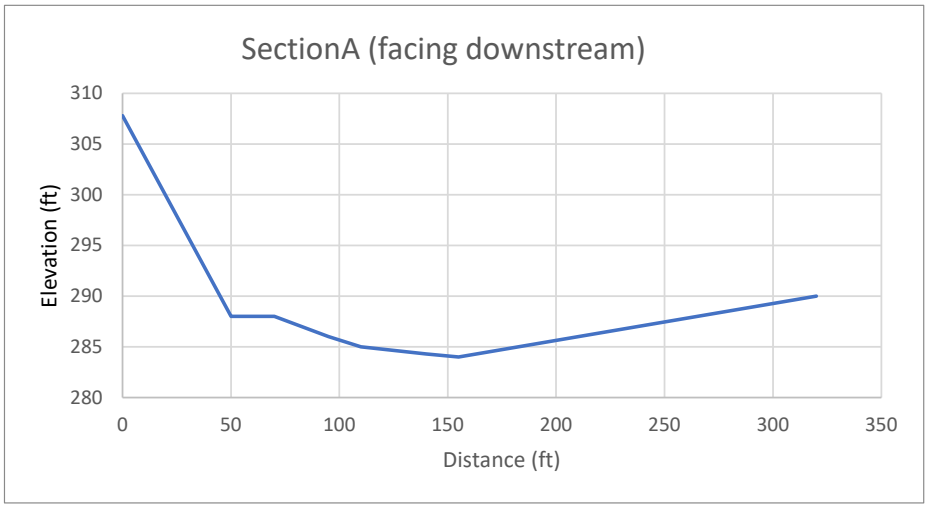
X (ft)	Y (ft)
0	290
15	282.5
70	279.5
90	279.5
208	282.5
221	286.9
246	286.9



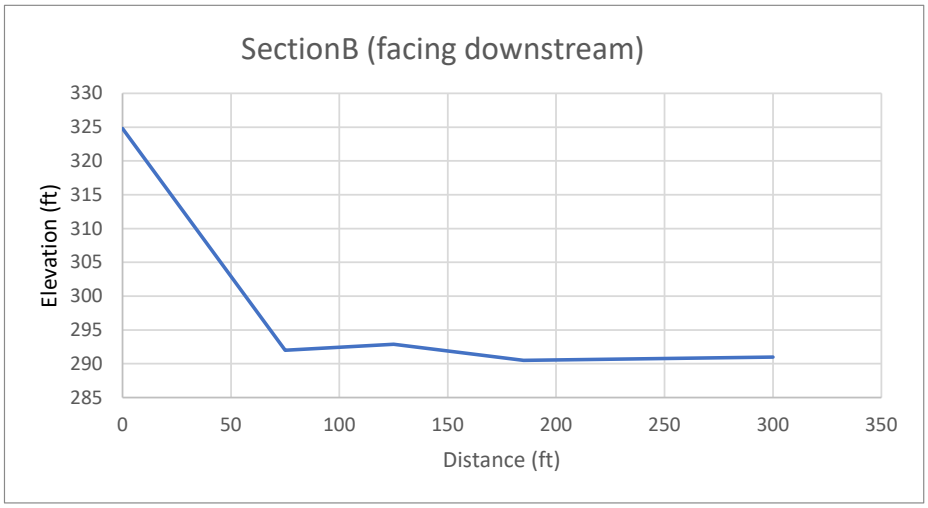
X (ft)	Y (ft)
0	283
25	282
52	281.1
91.3	280
155.6	279.5
191.3	281
219.9	282
248.5	283



X (ft)	Y (ft)
0	307.8
50	288
70	288
95	286
110	285
140	284.3
155	284
320	290

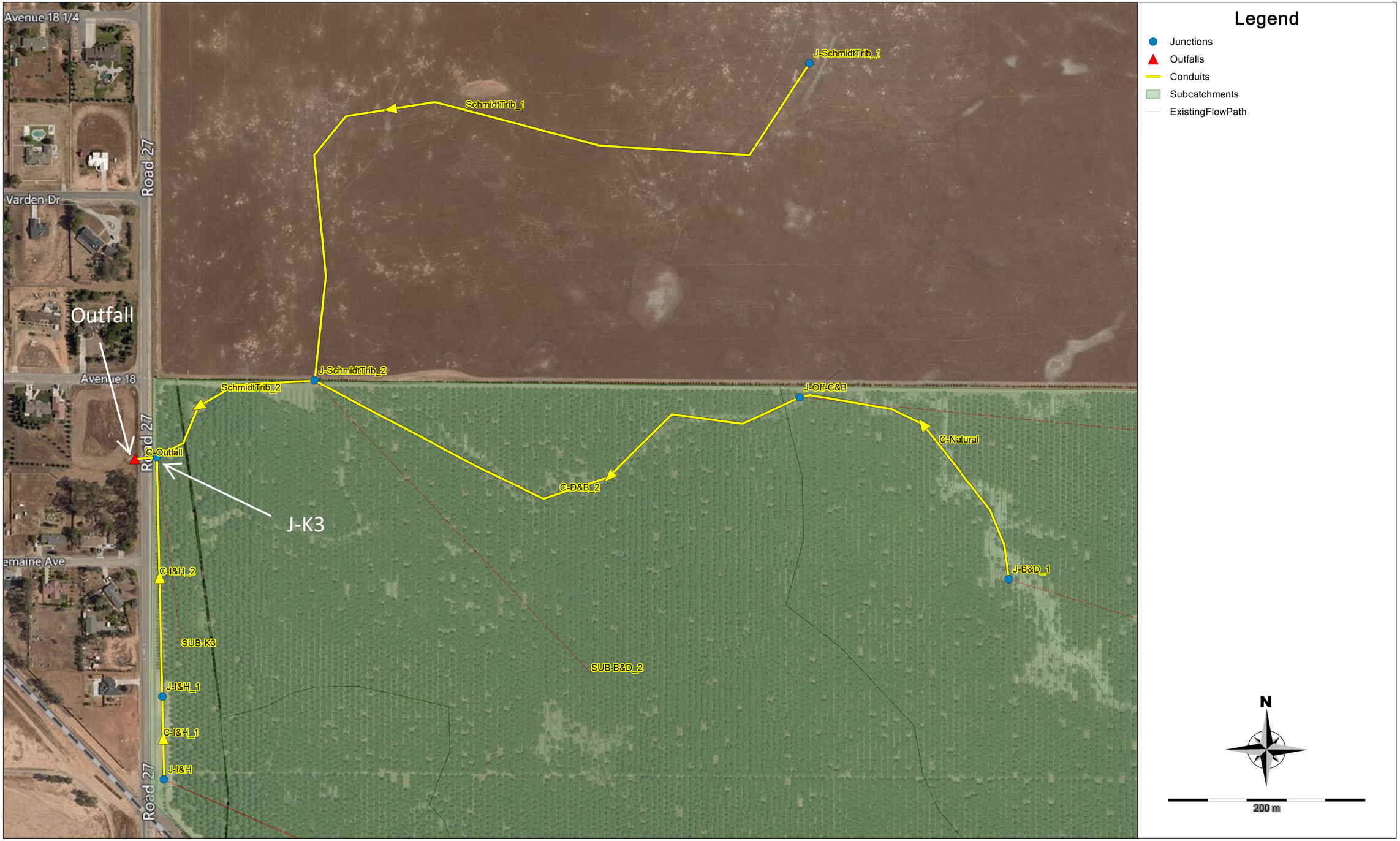


X (ft)	Y (ft)
0	324.8
75	292
125	292.9
185	290.5
300	291



Appendix D – PCSWMM Model Results

EXISTING CONDITIONS MODEL LAYOUT



Existing Conditions Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
C-D&B_2	J-Off-C&B	J-SchmidtTrib	1835.566	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	C-B&D_2	0.00256	15.1	1/1/2017 3:33	0.57	0	0.03
C-I&H_1	J-I&H	J-I&H_1	275	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionB	0.01818	5.47	1/1/2017 3:00	0.58	0	0.01
C-I&H_2	J-I&H_1	J-K3	725	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01504	3.96	1/1/2017 3:05	1.47	0	0.03
C-Natural	J-B&D_1	J-Off-C&B	954	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Channel	0.00695	14.21	1/1/2017 3:00	2.29	0.01	0.14
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	21.96	1/1/2017 5:34	3.57	0.48	0.39
SchmidtTrib_1	J-SchmidtTrib_1	J-SchmidtTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_1	0.00173	42.61	1/1/2017 4:24	0.83	0	0.04
SchmidtTrib_2	J-SchmidtTrib_2	J-K3	639.932	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_2	0.00141	35.47	1/1/2017 4:54	0.36	0	0.07

Existing Conditions Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-B&D_1	291.334	299	7.666	0		0.1	1.8	293.14	1/1/2017 3:00	1.8	14.78	14.78	0.348	0.348	-0.531	0	0	5.874	0	0	0	0
J-I&H	295	297	2	50		0.01	0.11	295.11	1/1/2017 3:00	0.11	5.63	5.63	0.133	0.133	0.017	0	0	34.19	0	0	0	0
J-I&H_1	290	292	2	0		0.05	0.25	290.25	1/1/2017 3:04	0.25	0	5.47	0	0.133	2.003	0	0	34.05	0	0	0	0
J-K3	279.1	282.1	3	0		0.47	1.47	280.57	1/1/2017 5:34	1.47	0.7	35.77	0.017	3.53	2.177	0	0	22.33	0	0	0	0
J-Off-C&B	284.7	296	11.3	0	C&B-Off-25yr	0.04	0.36	285.06	1/1/2017 3:15	0.36	10.32	24.49	0.232	0.582	-2.293	0	0	11.469	0	0	0	0
J-SchmidtTrib	284.6	293	8.4	0	A-Off-25yr	0.14	0.91	285.51	1/1/2017 4:14	0.91	48.37	48.37	2.74	2.74	-1.166	0	0	18.871	0	0	0	0
J-SchmidtTrib	280	284	4	0		0.15	0.59	280.59	1/1/2017 5:30	0.59	5.03	46.38	0.119	3.49	3.173	0	0	19.191	0	0	0	0

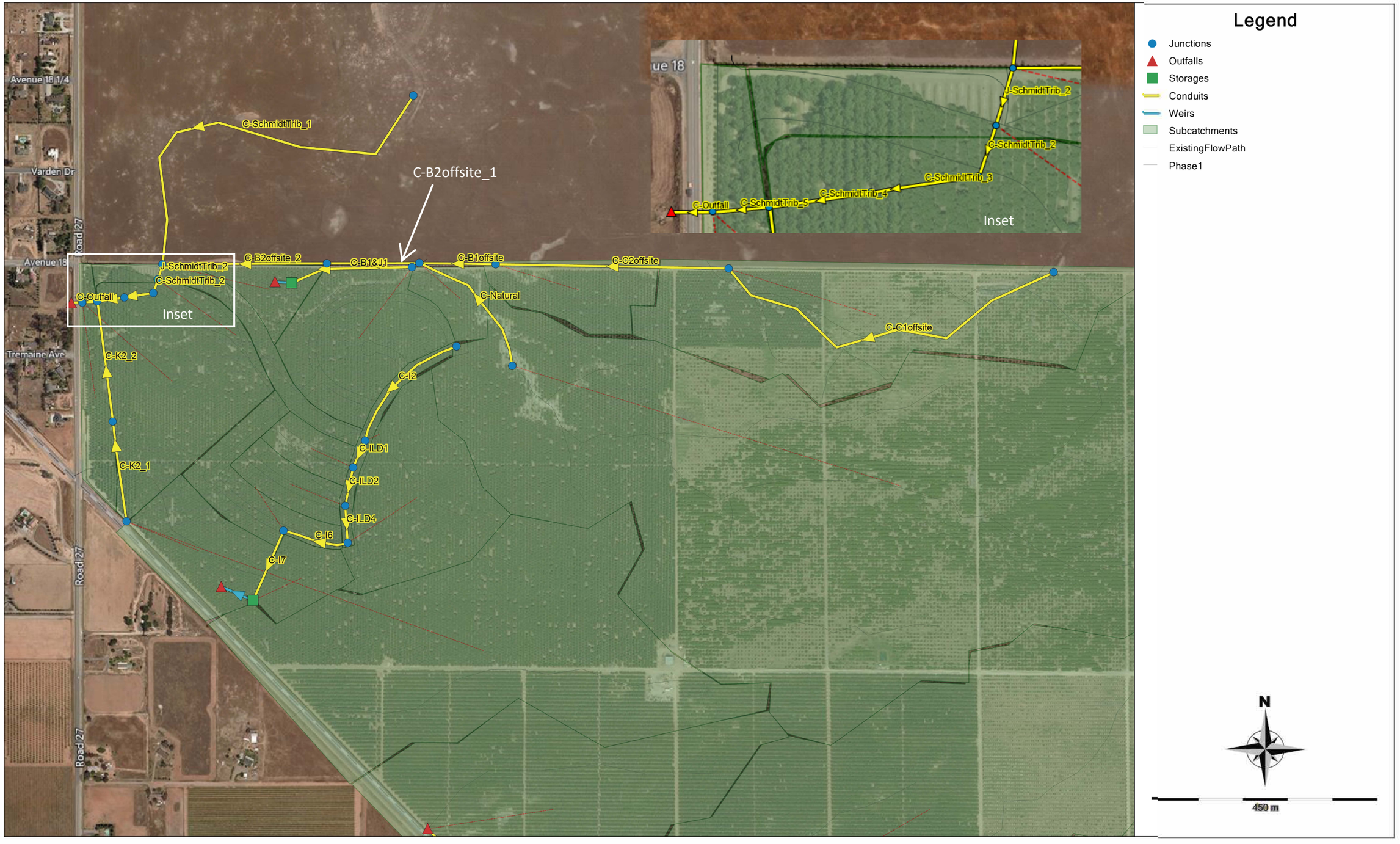
Existing Conditions Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
C-D&B_2	J-Off-C&B	J-SchmidtTrib	1835.566	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	C-B&D_2	0.00256	75.05	1/1/2017 3:27	0.91	0	0.07
C-I&H_1	J-I&H	J-I&H_1	275	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionB	0.01818	15.39	1/1/2017 3:02	0.95	0	0.01
C-I&H_2	J-I&H_1	J-K3	725	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01504	13.08	1/1/2017 3:17	1.62	0	0.05
C-Natural	J-B&D_1	J-Off-C&B	954	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Channel	0.00695	42.82	1/1/2017 3:03	3.49	0.05	0.22
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	49.72	1/1/2017 5:28	4.66	1.08	0.65
SchmidtTrib_1	J-SchmidtTrib_1	J-SchmidtTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_1	0.00173	165.99	1/1/2017 4:12	1.28	0	0.07
SchmidtTrib_2	J-SchmidtTrib_2	J-K3	639.932	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_2	0.00141	77.52	1/1/2017 3:42	0.53	0	0.13

Existing Conditions Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-B&D_1	291.334	299	7.666	0		0.16	2.5	293.84	1/1/2017 3:00	2.5	46.97	46.97	1.01	1.01	-0.23	0	0	5.174	0	0	0	0
J-I&H	295	297	2	50		0.01	0.2	295.2	1/1/2017 3:02	0.2	17.22	17.22	0.376	0.376	0.01	0	0	34.1	0	0	0	0
J-I&H_1	290	292	2	0		0.06	0.37	290.37	1/1/2017 3:17	0.37	0	15.39	0	0.376	-4.648	0	0	33.93	0	0	0	0
J-K3	279.1	282.1	3	0		0.69	2.36	281.46	1/1/2017 5:10	2.36	2.23	89.33	0.04	10.7	0.966	0	0	21.44	0	0	0	0
J-Off-C&B	284.7	296	11.3	0	C&B-Off-100yr	0.06	0.69	285.39	1/1/2017 3:16	0.68	40.65	89.85	0.838	1.85	-8.392	0	0	11.139	0	0	0	0
J-SchmidtTrib	284.6	293	8.4	0	A-Off-100yr	0.2	1.44	286.04	1/1/2017 3:59	1.44	155.1	155.1	8.31	8.31	-1.916	0	0	18.341	0	0	0	0
J-SchmidtTrib	280	284	4	0		0.31	1.48	281.48	1/1/2017 5:09	1.48	7.02	178.98	0.174	10.7	3.843	0	0	18.301	0	0	0	0

Phase 1 Conduits



Phase 1 Junction, Outfall, and Storage Nodes



Phase 1 Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
C1	J-Tracks_A	Outfall-G	1583.47	0.035	0	0	0.5	1	TRAPEZOIDAL	5	10	10	10	1		0.00052	0	1/1/2017 0:00	0	0	0
C-B1&J1	J-B1&J1	MAR#4	815	0.02	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00245	4.4	1/1/2017 3:00	1.37	0.1	0.8
C-B1offsite	J-Boffsite	J-B1offsite	492	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteB	0.00407	0.48	1/1/2017 5:36	0.05	0	0.23
C-B2offsite_1	J-B1offsite	J-B1offsite-1	630	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00127	5.4	1/1/2017 3:10	1.33	0.28	0.51
C-B2offsite_2	J-B1offsite-1	J-ASchTrib	1085	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	3	3	1		0.00295	5.69	1/1/2017 3:25	1.42	0.1	0.3
C-C1offsite	J-Coffsite	J-C1offsite	2504.545	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteC1	0.00427	1.03	1/1/2017 3:24	0.24	0	0.03
C-C2offsite	J-C1offsite	J-Boffsite	1543.338	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteC2	0.00551	0.59	1/1/2017 4:54	0.35	0	0.02
C-F	J-F	J-E	1827.84	0.035	0	0	0.5	1	TRAPEZOIDAL	5	10	10	10	1		0.00126	4.13	1/1/2017 3:02	0.24	0	0.22
C-I2	J-I2	J-I5	920	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00359	0	1/1/2017 0:00	0	0	0.17
C-I6	J-I6	J-I7	439	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00501	8.74	1/1/2017 3:00	3.58	0.04	0.22
C-I7	J-I7	MAR#1	503	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00636	17.87	1/1/2017 1:33	7.38	0.08	0.37
C-ILD1	J-I5	J-LD-1	195	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00103	3.34	1/1/2017 3:00	1.77	0.1	0.25
C-ILD2	J-LD-1	J-LD-2	259	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00193	5.1	1/1/2017 3:00	2.64	0.12	0.25
C-ILD4	J-LD-2	J-I6	244	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00451	7.54	1/1/2017 3:00	5.1	0.11	0.21
C-K2_1	OF-Tracks	J-K2_1	620	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	4	4	1		0.00565	5.08	1/1/2017 3:00	1.79	0.15	0.42
C-K2_2	J-K2_1	J-K2	670	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01536	4.3	1/1/2017 3:03	0.83	0	0.03
C-Natural	J-B&Dexisting	J-B1offsite	954	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Channel	0.00629	14.06	1/1/2017 3:00	2.64	0.01	0.13
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	19.61	1/1/2017 5:05	3.44	0.42	0.37
C-SchmidtTrib	J-SchmidtTrib_1	J-ASchTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtT	0.00173	38.54	1/1/2017 3:53	0.78	0	0.04
C-SchmidtTrib	J-SchmidtTrib_2	J-SchmidtTrib	100	0.013	0	0	0.5	1	RECT_CLOSED	3	10	0	0	1		0.0011	22.12	1/1/2017 4:25	2.66	0.18	0.29
C-SchmidtTrib	J-SchmidtTrib_3	J-SchmidtTrib	190	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.00263	21.77	1/1/2017 4:28	0.52	0	0.1
C-SchmidtTrib	J-SchmidtTrib_4	J-K2	180	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.00028	20.76	1/1/2017 4:34	0.35	0.01	0.12
C-SchmidtTrib	J-K2	J-K3	100	0.06	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.0011	19.58	1/1/2017 5:00	0.26	0.02	0.38
J-SchmidtTrib_	J-ASchTrib	J-SchmidtTrib	105	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtT	0.00124	21.97	1/1/2017 4:23	0.36	0.01	0.18

Phase 1 Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-ASchTrib	280	284	4	0		0.17	0.82	280.82	1/1/2017 4:31	0.82	1.3	42	0.031	2.25	3.246	0	0	18.961	0	0	0	0
J-B&Dexisting	290	298	8	0		0.06	0.82	290.82	1/1/2017 3:00	0.82	14.08	14.08	0.332	0.332	-0.752	0	0	7.18	0	0	0	0
J-B1&J1	281	287	6	0		0.94	1.79	282.79	1/1/2017 3:44	1.79	6.6	6.6	0.16	0.16	1.461	0	0	4.21	0	0	0	0
J-B1offsite	284	287	3	50		0.37	1.23	285.23	1/1/2017 3:07	1.23	0.27	14.42	0.006	0.432	0.735	0	0	6.45	0	0	0	0
J-B1offsite-1	283.2	285.7	2.5	0		0.17	0.81	284.01	1/1/2017 3:14	0.81	0	5.4	0	0.429	-0.178	0	0	1.69	0	0	0	0
J-Boffsite	286	288.5	2.5	100	B-Off-25yr	0.06	0.11	286.11	1/1/2017 5:36	0.11	0.56	0.75	0.013	0.102	12.359	0	0	4.29	0	0	0	0
J-C1offsite	294.5	296.5	2	50		0.05	0.11	294.61	1/1/2017 4:14	0.11	2.69	2.96	0.063	0.111	24.067	0	0	4.29	0	0	0	0
J-Coffsite	305.2	307.2	2	50	C-Off-25yr	0.01	0.06	305.26	1/1/2017 3:24	0.06	3.45	3.45	0.048	0.048	1.016	0	0	2.94	0	0	0	0
J-E	295.7	297.7	2	250		1.87	2.07	297.77	1/2/2017 0:00	2.07	9.02	13.01	0.212	0.378	0	0	0	2.93	0	0	0	0
J-F	298	300	2	0		0.05	0.41	298.41	1/1/2017 3:02	0.41	6.35	6.35	0.15	0.15	-9.913	0	0	4.59	0	0	0	0
J-I2	290.5	295	4.5	50		0	0	290.5	1/1/2017 0:00	0	0	0	0	0	0	0	0	4.5	0	0	0	0
J-I5	287.2	292.7	5.5	50		0.07	0.87	288.07	1/1/2017 3:00	0.87	3.56	3.56	0.089	0.089	0.003	0	0	4.63	0	0	0	0
J-I6	285.4	292.5	7.1	50		0.05	0.58	285.98	1/1/2017 3:00	0.58	1.35	8.81	0.032	0.225	0.054	0	0	6.52	0	0	0	0
J-I7	283.2	290.6	7.4	50		0.07	1.45	284.65	1/1/2017 1:30	1.45	4.64	13.28	0.112	0.337	-0.824	0	0	5.95	0	0	0	0
J-K2	279.21	283.21	4	0		0.41	1.27	280.48	1/1/2017 5:05	1.27	0	20.92	0	2.49	0.69	0	0	22.53	0	0	0	0
J-K2_1	289.5	291	1.5	0		0.04	0.32	289.82	1/1/2017 3:03	0.32	0	5.08	0	0.122	-1.117	0	0	23.48	0	0	0	0
J-K3	279.1	282.1	3	50		0.48	1.37	280.47	1/1/2017 5:05	1.37	9.74	19.64	0.249	2.72	0.001	0	0	2.13	0	0	0	0
J-LD-1	287	292.7	5.7	50		0.07	0.89	287.89	1/1/2017 3:00	0.89	1.88	5.19	0.045	0.134	0.01	0	0	4.81	0	0	0	0
J-LD-2	286.5	292.7	6.2	50		0.07	0.9	287.4	1/1/2017 3:00	0.9	2.57	7.62	0.059	0.193	-0.004	0	0	5.3	0	0	0	0
J-SchmidtTrib	284.6	293	8.4	0	A-Off-25yr	0.12	0.7	285.3	1/1/2017 3:44	0.7	39.37	39.37	1.75	1.75	-1.928	0	0	19.081	0	0	0	0
J-SchmidtTrib	279.87	283.87	4	0		0.23	0.94	280.81	1/1/2017 4:31	0.94	5.89	22.23	0.176	2.36	0.031	0	0	4.06	0	0	0	0
J-SchmidtTrib	279.76	283.76	4	100		0.21	0.8	280.56	1/1/2017 4:57	0.8	0	22.12	0	2.35	0.04	0	0	9.7	0	0	0	0
J-SchmidtTrib	279.26	285.039	5.779	0		0.39	1.24	280.5	1/1/2017 5:03	1.24	0	21.77	0	2.35	0.173	0	0	9.26	0	0	0	0
J-Tracks_A	295	297	2	0		0	0	295	1/1/2017 0:00	0	0	0	0	0	0	0	0	5	0	0	0	0
OF-Tracks	293	295	2	50		0.06	0.95	293.95	1/1/2017 3:00	0.95	5.16	5.16	0.122	0.122	-0.502	0	0	1.05	0	0	0	0

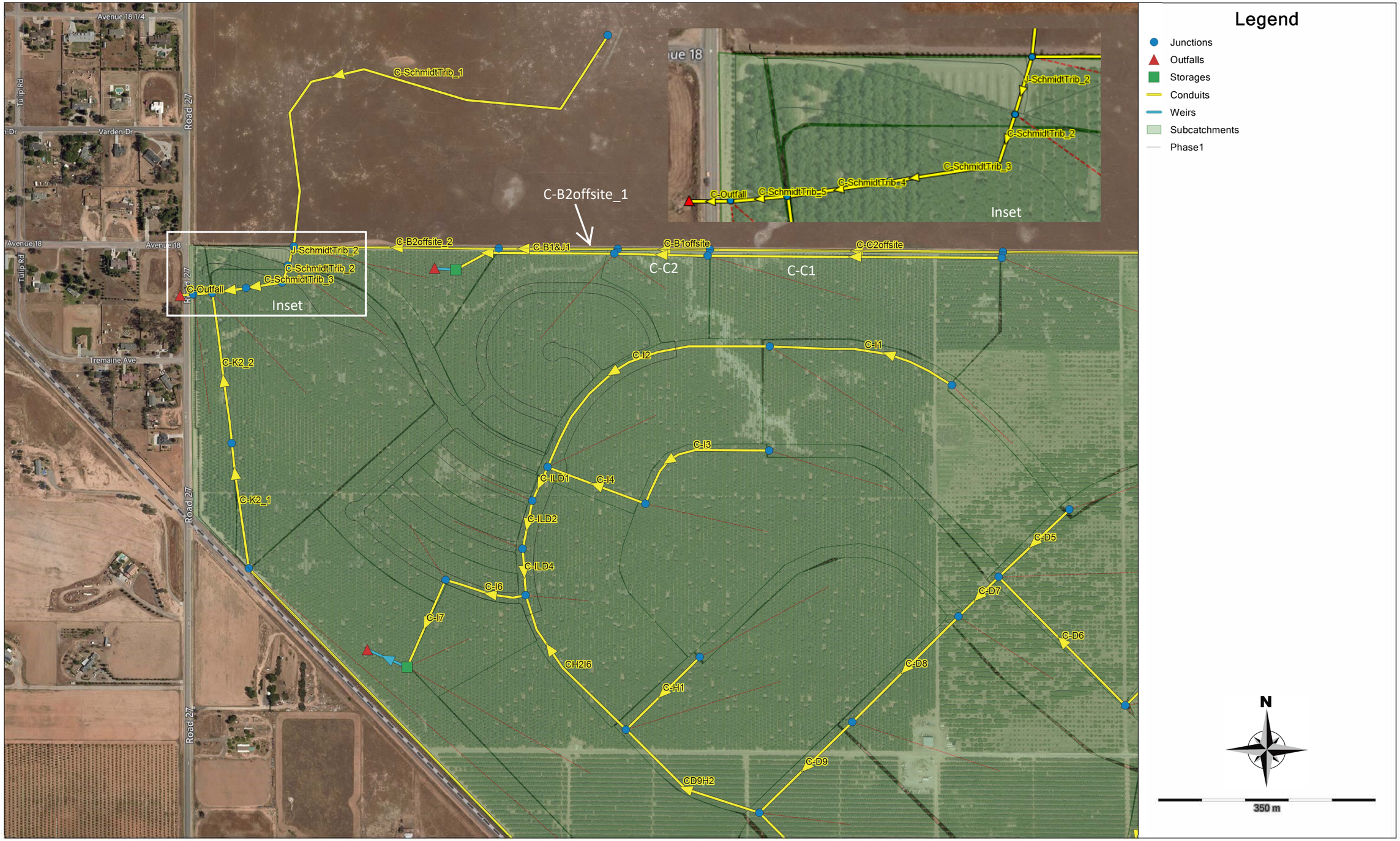
Phase 1 Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
C1	J-Tracks_A	Outfall-G	1583.47	0.035	0	0	0.5	1	TRAPEZOIDAL	5	10	10	10	1		0.00052	0	1/1/2017 0:00	0	0	0
C-B1&J1	J-B1&J1	MAR#4	815	0.02	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00245	8.73	1/1/2017 3:00	1.52	0.2	1
C-B1offsite	J-Boffsite	J-B1offsite	492	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteB	0.00407	8.69	1/1/2017 3:59	0.08	0.01	0.47
C-B2offsite_1	J-B1offsite	J-B1offsite-1	630	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00127	16.85	1/1/2017 3:25	2.07	0.87	0.8
C-B2offsite_2	J-B1offsite-1	J-ASchTrib	1085	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	3	3	1		0.00295	19.07	1/1/2017 3:30	1.95	0.32	0.76
C-C1offsite	J-Coffsite	J-C1offsite	2504.545	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteC1	0.00427	13.8	1/1/2017 3:17	0.78	0.01	0.09
C-C2offsite	J-C1offsite	J-Boffsite	1543.338	0.02	0	0	0.5	1	IRREGULAR	0	0	0	0	1	OffsiteC2	0.00551	10.62	1/1/2017 3:43	0.72	0	0.07
C-F	J-F	J-E	1827.84	0.035	0	0	0.5	1	TRAPEZOIDAL	5	10	10	10	1		0.00126	10.1	1/1/2017 3:22	0.27	0.01	0.37
C-I2	J-I2	J-I5	920	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00359	0	1/1/2017 0:00	0	0	0.23
C-I6	J-I6	J-I7	439	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00501	30.04	1/1/2017 3:00	5.25	0.15	0.28
C-I7	J-I7	MAR#1	503	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00636	38.02	1/1/2017 3:01	7.54	0.17	0.69
C-ILD1	J-I5	J-LD-1	195	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00103	4.68	1/1/2017 3:01	1.71	0.15	0.33
C-ILD2	J-LD-1	J-LD-2	259	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00193	8.46	1/1/2017 3:00	2.86	0.19	0.35
C-ILD4	J-LD-2	J-I6	244	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00451	13.89	1/1/2017 3:00	5.2	0.21	0.34
C-K2_1	OF-Tracks	J-K2_1	620	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	4	4	1		0.00565	14.49	1/1/2017 3:01	2.91	0.43	0.6
C-K2_2	J-K2_1	J-K2	670	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01536	12.18	1/1/2017 3:17	0.85	0	0.06
C-Natural	J-B&Dexisting	J-B1offsite	954	0.03	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Channel	0.00629	41.9	1/1/2017 3:01	4.14	0.03	0.22
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	58.49	1/1/2017 5:02	4.97	1.27	0.73
C-SchmidtTrib	J-SchmidtTrib_1	J-ASchTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtT	0.00173	158.26	1/1/2017 3:33	1.24	0	0.08
C-SchmidtTrib	J-SchmidtTrib_2	J-SchmidtTrib	100	0.013	0	0	0.5	1	RECT_CLOSED	3	10	0	0	1		0.0011	77.68	1/1/2017 4:13	3.96	0.62	0.74
C-SchmidtTrib	J-SchmidtTrib_3	J-SchmidtTrib	190	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.00263	74.36	1/1/2017 4:14	0.56	0.01	0.23
C-SchmidtTrib	J-SchmidtTrib_4	J-K2	180	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.00028	67.15	1/1/2017 4:19	0.39	0.02	0.26
C-SchmidtTrib	J-K2	J-K3	100	0.06	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_	0.0011	58.53	1/1/2017 4:55	0.27	0.07	0.79
J-SchmidtTrib_	J-ASchTrib	J-SchmidtTrib	105	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtT	0.00124	78.49	1/1/2017 4:11	0.38	0.03	0.45

Phase 1 Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-ASchTrib	280	284	4	0		0.49	2.18	282.18	1/1/2017 4:34	2.18	1.82	176.11	0.044	7.87	3.609	0	0	17.601	0	0	0	0
J-B&Dexisting	290	298	8	0		0.1	1.41	291.41	1/1/2017 3:01	1.41	44.72	44.72	0.965	0.965	-0.688	0	0	6.59	0	0	0	0
J-B1&J1	281	287	6	0		2.3	3.93	284.93	1/1/2017 3:50	3.93	11.83	11.83	0.264	0.264	9.418	5.82	0.932	2.068	0	0	0	0
J-B1offsite	284	287	3	50		0.64	2.31	286.31	1/1/2017 3:45	2.31	0.87	43.64	0.021	1.56	0.245	0	0	5.37	0	0	0	0
J-B1offsite-1	283.2	285.7	2.5	0		0.3	1.21	284.41	1/1/2017 3:22	1.21	0	16.85	0	1.56	-0.427	0	0	1.29	0	0	0	0
J-Boffsite	286	288.5	2.5	100	B-Off-100	0.1	0.33	286.33	1/1/2017 3:59	0.33	4.64	11.87	0.071	0.593	4.224	0	0	4.07	0	0	0	0
J-C1offsite	294.5	296.5	2	50		0.08	0.32	294.82	1/1/2017 3:36	0.32	9.91	21.76	0.198	0.546	5.12	0	0	4.08	0	0	0	0
J-Coffsite	305.2	307.2	2	50	C-Off-100	0.02	0.28	305.48	1/1/2017 3:11	0.28	23.04	23.04	0.337	0.337	-3.049	0	0	2.72	0	0	0	0
J-E	295.7	297.7	2	250		2.71	3	298.7	1/1/2017 4:24	3	27.16	32.83	0.601	0.798	0	0	0	2	0	0	0	0
J-F	298	300	2	0		0.63	0.7	298.7	1/1/2017 4:16	0.7	8.82	10.41	0.21	0.306	55.561	0	0	4.3	0	0	0	0
J-I2	290.5	295	4.5	50		0	0	290.5	1/1/2017 0:00	0	0	0	0	0	0	0	0	4.5	0	0	0	0
J-I5	287.2	292.7	5.5	50		0.08	1.13	288.33	1/1/2017 3:00	1.13	5.04	5.04	0.125	0.125	-0.004	0	0	4.37	0	0	0	0
J-I6	285.4	292.5	7.1	50		0.06	1.14	286.54	1/1/2017 3:00	1.13	16.78	30.54	0.147	0.45	-0.26	0	0	5.96	0	0	0	0
J-I7	283.2	290.6	7.4	50		0.34	1.54	284.74	1/1/2017 1:18	1.54	9.3	38.81	0.185	0.643	-0.279	0	0	5.86	0	0	0	0
J-K2	279.21	283.21	4	0		0.81	2.72	281.93	1/1/2017 5:02	2.72	0	68.22	0	8.21	0.433	0	0	21.08	0	0	0	0
J-K2_1	289.5	291	1.5	0		0.07	0.47	289.97	1/1/2017 3:17	0.47	0	14.49	0	0.34	-4.978	0	0	23.33	0	0	0	0
J-K3	279.1	282.1	3	50		0.89	2.82	281.92	1/1/2017 5:02	2.82	16.76	58.59	0.4	8.58	0.001	0	0	0.68	0	0	0	0
J-LD-1	287	292.7	5.7	50		0.09	1.19	288.19	1/1/2017 3:00	1.19	4	8.64	0.076	0.201	0.014	0	0	4.51	0	0	0	0
J-LD-2	286.5	292.7	6.2	50		0.09	1.25	287.75	1/1/2017 3:00	1.25	5.67	14.06	0.101	0.302	-0.019	0	0	4.95	0	0	0	0
J-SchmidtTrib	284.6	293	8.4	0	A-Off-100	0.19	1.27	285.87	1/1/2017 3:32	1.27	157.79	157.79	6.03	6.03	-3.632	0	0	18.511	0	0	0	0
J-SchmidtTrib	279.87	283.87	4	0		0.56	2.31	282.18	1/1/2017 4:34	2.31	8.57	78.89	0.247	7.84	0.011	0	0	2.69	0	0	0	0
J-SchmidtTrib	279.76	283.76	4	100		0.54	2.18	281.94	1/1/2017 5:01	2.18	0	77.68	0	7.83	0.009	0	0	8.32	0	0	0	0
J-SchmidtTrib	279.26	285.039	5.779	0		0.79	2.67	281.93	1/1/2017 5:02	2.67	0	74.36	0	7.83	0.064	0	0	7.83	0	0	0	0
J-Tracks_A	295	297	2	0		0	0	295	1/1/2017 0:00	0	0	0	0	0	0	0	0	5	0	0	0	0
OF-Tracks	293	295	2	50		0.1	1.36	294.36	1/1/2017 3:01	1.36	15.58	15.58	0.339	0.339	-0.286	0	0	0.64	0	0	0	0

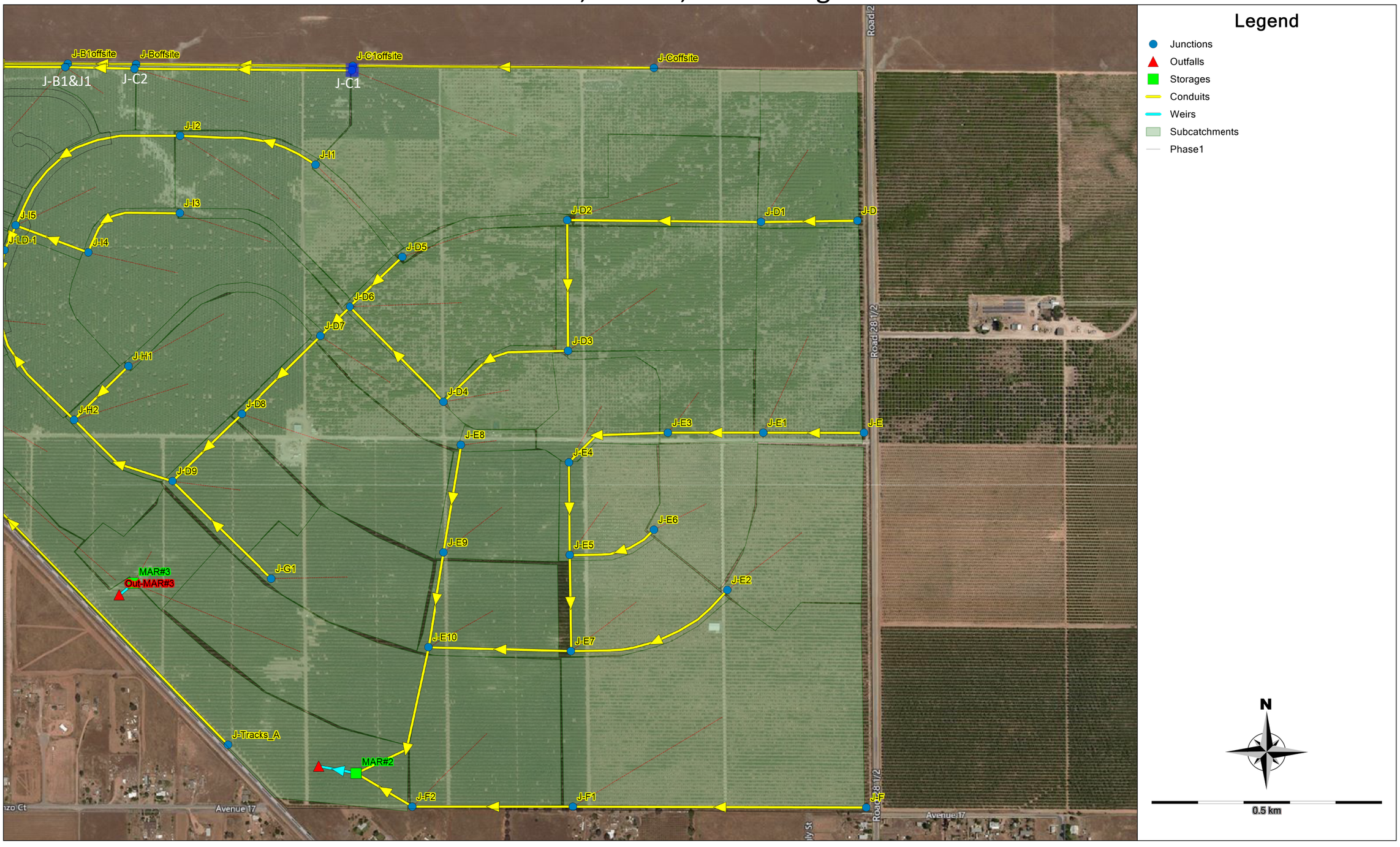
Full Buildout Conduits A



Full Buildout Junction, Outfall, and Storage Nodes A



Full Buildout Junction, Outfall, and Storage Nodes B



Full Buildout Conduits B



Full Buildout Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
									Trapezoidal												
C1	J-Tracks_A	OF-Tracks	4425	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00045	0	1/1/2017 0:00	0	0	0.15
C-B1&J1	J-B1&J1	MAR#4	815	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00245	33.5	1/1/2017 3:03	6.57	0.51	0.63
C-B1offsite	J-Boffsite	J-B1offsite	492	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00407	2.14	1/1/2017 3:44	1.35	0.06	0.32
C-B2offsite_1	J-B1offsite	J-B1offsite-1	630	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00127	1.64	1/1/2017 4:02	1	0.08	0.27
C-B2offsite_2	J-B1offsite-1	J-ASchTrib	1085	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	3	3	1		0.00295	1.4	1/1/2017 4:15	0.45	0.02	0.25
C-C1	J-C1	J-C2	1556.632	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00424	21.83	1/1/2017 3:01	5.71	0.5	0.53
C-C1offsite	J-Coffsite	J-C1offsite	2150	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	2	2	1		0.00498	2.84	1/1/2017 3:20	1.61	0.14	0.38
C-C2	J-C2	J-B1&J1	494.169	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00182	27.33	1/1/2017 3:02	3.62	0.48	0.7
C-C2offsite	J-C1offsite	J-Boffsite	1551	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	2	2	1		0.00548	2.34	1/1/2017 3:39	1.57	0.11	0.33
C-D1	J-D	J-D1	690	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.0029	0	1/1/2017 0:00	0	0	0.28
C-D2	J-D1	J-D2	1385	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00361	8.11	1/1/2017 3:02	3.29	0.6	0.73
C-D3	J-D2	J-D3	929	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00161	16.53	1/1/2017 3:03	3.59	0.62	0.62
C-D4	J-D3	J-D4	1019	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00226	26.92	1/1/2017 3:04	4.25	0.56	0.63
C-D5	J-D5	J-D6	515	0.013	0	0.5	0.5	1	CIRCULAR	2	0	0	0	1		0.00524	2.35	1/1/2017 3:01	2.27	0.14	0.63
C-D6	J-D4	J-D6	953	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00147	33.49	1/1/2017 3:04	4.07	0.61	0.65
C-D7	J-D6	J-D7	297	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00303	49.38	1/1/2017 3:03	3.68	0.67	0.94
C-D8	J-D7	J-D8	790	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00241	51.15	1/1/2017 3:05	5.01	0.73	0.77
C-D9	J-D8	J-D9	687	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00364	67.51	1/1/2017 3:04	6.69	0.78	0.75
CD9H2	J-D9	J-H2	853	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	2		0.0027	86.16	1/1/2017 3:05	5.53	0.82	0.76
C-E1	J-E	J-E1	722	0.013	0	1	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00623	0	1/1/2017 0:00	0	0	0.17
C-E10	J-E10	MAR#2	1140	0.013	0	18	0.5	1	RECT_CLOSED	4	6	0	0	1		0.00263	96.38	1/1/2017 3:06	6.83	0.61	0.59
C-E3	J-E1	J-E3	680	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00324	15.26	1/1/2017 3:02	4.28	0.65	0.68
C-E4	J-E3	J-E4	789	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00304	25.25	1/1/2017 3:03	4.62	0.69	0.73
C-E5	J-E4	J-E5	659	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00243	33.35	1/1/2017 3:03	4.19	0.67	0.77
CE5E7	J-E5	J-E7	684	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00409	54.08	1/1/2017 3:03	6.22	0.84	0.85
C-E6	J-E6	J-E5	654	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00612	12.14	1/1/2017 3:01	4.47	0.69	0.81
C-E7	J-E2	J-E7	1250	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00456	13.11	1/1/2017 3:02	3.36	0.47	0.74
CE7E10	J-E7	J-E10	1021	0.013	0	0	0.5	1	RECT_CLOSED	3	5	0	0	1		0.00196	75.88	1/1/2017 3:04	5.36	1.04	0.95
C-E8	J-E8	J-E9	775	0.013	0	0	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00348	1.15	1/1/2017 3:02	1.08	0.18	0.61
C-E9	J-E9	J-E10	683	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00732	15.58	1/1/2017 3:01	5.49	0.8	0.85
C-F1	J-F	J-F1	2098	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00324	0	1/1/2017 0:00	0	0	0.3
C-F2	J-F1	J-F2	1148	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00366	20.27	1/1/2017 3:04	1.63	0.37	0.77
C-F3	J-F2	MAR#2	464	0.035	0	22	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00216	26.38	1/1/2017 3:07	2.47	0.63	0.69
CG1D9	J-G1	J-D9	989	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00354	12.95	1/1/2017 3:02	3.24	0.53	0.76
C-H1	J-H1	J-H2	546	0.013	0	2	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00238	3.39	1/1/2017 3:01	3.22	0.66	0.58
CH2I6	J-H2	J-I6	902	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.0031	101.91	1/1/2017 3:05	5.47	0.64	0.7
C-I1	J-I1	J-I2	1006	0.013	0	0	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00417	1.91	1/1/2017 3:01	1.73	0.28	0.62
C-I2	J-I2	J-I5	1475	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00346	12.92	1/1/2017 3:02	3.22	0.54	0.76
C-I3	J-I3	J-I4	806	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00409	3.06	1/1/2017 3:01	2.69	0.21	0.39
C-I4	J-I4	J-I5	553	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00416	7.82	1/1/2017 3:00	2.18	0.3	0.69
C-I6	J-I6	J-I7	439	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00501	140.14	1/1/2017 3:06	7.13	0.69	0.73
C-I7	J-I7	MAR#1	503	0.013	0	15	0.5	1	CIRCULAR	4	0	0	0	2		0.00636	142.73	1/1/2017 3:07	8.55	0.62	0.63
C-ILD1	J-I5	J-LD-1	195	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00103	30.22	1/1/2017 3:02	3.61	0.94	0.82
C-ILD2	J-LD-1	J-LD-2	259	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00193	31.5	1/1/2017 3:03	4.27	0.71	0.74
C-ILD4	J-LD-2	J-I6	244	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00451	32.82	1/1/2017 3:03	4.29	0.49	0.8
C-K2_1	OF-Tracks	J-K2_1	620	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	4	4	1		0.00565	2.17	1/1/2017 3:05	1.41	0.06	0.28
C-K2_2	J-K2_1	J-K2	670	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01536	1.91	1/1/2017 3:16	0.2	0	0.03
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	17.82	1/1/2017 5:17	3.33	0.39	0.35
C-SchmidtTrib_1	J-SchmidtTrib_1	J-ASchTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_1	0.00173	38.13	1/1/2017 4:09	0.78	0	0.03
C-SchmidtTrib_2	J-SchmidtTrib_2	J-SchmidtTrib	100	0.013	0	0	0.5	1	RECT_CLOSED	3	10	0	0	1		0.0011	20.25	1/1/2017 4:35	2.62	0.16	0.27
C-SchmidtTrib_3	J-SchmidtTrib_3	J-SchmidtTrib	190	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_1	0.00263	19.94	1/1/2017 4:36	0.54	0	0.09
C-SchmidtTrib_4	J-SchmidtTrib_4	J-K2	180	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_1	0.00028	19	1/1/2017 4:42	0.36	0	0.11
C-SchmidtTrib_5	J-K2	J-K3	100	0.024	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_2	0.0011	18.88	1/1/2017 5:03	0.21	0.02	0.35
J-SchmidtTrib_2	J-ASchTrib	J-SchmidtTrib	105	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrap	0.00124	20.23	1/1/2017 4:30	0.36	0.01	0.17

Full Buildout Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-ASchTrib	280	284	4	0		0.15	0.78	280.78	1/1/2017 4:40	0.78	1.3	39.48	0.031	1.89	4.251	0	0	19.001	0	0	0	0
J-B1&J1	281	287	6	50		0.23	2.53	283.53	1/1/2017 1:37	2.53	6.87	33.9	0.166	0.855	-0.566	0	0	3.47	0	0	0	0
J-B1offsite	284	287	3	100		0.07	0.84	284.84	1/1/2017 3:58	0.84	0	2.14	0	0.048	0.517	0	0	2.16	0	0	0	0
J-B1offsite-1	283.2	285.7	2.5	0		0.03	0.27	283.47	1/1/2017 4:14	0.27	0	1.64	0	0.047	0.437	0	0	2.23	0	0	0	0
J-Boffsite	286	288.5	2.5	100	B-Off-25y	0.04	0.51	286.51	1/1/2017 3:43	0.51	0	2.34	0	0.048	0.991	0	0	1.99	0	0	0	0
J-C1	288.5	296.5	8	0		0.11	1.55	290.05	1/1/2017 3:01	1.55	22.12	22.12	0.538	0.538	-0.049	0	0	6.45	0	0	0	0
J-C1offsite	294.5	296.5	2	50		0.03	0.54	295.04	1/1/2017 3:32	0.54	0	2.84	0	0.05	3.332	0	0	1.46	0	0	0	0
J-C2	281.9	287	5.1	50		0.13	1.69	283.59	1/1/2017 1:38	1.69	6.25	28.08	0.151	0.689	0.044	0	0	3.41	0	0	0	0
J-Coffsite	305.2	307.2	2	100	C-Off-25y	0.03	0.77	305.97	1/1/2017 3:13	0.77	3.45	3.45	0.048	0.048	-3.574	0	0	1.23	0	0	0	0
J-D	308	312	4	50		0	0	308	1/1/2017 0:00	0	0	0	0	0	0	0	0	4	0	0	0	0
J-D1	306	310	4	50		0.08	1.12	307.12	1/1/2017 3:02	1.12	8.75	8.75	0.203	0.203	-0.048	0	0	2.88	0	0	0	0
J-D2	301	306	5	150		0.13	1.83	302.83	1/1/2017 3:03	1.83	10.19	18.08	0.227	0.431	0.023	0	0	3.17	0	0	0	0
J-D3	299.5	305	5.5	150		0.15	1.9	301.4	1/1/2017 3:03	1.9	12.71	28.33	0.299	0.729	-0.068	0	0	3.6	0	0	0	0
J-D4	297.2	303.2	6	150		0.22	2.5	299.7	1/1/2017 3:05	2.5	9.77	35.57	0.242	0.972	0.093	0	0	3.5	0	0	0	0
J-D5	299	303	4	150		0.05	0.51	299.51	1/1/2017 3:01	0.51	2.38	2.38	0.06	0.06	0.166	0	0	3.49	0	0	0	0
J-D6	295.8	301.8	6	50		0.17	2.66	298.46	1/1/2017 3:05	2.66	18.74	53.4	0.408	1.44	-0.033	0	0	3.34	0	0	0	0
J-D7	294.9	300.9	6	50		0.22	2.95	297.85	1/1/2017 3:05	2.95	3.18	52.03	0.079	1.52	-0.008	0	0	3.05	0	0	0	0
J-D8	293	299	6	50		0.24	3.21	296.21	1/1/2017 3:04	3.21	20.71	68.68	0.438	1.96	-0.025	0	0	2.79	0	0	0	0
J-D9	290.5	297	6.5	50		0.21	2.8	293.3	1/1/2017 3:05	2.8	10.65	88.89	0.22	2.47	-0.007	0	0	3.7	0	0	0	0
J-E	308.5	311.5	3	50		0	0	308.5	1/1/2017 0:00	0	0	0	0	0	0	0	0	3	0	0	0	0
J-E1	303	307.5	4.5	50		0.11	1.5	304.5	1/1/2017 3:02	1.5	15.95	15.95	0.362	0.362	0.001	0	0	3	0	0	0	0
J-E10	292	301	9	50		0.16	2.7	294.7	1/1/2017 3:05	2.7	11.83	100.74	0.249	2.6	0.013	0	0	6.3	0	0	0	0
J-E2	299.7	305.2	5.5	50		0.09	1.21	300.91	1/1/2017 3:02	1.21	13.72	13.72	0.315	0.315	-0.167	0	0	4.29	0	0	0	0
J-E3	300.8	305.8	5	50		0.13	1.9	302.7	1/1/2017 3:02	1.9	11.06	26.12	0.226	0.588	-0.003	0	0	3.1	0	0	0	0
J-E4	298.4	304.4	6	50		0.17	2.45	300.85	1/1/2017 3:03	2.45	10.12	34.67	0.248	0.836	0.001	0	0	3.55	0	0	0	0
J-E5	296.8	303.8	7	50		0.21	2.94	299.74	1/1/2017 3:03	2.94	11.46	55.48	0.28	1.38	-0.019	0	0	4.06	0	0	0	0
J-E6	300.8	304.8	4	50		0.08	1.22	302.02	1/1/2017 3:01	1.22	12.39	12.39	0.261	0.261	-0.086	0	0	2.78	0	0	0	0
J-E7	294	303	9	50		0.17	2.99	296.99	1/1/2017 3:04	2.99	12.76	78.18	0.28	1.97	-0.004	0	0	6.01	0	0	0	0
J-E8	299.7	303.2	3.5	50		0.04	0.44	300.14	1/1/2017 3:02	0.44	1.21	1.21	0.03	0.03	0.136	0	0	3.06	0	0	0	0
J-E9	297	302	5	50		0.1	1.4	298.4	1/1/2017 3:02	1.4	15.1	16.21	0.351	0.381	-0.133	0	0	3.6	0	0	0	0
J-F	305	309	4	50		0	0	305	1/1/2017 0:00	0	0	0	0	0	0	0	0	4	0	0	0	0
J-F1	298.2	302.2	4	50		0.1	1.19	299.39	1/1/2017 3:03	1.19	25.07	25.07	0.606	0.606	-0.164	0	0	2.81	0	0	0	0
J-F2	294	298	4	50		0.2	1.91	295.91	1/1/2017 3:06	1.91	11.85	30.96	0.281	0.888	0.275	0	0	2.09	0	0	0	0
J-G1	294	298.5	4.5	50		0.09	1.3	295.3	1/1/2017 3:02	1.3	13.49	13.49	0.288	0.288	-0.14	0	0	3.2	0	0	0	0
J-H1	291.5	296	4.5	50		0.08	1.03	292.53	1/1/2017 3:01	1.03	3.53	3.53	0.084	0.084	-0.055	0	0	3.47	0	0	0	0
J-H2	288.2	294.2	6	50		0.2	2.49	290.69	1/1/2017 3:05	2.49	18.71	104.04	0.391	2.94	0.011	0	0	3.51	0	0	0	0
J-I1	296.5	300	3.5	50		0.04	0.55	297.05	1/1/2017 3:01	0.55	1.95	1.95	0.046	0.046	-0.183	0	0	2.95	0	0	0	0
J-I2	292.3	296.8	4.5	50		0.1	1.3	293.6	1/1/2017 3:02	1.3	11.89	13.8	0.269	0.315	-0.035	0	0	3.2	0	0	0	0
J-I3	292.8	296.8	4	50		0.05	0.63	293.43	1/1/2017 3:01	0.63	3.1	3.1	0.074	0.074	-0.017	0	0	3.37	0	0	0	0
J-I4	289.5	294	4.5	50		0.07	0.94	290.44	1/1/2017 3:02	0.94	4.92	7.98	0.116	0.19	-0.085	0	0	3.56	0	0	0	0
J-I5	287.2	292.7	5.5	50		0.21	3.02	290.22	1/1/2017 3:03	3.02	11.75	32.16	0.252	0.758	-0.022	0	0	2.48	0	0	0	0
J-I6	285.4	292.5	7.1	50		0.22	3.1	288.5	1/1/2017 3:06	3.1	9.97	141.5	0.221	4.02	-0.003	0	0	4	0	0	0	0
J-I7	283.2	290.6	7.4	50		0.21	2.75	285.95	1/1/2017 3:07	2.75	4.37	143	0.111	4.13	0.004	0	0	4.65	0	0	0	0
J-K2	279.21	283.21	4	0		0.37	1.19	280.4	1/1/2017 5:15	1.19	9.04	19.48	0.232	2.29	0.55	0	0	22.61	0	0	0	0
J-K2_1	289.5	291	1.5	0		0.04	0.23	289.73	1/1/2017 3:15	0.23	0	2.17	0	0.086	-0.696	0	0	23.57	0	0	0	0
J-K3	279.1	282.1	3	50		0.43	1.29	280.39	1/1/2017 5:17	1.29	0.7	18.88	0.017	2.29	0.06	0	0	2.21	0	0	0	0
J-LD-1	287	292.7	5.7	50		0.19	2.71	289.71	1/1/2017 3:03	2.71	1.88	31.93	0.045	0.803	0.009	0	0	2.99	0	0	0	0
J-LD-2	286.5	292.7	6.2	50		0.15	2.48	288.98	1/1/2017 3:05	2.48	2.46	33.64	0.058	0.861	-0.046	0	0	3.72	0	0	0	0
J-SchmidtTrib_1	284.6	293	8.4	0	A-Off-25y	0.13	0.78	285.38	1/1/2017 3:48	0.78	39.37	39.37	1.75	1.75	-2.498	0	0	19.001	0	0	0	0
J-SchmidtTrib_2	279.87	283.87	4	0		0.2	0.88	280.75	1/1/2017 4:39	0.88	5.89	20.46	0.176	1.99	0.137	0	0	4.12	0	0	0	0
J-SchmidtTrib_3	279.76	283.76	4	100		0.18	0.73	280.49	1/1/2017 5:04	0.73	0	20.25	0	1.97	-0.035	0	0	9.77	0	0	0	0
J-SchmidtTrib_4	279.26	285.039	5.779	0		0.35	1.17	280.43	1/1/2017 5:14	1.17	0	19.94	0	1.98	0.258	0	0	9.33	0	0	0	0
J-Tracks_A	295	297	2	0		0	0	295	1/1/2017 0:00	0	0	0	0	0	0	0	0	2	0	0	0	0
OF-Tracks	293	295	2	50		0.06	0.62	293.62	1/1/2017 3:04	0.62	3.66	3.66	0.086	0.086	-0.115	0	0	1.38	0	0	0	0

Full Buildout Conduit Details

Name	Inlet Node	Outlet Node	Length (ft)	Roughness	Inlet Offset (ft)	Outlet Offset (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Geom2 (ft)	Geom3	Geom4	Barrels	X-Section Name	Slope (ft/ft)	Max. |Flow| (cfs)	Time Max. Flow	Max. |Velocity| (ft/s)	Max/Full Flow	Max/Full Depth
									Trapezoidal												
C1	J-Tracks_A	OF-Tracks	4425	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00045	0	1/1/2017 0:00	0	0	0.19
C-B1&J1	J-B1&J1	MAR#4	815	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00245	30.76	1/1/2017 3:02	2.34	0.47	1
C-B1offsite	J-Boffsite	J-B1offsite	492	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00407	23.02	1/1/2017 3:40	2.22	0.67	0.93
C-B2offsite_1	J-B1offsite	J-B1offsite-1	630	0.035	0	0	0.5	1	TRAPEZOIDAL	2	2	2	2	1		0.00127	21.33	1/1/2017 3:39	2.37	1.1	0.89
C-B2offsite_2	J-B1offsite-1	J-ASchTrib	1085	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	3	3	1		0.00295	23.72	1/1/2017 3:45	2.18	0.4	0.75
C-C1	J-C1	J-C2	1556.632	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00424	10.33	1/1/2017 3:00	3.6	0.24	0.46
C-C1offsite	J-Coffsite	J-C1offsite	2150	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	2	2	1		0.00498	21.25	1/1/2017 3:32	2.93	1.05	1
C-C2	J-C2	J-B1&J1	494.169	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00182	26.68	1/1/2017 3:02	2.64	0.47	0.86
C-C2offsite	J-C1offsite	J-Boffsite	1551	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	2	2	1		0.00548	20.64	1/1/2017 3:42	2.78	0.97	1
C-D1	J-D	J-D1	690	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.0029	3.97	1/1/2017 3:01	1.69	0.33	0.92
C-D2	J-D1	J-D2	1385	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00361	12.09	1/1/2017 2:55	4.12	0.89	1
C-D3	J-D2	J-D3	929	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00161	23.82	1/1/2017 2:55	3.49	0.89	1
C-D4	J-D3	J-D4	1019	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00226	39.08	1/1/2017 3:00	4.32	0.82	1
C-D5	J-D5	J-D6	515	0.013	0	0.5	0.5	1	CIRCULAR	2	0	0	0	1		0.00524	3.81	1/1/2017 2:58	2.3	0.23	1
C-D6	J-D4	J-D6	953	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00147	49.91	1/1/2017 3:02	3.97	0.91	1
C-D7	J-D6	J-D7	297	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	2		0.00303	73.58	1/1/2017 3:04	5.21	1	1
C-D8	J-D7	J-D8	790	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00241	77.83	1/1/2017 3:06	6.19	1.1	1
C-D9	J-D8	J-D9	687	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	1		0.00364	99.83	1/1/2017 3:05	10.82	1.15	0.69
CD9H2	J-D9	J-H2	853	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	2		0.0027	35.29	1/1/2017 3:06	2.88	0.34	0.69
C-E1	J-E	J-E1	722	0.013	0	1	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00623	2.39	1/1/2017 3:03	1.84	0.29	0.89
C-E10	J-E10	MAR#2	1140	0.013	0	18	0.5	1	RECT_CLOSED	4	6	0	0	1		0.00263	127.29	1/1/2017 3:05	7.48	0.8	0.71
C-E3	J-E1	J-E3	680	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00324	22.14	1/1/2017 3:00	4.51	0.95	1
C-E4	J-E3	J-E4	789	0.013	0	0	0.5	1	CIRCULAR	3	0	0	0	1		0.00304	32.27	1/1/2017 3:03	4.6	0.88	1
C-E5	J-E4	J-E5	659	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00243	42.04	1/1/2017 3:05	4.47	0.85	1
CE5E7	J-E5	J-E7	684	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00409	66.13	1/1/2017 3:02	6.87	1.03	1
C-E6	J-E6	J-E5	654	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00612	15.41	1/1/2017 2:57	4.91	0.87	1
C-E7	J-E2	J-E7	1250	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00456	23.22	1/1/2017 3:01	4.85	0.84	1
CE7E10	J-E7	J-E10	1021	0.013	0	0	0.5	1	RECT_CLOSED	3	5	0	0	1		0.00196	96.21	1/1/2017 3:05	6.41	1.32	1
C-E8	J-E8	J-E9	775	0.013	0	0	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00348	3.31	1/1/2017 3:07	2.26	0.53	1
C-E9	J-E9	J-E10	683	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00732	19.68	1/1/2017 3:02	6.27	1.02	1
C-F1	J-F	J-F1	2098	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00324	0	1/1/2017 0:00	0	0	0.48
C-F2	J-F1	J-F2	1148	0.035	0	0	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00366	38.74	1/1/2017 3:06	2.38	0.71	0.98
C-F3	J-F2	MAR#2	464	0.035	0	22	0.5	1	TRAPEZOIDAL	2	5	2	2	1		0.00216	57.73	1/1/2017 2:59	4.16	1.37	0.83
CG1D9	J-G1	J-D9	989	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00354	0.59	1/1/2017 3:00	0.61	0.02	0.34
C-H1	J-H1	J-H2	546	0.013	0	2	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00238	4.82	1/1/2017 3:00	3.55	0.94	0.74
CH2I6	J-H2	J-I6	902	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.0031	61.11	1/1/2017 3:08	2.59	0.38	0.91
C-I1	J-I1	J-I2	1006	0.013	0	0	0.5	1	CIRCULAR	1.5	0	0	0	1		0.00417	2.69	1/1/2017 3:00	1.98	0.4	0.72
C-I2	J-I2	J-I5	1475	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00346	20.5	1/1/2017 2:58	4.41	0.85	1
C-I3	J-I3	J-I4	806	0.013	0	0	0.5	1	CIRCULAR	2	0	0	0	1		0.00409	4.3	1/1/2017 3:00	2.86	0.3	0.69
C-I4	J-I4	J-I5	553	0.013	0	0	0.5	1	CIRCULAR	2.5	0	0	0	1		0.00416	9.25	1/1/2017 2:52	2.5	0.35	1
C-I6	J-I6	J-I7	439	0.013	0	0	0.5	1	CIRCULAR	4	0	0	0	2		0.00501	199.78	1/1/2017 3:05	7.95	0.98	1
C-I7	J-I7	MAR#1	503	0.013	0	15	0.5	1	CIRCULAR	4	0	0	0	2		0.00636	204.84	1/1/2017 3:06	8.89	0.89	0.87
C-ILD1	J-I5	J-LD-1	195	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00103	43.93	1/1/2017 2:58	6.27	1.36	1
C-ILD2	J-LD-1	J-LD-2	259	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00193	8.05	1/1/2017 3:04	0.89	0.18	1
C-ILD4	J-LD-2	J-I6	244	0.013	0	0	0.5	1	CIRCULAR	3.5	0	0	0	1		0.00451	12.72	1/1/2017 2:59	1.32	0.19	1
C-K2_1	OF-Tracks	J-K2_1	620	0.035	0	0	0.5	1	TRAPEZOIDAL	1.5	2	4	4	1		0.00565	3.15	1/1/2017 3:03	1.59	0.09	0.33
C-K2_2	J-K2_1	J-K2	670	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SectionA	0.01536	2.78	1/1/2017 3:12	0.21	0	0.06
C-Outfall	J-K3	Outfall	94	0.024	0	0	0.5	1	ARCH	3	6	0	0	1		0.00319	69.46	1/1/2017 5:18	5.6	1.51	0.78
C-SchmidtTrib_1	J-SchmidtTrib_1	J-ASchTrib	2660	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrib_1	0.00173	153.39	1/1/2017 3:56	1.22	0	0.09
C-SchmidtTrib_2	J-SchmidtTrib_2	J-SchmidtTrib	100	0.013	0	0	0.5	1	RECT_CLOSED	3	10	0	0	1		0.0011	91.17	1/1/2017 4:27	4.61	0.73	0.79
C-SchmidtTrib_3	J-SchmidtTrib_3	J-SchmidtTrib	190	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_1	0.00263	87.37	1/1/2017 4:29	0.73	0.01	0.24
C-SchmidtTrib_4	J-SchmidtTrib_4	J-K2	180	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_1	0.00028	79.28	1/1/2017 4:36	0.52	0.02	0.27
C-SchmidtTrib_5	J-K2	J-K3	100	0.024	0	0	0.5	1	IRREGULAR	0	0	0	0	1	Schmidt_Prop_2	0.0011	69.63	1/1/2017 5:11	0.24	0.09	0.83
J-SchmidtTrib_2	J-ASchTrib	J-SchmidtTrib	105	0.01	0	0	0.5	1	IRREGULAR	0	0	0	0	1	SchmidtTrap	0.00124	92.63	1/1/2017 4:26	0.44	0.04	0.48

Full Buildout Junction Details

Name	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	Ponded Area (ft²)	Inflow Time Series	Avg. Depth (ft)	Max. Depth (ft)	Max. HGL (ft)	Time Max. HGL	Rep. Max. Depth (ft)	Max. Lat. Inflow (cfs)	Max. Total Inflow (cfs)	Total Lat. Inflow (MG)	Total inflow (MG)	Flow Error (%)	Hours Surcharged (h)	Max. Surcharge (ft)	Min. Freeboard (ft)	Hours Flooded (h)	Max. Flood Rate (cfs)	Total Flood Vol. (MG)	Max. Ponded Depth (ft)
J-ASchTrib	280	284	4	0		0.53	2.35	282.35	1/1/2017 4:58	2.35	1.82	175.46	0.044	9.39	3.137	0	0	17.431	0	0	0	0
J-B1&J1	281	287	6	50		1.23	3.11	284.11	1/1/2017 3:41	3.1	12.21	71.19	0.274	1.57	0.093	0.73	0.108	2.892	0	0	0	0
J-B1offsite	284	287	3	100		0.24	3	287	1/1/2017 3:04	3	0	23.02	0	0.759	0.12	1.04	1.002	0	0.02	3.59	0	0.002
J-B1offsite-1	283.2	285.7	2.5	0		0.11	1.57	284.77	1/1/2017 3:26	1.57	0	21.33	0	0.758	-1.489	0	0	0.93	0	0	0	0
J-Boffsite	286	288.5	2.5	100	B-Off-100	0.14	1.74	287.74	1/1/2017 3:50	1.74	10.6	21.61	0.151	0.756	-0.37	0	0	0.76	0	0	0	0
J-C1	288.5	296.5	8	0		0.04	1	289.5	1/1/2017 3:00	0.99	52.27	52.27	0.998	0.998	-0.236	0	0	7	0	0	0	0
J-C1offsite	294.5	296.5	2	50		0.11	1.49	295.99	1/1/2017 3:44	1.49	0	21.25	0	0.615	1.758	0	0	0.51	0	0	0	0
J-C2	281.9	287	5.1	50		0.61	2.19	284.09	1/1/2017 3:42	2.19	16.02	66.75	0.289	1.3	0.454	0	0	2.91	0	0	0	0
J-Coffsite	305.2	307.2	2	100	C-Off-100	0.18	3.94	309.14	1/1/2017 3:18	3.94	28.06	28.06	0.598	0.598	-2.9	0.95	2.436	0	0.9	13.55	0.117	1.936
J-D	308	312	4	50		0.02	1.67	309.67	1/1/2017 3:04	1.65	0	3.97	0	0.008	1.71	0	0	2.33	0	0	0	0
J-D1	306	310	4	50		0.14	3.55	309.55	1/1/2017 3:06	3.55	18.44	18.44	0.353	0.361	0.026	0	0	0.45	0	0	0	0
J-D2	301	306	5	150		0.22	5.01	306.01	1/1/2017 3:03	5.01	19.84	30.87	0.381	0.734	-0.381	0.24	0.513	0	0.04	0.38	0	0.013
J-D3	299.5	305	5.5	150		0.27	6.5	306	1/1/2017 3:03	6.5	28.2	58.87	0.532	1.27	0.002	0	0	0.3	0	0	0	0
J-D4	297.2	303.2	6	150		0.35	8.25	305.45	1/1/2017 3:04	8.25	13.95	66.67	0.344	1.61	-0.091	0	0	0.45	0	0	0	0
J-D5	299	303	4	150		0.12	5.55	304.55	1/1/2017 3:04	5.54	3.38	12.78	0.084	0.088	-0.37	0.21	1.549	0	0.19	6.7	0.005	1.549
J-D6	295.8	301.8	6	50		0.33	8.74	304.54	1/1/2017 3:04	8.74	34.51	89.35	0.67	2.37	0.022	0	0	1.76	0	0	0	0
J-D7	294.9	300.9	6	50		0.37	8.13	303.03	1/1/2017 3:05	8.13	6.29	78.2	0.14	2.51	-0.003	0	0	2.17	0	0	0	0
J-D8	293	299	6	50		0.46	6.84	299.84	1/1/2017 3:02	6.84	35.97	99.17	0.706	3.21	-0.001	0	0	3.56	0	0	0	0
J-D9	290.5	297	6.5	50		0.06	1.53	292.03	1/1/2017 3:05	1.53	17.75	130.43	0.35	4.03	-0.003	0	0	4.97	0	0	0	0
J-E	308.5	311.5	3	50		0.01	1.18	309.68	1/1/2017 3:06	1.18	0	2.39	0	0.004	1.4	0	0	1.82	0	0	0	0
J-E1	303	307.5	4.5	50		0.19	6.76	309.76	1/1/2017 3:02	6.76	30.04	30.04	0.599	0.603	0.129	0	0	0.54	0	0	0	0
J-E10	292	301	9	50		0.22	3.27	295.27	1/1/2017 3:04	3.27	19.75	129.35	0.395	4.02	-0.017	0	0	5.73	0	0	0	0
J-E2	299.7	305.2	5.5	50		0.13	4.29	303.99	1/1/2017 3:02	4.27	28.58	28.58	0.545	0.545	-0.06	0	0	1.21	0	0	0	0
J-E3	300.8	305.8	5	50		0.22	6.8	307.6	1/1/2017 3:03	6.8	17.13	39.06	0.35	0.948	-0.041	0	0	0.5	0	0	0	0
J-E4	298.4	304.4	6	50		0.26	6.89	305.29	1/1/2017 3:04	6.89	14.54	45.83	0.354	1.3	-0.06	0	0	1.01	0	0	0	0
J-E5	296.8	303.8	7	50		0.3	6.91	303.71	1/1/2017 3:03	6.91	16.41	73.25	0.4	2.1	-0.093	0	0	1.99	0	0	0	0
J-E6	300.8	304.8	4	50		0.14	4.65	305.45	1/1/2017 3:00	4.65	18.89	18.89	0.4	0.4	-0.027	0	0	0.35	0	0	0	0
J-E7	294	303	9	50		0.25	5.74	299.74	1/1/2017 3:05	5.74	18.33	105.38	0.409	3.06	-0.159	0	0	3.26	0	0	0	0
J-E8	299.7	303.2	3.5	50		0.05	2.14	301.84	1/1/2017 3:01	2.14	2.32	2.89	0.05	0.05	0.113	0	0	2.86	0	0	0	0
J-E9	297	302	5	50		0.15	4.32	301.32	1/1/2017 3:02	4.31	21.77	22.21	0.507	0.558	0.155	0	0	0.68	0	0	0	0
J-F	305	309	4	50		0	0	305	1/1/2017 0:00	0	0	0	0	0	0	0	0	4	0	0	0	0
J-F1	298.2	302.2	4	50		0.13	1.94	300.14	1/1/2017 3:04	1.94	54.93	54.93	1.08	1.08	-0.122	0	0	2.06	0	0	0	0
J-F2	294	298	4	50		0.26	4.02	298.02	1/1/2017 2:58	4.02	25.33	61.48	0.494	1.58	0.573	0.5	2.02	0	0.13	23.43	0.005	0.02
J-G1	294	298.5	4.5	50		0.01	0.27	294.27	1/1/2017 3:00	0.27	23.81	23.81	0.466	0.466	-0.049	0	0	4.23	0	0	0	0
J-H1	291.5	296	4.5	50		0.09	1.32	292.82	1/1/2017 3:00	1.32	4.96	4.96	0.119	0.119	1.922	0	0	3.18	0	0	0	0
J-H2	288.2	294.2	6	50		0.09	3.27	291.47	1/1/2017 3:05	3.27	34.03	163.89	0.643	4.79	-0.025	0	0	2.73	0	0	0	0
J-I1	296.5	300	3.5	50		0.05	0.66	297.16	1/1/2017 3:00	0.66	2.73	2.73	0.065	0.065	-0.126	0	0	2.84	0	0	0	0
J-I2	292.3	296.8	4.5	50		0.13	3.12	295.42	1/1/2017 3:03	3.11	23.4	26.09	0.453	0.518	-0.11	0	0	1.38	0	0	0	0
J-I3	292.8	296.8	4	50		0.06	0.75	293.55	1/1/2017 3:00	0.75	4.34	4.34	0.104	0.104	-0.087	0	0	3.25	0	0	0	0
J-I4	289.5	294	4.5	50		0.1	2.53	292.03	1/1/2017 3:03	2.53	8.16	12.46	0.192	0.296	-0.079	0	0	1.97	0	0	0	0
J-I5	287.2	292.7	5.5	50		0.4	4.56	291.76	1/1/2017 3:04	4.56	20.13	48.67	0.404	1.22	-0.183	0	0	1.44	0	0	0	0
J-I6	285.4	292.5	7.1	50		0.32	5.56	290.96	1/1/2017 3:05	5.56	18.74	208.34	0.366	6.55	0.007	0	0	8.84	0	0	0	0
J-I7	283.2	290.6	7.4	50		0.29	4.17	287.37	1/1/2017 3:06	4.17	8.38	205.62	0.183	6.74	-0.003	0	0	3.23	0	0	0	0
J-K2	279.21	283.21	4	0		0.82	2.84	282.05	1/1/2017 5:18	2.84	14.53	79.98	0.36	9.8	0.255	0	0	20.96	0	0	0	0
J-K2_1	289.5	291	1.5	0		0.05	0.27	289.77	1/1/2017 3:12	0.27	0	3.15	0	0.123	-7.135	0	0	23.53	0	0	0	0
J-K3	279.1	282.1	3	50		0.89	2.95	282.05	1/1/2017 5:18	2.95	2.23	69.63	0.04	9.82	0.009	0	0	0.55	0	0	0	0
J-LD-1	287	292.7	5.7	50		0.1	4.06	291.06	1/1/2017 3:05	4.05	4	47.8	0.076	1.3	0	0.21	0.556	1.644	0	0	0	0
J-LD-2	286.5	292.7	6.2	50		0.14	4.53	291.03	1/1/2017 3:05	4.51	5.22	12.99	0.1	0.218	-0.09	0.29	1.026	1.674	0	0	0	0
J-SchmidtTrib_1	284.6	293	8.4	0	A-Off-100	0.24	1.25	285.85	1/1/2017 3:56	1.25	155.1	155.1	8.31	8.31	-2.676	0	0	18.531	0	0	0	0
J-SchmidtTrib_2	279.87	283.87	4	0		0.59	2.47	282.34	1/1/2017 4:58	2.47	8.57	92.9	0.247	9.35	0.008	0	0	2.53	0	0	0	0
J-SchmidtTrib_3	279.76	283.76	4	100		0.55	2.31	282.07	1/1/2017 5:17	2.31	0	91.17	0	9.31	-0.002	0	0	8.19	0	0	0	0
J-SchmidtTrib_4	279.26	285.039	5.779	0		0.8	2.8	282.06	1/1/2017 5:18	2.8	0	87.37	0	9.31	0.051	0	0	7.7	0	0	0	0
J-Tracks_A	295	297	2	0		0	0	295	1/1/2017 0:00	0	0	0	0	0	0	0	0	2	0	0	0	0
OF-Tracks	293	295	2	50		0.08	0.74	293.74	1/1/2017 3:02	0.74	5.08	5.08	0.123	0.123	-0.227	0	0	1.26	0	0	0	0

Appendix E – Soils and Geotechnical Information

KENNETH D. SCHMIDT AND ASSOCIATES
GROUNDWATER QUALITY CONSULTANTS
600 WEST SHAW, SUITE 250
FRESNO, CALIFORNIA 93704
TELEPHONE (559) 224-4412

March 19, 2018

Mr. Glenn Pace, Manager
Pembrook Development
175 E. Main Avenue, Suite 110
Morgan Hill, CA 95037

Re: Castellina Developmnent

Dear Glenn:

Following is our letter report on the subsurface geologic conditions and water levels in terms of recharge of storm runoff for the proposed development. Normally, I address subsurface geologic conditions first. However, in this case, there are some very important water level issues that are somewhat unusual. Thus they are discussed first.

Water Levels

The southernmost boring by Technicon (B-1) encountered groundwater at a depth of only 70 feet. We have previously evaluated groundwater levels near the Fresno River as part of several Master Water Plans for the City of Madera. The latest of these was in 2012. Shallow groundwater has been recognized for decades along the Fresno River, particularly near and upstream of the Santa Fe Railroad tracks. This shallow groundwater is largely due to recharge from Madera Irrigation District (MID) releases of surface water down the Fresno River, and partly due to floodflows. This shallow groundwater, including that at Boring B-1, is not indicated to be perched. "Perched groundwater" is defined as being underlain by unsaturated materials, which is not indicated to be the situation beneath or near the Fresno River. In general, shallower groundwater levels are present in shallower strata, and deeper groundwater levels are present in deeper strata in most of the San Joaquin Valley. Thus water-level measurements for shallow domestic wells in the vicinity of the project have normally been shallower than those in deep irrigation wells.

Besides at Boring B-1, shallow groundwater has been indicated at three wells, based on California Department of Water Resources (DWR) water-level measurements and hydrographs: 1) Well T11S/R18E-5J1 (located about half a mile east of the east

boundary of the property, along the alignment of Avenue 17-1/2), 2) Well T11S/R18E-7L1 (located about half a mile southwest of the southwest corner of the project, near the alignment of Avenue 16-1/2), and 3) Well T11S/R18E-8Q1, located near Road 28-1/2, about one mile south of the south boundary of the project. The locations of these wells are shown on Figure 1. Depth to water in Well T11S/R18E-5J1 usually ranged from about 57 to 80 feet during 1960-88 (the period of record). Depth to water in Well T11S/R18E-7L1 usually ranged from about 60 to 105 feet during 1965-2005 (the period of record). The water level in this well fell about 30 feet between 1970 and 2005, or less than one foot per year. Depth to water in Well T11S/R18E-8Q1 usually ranged from about 15 to 35 feet between 1959 and 2008. There was no indication of a long-term water-level decline in this well. It is located just downstream of the Santa Fe Railroad tracks on the south side of the Fresno River.

If one considers Well 7L1, Boring B-1, and Well 5J1, shallow groundwater is indicated at distances ranging from about 0.8 mile to 1.3 miles from the Fresno River. Thus shallow groundwater (about 100 feet deep or less) is indicated to be present beneath the south and southeast parts of the project site. This is important, because much shallower dry wells could be used in the southeast part of the project site, or maybe no dry wells would be necessary for recharge.

Shallow water levels beneath the project site are expected to be deeper to the northwest, away from the Fresno River. Shallow water levels beneath the rest of the project site (besides at Boring B-1) have not been clearly defined, but based on available data are expected to increase to the northwest, and may be up to about 200 feet deep beneath the northwest part of the project site.

Subsurface Geologic Conditions

We prepared two subsurface geologic cross sections extending through the project site (Figure 1). These are based primarily on drillers logs for wells and secondarily on soil boring logs. Cross Section A-A′ (Figure 2) extends from near the northwest corner of the project site to the southeast, generally near the Santa Fe Railroad tracks, to a well about a quarter of a mile south of the project site. Cross Section B-B′ (Figure 3) extends from near Road 27 and a quarter of a mile north of Avenue 17, to the east through the project site to near Road 28-1/2.

Cross Section A-A′ is considered useful for evaluating the proposed stormwater recharge areas just northeast of the Santa

Fe Railroad tracks. Soil borings B-5 and B-1 are along this cross section. Sand is indicated to be predominant within the uppermost 300 feet along this cross section. A surficial hardpan layer or fine-grained deposits are indicated within the uppermost 10 to 20 feet. Beneath this surficial material is an extensive relatively thick sand layer. An obvious trend along this section is more sand to the southeast, as one approaches the Fresno River, as expected. No continuous clay layers are indicated along the cross section. This means that water recharged into the uppermost sand layer will readily reach the groundwater. It should be noted that at Boring B-1, the groundwater was only 70 feet deep. Cross Section A-A' indicates that storm basin recharge could be done without the use of dry wells, if the storm water basins were excavated to about 30 to 40 feet in depth, as has been practiced in the City of Fresno for over 50 years.

Cross Section B-B' illustrates well the significant changes in subsurface geologic conditions as one progresses to the east beneath the central and east parts of the project site. For most of the section east of the Santa Fe Railroad tracks, clay is predominant and laterally extensive. Sands in this area, except for three localized areas, are generally less than about ten feet thick. Recharge by dry wells in the central and northeast parts of the project site isn't considered feasible, because thicker sands aren't present, except below a depth of about 300 feet. These deposits are indicated to be saturated (meaning an injection well would be necessary for recharge).

Summary and Conclusions

Storm basins, as developed in the City of Fresno, can be used for recharge along the southwest part of the project site and possibly in the southeast part. Soil borings haven't been done in the southeast part of the area. If storm basins aren't practical, relatively shallow dry wells (less than 50 feet deep) could be constructed. These wells would be similar in design to those previously installed in the south part of the City of Madera. It is recommended that stormwater sites in the central and northeast parts of the project site not be used for recharge, but rather storm water in these areas should be rerouted to the southwest or southeast parts of the project site. It is recommended that two or three more 100-feet deep borings be done in the east part of the project site (east of Road 28).

Please call me if you have any questions.

Sincerely Yours,

Kenneth D. Schmidt

KDS/ms

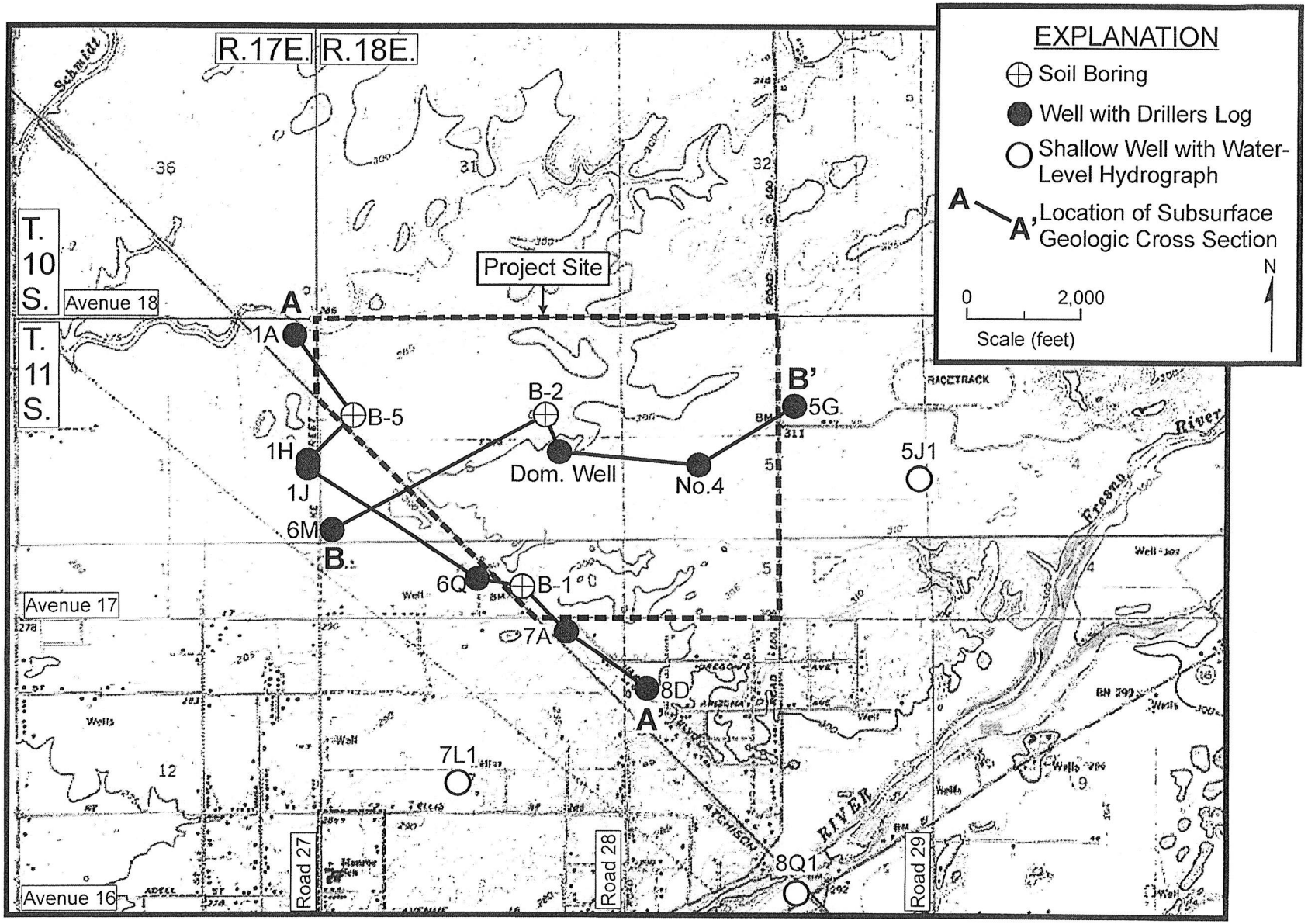


FIGURE 1 - LOCATION OF SELECTED WELLS, SOIL BORINGS, SUBSURFACE GEOLOGIC CROSS SECTIONS, AND SHALLOW WELLS WITH WATER-LEVEL HYDROGRAPHS

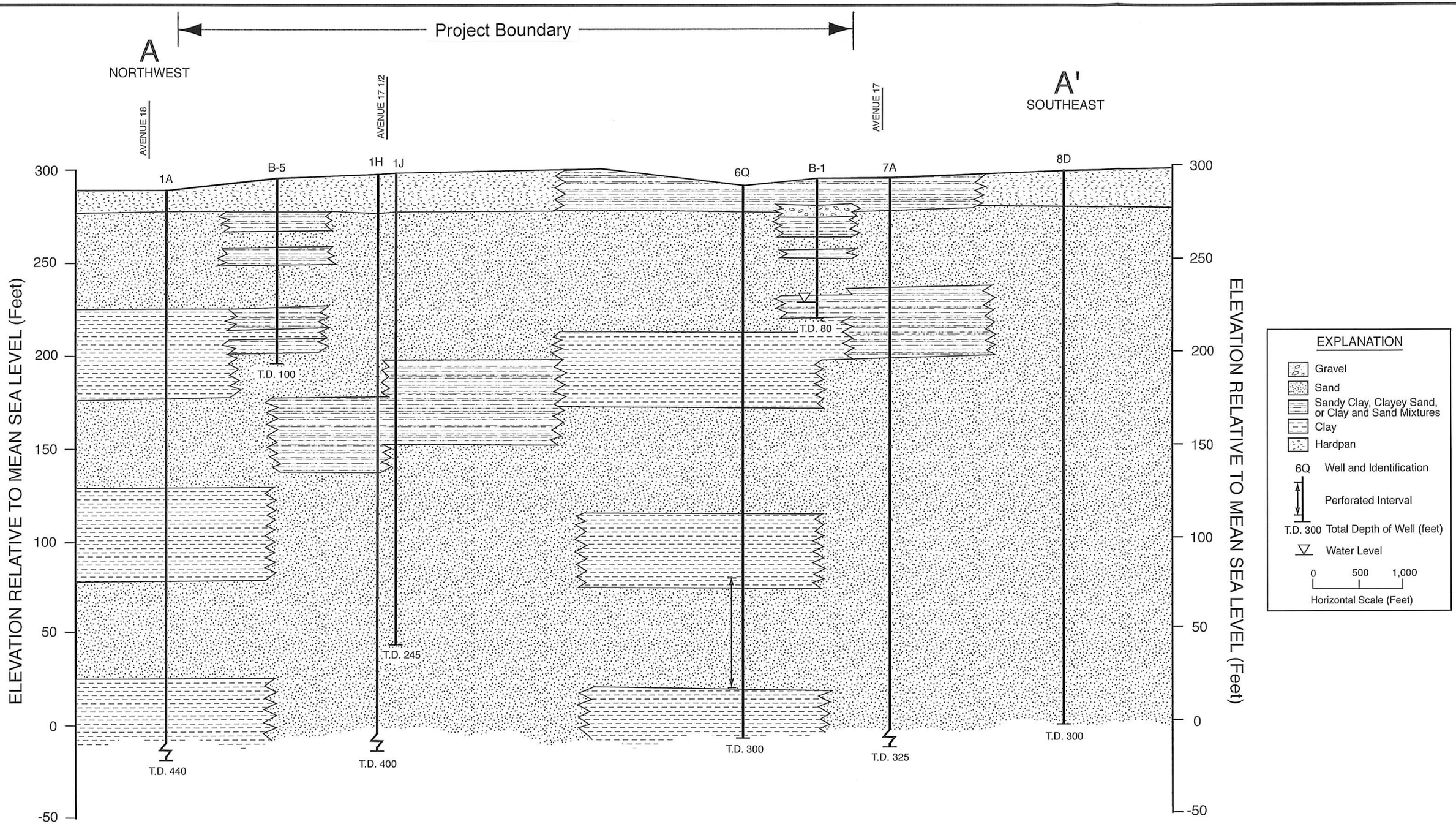


FIGURE 2 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

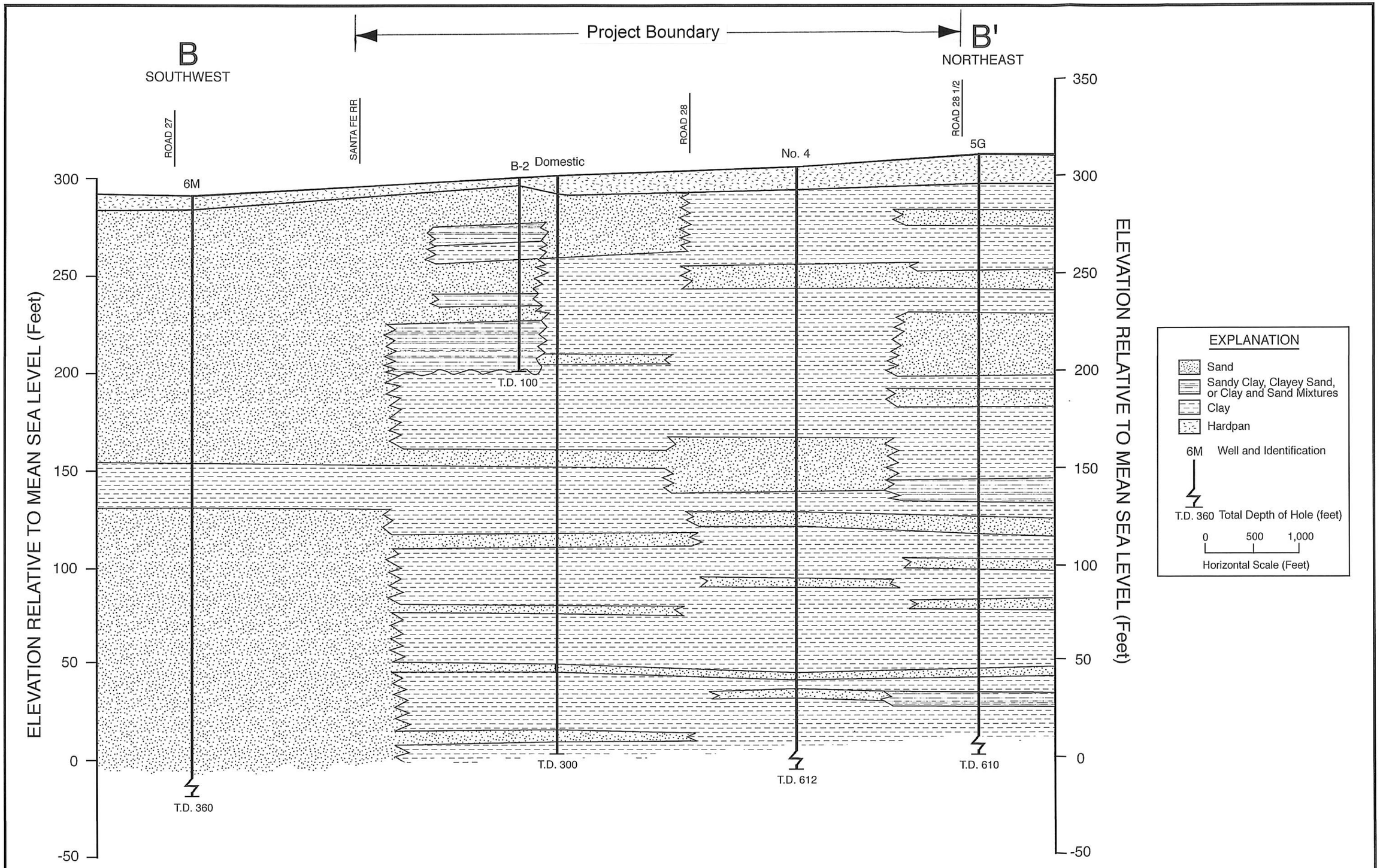


FIGURE 3 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

Infiltration:Parameter Estimates

From Gsshawiki

It is best to use soil property and Green-Ampt infiltration parameters derived from field and laboratory measurements of infiltration on the study watershed. Even under controlled conditions hydraulic soil property measurements are very difficult. Hysteresis effects and the extremely non-linear behavior of soil water retention make it very difficult to uniquely identify soil infiltration parameters. Hydrologic studies seldom have budgets sufficient to determine the needed parameters in the field.

Considerable prior research has been performed to relate soil infiltration parameter values to textural classification. Some highly relevant references are Rawls and Brakensiek (1983) and (1985), and Rawls et al. (1982) and (1983). Table 9 summarizes Rawls and Brakensiek soil parameter estimates as a function of United States Department of Agriculture (USDA) textural classification. It is important to note that the values listed in Table 9 were derived from the geometric mean of tests on a large number of soil samples. Hydraulic conductivies for all GA based approaches are half of the saturated values listed in Table 9 (Rawls, et al., 1982). The variance of these values is large, indicating significant uncertainty or low correlation between textural classification and soil texture. However, these values are useful because they provide an initial estimate of infiltration parameters. The variances of the values in Table 9 are listed in the original papers, and are published in Maidment (1993).

USDA Textural Classification	Total Porosity/Saturation θ_s (cm^3/cm^3)	Effective Porosity/Saturation θ_e (cm^3/cm^3)	Field Capacity Saturation θ_f (cm^3/cm^3)	Wilting Point Saturation θ_{wp} (cm^3/cm^3)	Residual Saturation θ_r (cm^3/cm^3)	Bubbling Pressure Geometric Mean Ψ_b (cm)	Pore Size Distribution Arithmetic Mean λ (cm/cm)	Saturated Hydraulic Conductivity (multiply by 0.5 for GA methods) K_s (cm/h)	Wetting Front Suction Head (Capillary Head) Ψ_f (cm)
Sand	0.437	0.417	0.091	0.033	0.02	7.26	0.694	23.56	4.95
Loamy sand	0.437	0.401	0.125	0.055	0.035	8.69	0.553	5.98	6.13
Sandy loam	0.453	0.412	0.207	0.095	0.041	14.66	0.378	2.18	11.01
Loam	0.463	0.434	0.27	0.117	0.027	11.15	0.252	1.32	8.89
Silt loam	0.501	0.486	0.33	0.133	0.015	20.79	0.234	0.68	16.68
Sandy clay loam	0.398	0.330	0.255	0.148	0.068	28.08	0.319	0.30	21.85
Clay loam	0.464	0.390	0.318	0.197	0.075	25.89	0.242	0.20	20.88
Silty clay loam	0.471	0.432	0.366	0.208	0.040	32.56	0.177	0.20	27.30
Sandy clay	0.430	0.321	0.339	0.239	0.109	29.17	0.223	0.12	23.90
Silty clay	0.479	0.423	0.387	0.250	0.056	34.19	0.150	0.10	29.22
Clay	0.475	0.385	0.396	0.272	0.090	37.30	0.165	0.06	31.63

Table 9 - Rawls & Brakensiek soil parameter estimates.

In the table soil moistures θ, are listed for saturation (s), effective saturation (e), field capacity (f), wilting point (wp), and residual (r). These values are applicable for all approaches. These are followed by the bubbling pressure Ψ_b (used for RE), the pore distribution index (used for RE, GAR and multi-layer GA in continuous mode), saturated hydraulic conductivity K_s (used directly for RE, halved for all GA approaches), the wetting front suction head Ψf (used for all GA approaches).

Standard practice in developing GSSHA models is to obtain digital soil textural classification data and use these data to develop an index map of soil types. Soil textural maps may be combined with land use or vegetation maps. Land use and vegetation can strongly influence soil hydraulic properties. The Mapping Table is used to assign initial parameters to the soil types in the index map. One or more of these parameters, typically K_s and Ψf or Ψ_b, are used as calibration parameters. As discussed by Senarath et al (2000), calibration is best done using an automated calibration method, such as SCE (Duan et al, 1992), combined with long term simulations. The possible parameter values are bounded by the range found in literature values, unless other factors, such as land use or vegetation, dictate otherwise. The range of values may be narrowed by making field and laboratory measurements of parameters.

GSSHA User's Manual

March 6, 2018 TES No. 180060.001

Mr. Glenn Pace
Castellina, LLC
175 East Main Street, Suite 110
Madera, CA 95037
Email: tom@mccloskeyconsultants.com

Project: Proposed Castellina Madera Drilling
Southeast of Avenue 18 and Road 27
Madera County, California

Subject: Drilling and Soil Logging Services

Dear Mr. Pace:

In accordance with your request and authorization, **TECHNICON Engineering Services, Inc. (TECHNICON)** completed drilling and soil logging services at the above referenced site located in Madera County, California. The attached Site Map, Figure 1, provides the location of site and the Site Map, Figure 2, provides the locations of the test borings. The boring locations were selected by Castellina, LLC. The test borings were requested to assess subsurface conditions of the soils in the upper 25 to 100 feet below ground surface (bgs).

FIELD EXPLORATION

The field exploration, conducted from February 5th, 6th, 8th, and 20th, 2018, consisted of drilling five (5) exploratory test borings and a site reconnaissance by a staff engineer. The test borings were drilled with a CME 75 truck-mounted drill rig using hollow stem augers equipped with a 5-foot-long continuous soil sampler to depths of 25, 80, and 100 feet below the existing ground surface (bgs). Perched groundwater was encountered at boring B-2 at a depth of 70 feet bgs, and was terminated at 80 feet bgs due to heaving granular soil below the groundwater. A detailed representation of the stratigraphy at the specific exploration locations is provided on the attached boring logs.

EARTH MATERIALS

The general earth material profile depicted by the subsurface exploration consisted of near surface soils of silty sand and clayey sand, underlain by laterally discontious alternating layers of sandy silt, poorly graded sand with silt, clayey sand, sandy clay, clayey silt, and silty sand extending to the depth explored 100 feet bgs. Strongly cemented layers of hard pan were encountered at B-2 at depths ranging from 1.5 to 7 feet bgs, and at B-3 at depths ranging from 2 to 5.5 feet bgs. A more detailed representation of the stratigraphy at the specific exploration locations is provided on the attached boring logs. Perched groundwater was encountered within boring B-2 at a depth of 70 feet bgs.

However, groundwater was not encountered within the depth of exploration in the remainder of the borings. We trust that this letter satisfies your needs. If you have any questions regarding the information presented, please contact me at your convenience.

Sincerely,
TECHNICON Engineering Services, Inc.

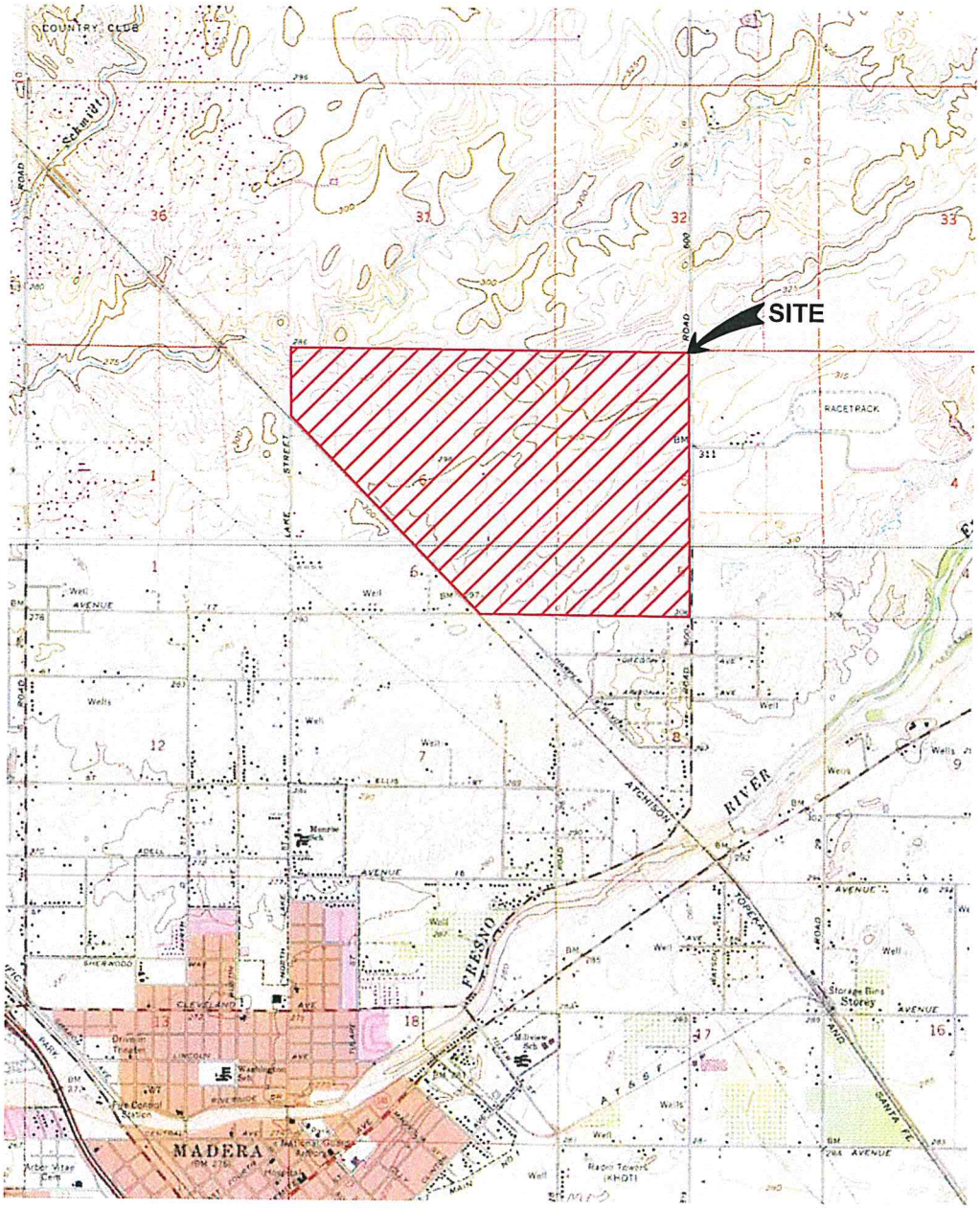
Sarbjit S. Athwal, EIT
Project Engineer



Salvador Alvarez, PE
Geotechnical Engineering Manager

SA:SS:vm

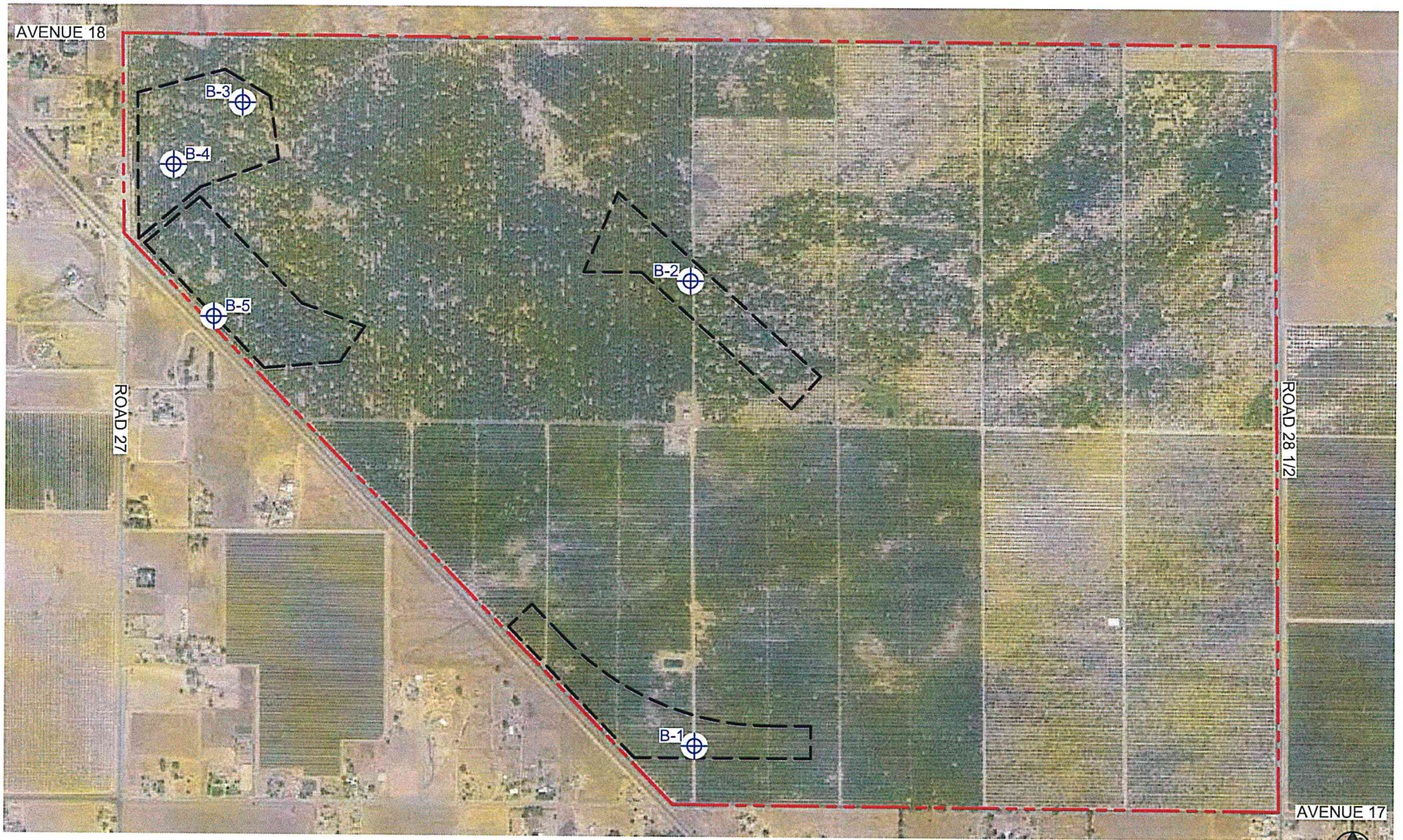
Attachments: Figure 1, Vicinity Map
Figure 2, Site Map
Boring Logs



LAT.: 37.0034°N, LONG.: 120.0408°W, 5&6-T11S-R18E, MDB&M,
USGS MAPS: KISMET & MADERA, DATES: 1961 & 1963, PHOTOS REV.: 1987 & 1981

NORTH

TECHNICON ENGINEERING SERVICES, INC.	PROJECT: 180060.001 SOURCE: USGS TOPOGRAPHIC MAPS	VICINITY MAP PROPOSED CASTELLINA MADERA DRILLING SE OF AVENUE 18 AND ROAD 27 MADERA COUNTY, CALIFORNIA	FIGURE 1 NTS



NORTH

SCALE: 1"=1000'

0' 500' 1000'

B-5 =SOIL BORING LOCATIONS

TECHNICON ENGINEERING SERVICES, INC.	PROJECT: 180060.001	DATE: 3/2/18	SITE MAP PROPOSED CASTELLINA MADERA DRILLING SE OF AVENUE 18 AND ROAD 27 MADERA COUNTY, CALIFORNIA	FIGURE 2
	SOURCE: GOOGLE EARTH	APPROVED BY: SS		

TECHNICON ENGINEERING SERVICES, INC.
Technicon Engineering Services, Inc.
4539 N. Brawley Avenue #108
Fresno, CA 93722
Telephone: 559-276-9311

KEY TO SYMBOLS

PROJECT NAME Castellina Madera Drilling
DATE OF EXPLORATION 2/5/2018
PROJECT LOCATION Madera, California
PROJECT NUMBER 180060

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

		FILL
	SW	WELL GRADED SAND
	SP	POORLY GRADED SAND
	SM	SILTY SAND
	SC	CLAYEY SAND
	PT	PEAT
	OL	LOW PLASTICITY ORGANIC SILT
	OH	HIGH PLASTICITY ORGANIC SILT
	ML	LOW PLASTICITY SILT
	MH	HIGH PLASTICITY SILT
	GW	WELL GRADED GRAVEL
	GP	POORLY GRADED GRAVEL
	GM	SILTY GRAVEL
	GC	CLAYEY GRAVEL
	CL	LOW PLASTICITY CLAY
	CH	HIGH PLASTICITY CLAY

SAMPLER SYMBOLS

- STANDARD PENETRATION TEST
- CALIFORNIA SAMPLER
- MODIFIED CALIFORNIA SAMPLER
- SHELBY TUBE SAMPLER
- ROCK CORE BARREL
- BULK SAMPLE

- Water Level at Time of Drilling
- Water Level at End of Drilling
- Water Level After 24 Hours
- Assumed stratum line
- Observed stratum line

Note 1: The degree of saturation shown on the boring logs is based on an assumed specific gravity of 2.65. The actual degree of saturation may vary.

Note 2: The stratum lines shown on the logs represent the approximate boundary between soil types; the actual in-situ transition may be gradual.

ABBREVIATIONS

LL	- LIQUID LIMIT (%)
PI	- PLASTIC INDEX (%)
W	- MOISTURE CONTENT (%)
DD	- DRY DENSITY (PCF)
S	- DEGREE OF SATURATION (%)
NP	- NON PLASTIC
-200	PERCENT PASSING NO. 200 SIEVE
PP	- POCKET PENETROMETER (TSF)
TV	- TORVANE
PID	- PHOTOIONIZATION DETECTOR
UC	- UNCONFINED COMPRESSION
ppm	- PARTS PER MILLION

KEY TO SYMBOLS 2 - TECHNICON.GDT - 3/2/18 13:45 - \\TECH2\USERSHARES\TESDATA\USERS\SARBS\PROJECTS\MADERA\180060- CASTELLINA MADERA DRILLING\180060- BORING LOGS.GPJ

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Fresno, CA 93722
Telephone: 559-276-9311

BORING B1

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/5/18 **COMPLETED** 2/5/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL 70 ft
DRILL RIG TYPE CME 75
BORING DEPTH 80 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Sandy SILT (ML)** - reddish brown, moist, low plasticity, with clay				
5				**Clayey SAND (SC)** - reddish brown, moist, fine to coarse grained				
10				Brown				
15				**Sandy SILT (ML)** - gray, moist, low plasticity, with clay				
				With gravel				
20				**Silty SAND (SM)** - brown, moist, fine to coarse grained, with gravel				
25				**Sandy SILT (ML)** - gray, moist, low plasticity, iron oxide staining				
				Poorly Graded SAND WITH SILT (SP-SM) - gray, moist, fine to coarse grained				
30				**Sandy SILT (ML)** - gray, moist, low plasticity, with fine sand, iron oxide staining				
35				**Silty SAND (SM)** - gray, moist, fine to medium grained				

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Technicon Engineering Services, Inc.
4539 N. Brawley Avenue #108
Fresno, CA 93722
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BORING B1

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/5/18 **COMPLETED** 2/5/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL 70 ft
DRILL RIG TYPE CME 75
BORING DEPTH 80 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
35								
				Sandy SILT (ML) - gray, moist				
				Silty SAND (SM) - gray, moist, fine to medium grained				
40				**Sandy SILT (ML)** - gray, moist, low plasticity, with fine sand				
45				**Poorly Graded SAND WITH SILT (SP-SM)** - light brown, moist, fine to coarse grained				
				Dark brown				
50				Light brown, moist				
55								
60								
65				**Sandy SILT (ML)** - gray, moist, iron oxide staining				
70				▽				

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Fresno, CA 93722
Telephone: 559-276-9311

BORING B1

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/5/18 **COMPLETED** 2/5/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL 70 ft
DRILL RIG TYPE CME 75
BORING DEPTH 80 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
70				**Sandy SILT (ML)** - gray, moist, iron oxide staining *(continued)* Wet Wet, low plasticity, with clay				
75				**Poorly Graded SAND WITH SILT (SP-SM)** - light brown, wet, fine to coarse grained				
80								

NOTES:
1. Bottom of boring at 80.0 feet.
2. Groundwater encountered at 70.0 feet.
3. Boring backfilled with soil cuttings 2/5/18.

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BORING B2

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/6/18 **COMPLETED** 2/6/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Clayey SAND (SC)** - brown, moist, fine to medium grained, strong cementation				Hard Pan 1.5' to 7'
5				**Silty SAND (SM)** - brown, moist, fine to medium grained, strong cementation				
10				**Poorly Graded SAND WITH SILT (SP-SM)** - brown, moist, fine to coarse grained				
15				**Poorly Graded SAND (SP)** - light brown, moist, fine to coarse grained				
				Poorly Graded SAND WITH SILT (SP-SM) - light brown, moist, fine to coarse grained				
20				**Poorly Graded SAND (SP)** - light brown, moist, fine to coarse grained				
				Clayey SAND (SC) - reddish brown, moist, fine to coarse grained				
25				**Silty SAND (SM)** - light brown, moist, fine to coarse grained				
				Sandy SILT (ML) - gray, moist, with gravel				
30				**Silty SAND (SM)** - brown, moist, fine to coarse grained				
				Poorly Graded SAND WITH SILT (SP-SM) - gray, moist, fine to coarse grained				
				Clayey SILT (CL-ML) - gray, moist				
35								

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Technicon Engineering Services, Inc.
4539 N. Brawley Avenue #108
Fresno, CA 93722
Telephone: 559-276-9311

BORING B2

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/6/18 **COMPLETED** 2/6/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
35				**Clayey SILT (CL-ML)** - gray, moist *(continued)* With fine to medium sand				
40				**Poorly Graded SAND WITH SILT (SP-SM)** - light brown, moist, fine to medium grained				
45				**Clayey SILT (CL-ML)** - gray, moist				
				Sandy SILT (ML) - gray, moist				
				Poorly Graded SAND WITH SILT (SP-SM) - gray, moist, fine to coarse grained Moist				
50								
55				**Silty SAND (SM)** - light brown, moist, fine to coarse grained				
60				**Sandy SILT (ML)** - gray, moist, with fine to medium sand				
				Silty SAND (SM) - gray, moist, fine to coarse grained, manganese				
65				**Sandy SILT (CL-ML)** - gray, moist, iron oxide staining				
				Poorly Graded SAND WITH SILT (SP-SM) - gray, moist, fine to coarse grained				
70								

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Fresno, CA 93722
Telephone: 559-276-9311

BORING B2

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/6/18 **COMPLETED** 2/6/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
70								
				Clayey SILT (CL-ML) - gray, moist				
				Poorly Graded SAND WITH SILT (SP-SM) - gray, moist, fine to coarse grained				
				Sandy SILT (ML) - gray, moist				
75				Brown, moist, with clay				
				Increased clay				
80				**Clayey SAND (SC)** - gray, moist, fine to medium grained				
85								
90				Reddish brown, moist, fine to coarse grained, increased sand				
				Brown				
				Sandy CLAY (CL) - brown, moist, medium plasticity				
95								
				Clayey SAND (SC) - brown, moist, fine to medium grained				
100								

NOTES:
1. Bottom of boring at 100.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 2/6/18.

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BORING B3

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/8/18 **COMPLETED** 2/8/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 25 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - brown, moist, fine to coarse grained				
5				With clay				Hard Pan (2'-5.5')
10				**Sandy SILT (ML)** - gray, moist, Borderline				
15				**Poorly Graded SAND WITH SILT (SP-SM)** - gray, moist, fine to coarse grained				
20				**Silty SAND (SM)** - brown, moist, fine to medium grained				
25				**Sandy SILT (ML)** - gray, moist				
				Poorly Graded SAND (SP) - gray, moist, fine to coarse grained				

NOTES:
1. Bottom of boring at 25.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 2/8/18.

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Telephone: 559-276-9311

BORING B4

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/8/18 **COMPLETED** 2/8/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 25 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - brown, moist, fine to medium grained				
				Sandy CLAY (CL) - dark brown, moist, medium plasticity				
				Clayey SILT (CL-ML) - light gray, moist, low plasticity				
5				**Sandy CLAY (CL)** - brown, dry, high plasticity				
				Sandy SILT (ML) - brown, moist				
				Sandy CLAY (CL) - reddish brown, moist, medium plasticity				
10				**Silty SAND (SM)** - reddish brown, moist, fine to coarse grained, trace clay				
15								
20				Brown, fine to medium grained				
25				Reddish brown, fine to coarse grained, trace clay				

NOTES:
1. Bottom of boring at 25.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 2/8/18.

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Fresno, CA 93722
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BORING B5

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/20/18 **COMPLETED** 2/20/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0				**Silty SAND (SM)** - reddish brown, moist, fine to medium grained, trace clay				
5				**Clayey SAND (SC)** - brown, moist, fine to medium grained				
10				**Poorly Graded SAND WITH SILT (SP-SM)** - brown, moist, fine to coarse grained				
15				**Clayey SAND (SC)** - reddish brown, moist, fine to coarse grained, with coarse sand				
				Sandy CLAY (CL) - brown, moist, medium plasticity, with fine to medium sand				
20				**Clayey SAND (SC)** - brown, moist, fine to coarse grained				
25				**Silty SAND (SM)** - brown, moist, fine to medium grained				
30				**Poorly Graded SAND WITH SILT (SP-SM)** - gray, moist, fine to coarse grained				
35				**Silty SAND (SM)** - gray, moist, fine to coarse grained				

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BORING B5

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/20/18 **COMPLETED** 2/20/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
35				**Silty SAND (SM)** - gray, moist, fine to coarse grained *(continued)*				
				Sandy SILT (ML) - gray, moist				
40								
45				**Poorly Graded SAND WITH SILT (SP-SM)** - brown, moist, fine to coarse grained				
50				**Silty SAND (SM)** - brown, moist, fine to coarse grained Gray				
55								
60								
65				**Poorly Graded SAND WITH SILT (SP-SM)** - gray, moist, fine to coarse grained				
70								

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BORING B5

PROJECT NAME Castellina Madera Drilling
PROJECT NUMBER 180060
PROJECT LOCATION Madera, California
SURFACE DESCRIPTION Flat Orchard Fields
DATE STARTED 2/20/18 **COMPLETED** 2/20/18
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services, Inc.
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME 75
BORING DEPTH 100 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Alvarez

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
70				**Sandy SILT (ML)** - light brown, moist, with fine sand				
				Silty SAND (SM) - brown, moist, fine to coarse grained				
75				**Sandy SILT (ML)** - light brown, moist				
				Silty SAND (SM) - brown, moist, fine grained				
80				**Sandy SILT (ML)** - light brown, moist, with fine sand				
				Silty SAND (SM) - light brown, moist, fine to medium grained				
				Clayey SAND (SC) - brown, moist, fine to medium grained				
85				**Sandy CLAY (CL)** - brown, moist, with fine sand				
				Clayey SAND (SC) - brown, moist, fine to medium grained, moderate cementation				
90				Increased sand				
				Decreased sand, increased clay				
				Decreased clay				
95				**Silty SAND (SM)** - light brownish gray, moist, fine to coarse grained, trace clay				
				No clay				
100								

NOTES:
1. Bottom of boring at 100.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 2/20/18.

Appendix F – MAR Basin Details

Basin ID MAR #1 Full Buildout

Depth (ft)	Length (ft)	Width (ft)	Area (AC)	Volume (AC-FT)
0	240	145	0.80	0.00
1	246	151	0.85	0.83
2	252	157	0.91	1.71
3	258	163	0.97	2.64
4	264	169	1.02	3.64
5	270	175	1.08	4.70
6	276	181	1.15	5.81
7	282	187	1.21	6.99
8	288	193	1.28	8.24
9	294	199	1.34	9.55
10	300	205	1.41	10.93
11	306	211	1.48	12.38
12	312	217	1.55	13.90
13	318	223	1.63	15.50
14	324	229	1.70	17.16
15	330	235	1.78	18.91
16	336	241	1.86	20.73
17	342	247	1.94	22.64
18	348	253	2.02	24.62
19	354	259	2.10	26.69
20	360	265	2.19	28.84
21	366	271	2.28	31.08
22	372	277	2.37	33.41
23	378	283	2.46	35.83
24	384	289	2.55	38.33
25	390	295	2.64	40.93

	Length	Width	Area (AC)
Total Area with Buffer 30-ft	420	325	3.13

Invert Elevation (ft)	265	NAVD88
Rim Elevation (ft)	290	NAVD88

Phase 1 MAR #1

Depth (ft)	Length (ft)	Width (ft)	Area (AC)	Volume (AC-FT)
0	60	60	0.08	0.00
1	66	66	0.10	0.09
2	72	72	0.12	0.20
3	78	78	0.14	0.33
4	84	84	0.16	0.48
5	90	90	0.19	0.66
6	96	96	0.21	0.86
7	102	102	0.24	1.08
8	108	108	0.27	1.34
9	114	114	0.30	1.63
10	120	120	0.33	1.94

	Length	Width	Area (AC)
Total with 30ft Buffer	150	150	0.52

Invert Elevation (ft)	280	NAVD88
Rim Elevation (ft)	290	NAVD88

Basin ID MAR #2 Full Buildout

Depth (ft)	Length (ft)	Width (ft)	Area (AC)	Volume (AC-FT)
0	200	120	0.55	0.00
1	206	126	0.60	0.57
2	212	132	0.64	1.19
3	218	138	0.69	1.86
4	224	144	0.74	2.58
5	230	150	0.79	3.34
6	236	156	0.85	4.16
7	242	162	0.90	5.04
8	248	168	0.96	5.97
9	254	174	1.01	6.96
10	260	180	1.07	8.00
11	266	186	1.14	9.11
12	272	192	1.20	10.28
13	278	198	1.26	11.52
14	284	204	1.33	12.82
15	290	210	1.40	14.18
16	296	216	1.47	15.62
17	302	222	1.54	17.13
18	308	228	1.61	18.71
19	314	234	1.69	20.36
20	320	240	1.76	22.09
21	326	246	1.84	23.90
22	332	252	1.92	25.79
23	338	258	2.00	27.76
24	344	264	2.08	29.80
25	350	270	2.17	31.94

	Length	Width	Area (AC)
Total Area with Buffer	380	300	2.62

Invert Elevation (ft)	271	NAVD88
Rim Elevation (ft)	296	NAVD88

Basin ID MAR #3 Full Buildout

Depth (ft)	Length (ft)	Width (ft)	Area (AC)	Volume (AC-FT)
0	177	107	0.43	0.00
1	183	113	0.47	0.45
2	189	119	0.52	0.95
3	195	125	0.56	1.49
4	201	131	0.60	2.07
5	207	137	0.65	2.70
6	213	143	0.70	3.38
7	219	149	0.75	4.10
8	225	155	0.80	4.88

	Length	Width	Area (AC)
Total Area with Buffer	255	185	1.08

Invert Elevation (ft)	278	NAVD88
Rim Elevation (ft)	286	NAVD88

Basin ID MAR #4 Full Buildout

Depth (ft)	Height (ft)	Base (ft)	Area (AC)	Volume (AC-FT)
0	186	279	0.60	0.00
1	192	285	0.63	0.61
2	198	291	0.66	1.26
3	204	297	0.70	1.94
4	210	303	0.73	2.65
5	216	309	0.77	3.40
6	222	315	0.80	4.18
7	228	321	0.84	5.00
8	234	327	0.88	5.87
9	240	333	0.92	6.76
10	246	339	0.96	7.70
11	252	345	1.00	8.68

	Height	Base	Area (AC)
Total Area with Buffer 30-ft	282	375	1.21

Invert Elevation (ft)	279	NAVD88
Rim Elevation (ft)	290	NAVD88

MAR #4 Phase 1

Depth (ft)	Length (ft)	Width (ft)	Area (AC)	Volume (AC-FT)
0	34	34	0.03	0.00
1	40	40	0.04	0.03
2	46	46	0.05	0.07
3	52	52	0.06	0.13
4	58	58	0.08	0.20
5	64	64	0.09	0.29
6	70	70	0.11	0.39
7	76	76	0.13	0.52
8	82	82	0.15	0.66
9	88	88	0.18	0.83
10	94	94	0.20	1.02
11	100	100	0.23	1.24

	Height	Base	Area (AC)
Total Area with Buffer 30-ft	130	130	0.39

Invert Elevation (ft)	279	NAVD88
Rim Elevation (ft)	290	NAVD88

I-2 Castellina Water Supply Assessment

SB 610
WATER SUPPLY ASSESSMENT

FOR THE
CASTELLINA
SPECIFIC PLAN PROJECT

Castellina Specific Plan Project
SB 610 Water Supply Assessment

Prepared for the
County of Madera

Administrative Draft

May 2019

Prepared by:

Tully & Young
Comprehensive Water Planning

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SECTION 1 – PROJECT INTRODUCTION

As the lead agency under the California Environmental Quality Act ("CEQA"), Madera County ("County") is assessing the potential environmental effects associated with the proposed Castellina development ("Proposed Project"). To inform the CEQA analysis, this Water Supply Assessment ("WSA") has been prepared for the Proposed Project.

1.1 ANALYTICAL METHOD

This WSA estimates the Proposed Project's water demand through build-out, presents and discusses the availability of water sources identified to meet that demand, and assesses whether expected water sources will be sufficient to meet the projected water demand of the Proposed Project during normal, single dry, and multiple dry year conditions.

The above-referenced analytical method is derived from the Water Supply Assessment Law ("WSA Law") codified at Water Code section 10910 *et seq.* The WSA Law, sometimes referred to as "SB 610," outlines the information and analysis that must be included in a CEQA document prepared for certain projects of a specified size and composed of certain land-uses (e.g., subdivisions larger than 500 residential units).[1] For such covered projects, the WSA Law requires an assessment of whether projected water supplies identified to serve a proposed project will be sufficient to meet existing and planned water demands over a 20-year horizon. The WSA Law expressly anticipates events like the most recent drought by requiring assessment of water supply sufficiency in single dry years and multiple dry years – not just under normal, or average, hydrologic conditions. The Proposed Project requires a WSA because it is a residential development of more than 500 dwelling units. The WSA will be incorporated into the CEQA document — an Environmental Impact Report (EIR) — being prepared for the Proposed Project (the Project EIR).[2]

In addition to the WSA Law, the County has recently adopted an ordinance directed at aiding with long-term groundwater sustainability in the Madera Subbasin.[3] The County's ordinance added a new chapter to the County Code entitled "Large Scale Development Groundwater Balance."[4] While not associated with WSA Law as described previously, the groundwater balance methodology described in the County Code is included as a separate assessment in this WSA (see Section 4).

[1] Water Code § 10912(a).
[2] Water Code § 10911(b).
[3] The Madera Subbasin is a geographic area defined by the California Department of Water Resources. More information about the subbasin is included in Section 3.
[4] Madera County Code, Title 13, Chapter 13.110, adopted August 22, 2017.

1.2 DOCUMENT PREPARATION AND APPROVAL

The WSA Law requires that the lead agency – in this case, the County – identify a "public water system"[5] and further requires the lead agency to request that each identified public water system prepare a WSA for the project. If the lead agency is not able to identify a public water system that may supply water for the project, the lead agency must prepare the WSA itself after consulting with "*any entity serving domestic water supplies whose service area includes the project site, the local agency formation commission, and any public water system adjacent to the project site*."[6]

In this case, the County has prepared the WSA because (1) the City of Madera ("City") does not plan to serve the Proposed Project, though it lies within the City's Urban Growth Boundary[7], and (2) the Madera Valley Water Company, a local mutual water company serving approximately 2,000 customers nearby, is unable to make any commitments to expand its shareholder service area at this time.[8] This document provides the necessary information for the County to make its determinations and to comply with the assessment of water supply sufficiency as required by the WSA Law.

The governing body of the County is required to approve this WSA. The County will be required to determine, based on the entire record, whether projected water supplies will be sufficient to satisfy the demands for the Proposed Project, in addition to existing and planned future uses.

This document provides the necessary information for the County to make its determinations and to comply with the assessment of water supply sufficiency as required by statute and to determine compliance with its own ordinance.

1.3 DOCUMENT ORGANIZATION

The WSA is organized according to the following sections:

- **Section 1: Proposed Project Introduction**. This section provides an overview of the WSA's purpose and organization, along with a detailed description of the Proposed Project, including the land use elements that will create water demand.

[5] A "public water system" is a system that provides water for human consumption that has at least 3,000 service connections.
[6] Water Code § 10910(b).
[7] See City of Madera General Plan Land Use Diagram as amended January 2016, last accessed November 2016 at the following: http://www.cityofmadera.ca.gov/wp-content/uploads/2016/04/General-Plan-Map-0116-Reference-Scale.pdf?x47788
[8] Madera Valley Water Company may be able to operate the Proposed Project's public water system, but would require approval from existing shareholders. Furthermore, the intent to use groundwater to serve the Proposed Project would be developed through an on-site delivery system, and requires the same assessment for water supply sufficiency whether assessed by the County or MVWC.

- **Section 2: Proposed Project Estimated Water Demands**. This section describes the methodology used to estimate water demands of the Proposed Project and details the estimated water demands from initiation through build-out, including an overall 20-year horizon.
- **Section 3: Water Supply Characterization**. This section characterizes the water sources identified to serve the Proposed Project. Water sources are characterized for their projected availability during normal, single dry, and multiple dry year conditions.
- **Section 4: Sufficiency Analysis**. This section assesses whether the projected availability of the identified water sources will be sufficient to meet the Proposed Project's water demand during normal, single dry, and multiple dry year conditions. The analysis integrates the demand detailed in Section 2 with the characterization of the Proposed Project's water sources detailed in Section 3. This section also applies the County's new groundwater balance ordinance methodology to evaluate whether the Proposed Project attains the County's required groundwater balance.

1.4 PROPOSED PROJECT DESCRIPTION

The Proposed Project is situated on 792 acres located north of the City of Madera in Madera County ("Project Site"). The Project Site is located approximately 3 miles east of Highway 99 and approximately 1 mile north of the City, and is bordered by the Avenue 18 alignment on the north, Road 28½ on the east, Road 27 on the west, the BNSF railway on the southwest, and the Avenue 17 alignment on the south (see **Figure 1-1**).[9]

As described below, the Proposed Project site includes several residential and non-residential land-use classifications including market rate housing, active adult housing, mixed use commercial and residential elements, public facilities, parks (including trails and plazas), community gardens, an active adult community center, and open space (including storm water retention and managed aquifer recharge percolation facilities). The Proposed Project represents a portion of the City's General Plan designated as Village B, which is identified for future City expansion.[10]

1.4.1 Project Summary

As described in more detail in the Castellina Specific Plan (CSP), the Proposed Project intends:

> "*…the development of up to 3,072 market rate and active adult single-family, multi-family and mixed-use residential units; approximately 21 acres of commercial mixed-use, and approximately 131 acres of parks, trails, plazas, community gardens, and other open space*." (CSP, Section 2.1)

[9] Avenues 17 and 18 do not currently exist at the Project Site and are merely alignments at this time.
[10] City of Madera General Plan, October 2009, p. 8-39.

Figure 1-2 provides the Proposed Project's land-use plan[11] while **Table 1-1** presents the detailed residential unit counts and non-residential acreage used to derive the demand forecast presented in Section 2.

Figure 1-1: Project Location



[11] Figure 1-2 is Figure 2-5 from the Castellina Specific Plan.

Figure 1-2 – Proposed Project Parcel Map

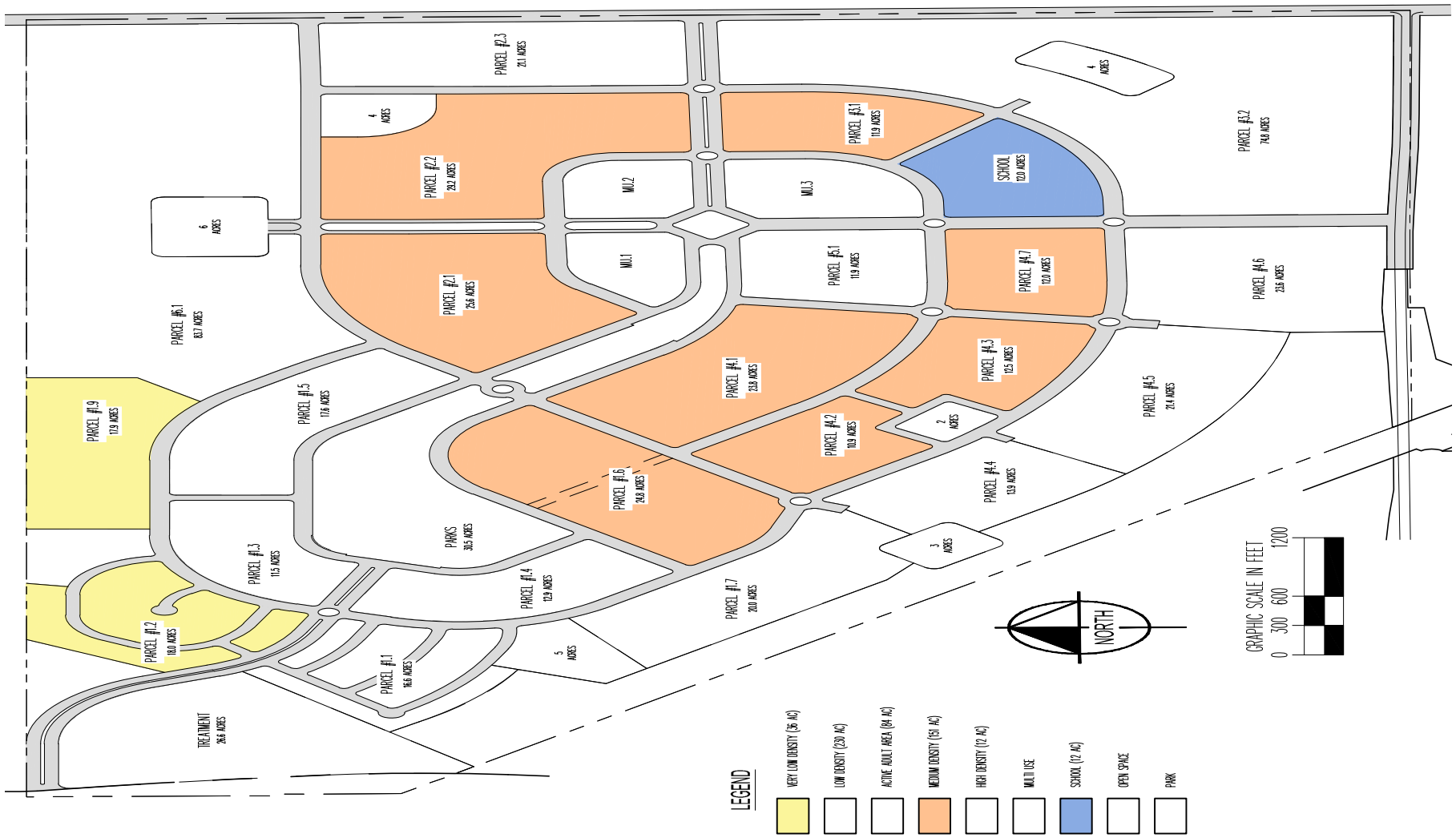


Table 1-1 – Summary of Proposed Project Land Uses and Acreages

Land Use	Gross Acreage	Net Acreage	Details
Very Low Density	36	30	90 Dwelling Units
Low Density	230	184	1,104 Dwelling Units
Active Adult Low Density	84	67	402 Dwelling Units
Medium Density	148	114	1,026 Dwelling Units
High Density	12	12	248 Dwelling Units
Village Mixed Use	21	21	202 Dwelling Units
Village Commercial			134,000 SF
Neighborhood Parks	20		
Community Garden	3		
Central Park	31		
Grand Promenade	3		
Linear Pathways	6		
Village Green	2		
Open Space, WWTP, Storm Retention	61		
Active Adult Amenity Center	6		
Elementary School	15		
Roads & Other Misc. Areas	114		
Total	**792**	**3,072 Dwelling Units and 134,000 SF**	

1.4.2 Proposed Project Phasing

For purposes of this WSA, the Proposed Project anticipates all of the 3,072 residential units will be constructed within the 20-year planning window required by the WSA Law. **Table 1-2** presents the phasing assumed for the purposes of the WSA.[12] Before constructing any homes, site grading and project-wide infrastructure development will begin and continue throughout all phases of the Proposed Project, as necessary. These activities include installing facilities for potable water, sewer, other utilities, recharge basins, and roadways. During these activities, a small water demand will exist – referred to in this WSA as "construction water." This demand is included in the forecast annual water demands presented in Section 2.

[12] The project phasing is only an estimate based upon currently available planning. Actual phasing will depend on several factors, including the market for new homes.

Table 1-2 – Phasing Plan

Project Element	Unit Count				
	2020	2025	2030	2035	2040
Very Low Density	23	45	90	90	90
Low Density	138	276	552	1,104	1,104
Active Adult Low Density	0	101	201	402	402
Medium Density	128	257	513	1,026	1,026
High Density	0	62	124	248	248
Village Mixed Use	0	101	202	202	202
Total	289	841	1,682	3,072	3,072

SECTION 2 – PROPOSED PROJECT ESTIMATED WATER DEMANDS

This section describes the methodology, provides the supporting evidence, and presents the estimated annual water demands for the Proposed Project. For the purpose of estimating annual water demand, the Proposed Project is planned to develop according to the phasing presented in **Table 1-2**.

2.1 DETERMINING UNIT WATER DEMAND FACTORS

As detailed in Section 1, the Proposed Project consists of up to 3,072 residential units and accompanying infrastructure and improvements such as streetscapes, along with village commercial, community areas, amenity center, parks, and an elementary school. To understand the water needs of the Proposed Project, unique water demand factors are used that correspond with the anticipated residential lots and other Proposed Project attributes. This subsection presents the methodology for determining the unit water demand factors that become the basis of the Proposed Project water demand estimate.

Two distinct groups of demand factors are presented: (1) residential, and (2) non-residential. For this WSA, the non-residential uses consist of both typical uses, such as parks and commercial areas, and non-typical uses such as community gardens and a community center. Though not affecting the demand, the non-residential landscape needs (e.g. streetscapes, parks, etc.) will be meet with non-potable water sources, primarily recycled water derived from the Proposed Project's indoor water uses.

Values developed for each distinct group are based on several sources of information, details of which are provided in the following subsections.

2.1.1 Current and Future Mandates Affecting Water Use

There are several factors that affect the development of unit water demand use, ranging from state and County landscape and other water-use mandates to changes in the types of housing products being offered. These factors are incorporated into unit water demand factor determination and discussed in this section. Characteristics of the factors relevant to this WSA are described below.

Water Conservation Objectives

In 2009, Governor Arnold Schwarzenegger signed Senate Bill No. 7 (SBX7-7), which established a statewide goal of achieving a 20 percent reduction in urban per capita water use by 2020 for urban retail water suppliers.[13] Since the Proposed Project is yet to be built, this legislation only indirectly applies.

[13] California Water Code § 10608.20.

However, the efforts undertaken throughout the County and the State by urban retail suppliers to comply with this statute, though not directly, would affect the Proposed Project's use of appliances, fixtures, landscapes and other water using features, through changes or additions to County ordinances and/or through a continuing "conservation ethic" developed in communities in and around the Proposed Project as a result of the most recent statewide drought conditions.

To respond to the recent drought conditions, Governor Brown issued Executive Order B-37-16 in May 2016 entitled "*Making Water Conservation a California Way of Life*." This further illustrates the growing water conservation ethic in the state. In May 2018, Governor Brown signed into law SB 606 and AB 1668 that effectively implement the direction in the May 2016 Executive Order.

Indoor Infrastructure Requirements

Beginning in January 2010, the California Building Standards Commission adopted the statewide mandatory Green Building Standards Code (hereafter the "CAL Green Code") requiring the installation of water-efficient indoor and outdoor infrastructure for all new projects after January 1, 2011. The CAL Green Code was incorporated as Part 11 into Title 24 of the California Code of Regulations, and was revised in 2013, again in 2016, and is expected again in 2019, with the revisions taking effect on January 1 of the following year. However, these revisions have not had substantial implications to the water use already contemplated by the 2010 Cal Green Code.[14] The primary impact of the 2013 update was applicability of the Cal Green Code to remodels. The focus of the 2016 update was to address changes to the State's Model Water Efficient Landscape Ordinance ("MWELO") in response to emergency regulations adopted during the drought.[15]

The CAL Green Code applies to the planning, design, operation, construction, use and occupancy of every newly constructed or remodeled building or structure. The Proposed Project must satisfy the indoor water use infrastructure standards necessary to meet the CAL Green Code as well as the outdoor requirements described by MWELO. The Proposed Project will satisfy these indoor requirements through the use of appliances and fixtures such as high-efficiency toilets, faucet aerators, on-demand water heaters, or other fixtures, as well as Energy Star and California Energy Commission-approved appliances. Outdoor requirements are discussed in the following subsection.

[14] The 2010 CAL Green Code was evaluated for updates during the 2012 Triennial Code Adoption Cycle. The State evaluated stakeholder input, changes in technology, implementation of sustainable building goals in California, and changes in statutory requirements. As such, the scope of CAL Green was increased to include both low-rise and high-residential structures, additions and alterations. Guide to the 2013 California Green Building Standards Code (Residential), California Department of Housing and Community Development, 2013.

[15] The 2016 Triennial Code Adoption Cycle consisted primarily of the MWELO updates adopted in response to the drought. Indoor infrastructure changes were limited to some minor non-residential fixture changes and changes to the voluntary Tier 1 and Tier 2 requirements. Additionally, the Code was updated to match the new Title 20 Appliance Efficiency Regulations. *2015 Report to the Legislature, Status of the California Green Building Standards Code.*

California Model Water Efficient Landscape Ordinance and County Ordinance

The Water Conservation in Landscaping Act was enacted in 2006, requiring the Department of Water Resources ("DWR") to update the Model Water Efficient Landscape Ordinance ("MWELO").[16] In 2009, the Office of Administrative Law (OAL) approved the updated MWELO, which required a retail water supplier or a county to adopt the provisions of the MWELO by January 1, 2010, or to enact its own provisions equal to or more restrictive than the MWELO provisions.[17,]

In response to the Governor's executive order dated April 1, 2015, (EO B-29-15), DWR updated the MWELO and the California Water Commission approved the adoption and incorporation of the updated State standards for MWELO on July 15, 2015. [18, 19] The changes included a reduction to 55 % for the maximum amount of water that may be applied to a landscape for residential projects, and non-residential projects to 45 %, which effectively reduces the landscape area that can be planted with high water use plants, such a turf. For residential projects, the coverage of high water use plants is reduced to 25% of the landscaped area (down from 33%). The newly updated MWELO also now applies to new construction with a landscape area greater than 500 square feet (the prior MWELO applies to landscapes greater than 2,500 square feet).[20]

Madera County adopted a water efficiency landscaping ordinance on January 5, 2010, to comply with the AB 1881 requirements.[21] This landscaping ordinance applied to the then current MWELO standards and is now obsolete. With the revised MWELO in 2015, the County has yet to update its ordinance and is not listed as in compliance with the state as of the drafting of this WSA.[22]

However, the Proposed Project includes water conservation features that even extend beyond the updated MWELO. Therefore, this WSA calculates demands that are fully in compliance with, and in fact go beyond, the revised MWELO and likely any future updated County requirements.

The MWELO provides a methodology to calculate total water use based upon a given plant factor and irrigation efficiency. Finally, the MWELO requires the landscape design plan to

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[16] Gov. Code §§ 65591-65599.

[17] California Code of Regulations (CCR), Tit. 23, Div. 2, Ch. 27, Sec. 492.4. The MWELO provides the local agency discretion to calculate the landscape water budget assuming a portion of landscape demand is met by precipitation, which would further reduce the outdoor water budget. For purposes of a conservative analysis, precipitation is not assumed to satisfy a portion of the outdoor landscape requirement because the determination of an appropriate effective precipitation factor is highly uncertain given the various landscape slopes, terrain composition, concurrent watering schedules, etc.

[18] The County landscape ordinance will be updated to be at least as stringent as the updated MWELO, or else the MWELO will be applied as the default landscape ordinance.

[19] These updated changes have been incorporated into California Code of Regulations (CCR), Tit. 23, Div. 2, Ch. 27, Sec. 490-495.

[20] CCR Tit. 23, Div. 2, Ch. 27, Sec. 490.1.

[21] Madera Country Ordinance 647, Jan 5, 2010

[22] Agencies in compliance are listed here: http://www.water.ca.gov/wateruseefficiency/landscapeordinance/mwelo_reports.cfm

delineate hydrozones (based upon plant factors) and then to assign a unique valve for each hydrozone (low, medium, high water use).[23]

Metering, Volumetric Pricing, and Water Budgets

California Water Code section 525 requires water purveyors to install meters on all new service connections after January 1, 1992. California Water Code section 527 requires water purveyors to charge for water based upon the actual volume of water delivered if a meter has been installed. Though the water retailer for the Proposed Project would be billing customers on a volumetric basis, this action alone is not expected to substantially reduce water use. However, it is anticipated that the retail billing system would encourage and help maintain reasonable use (e.g. through implementation of a tiered rate structure and/or water budgets), so that the Proposed Project's water demands at build-out are not reasonably expected to grow as the Proposed Project ages.

Project Specific Landscape Requirements

The Proposed Project includes a numbers of requirements for landscape efficiency beyond what is found in MWELO. Landscaping guidelines have been prepared for the project as well as water budgets for various landscape types. Among the numerous restrictions is a limit on residential turf to 25 percent of the landscape area for each residential lot classification.[24] Other restrictions include a vast majority of identified plant-types defined by the MWELO's guidance documents as having "Low" or "Very Low" water use.[25] Using defined methods, guidelines for landscaping for many portions of the Proposed Project have been defined and water budgets have been prepared. This information is presented later in this section.

The effect of these strict landscaping guidelines are that outdoor water use will be lower than the maximum allowed under the current MWELO. This changes the character of typical residential development, replacing turf with ornamental shrubs, groundcovers, and trees as well as a reliance on numerous native or adaptive species for landscaping.

2.2 RESIDENTIAL WATER USE DEMAND FACTORS

The Proposed Project anticipates six general lot-size designations. The size of the lot generally has the greatest impact on the annual per-lot demand for water as the irrigation needs for landscaping generally increase with larger landscaped areas. However, as discussed previously, the Proposed Project includes defined plant material selection and design that significantly reduces the outdoor component of the forecast residential water demands compared to more conventional landscape designs, thus limiting, but not eliminating, this traditional lot-size effect. In contrast, indoor water demands remain relatively consistent regardless of lot size, but do vary

[23] CCR Tit. 23, Div. 2, Ch. 27, Secs. 492.3(a)(2)(A) and 492.7(a)(2).
[24] Castellina Specific Plan, Appendix C
[25] The MWELO water use methods refer to plant water use factors as defined by the University of California's Water Use Classifications of Landscape Species (WUCOLS). Reference is available here: http://ucanr.edu/sites/WUCOLS/

slightly based on the number of people per dwelling unit. For instance, the Proposed Project's Active Adult housing anticipates lower occupancy rates than conventional homes, resulting in a lower indoor demand forecast. Distinct demand factors are provided for the following residential uses:

- Indoor Residential Use – this category identifies the generally anticipated water use for the average conventional homes and Active Adult homes.
- Outdoor Residential Use – this category addresses the landscape water demands for the various planned lot sizes.

For purposes of this WSA, residential unit water demand factors are described as "the acre-feet of water use annually per dwelling unit" – or acre-feet/dwelling unit ("af/du"). As discussed later in this WSA, both the residential indoor and outdoor demands will be met with potable groundwater, whereas non-residential outdoor demands will be met with non-potable supplies from recycled water derived from the indoor demands.

2.2.1 Indoor Residential Water Use Factors

The Proposed Project's residential elements would be built in accordance with all applicable building codes including the Cal Green Code discussed previously, as it may be further modified prior to Proposed Project implementation.

The Proposed Project's indoor demands are estimated using an assumed value of 55 gallons-per person per day, multiplied by the assumed occupancy rates for conventional, Active Adult and high-density classifications. For purposes of this WSA, conventional housing assumes an average occupancy rate of 3.7 people per house, with Active Adult and high-density classifications assuming 2 persons per house.[26] The assumed per-person rate of 55 gallons per day is derived from California Water Code Section 10608.20(b)(2)(A), which states a value of 55 gallons per capita (i.e., per person) per day ("gpcd") be used for estimating indoor residential use targets. When multiplied, the per-person use results in a per-dwelling unit demand of 0.23 acre-feet per year for conventional housing and 0.12 for high-density and Active Adult housing.

[26] The 3.7 person per house occupancy rate is higher than the average single family occupancy rate for the County of Madera (3.3) or the State Average (2.97) per the California Department of Finance census data. However, the City of Madera is slightly higher (3.87) and "incorporated" areas in the County are about the same (3.72). The data is available from "*E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark*" available at: http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-5/.

The 55 gpcd indoor use value has been confirmed through analyses of residential water meter data and is reflective of new suburban single-family dwelling units and older homes retrofitted with new water efficient fixtures and appliances.[27]

2.2.2 Outdoor Residential Water Use Factors

Outdoor water use is primarily a factor of lot size and the type and extent of landscaped area. The Proposed Project includes up to 3,072 residential lots with three average lot sizes for the single-family classifications: 14,520 square feet (sf.) for VLDR, 7,260 sf. for LDR and Active Adult, and 4,840 sf. for MDR. [28] Outdoor demands for the multi-family classification are calculated using gross acreage values.

Outdoor demands for the Proposed Project are calculated based on a number of factors including the regulations and calculation methodologies contained in MWELO. The MWELO provides for determining the Maximum Applied Water Allowance ("MAWA") where the maximum is determined as 55 percent of the reference evapotranspiration for the area, resulting in the following equation:[29]

> *MAWA = (ETo) (0.62)(0.55 x LA), where ETo is the reference evapotranspiration in inches per year, and LA is the landscape area. 0.62 is a conversion factor to gallons. The resulting value is in "gallons per year"*

A primary factor in this calculation is evapotranspiration ("ET"). The methodology directs the use of ET from a reference crop, such as maintained grass – a value referred to as ETo. For the Proposed Project, the ETo is 55 inches per year (or over 4.5 feet per year).[30]

Besides the ETo value, the primary factor driving outdoor water use on a per-lot basis is the square footage of landscape area. In addition to MWELO, the Proposed Project relies on landscaping restrictions that exceed the MWELO maximums. Specifically, the project restricts turf to 25 percent of the landscaped area, and restricts plant choices to a majority of low and very-low water use species. More information about these restrictions is discussed in **Section 2.1.1** above.

The calculations for water use are based on specific restrictions and the water efficient character of the Proposed Project as presented in the CSP. The Proposed Project utilizes individual calculations for each parcel type based on typical landscape areas, plant types, and average plant

[27] With the increasingly stringent requirements of building codes as well as water and energy efficiency codes, it is likely that the actual indoor demand of the Proposed Project may be below the stated 0.23 af/yr. Recently, the Governor issued Executive Order B-37-16 that, among other orders, directed state agencies to develop new urban water use targets including a standard for indoor residential per-capita water use. These new targets are to "build upon the existing state law" that requires a 20% reduction in urban water use by 2020 – which already includes the suggested 55 gallons-per-person per day planning guidance.
[28] Certain lots may be slightly larger or smaller, depending on the grading and final layout of the Proposed Project. However, those variations will be nominal and will not materially affect the Proposed Project's total demand.
[29] This formula reflects the latest revision to the MAWA that became mandatory as of December 1, 2015.
[30] ETo is consistent with California Irrigation Management Information System data available for the region.

water use factors defined in the CSP. The following assumptions form the basis of the residential landscape unit demand factors:

- Plant Factors (PF) – based upon the plant palette described in Appendix C of the CSP, the following factors are assumed:
    - Turf = 0.6 (assumes use of certain Fescues, Bermuda Grass, and some other turf varieties with relatively low irrigation requirements. Some grass varieties, such as St Augustine, Zoysia, and Buffalo grass, may have factors less than 0.6.)
    - Shrubs and Trees = 0.3
- Because much of the landscape area will be trees and shrubs, the landscape area is reduced by 3 percent to reflect the "open/non-irrigated" space between plants. This area does not receive irrigation when using drip irrigation systems, which will be used for irrigating the trees and shrubs. This small deduction is reflected in the demand calculations for each residential lot category.

Using these values and the MAWA equation, demand factors for each residential lot category are presented here:

- **Very Low Density** – The proposed 90 lots of this designation will include single family dwellings with accessory structures. The average lot size is approximately 14,520 sf. These very large lots will allow for development with large setbacks from roads and neighbors as well as allowing for some buffer space from adjacent agricultural use consistent with rural residential properties. For purposes of this WSA, an average of 66 percent of the lot is assumed to be landscaped, with 25 percent of this area turf (maximum allowed in the CSP guidelines), and the remainder mostly drought-tolerant and native or adaptive shrubs and trees. The resulting outdoor demand factor is forecast to be 0.36 acre-feet per dwelling unit.

- **Low Density** – The proposed 1,104 single family dwellings will be built on lots averaging 7,260 sf. It should be noted that while this lot type is most consistent with traditional detached single family dwellings, the lot size is generally larger than modern single family detached developments. For purposes of this WSA, an average of 52 percent of the lot is assumed to be landscaped, with 25 percent of this area turf (maximum allowed in the CSP guidelines), and the remainder mostly drought-tolerant and native or adaptive shrubs and trees. The resulting outdoor demand factor is forecast to be 0.14 acre-feet per dwelling unit.

- **Active Adult Low Density** – The proposed 402 lots will mimic the Low Density classification, but with a slightly smaller assumed home footprint. This results in an average of 55 percent of the lot assumed to be landscaped with an outdoor demand factor forecast to be 0.15 acre-feet.

- **Medium Density** – The proposed 1,026 attached and detached single-family dwelling units in this classification will be constructed on lots averaging 4,840 sf. Other configurations within this classification, as described in the CSP, may include half-plexes, cluster, alley, courtyard, green-court, zero-lot line, brownstones, townhomes, or condominiums. For purposes of this WSA, an average of 50 percent of the lot is assumed to be landscaped, with 25 percent of this area turf, and the remainder mostly drought-tolerant and native or adaptive shrubs and trees. The resulting outdoor demand factor is forecast to be 0.10 acre-feet per dwelling unit.

- **High Density** – The proposed 248 units will include a variety of attached and multi-family dwellings on lots with an average of about 2,000 square-feet. Buildings can be configured into units similar to the medium density but with smaller footprints or can be presented as multi-story units. This dwelling unit type is typically associated with community controlled outdoor spaces so the average outdoor demands are quite low per unit. For purposes of this WSA, an average of 25 percent of the lot is assumed to be landscaped, with 25 percent of this area turf, and the remainder mostly drought-tolerant and native or adaptive shrubs and trees. The resulting outdoor demand factor is forecast to be 0.01 acre-feet per dwelling unit.

- **Mixed Use Residential.** – The proposed 202 units typically exist above commercial space. Outdoor demands are minimal if present but are assigned to the commercial portion of the Proposed Project. For purposes of this WSA, this classification assumes zero outdoor water demand.

2.2.3 Summary of Residential Water Use Demand Factors

Table 2-1 provides a summary of the unit water demand factor used to estimate the Proposed Project's water use.

Table 2-1 – Summary of Residential Demand Factors

Water Demand Category by Dwelling Unit (du) Type	Indoor Factor	Outdoor Factor	Total Demand Factor (af/du)
Very Low Density	0.23	0.36	0.59
Low Density	0.23	0.14	0.37
Active Adult Low Density	0.12	0.15	0.27
Medium Density	0.23	0.10	0.32
High Density	0.12	0.01	0.13
Mixed Use	0.12	0.00	0.12

2.3 NON-RESIDENTIAL WATER USE DEMAND FACTORS

The Proposed Project has several non-residential features ranging from the Grand Promenade, the Village Center, and an Active Adult Amenity Center, to a central park and community gardens. Many of these proposed land-uses are unique, requiring specific demand forecasts for each component.

For purposes of this WSA, the demand for non-residential classifications is described as either "the acre-feet of water use annually per acre of land," acre-feet/acre (af/ac), or as a single demand projection for a demand category such as the indoor uses for the elementary school, acre-feet/unit (af/unit). These values reflect indoor or outdoor water needs expected for typical non-residential use for each of the following classifications:

- Village Center Indoor
- Elementary School Indoor
- Active Adult Amenity Center Indoor
- Non-residential Outdoor (to be served with non-potable supplies)
    - Neighborhood Parks
    - Active Adult Amenity Center
    - Community Garden[31]
    - Central Park
    - Grand Promenade
    - Linear Pathways
    - Village Green
    - Elementary School
    - Streetscape Landscaping
- Other miscellaneous uses, including temporary irrigation to establish open space landscaping, and temporary construction water.

The method and basis for determining the unit water demand factor for each of these classifications is detailed in the following subsections.

2.3.1 Village Center Indoor

The proposed Village Center is anticipated to include up to 134,000 square feet (sf.) of commercial space on approximately 21 acres with 202 residential units typically located above the commercial space (associated residential demands were discussed in the prior subsection). Water uses will primarily include retail, service, professional, and offices meant to serve the daily convenience needs of the Proposed Project's residents. Based upon meter studies conducted on existing neighborhood commercial facilities elsewhere in California, coupled with

[31] The community gardens will likely be served by potable supplies to the extent the gardens are used to grow food crops by local residents. However, because the demand is forecast to be small, the use is incorporated in with all other non-residential landscape demands. Because of the small volume, service with potable water would not be expected to affect the analysis and conclusions of this WSA.

the on-going commitment toward more efficient water use, the indoor unit demand factor for this classification is estimated at 1 acre-foot/acre for the purposes of this WSA.[32]

2.3.2 Elementary School Indoor

The Proposed Project includes an elementary school located on approximately 15 acres. Based upon meter studies for existing elementary schools, total school use – indoor and outdoor – ranges from 20 to 30 gallons per day per student. Depending on the schools' landscape design and operation, 60 to 70 percent of this demand is used to meet outdoor needs. Therefore, for purposes of this WSA, indoor demands are based upon an assumed use of 10 gallons per day per student, for an estimated student body of 700. This unit demand factor would reflect all administrative, teacher, student, cafeteria, and janitorial uses for the school, averaged on a per-student basis. The result is a forecast indoor demand of 7.8 acre-feet, rounded to 8 acre-feet for purposes of this WSA.

2.3.3 Active Adult Amenity Center Indoor

The Proposed Project includes a community center for the active adult community. Centers like the one proposed typically have bathrooms, activity areas, and kitchen facilities. Given the size of the active adult community, the amenity center will be on 5 acres and provide both indoor and outdoor space. This indoor unit demand factor is assumed equivalent to the Village Center commercial use. Using the value of 1 acre-foot per acre, the center is forecast to demand 5 acre-feet annually.

2.3.4 Central Park Restroom Facilities

Because the proposed Central Park will include multiple sporting fields, it will be equipped with two separate bathroom facilities. For purposes of this WSA, each bathroom facility is assumed to demand 1 acre-foot annually – equivalent to the indoor use of 4 single family homes. This is a conservatively high estimate.

2.3.5 Non-Residential Outdoor (Landscaped Areas)

The Proposed Project includes several distinct outdoor landscaping areas including traditional parks and linear parks as well as community areas and ornamental landscaping in the Village Center. For purposes of estimating water demand, assumptions have been made regarding the percentage of each acre that is irrigated, the percentage of irrigated area that is turf versus shrubs and groundcover, and the number of trees. Appendix C of the CSP provides significant details on the Proposed Project's landscaping direction and plant selection.

The Proposed Project includes 20 acres of smaller Neighborhood Parks located throughout the various neighborhoods, 6 acres of Linear Pathways, and a large 31-acre Central Park. Other smaller features include 3 acres of Community Gardens, a 3-acre Grand Promenade, a 2-acre

[32] Tully & Young, Inc. has performed several meter studies in California's Central Valley, including recently in the City of Lincoln. Specific small and large mixed-use commercial developments were analyzed and found to range from 0.78 af/ac/yr to 1.22 af/ac/yr for the total indoor and outdoor area (hard space such as parking and sidewalks).

Village Green, nearly 3 acres of turf-based play area at the school, and streetscape landscaping along entry roads, corridors and internal roadways. As noted previously, these demands will be met with non-potable supplies derived from recycled water. The primary assumptions used to estimate the outdoor demand for these features include:

- The assumed reference evapotranspiration (ETo) – as discussed previously, an ETo of 55 inches per year is assumed.
- Plant Factors (PF) – based upon the plant palette described in Appendix C of the CSP, the following factors are assumed:
    - Turf = 0.6 (assumes use of certain Fescues, Bermuda Grass, and some other turf varieties with relatively low irrigation requirements. Some grass varieties, such as St Augustine and Buffalo grass, may have factors < 0.6)
    - Shrubs and Trees = 0.3
    - Community Garden = 0.8 (but is assumed to only be used 75% of the year, resulting in a plant factor for calculations of 0.6)
- The estimated square footage of each type of planting within each land-use category (LA)

These assumptions are combined in the following formula:

> *Demand = (ETo) (0.62)(PF x LA)/IE, where ETo is the reference evapotranspiration in inches per year, PF is the plant factor, LA is the landscape area, and IE is the irrigation efficiency for each planting type by land classification. 0.62 is a conversion factor to gallons. The resulting value is in "gallons per year," which is converted to acre-feet per year*

Table 2-2 presents the assumed percentages of irrigated land per each planting designation.

Table 2-2 – Summary of Non-Residential Landscape Demand Factors[33]

Public Use Element	Total Open Area (acres)	% of Total Open Area Irrigated	Total Irrigated Area	% of Irrigated Area in Turf	Average Demand Factor (af/yr)	Forecast Demand (af/yr)
Neighborhood Parks	20	75%	15	25%	1.73	26.0
Active Adult Amenity Center	6	40%	2	15%	1.61	3.9
Community Garden	3	80%	2.4	0%	2.75	6.6
Village Square	2	30%	0.6	25%	1.79	1.1
Grand Promenade	3	70%	2.1	0%	1.39	2.9
Central Park	31	80%	25	60%	2.20	54.7
Linear Pathways and Paseos	6	60%	3.6	0%	1.39	5.0
Town Center/Mixed Use	2.1	10%	0.2	0%	1.80	0.4
Elementary School	9	30%	2.7	25%	1.71	4.6
Streetscape Landscaping	30.7	100%	30.7	0%	1.10	33.9
					Total	138.9

2.3.6 Other Miscellaneous Uses

The Proposed Project has two primary additional miscellaneous land uses with water demands, albeit only temporary demands. These uses have minimal impacts to the overall forecast water use due to their limited duration.

Construction Water

As stated in Section 1, the Proposed Project would include site grading and infrastructure installation during early phases of construction that will require dust suppression and other incidental water uses. These would not continue beyond the construction phases of the Proposed Project. For purposes of identifying incremental water demands, construction water is conservatively assumed for purposes of this WSA to be 4 acre-feet per year (this is about 1,200,000 gallons – or about 300 fill-ups of a 4,000-gallon water truck per year).

Open Space Establishment

As stated in Section 1, the Proposed Project would include percolation ponds and swales to capture and percolate storm water runoff. These areas are intended to be seeded with native or drought-tolerant water use plants and will require irrigation during establishment only. The 61 acres of this type of open space is expected to annually require 2.6 acre-feet per acre during establishment.

2.4 Proposed Project Water Demand Projection

Combining the Proposed Project's land use details and phasing with the demand factors presented in **Table 2-1** and **Table 2-2**, the water demands for the Proposed Project from implementation to build-out can be estimated. Because the estimated demands will be met with different supplies, **Table 2-3** presents the demands organized by "potable" and "non-potable"

[33] Irrigated area and turf area percentages are further discussed and detailed in the Castellina Specific Plan.

supply sources. Upon completion of the Proposed Project, the potable demands are conservatively estimated at 996 acre-feet of water annually, excluding considerations of non-revenue water (see below), and up to approximately 1,107 acre-feet of water annually when considering of non-revenue water. Demands met with non-potable supplies are estimated to be 139 acre-feet annually, with approximately 15 acre-feet of distribution system losses. Combined, the Proposed Project's overall estimated water demand is about 1,261 acre-feet annually (see **Table 2-3**).

2.4.1 Non-Revenue Water Demands

The demand factors presented earlier in this section represent the demand for water at the residential customer meter for each category. To fully represent the Proposed Project's demand on water resources, non-revenue water also needs to be included. Non-revenue water represents all of the water necessary to deliver to the customer accounts and reflects distribution system leaks, water demands from potentially un-metered uses such as fire protection, hydrant flushing, and unauthorized connections, and inescapable inaccuracies in meter readings.[34] In most instances, the predominant source of non-revenue water is from system leaks – the loss from fittings and connections from water sources through treatment plants, tanks, pumping plants, major delivery system back-bone pipelines, and community distribution systems. Because the delivery system distributing water within the Proposed Project will be new, the percentage of non-revenue water is estimated to meet the 10 percent goal set forth by the American Water Works Association. Therefore, the Proposed Project's potable water delivery system is expected to require about an additional 111 acre-feet per year at build-out to serve the Proposed Project's potable needs, and about 15 acre-feet for the non-potable delivery system. These values are included as the "loss factor" in **Table 2-3** and are considered to return to the groundwater system through percolation.

[34] The American Water Works Association and the California Urban Water Conservation Council recognize the inherent non-revenue water that is either lost or not accounted for in urban treated water distribution systems, and suggest purveyors strive for conveyance losses equal to 10% of all water delivered to customers. Obtaining this value depends on numerous factors including the age and extent of distribution system infrastructure, meter rehabilitation programs, and how a purveyor tracks fire flows and hydrant flushing.

Table 2-3 – Proposed Project Forecast Water Demands

Category	Cumulative Units or Acreage					Demand Factor (af/du or af/ac)	Forecast Demand (af/yr)				
	2020	2025	2030	2035	2040		2020	2025	2030	2035	2040
Residential (potable supplies)											
Active Adult Indoor	0	101	201	402	402	0.12	0	12	25	50	50
Conventional Indoor	289	578	1155	2220	2220	0.23	66	132	263	506	506
High Density Indoor	0	62	124	248	248	0.12	0	8	15	31	31
Mixed Use Indoor	0	101	202	202	202	0.12	0	12	25	25	25
						Indoor Subtotal	66	164	328	611	611
VLD Conventional	23	45	90	90	90	0.36	8	16	33	33	33
LD Conventional	138	276	552	1104	1104	0.14	20	39	78	157	157
MD Conventional	128	257	513	1026	1026	0.10	12	25	49	98	98
LD Active Adult	0	101	201	402	402	0.15	0	15	30	59	59
High Density	0	62	124	248	248	0.01	0	1	1	2	2
Mixed Use Residential	0	101	202	202	202	0.00	0	0	0	0	0
						Outdoor Subtotal	40	95	191	349	349
Non-Residential (potable supplies)											
Village Center (Mixed Use)	0	5	11	21	21	1	0	5	11	21	21
Elementary School	0	0	1	1	1	8	0	0	8	8	8
Central Park Restrooms	0	1	2	2	2	1	0	1	2	2	2
Active Adult Center	0	2	3	5	5	1	0	2	3	5	5
						Indoor Subtotal	0	8	24	36	36
						Indoor Total	66	172	352	647	647
						Outdoor Total	40	95	191	349	349
						Indoor Non-revenue water at 10%	7	19	39	72	72
						Outdoor Non-revenue water at 10%	4	11	21	39	39
						Total Indoor (w/ loss)	73	192	391	719	719
						Total Outdoor (w/ loss)	44	106	212	388	388
						Total Demand (for Potable w/ loss)	118	297	603	1107	1107
Non-Residential (landscaped area as part of total area - irrigated with non-potable supplies)											
Neighborhood Parks	0	5	10	15	15	1.7	0	9	17	26	26
Active Adult Amenity Center	0	1	1	2	2	1.6	0	2	2	4	4
Community Garden	0	2	2	2	2	2.7	0	5	5	7	7
Village Square	0	0	3	1	1	1.8	0	0	5	1	1
Grand Promenade	0	2	2	2	2	1.4	0	3	3	3	3
Central Park	0	5	10	25	25	2.2	0	11	22	55	55
Linear Pathways and Paseos	0	3	6	4	4	1.4	0	4	8	5	5
Town Center/Mixed Use	0	0.2	0.2	0.2	0	1.8	0	0.4	0.4	0.4	0.4
Elementary School	0	0	3	3	3	1.7	0	0	5	5	5
Streetscape Landscaping	0	5	10	31	31	1.1	0	6	11	34	34
						Outdoor Subtotal (for Non-potable)	0	40	79	139	139
						Outdoor Non-revenue water at 10%	0	4	9	15	15
Other Miscellaneous Uses											
Open Space	34	61	61	61	61	2.60 (est.)	88	79	0	0	0
Construction Water	1	1	1	0	0	4	4	4	4	0	0
						Misc. Subtotal (for Non-potable)	92	83	4	0	0
						Total Demand (for Non-potable w/ loss)	92	127	92	154	154
						Total Project Demand	210	425	694	1261	1261

2.4.2 Water Demands during Single- and Multiple-Dry Year Conditions

To adequately assess the sufficiency of available water supplies – discussed in Section 4 – the Proposed Project's normal-year water demand is modified to reflect anticipated increases in demand during drier conditions. Conservative modifications to the Proposed Project's water demand to reflect conditions expected during dry conditions are as follows (see **Table 2-4**):

Single dry year: Landscape irrigation demands would increase to reflect the generalized earlier start of the landscape irrigation season due to limited rainfall in the single driest year. Since this increase only applies to the outdoor portion of a customer's demand, an adjustment factor of 5 percent is applied to the total normal-year water demand values to conservatively reflect the expected increase in demand for water.[35]

Multiple dry years: During multiple dry years, demands are also expected to increase during the first in a series of dry years – as discussed above for the single dry year condition. However, during the second, third or more consecutive dry years, demands also are expected to reflect water shortage contingency plans implemented by the retail water purveyor.[36] During the second year, the water purveyor is assumed to request a reduction target of 10 percent. To be conservative, this WSA assumes a resulting demand reduction of 5 percent to accommodate conservatively low participation by customers. Thus, the already higher expected demand increase of 5 percent during dry conditions is decreased by 5 percent to reflect conservation – resulting in the original normal condition demand forecast. During the third year or additional years, the purveyor is expected to set a conservation target of 20 percent. For this analysis, the demands in the third year are reduced by 15 percent. Thus, during multiple dry conditions, demands initially increase due to reduced effective precipitation, but then decrease due to short-term conservation measures, with a net effect of a 10 percent reduction from the forecasted normal condition.

[35] Based on meter studies and work with DWR on "weather normalization" of per capita water use values, Tully & Young has demonstrated that urban water use increases during low rainfall months. Based on conversations with urban water purveyors, DWR and landscape water professionals, it appears common for landscape irrigation timers to be turned on "early" when February and March are unusually dry.

[36] This WSA anticipates the retail purveyor serving the Proposed Project will apply a water shortage contingency plan to address drought conditions. This is consistent with the County's ordinance regarding water conservation.

Table 2-4 –Proposed Project Water Demands under Dry-Year Conditions

		Multiple Dry Year		
	Single Dry	Year 1	Year 2	Year 3 +
% Increase (reduction)	5%	5%	0%	-10%
Resulting Potable Demand (af/yr)	1,162	1,162	1,107	996
Resulting Non-potable Demand (af/yr)	162	162	154	139
Total Demand (af/yr)	1,324	1,324	1,261	1,135

SECTION 3 – WATER SUPPLY CHARACTERIZATION

This section characterizes the intended water supply that will be used to serve the estimated water demands of the Proposed Project as detailed in Section 2.[37]

The Proposed Project intends to rely solely on groundwater to meet the Proposed Project's estimated total water demand (see **Table 2-3**). However, since a portion of the demand will be met by recycled water derived from the Proposed Project's indoor demands, only a portion of the entire demand will be extracted from the groundwater – since some of the water is used twice. Furthermore, because of the Proposed Project's commitment to efficiency and groundwater sufficiency, captured stormwater will be directed to the groundwater system through managed aquifer recharge facilities, and excess recycled water will be sent off-site to offset current irrigated agriculture's use of groundwater. This planned operation significantly limits the consumptive use of groundwater that leaves the system, and is designed to exceed the County's groundwater balance ordinance. These Proposed Project elements are further discussed in Section 4. The net consumptive use of groundwater supplies is estimated to be 506 acre-feet annually – a significant reduction from current consumption of groundwater used to irrigate the existing on-site tree crops.

Many existing users, including the existing irrigated agriculture on the site of the Proposed Project, share groundwater available in the aquifer beneath the Proposed Project. This section provides a detailed characterization of the aquifer, as well as historic and projected uses of this shared resource. Section 4 details the sufficiency of groundwater resources to meet the long-term needs of the Proposed Project, and provides an analysis using the County's groundwater balance methodology.

3.1 CHARACTERIZATION OF GROUNDWATER SUPPLIES

If a project's water supply includes groundwater, the WSA must include: a description of any groundwater basin or basins from which the proposed project will be supplied, a detailed description and analysis of historical and projected groundwater pumping, and an analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project (the sufficiency analysis is presented in Section 4).[38]

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[37] Water Code Section 10910(d)(1) requires that "The assessment... include an identification of any existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project, and a description of the quantities of water received in prior years by the public water system...under existing water supply entitlements, water rights, or water service contracts. (2) An identification of existing water supply entitlements, water rights, or water service contracts held by the public water system...shall be demonstrated by providing information related to all of the following: (A) Written contracts or other proof of entitlement to an identified water supply. (B) Copies of a capital outlay program for financing the delivery of a water supply that has been adopted by the public water system. (C) Federal, state, and local permits for construction of necessary infrastructure associated with delivering the water supply. (D) Any necessary regulatory approvals that are required in order to be able to convey or deliver the water supply."

[38] Water Code § 10910(f).

The Proposed Project, located about one mile north-northeast of the City of Madera, is within California's San Joaquin Valley and overlies the San Joaquin Valley Groundwater Basin. This area of the Central Valley is largely agricultural, with a significant groundwater subbasin that has been used historically for irrigation and, to a much lesser degree, for municipal demands in the City of Madera, for local community water systems, and for individual domestic uses scattered throughout the valley. The extent of this subbasin and its connection with adjacent subbasins has been assessed by the California Department of Water Resources (DWR).

The Proposed Project is within the Madera Subbasin (Basin No. 5-22.06, hereafter "Basin"), as defined by DWR Bulletin 118.[39] The Basin covers an area of 614 square miles and is located entirely within Madera County. It is bound on the south by the San Joaquin River, on the northwest by the southeastern boundary of the Chowchilla Subbasin, and on the east by the crystalline basement bedrock of the Sierra Nevada foothills. DWR Bulletin 118 characterizes this Basin as being in critical overdraft since 1980. In January 2016, DWR released an updated list of critically-overdrafted basins, which included this Basin.[40] See **Figure 3-1** for DWR's representation of the Groundwater Basins.

3.1.1 Geology

In the San Joaquin Valley, the stratigraphic succession of geologic formations in the valley include, from oldest to youngest: crystalline basement rock, marine and continental sedimentary rocks, Ione Formation, Mehrten Formation, continental deposits of tertiary and quaternary age, and continental deposits of quaternary age. The youngest formation is further divided into the Older Alluvium and the Younger Alluvium.

Those formations which consist of the main freshwater-bearing aquifer system within the Madera Basin and underlying the Project include (from oldest to youngest):

- Continental Deposits of Tertiary and Quaternary Age
- Continental Deposits of Quaternary Age (Older Alluvium)
- Continental Deposits of Quaternary Age (Younger Alluvium)

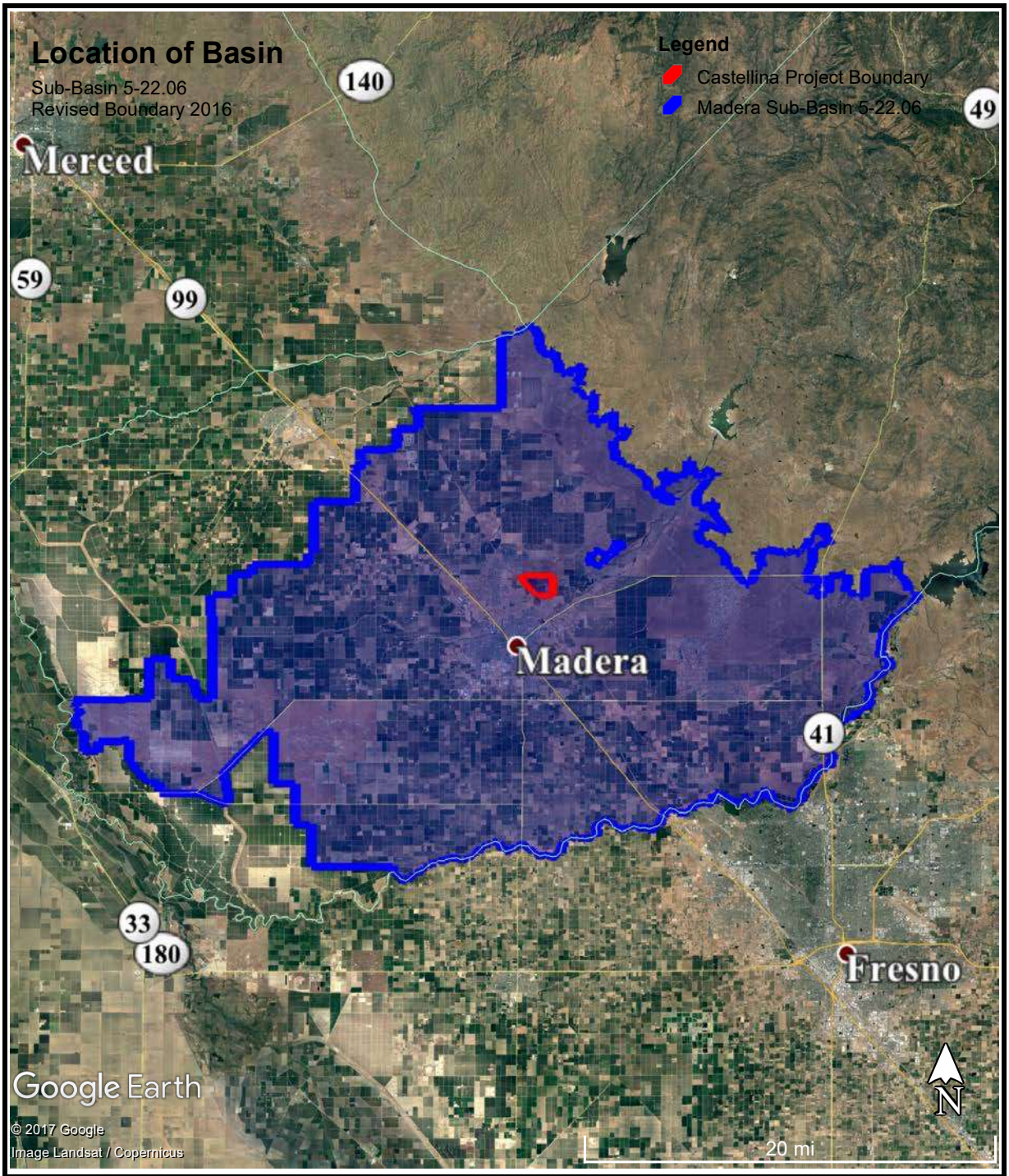
3.1.1.1 Continental Deposits of Tertiary and Quaternary Age

The continental deposits of Tertiary and Quaternary age underlie most of Madera County, but do not crop out at the surface. The formations dip gently southwest and overlie the marine and continental rocks (Mitten *et. al.*, 1970). The deposits consist of interbedded, poorly sorted sand, silt, clay and conglomerate, with layers of hardpan. The deposits become finer grained with depth and distance from the foothills. The lower part of the deposits contains blue and green clays and the upper portion contains red, yellow, and brown clays, which are interpreted to have been deposited under reducing and oxidizing conditions, respectively. In the past, few water wells penetrated the continental deposits. The water-bearing capacity of this formation is unclear

[39] http://www.water.ca.gov/groundwater/bulletin118/basindescriptions/5-22.06.pdf
[40] http://www.water.ca.gov/groundwater/sgm/cod.cfm

at this time; however, many new agricultural wells are drilling deeper into this formation to produce additional groundwater.

Figure 3-1 – Location of Basin 5-22.06



Tully & Young
Comprehensive Water Planning

Image Sources:
Google Earth Pro, Licensed
Bulletin 118 2016 Update Data, DWR

3.1.1.2 Continental Deposits of Quaternary Age (Older Alluvium)

The older alluvium of Pleistocene and Holocene age underlies most of the Proposed Project area and is the primary freshwater bearing formation within the Subbasin (Mitten *et. al.*, 1970). The older alluvium outcrops south of the San Joaquin River and north of the Chowchilla River. Janda (1965) correlated the formation near Little Table Mountain with the Turlock Lake, Riverbank, and Modesto Formations of Davis and Hall (1959). The older alluvium dips gently southwest and ranges in thickness from zero to about 1,000 feet (Mitten *et. al.* 1970). It overlies the continental deposits of Tertiary and Quaternary age and overlaps the Ione Formation (where present) and the basement complex. The older alluvium consists mostly of interbedded lenses of clay, silt, sand, and some gravel. Cemented hardpan occurs throughout the area near the ground surface. The source of the older alluvium is from the Sierra Nevada (Mitten *et. al.* 1970). The older alluvium decreases in grain size with depth and grades into the underlying fine-grained continental deposits of Tertiary and Quaternary age (Mitten *et. al.* 1970). The base of the older alluvium is defined where the resistivity on electric logs reflect a change from relatively coarse to fine grained sediment (Mitten *et. al.* 1970).

Mitten *et. al.* (1970) summarized aquifer characteristics based on aquifer tests made by the USGS in the late 1960's and reported aquifer transmissivity values ranging from 18,000 to 99,000 gallons per day per foot (gpd/ft) of drawdown in the Madera area. Based on multiple well tests throughout the Madera area, transmissivities of deposits above a depth of 500 feet (with significant coarse-grained deposits) range in transmissivities from 50,000 to 250,000 gpd/ft of drawdown. The underlying continental deposits normally range in transmissivities from about 10,000 to 30,000 gpd/ft of drawdown (Boyle, 2008).

3.1.1.3 Continental Deposits of Quaternary Age (Younger Alluvium)

The younger alluvium is a well-sorted sedimentary formation and overlies the older alluvium. It does not contain the cemented hard pan, which differentiates itself from the older alluvium. The younger alluvium overlies the older alluvium and covers a significant portion of Madera County. The younger alluvium is indistinguishable from the older alluvium in the subsurface. The estimated thickness ranges from zero to 50 feet and is unsaturated, except when saturated near streams and channels (Mitten *et.al* 1970).

3.1.2 Current Groundwater Conditions and Trends

DWR generated groundwater elevation contours for fall 2016 from DWR monitored wells suggest that the groundwater gradient (flow direction) in the vicinity of the Proposed Project is generally from the southeast to northwest. As shown in **Figure 3-2**, groundwater elevation contours from fall 2016 indicate elevations range from 20 feet above mean sea level (msl) in the southeastern portion of the Proposed Project, to near mean sea level in the northwestern portion of the Project, or approximately 287 to 292 feet below ground surface (bgs), respectively.

Groundwater elevation data from DWR monitored wells in the vicinity of the Proposed Project provide a historical perspective on groundwater use and conditions. Groundwater level data were accessed from DWR's Water Data Library (WDL)[41] for the DWR monitored wells with

[41] http://www.water.ca.gov/waterdatalibrary/

historical groundwater elevation data in the vicinity, as shown by the insets included on **Figure 3-2**.

The Basin has experienced significant declines in groundwater elevations for several decades. Regional declines in the groundwater basin have varied between approximately 60 and 200 feet since 1970. Current groundwater extraction rates within the Basin will likely continue for the foreseeable future as the County works with others to stabilize the basin, as is now legally required and detailed in a Groundwater Sustainability Plan for the Basin due to the State by January 31, 2020.

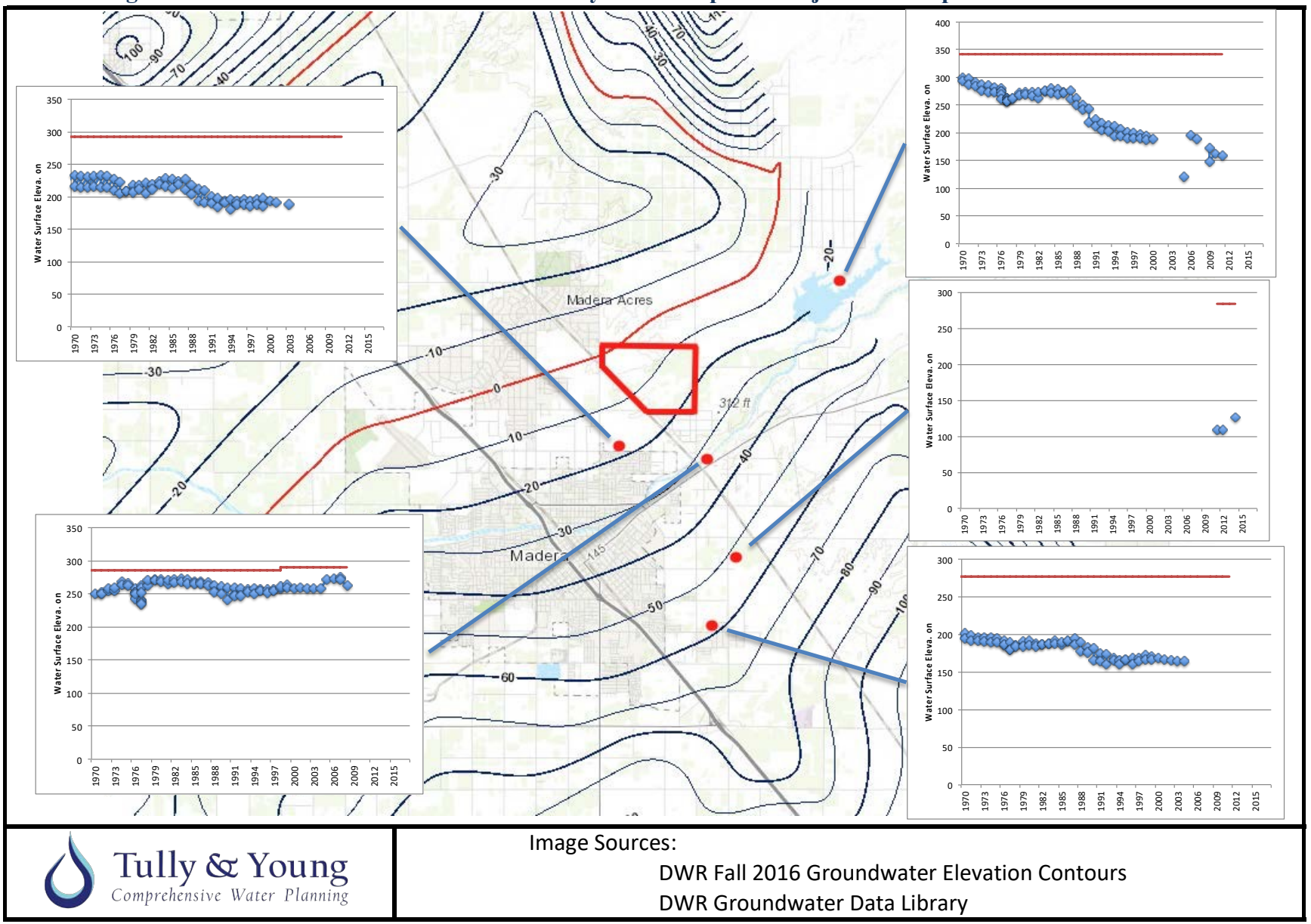
It is important to note that California experienced a statewide drought from 2012 through 2016, which may have exacerbated rates of groundwater decline in some portions of the subbasin over the past few years, most notably in areas where groundwater extraction increased to supplement reduced or nonexistent surface water supply. It is also important to recognize that the land proposed for development has been actively irrigated as an orchard using groundwater. The parcel's current and historic use to serve irrigated agriculture is reflected in the representative Basin groundwater conditions.

An additional important attribute of the Basin is the base of freshwater. This term describes the interface of freshwater and brackish water in an aquifer system. An often referenced study from 1973 characterized the base of freshwater in the San Joaquin Valley by mapping salinity levels in various wells throughout the region.[42] Using data from this study, the base of freshwater occurs at an elevation of approximately 1,200 feet below msl beneath the middle of the Proposed Project, or at a depth of approximately 1,500 feet bgs.

Given the approximate groundwater elevation of 10 feet above msl beneath the Proposed Project in fall 2016 (**Figure 3-3**), the data suggest that there is nearly 1,200 feet of saturated freshwater-bearing aquifer material in the immediate vicinity of the Proposed Project area. If the Subbasin experiences the same rate of decline over this timeframe, the projected decline over the next 30 years would be 300 feet using a conservative rate of groundwater decline of 10 feet per year. The base of freshwater is reported to be at a depth of approximately 1,500 feet, as discussed above, indicating there is currently approximately 1,200 feet of saturated aquifer available. The rate of decline in this portion of the Subbasin can be expected to stabilize during the next sequence as a result of the GSP, as well as a through the development and implementation of the Proposed Project's groundwater management strategies.

[42] Page, R.W., Base of Fresh Groundwater (approximately 3,000 micromhos) in the San Joaquin Valley, California, USGS, Hydrologic Investigations Atlas HA-489, 1973.

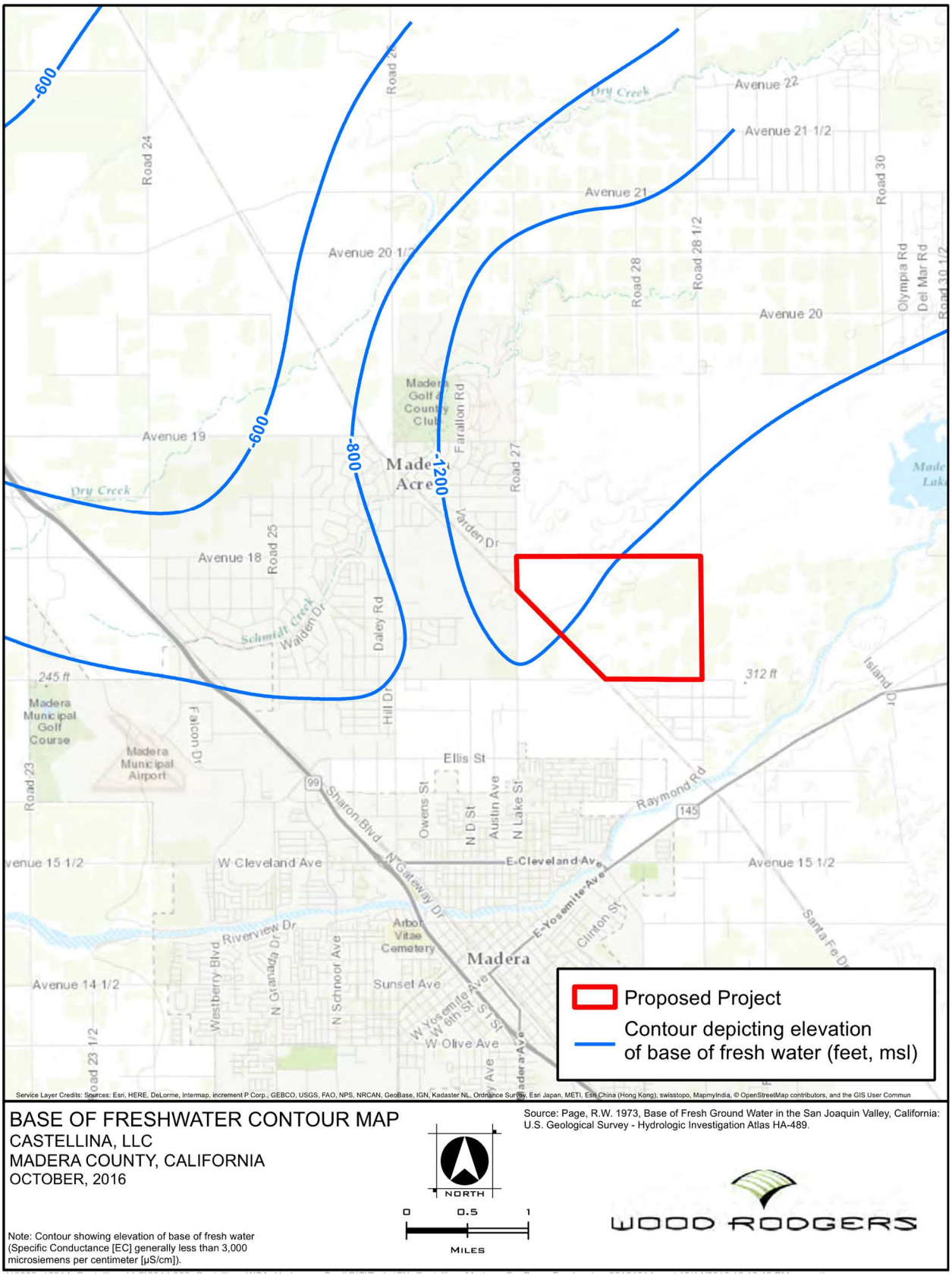
Figure 3-2 – Groundwater Levels in the Vicinity of the Proposed Project from Representative Well Locations



Tully & Young
Comprehensive Water Planning

Image Sources:
DWR Fall 2016 Groundwater Elevation Contours
DWR Groundwater Data Library

Figure 3-3 – Base of Freshwater in the Vicinity of the Proposed Project



3.2 GROUNDWATER MANAGEMENT IN THE MADERA GROUNDWATER SUBBASIN

In California, regulation of groundwater has largely been left to local authorities. There are a variety of methods available for managing groundwater resources in California and the degree of groundwater management in any basin is often dependent on water availability and demand.[43] Typically, local groundwater management strategies include monitoring groundwater levels and production amounts, and conjunctive use of groundwater and surface water supplies.

The Madera Regional Groundwater Management Plan (GMP) was prepared in December 2014 to provide an outline for a coordinated regional effort between participating agencies to implement steps to improve groundwater conditions within the San Joaquin Valley portion of Madera County.[44] The GMP Participants include City of Chowchilla; Chowchilla Water District; City of Madera; Madera County; Madera Irrigation District; and South-East Madera County United. Several water districts within the County have prepared similar groundwater management plans for their respective areas. The Proposed Project is located within Madera County's jurisdiction.

In addition to the GMP prepared for the groundwater basins, the State of California passed the Sustainable Groundwater Management Act (SGMA), which consist of three bills (AB 1739, SB 1168, and SB 1319). SGMA outlines necessary steps for local groundwater agencies to reach sustainable groundwater use. The framework allows local agencies to establish a Groundwater Sustainability Agency (GSA) in order to develop and implement groundwater sustainability plans (GSPs) for their respective jurisdiction. Where multiple GSAs cover a defined basin, the GSAs may submit one GSP or individual GSPs. If individual GSPs are developed, each GSA must provide the State with agreements demonstrating coordination on GSPs and cooperation for on-going implementation and enforcement. The GSP for the Basin must be submitted to the State by January 31, 2020. As shown in **Figure 3-4**, multiple agencies within Madera County are GSAs within the Basin and are preparing four separate GSPs along with a coordination agreement. As shown in **Figure 3-4**, the Proposed Project currently is included in the Madera County GSA, where the Madera County GSA is working on a joint GSP with three other GSAs: Madera Irrigation District, the City of Madera, and Madera Water District.[45]

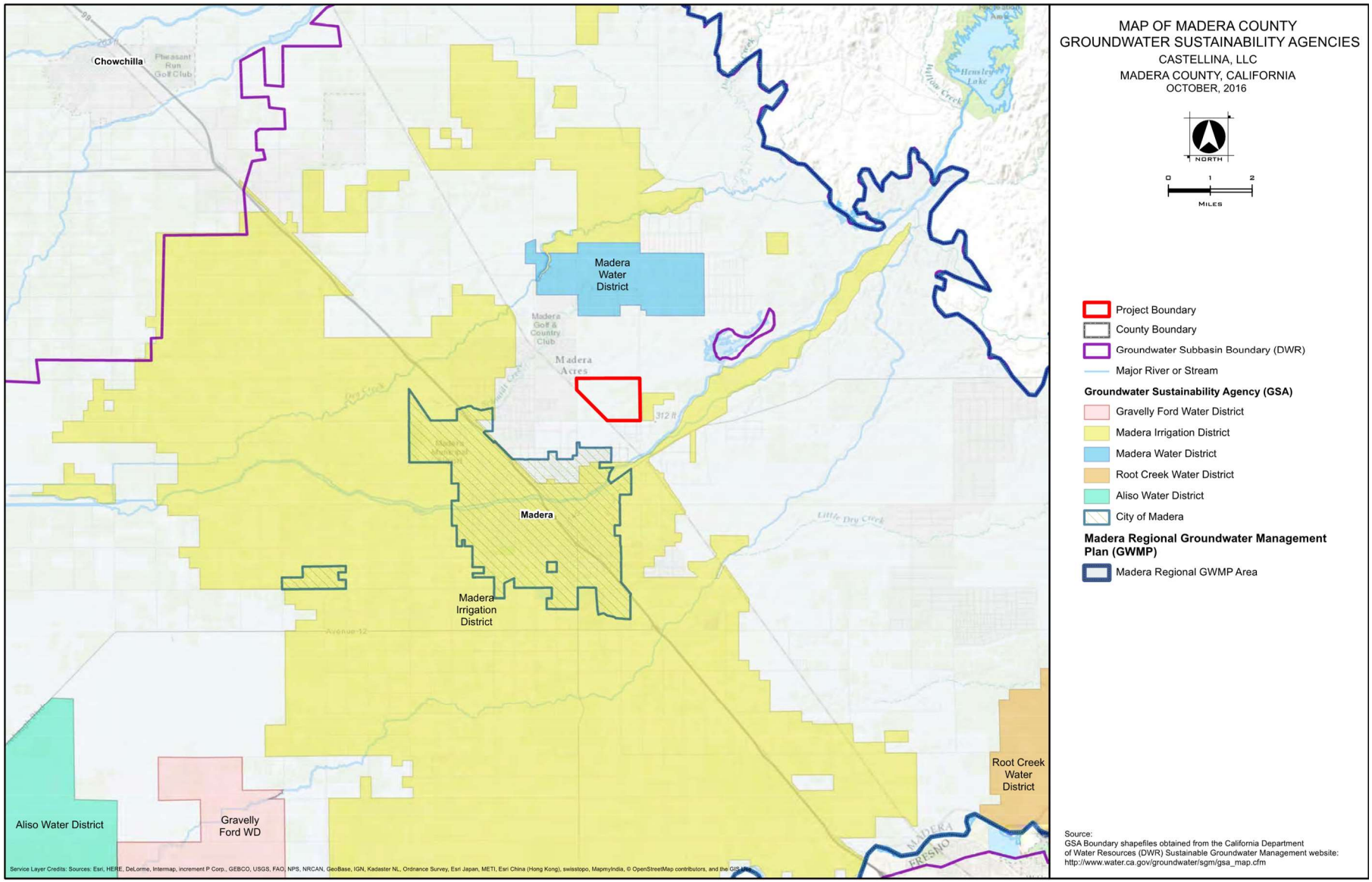
3.3 WATER RIGHTS, FINANCING, AND REGULATORY APPROVALS[46]

Upon construction of the Proposed Project, ownership and operation of all water utility systems will be transferred to a qualified water purveyor. There are two alternatives for the water purveyor: (1) an investor-owned public utility company, or (2) a mutual water company. The water purveyor will be responsible for the continued operation and maintenance of all utility systems.

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[43] Department of Water Resources, Bulletin 118 (2003), Ch. 2.
[44] Madera Regional Groundwater Management Plan, December 2014, pp. 153.
[45] Madera County became the exclusive GSA for the Proposed Project area in May 2017, referred to as the 'County of Madera – 2 GSA" (differentiating it from the GSA role the County also plays in the Chowchilla subbasin and the Delta-Mendota subbasin). See the County's explanation here: http://www.maderacountywater.com/
[46] See Water Code Section 10910(d)(2)

Figure 3-4 – Groundwater Sustainability Agencies (GSAs) in the Vicinity of the Proposed Project



Importantly, however, the type of water purveyor will not have any impact on the Proposed Project's estimated water demand or the availability of the groundwater resources available to serve the Proposed Project, as described later in Section 4.

Absent an adjudication of a groundwater basin, California common law governs the right to use and extract percolating groundwater from a basin. The Madera Subbasin is an unadjudicated groundwater basin and therefore subject to these common law rules. The owner of real property overlying a groundwater aquifer possesses a right as part and parcel of the land to extract groundwater from beneath the property for use on overlying land within the watershed. The Proposed Project applicants are, or will become as a result of approval of the Proposed Project, landowners overlying the Basin. Accordingly, both the current owner of the property and the proposed applicant of the Proposed Project are overlying owners and are entitled to produce groundwater to serve their reasonable and beneficial uses within the watershed or drainage area of the basin. These rights, however, are subject to the County's oversight and management, as conditioned by ordinances such as the recently enacted groundwater balance ordinance, and as may be required to conform to SGMA.

3.3.1 Financing the Water Supply

The Proposed Project anticipates replacing or renovating existing wells (as required to meet the well standard for municipal wells) on the parcel to access groundwater in the Basin. New wells and other related infrastructure will be constructed by either the developer or the eventual water purveyor. The anticipated expenses of infrastructure are relatively modest compared to the development as a whole, and financing is not expected to create a barrier to implementing the water supply plans identified in this WSA.

3.3.2 Regulatory Approvals and Permits

Prior to drilling new municipal wells, the Proposed Project will need to acquire permits from the County as detailed in the County's municipal code. The Proposed Project will likely be subject to at least the following regulatory approvals and filings for new wells:

- County Permit for Water System Design Standards[47]
- California Statues Related to the creation of a Drinking Water System[48]
- Well Completion Report must be filed with the Department of Water Resources[49] and Madera County Department of Environmental Health[50]
- Meter permit required through County Public Works Department[51]
- Certification for operating a municipal well from the California SWRCB's Division of Drinking Water.

[47] Madera County Code § 13, et seq.
[48] Water Code § 14300, et seq.
[49] Water Code § 13750, et seq.
[50] Madera County Code §13.52 Well Standards
[51] County Ordinance 674

SECTION 4 – SUFFICIENCY ANALYSIS

This section assesses whether sufficient water supplies exist to meet the estimated water demand of the Proposed Project.[52] The WSA provides a reasoned analysis of the likely availability of the identified supplies to serve the Proposed Project, while considering the demands of existing and other planned future land uses. [53] In conformance with WSA Law, this section includes an analysis of sufficiency of identified groundwater supplies to serve the Proposed Project, considering variations in supply and demand characteristics under normal, single-dry and multi-dry hydrologic conditions.

Additionally, this section applies the County's methodology outlined in its recently adopted ordinance directed at large development projects. This section assesses the groundwater balance conditions when considering the Proposed Project as described in Section 1 – with the intent for 3,072 residential housing units.

4.1 WSA LAW SUFFICIENCY ANALYSIS

The WSA Law sufficiency analysis integrates the water demands detailed in Section 2 with the groundwater supplies characterized in Section 3.

The Proposed Project's demand will be met by groundwater and recycled water, with the recycled water generated from the treated wastewater flow produced from the Proposed Project's indoor residential and non-residential uses. Thus, the entire Proposed Project demand is reliant on the initial extraction of groundwater, where the initial extraction matches the demand only for the potable needs. As detailed in **Table 2-3**, the potable demand is estimated to be 1,107 acre-feet annually – varying slightly during single and multiple dry years as presented in **Table 2-4**, ranging from 996 acre-feet to 1,162 acre-feet.

The Proposed Project's potable demand is presented in **Table 4-1** beginning with expected conditions in 2020, and continuing with 5-year increments through 2040. The analysis assumes that the Proposed Project is fully constructed by 2035. This represents the quantity of groundwater extracted to meet the overall demands. **Table 4-1** incorporates the Proposed Project's potable water demand projection from **Table 2-3**, based on the anticipated build-out schedule detailed in Section 1, and the adjusted demands for the single-dry and multiple dry year conditions. Prior to consideration of the County's groundwater balance ordinance, **Table 4-1** represents that sufficient

[52] CWC § 10910 (c)(4) provides that "the water supply assessment for the project shall include a discussion with regard to whether the total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses."

[53] *Vineyard Area Citizens for Responsible Growth, Inc*. v. *City of Rancho Cordova* (2007) 40 Cal.4th 412, 430-32.

groundwater exists in the Madera subbasin to meet the needs of the Proposed Project. While this may demonstrate passing of a basic test regarding the availability of groundwater, it does not address the County's groundwater balance ordinance requirements, which is a more applicable test of water supply sufficiency for purposes of this WSA. That analysis follows in the next subsection.

Table 4-1 – Assessment of Sufficiency for Potable Water Demands

Year	Potable Water Demand (af/yr)	Hydrologic Year Type		Groundwater Extracted (af/yr)	Sufficient Groundwater Available?
2020	118	Normal		118	yes
	123	Single Dry		123	yes
	123	Multiple Dry	Year 1	123	yes
	118		Year 2	118	yes
	106		Year 3	106	yes
2025	297	Normal		297	yes
	312	Single Dry		312	yes
	312	Multiple Dry	Year 1	312	yes
	297		Year 2	297	yes
	268		Year 3	268	yes
2030	603	Normal		603	yes
	633	Single Dry		633	yes
	633	Multiple Dry	Year 1	633	yes
	603		Year 2	603	yes
	542		Year 3	542	yes
2035	1,107	Normal		1,107	yes
	1,162	Single Dry		1,162	yes
	1,162	Multiple Dry	Year 1	1,162	yes
	1,107		Year 2	1,107	yes
	996		Year 3	996	yes
2040	1,107	Normal		1,107	yes
	1,162	Single Dry		1,162	yes
	1,162	Multiple Dry	Year 1	1,162	yes
	1,107		Year 2	1,107	yes
	996		Year 3	996	yes

4.2 APPLYING THE COUNTY'S GROUNDWATER BALANCE ORDINANCE

As previously discussed, the County adopted the Large Scale Development Groundwater Balance ordinance ("Ordinance") in August 2017.[54] The Ordinance directs a large development – such as the Proposed Project – to "*quantify tabulate and calculate a Groundwater Balance…*" (Madera County Code 13.110.050) and, "[*p]rior to the issuance of entitlements for a Large Scale Development, the applicant for such entitlements shall demonstrate to the satisfaction of the County a Groundwater Balance for the development…*" (Madera County Code 13.110.060). This subsection provides the applicant's representative groundwater balance.

4.2.1 Groundwater Balance Methodology

This WSA provides for assessment of whether existing and planned water supplies are projected to be sufficient to meet demands of the Proposed Project—plus demand from existing and planned future land uses in the service area where the new Proposed Project is located. Here, the Proposed Project is not located within the service area of any existing public water system and, therefore, there are no other existing or future customers beyond those that share the groundwater resources of the Madera Subbasin.

While a formal "public water system's existing and planned future uses"[55] do not exist in the context of the WSA Law, the County's strategy for assuring that new developments do not impact existing or planned future uses directs large urban development projects to demonstrate a groundwater balance as defined in the Ordinance. This is primarily accomplished by mitigating groundwater use that exceeds an established sustainability credit through (1) alternative supplies to serve the new demands or (2) augmenting groundwater resources. As discussed later, in conjunction with the low-water demanding land-use and landscaping attributes described in Section 2, the Proposed Project intends to capture stormwater and use managed aquifer recharge (MAR) facilities to replenish the Basin and achieve the County's required groundwater balance.

The Ordinance defines the methodology the applicant must use to calculate the groundwater balance. This calculation is presented later under Section 4.2.3 using the Ordinance's steps as described below. As detailed in Madera County Code 13.110.070, the following steps are necessary:

1. Determine the demand to be satisfied by groundwater – Section 2 of this WSA provides the necessary detail required per this step. As presented in Table 2-3, the Proposed Project requires 1,107 acre-feet of groundwater to be extracted annually at build-out.

[54] Madera County Code 13.110
[55] Water Code Section 10910(c)(3)

2. Determine total project recharge and offsets – The Ordinance discusses four separate parts for this step:

    a. Determine the amount of effluent generated and percolated into the Basin.

    b. Determine the storm drain and excess irrigation flows percolated into the Basin.

    c. Determine if any set aside credits are applicable, such as from previously farmed lands that will become fallow or dry-farmed that are within the Basin.

    d. Confirm the per-acre Sustainable Yield applicable to the project location.

The Ordinance defines two critical terms for determining whether any project satisfies the groundwater balance objectives: [56]

1. Groundwater Balance: defined as a condition where the quantity extracted for the project, minus credits, does not exceed the per-acre Sustainable Yield of the Basin.

2. Sustainable Yield: defined as the maximum quantity of water per acre of a project that can be withdrawn from the Basin without causing an undesirable result, with the per-acre value being established by the County from time to time.

While the County adopted the Ordinance in August 2017, a sustainable yield value is still under development as part of the County's efforts to comply with SGMA. However, while a sustainable yield value has not been officially adopted, the County is publically discussing a value that would apply to all lands within the County GSA – including the Proposed Project.

As such, and for purposes of the groundwater balance calculation presented later, a proxy value for sustainable yield of 0.5 acre-feet per acre per year is assumed. This value was initially presented during a technical workshop in Madera County on October 18, 2018, and has been a consistent value since.[57] This WSA anticipates that this value will be formally presented in the draft GSP that is scheduled to be publicly available in July 2019.[58] This value is used as a proxy value for the County's Sustainable Yield in the groundwater balance determination presented later.

[56] Madera County Code 13.110.030: Definitions.
[57] The presentation from 10/18/18 is available here: http://www.maderacountywater.com/wp-content/uploads/2018/10/Madera-Third-Tech-Workshop-10-18-18-full-draft-rev5.pdf. Slide 16 presents the value.
[58] According to the Madera County website, the GSP chapters will be fully available in July 2019 (http://www.maderacountywater.com/) (Last accessed April 2019)

4.2.2 Proposed Project Stormwater Capture and Recharge

The Proposed Project incorporates a stormwater capture, retention and percolation system that will be used to recharge the Basin with on-site stormwater. (see CSP Section 4.5 and 5.4). This element provides offset credits in accordance with the Ordinance Part 2(b).

As presented in the CSP, the Proposed Project will integrate the stormwater collection system with managed aquifer recharge (MAR) facilities to enable capture, retention and percolation of stormwater collected from the entire site.

The collection and recharge of stormwater is the primary approach to achieving a groundwater balance for the Proposed Project's (see conceptual graphic in **Figure 4-1**). Based upon the calculations presented below, the recharge of on-site stormwater is expected to significantly contribute to achieving a balanced condition.

Figure 4-1: Stormwater capture and recharge (conceptual)

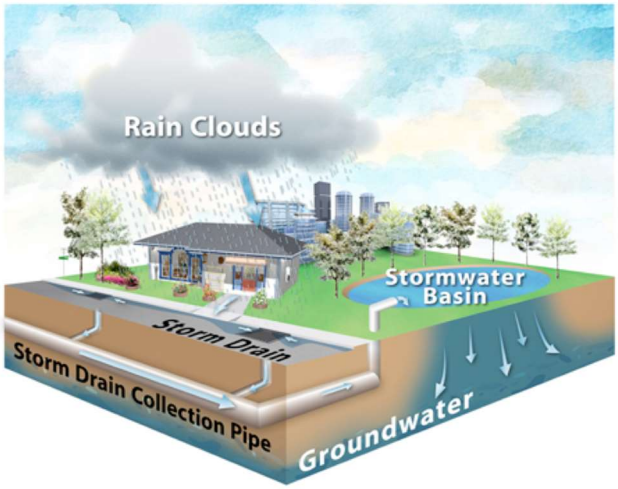


Photo credit: Fresno Irrigation District

Stormwater Runoff and Recharge

As presented in Section 1, the Proposed Project encompasses about 792 acres (see **Table 1-1**). Rainfall onto the various land uses will result in both percolation and runoff, with differing rates of each depending on the rainfall intensity and duration, as well as the characteristics of the land use (e.g. pervious or impervious). For purposes of estimating the potential average runoff, this WSA assumes a runoff coefficient unique to the varying land classifications.

For residential areas, the runoff coefficient corresponds to the average lot size and assumed roof-area and hardscape that affect the ratio of pervious to impervious soil cover. **Table 4-2** presents the calculated pervious area based on residential lot assumptions. The runoff coefficient used in **Table 4-3** reflects a blended condition for residential lots, where 85 percent of annual rainfall on impervious areas is collected and 10 percent of annual rainfall on pervious portions is collected into the stormwater system. This reflects variations in storm intensity where runoff will occur from pervious areas when soils are saturated. High density and mixed use residential areas, along with non-residential areas assume either 85 percent (e.g. for apartments and commercial areas) or 10 percent (e.g. for parks and open space).

Table 4-2 – Residential Lot Runoff Assumptions

Type	Residential Lot Assumptions (in square feet)				% Pervious
	Net Lot Size	House Foundation	Hardscape Area	Remaining Area	
VLD	14,520	2,500	2,500	9,520	66%
AA	7,260	1,800	1,500	3,960	55%
LD	7,260	2,000	1,500	3,760	52%
MD	4,840	1,200	1,200	2,440	50%

The runoff coefficient, when multiplied by the total area of the land-use classification and considering Madera's average annual rainfall of about 12 inches,[59] provides an estimated stormwater runoff quantity that would be routed to the MAR facilities.

The resulting estimate, by land classification and for the entire project area, is presented in **Table 4-3**. The Proposed Project anticipates capturing about 347 acre-feet of stormwater annually. This stormwater will be directed to specially designed MAR facilities utilizing deep dry well technology to allow rapid recharge into the Basin.

Deep dry wells are a newer method that is beginning to be employed in California for purposes of stormwater capture and recharge. These wells create a vertical connection to non-saturated subsurface layers that allows stormwater to quickly be recharged below otherwise confining or constraining soil layers. Various percolation testing is occurring at the site to determine design configurations, but the Proposed Project anticipates that use of these wells, in conjunction with retention/percolation ponds, will limit exposure of retained stormwater to evaporation, allowing the majority of the water to recharge the basin. **Figure 4-2** presents a schematic of a dry well configuration. The Proposed Project anticipates the use of deep dry wells located within the retention ponds as well as potentially adjacent to or within parks or other public areas.

[59] http://www.cnrfc.noaa.gov/awipsProducts/RNOWRKCLI.php

Table 4-3 – Estimated Volume of Captured Stormwater for Recharge

Land Use Type	Gross Acreage [1]	Runoff Coefficient [2]	Stormwater Capture (af) [3]
Very Low Density Residential	36	0.33	12
Low Density Residential [4]	314	0.41	130
Medium Density Residential	148	0.45	66
High Density Residential	12	0.85	10
Mixed Use	21	0.85	18
Neighborhood Parks	20	0.10	2
Community Garden	3	0.10	0
Central Park	31	0.10	3
Grand Promenade	3	0.10	0
Linear Pathways	6	0.10	1
Village Green	2	0.10	0
Open Space	61	0.10	6
Active Adult Amenity Center	6	0.10	1
Elementary School	15	0.10	2
Roads & Other Miscellaneous Areas	114	0.85	97
Total	792		347

Notes:

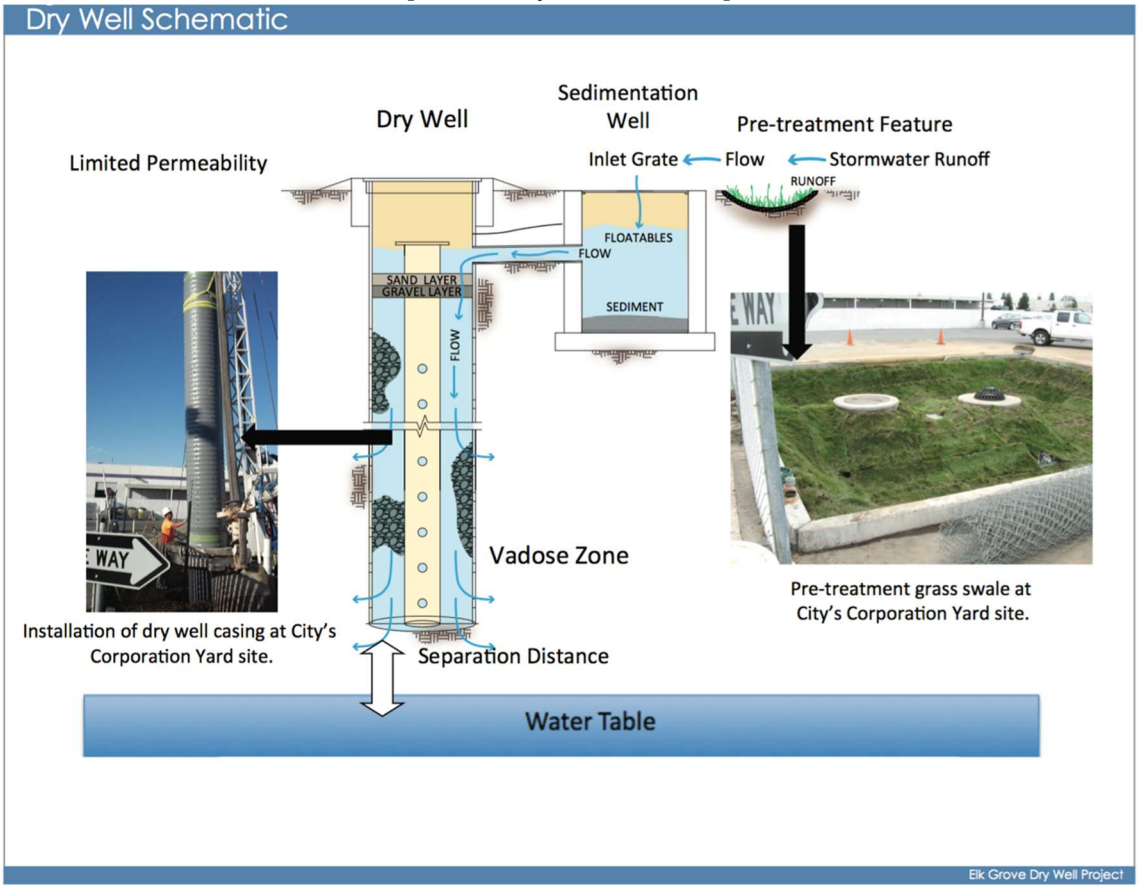
1. Gross acres includes all land (including streets and rights-of-way)
2. Assumed based upon 10% from pervious soils and 85% from impervious areas
3. Assumes 12" of avg rainfall (Volume = acreage X coef. X rainfall)
4. Includes active-adult community.

Water Quality Considerations of Deep Dry Wells

While the use of deep dry wells to facilitate groundwater recharge is just emerging in the Central Valley, it is a proven mechanism when designed and operated properly. However, the potential for the introduction of pollutants in stormwater has been raised as concerns as part of other deep dry well projects. Based upon some initial research, the risk should be minimal for the County. For example, a recent study supported by SWRCB grant funding looked at this issue extensively, reporting:

"*The risks associated with the use of dry wells are primarily linked to the potential to introduce pollutants into the aquifer. Data collected at the two project sites in Elk Grove combined with modeling results did not provide evidence that groundwater quality would be degraded by the use of dry wells. Practices in other states and conclusions reached by US EPA suggest that with proper dry well siting, design, and maintenance, dry wells can be used safely. Results from this project are consistent with these conclusions*." (Executive Summary, p. vi-4)[60]

Figure 4-2 – Dry Well Schematic
[source: City of Elk Grove[61]]



Calculations of Evaporative Loss from MAR Facilities

The estimated volume of stormwater captured and routed to retention ponds and deep dry wells is estimated at about 347 acre-feet during normal precipitation conditions (e.g. about 12 inches of rain per year). As presented later in this Section, a portion of this water evaporates from the ponds, depending on storm intensities, local weather

[60] City of Elk Grove Dry Well Project – Final Report (March 2017).
[61] City of Elk Grove Dry Well Project – Final Report (March 2017, Figure 3-5). Available at http://www.elkgrovecity.org/UserFiles/Servers/Server_109585/File/Departments/Public%20Works/Drainage/Dry%20Wells/Final%20Report.pdf

conditions affecting evaporation, timing and volume of recharge rates to remove water from the ponds, and likely other factors. For purposes of this WSA, the portion of collected stormwater that evaporates is based on assumed surface areas of stormwater in the ponds during certain months of the year. Typically, the stormwater will be collected during months when evaporation rates are lowest, limiting the loss. **Table 4-4** provides the assumed pond surface areas, evaporation rates, and resulting loss on a monthly basis.

Table 4-4 – Estimated Evaporation from Stormwater Retention Ponds

Month	Avg ETo (inches)	Ponding Size (acres)	Est. Evap. (acre-feet)
Jan	1.09	10	0.91
Feb	1.99	10	1.66
Mar	3.75	10	3.13
Apr	5.09	5	2.12
May	7.33	0	
Jun	8.29	0	
Jul	8.32	0	
Aug	7.62	0	
Sep	5.59	0	
Oct	3.55	2	0.59
Nov	1.76	5	0.73
Dec	1.07	10	0.89
Total	**55.45**		**10**

4.2.3 Proposed Offsite Recycled Water Use

The Proposed Project will generate wastewater that will ultimately produce Title 22 compliant recycled water for beneficial reuse to serve the non-residential landscaping and be available for offsite use in-lieu of existing groundwater use for irrigated agriculture.

A preliminary design of the wastewater system, including flow generation estimates, timing, infrastructure, and phasing was prepared as part of the CSP.[62] The analysis estimated an average annual flow generation of 0.578 mgd (equivalent to 647 acre-feet annually). This value matches the estimate of indoor demand (residential and non-residential) shown in **Table 2-3**. To be conservative, this WSA assumes about 1 percent of the indoor potable demand is "consumed" and does not generate a flow to the wastewater treatment facility. The resulting estimate of influent is 641 acre-feet annually. The non-residential outdoor demands within the Proposed Project, which do not generate flows to the wastewater facility but use the resulting recycled water, are

[62] Water Works Engineers was retained by the applicant to develop the draft "Castellina Community Water and Wastewater Facility Plan" (October 24, 2018). A copy of that plan is included in the Proposed Project's Infrastructure Master Plan prepared in December 2018.

estimated at 139 acre-feet, requiring an additional 15 acre-feet to account for incidental system losses (see **Table 2-3**). Furthermore, the wastewater treatment process is assumed to result in some water evaporating from temporary recycled water storage ponds and transported offsite with the biosolids.

Using these estimates, the recycled water system is anticipated to produce 475 acre-feet annually that would be available for delivery to offsite irrigated agriculture. For purposes of preliminary analysis, the previously mentioned infrastructure plan anticipate this water would be delivered within a 3-mile radius of the Proposed Project. Under the County's ordinance, this offsite use can be considered in the determination of credits when calculating the groundwater balance.[63]

4.2.4 Groundwater Balance Determination

As previously presented, the County's groundwater balance methodology states that a project is determined to be meeting the balance requirements if the following equation is satisfied:

"Project Demand" – "Recharge Credits" < "Sustainable Yield"

Where:

"Project Demand" is 1,107 acre-feet per year (see **Table 2-3**)

"Recharge Credits" reflect stormwater recharge credits and system losses (see Ordinance Part 2), and equal 463 acre-feet annually (see **Table 2-3** and **Table 4-3**).[64]

"Offset Credits" reflect the planned delivery of recycled water to local irrigated agriculture for use in-lieu of or to augment the agricultural parcel's sustainable yield value of 0.5 acre-foot per acre, and equal to 475 acre-feet annually (see Section 4.2.3).

Using the Proposed Project's specific information, the equation becomes:

(1,107 acre-feet) – (463 acre-feet) – (475 acre-feet) < (0.5 acre-feet/acre) x (792 acres);

which becomes:

[63] Madera County Ordinance 13.110.070(B)(2)(e): "Recharge in the impact area (including in-lieu recharge) outside the limits of the subject development developed for the benefit of the large scale development's ground water balance may also be taken into account."
[64] System losses for the potable and non-potable systems are estimated at 111 acre-feet and 15 acre-feet, respectively (see Table 2-3), and the MAR system contributes an average net recharge of 337 acre-feet (Table 4-3 minus Table 4-4).

169 acre-feet < 396 acre-feet;

which demonstrates the Proposed Project satisfies the County's ordinance requirement, since the Proposed Project's groundwater balance value does not exceed the Sustainable Yield value.

Figure 4-3 graphically presents a detailed flow diagram of the Proposed Project's extraction and use of groundwater and recycled water, and the associated return flows and other recharge elements that achieve the County's desired balance. Each of the specific values presented in **Figure 4-3** are detailed here:

a) 1,107 af/yr – This extracted quantity would meet the actual residential and non-residential uses, the ET demands of residential landscape, and the water that leaks from the underground delivery system (percolating back into the aquifer).

b) 349 af/yr – This reflects the residential landscape ET at build-out. The demand reflects the Proposed Project's focus on low-water use and mostly adaptive and native plants for landscaping, and strict limits on turf. All of this is expected to leave the Basin through evapotranspiration to the atmosphere as indicated in the Net Consumptive Use cloud.

c) 611 af/yr – This is the volume expected to enter all of the residential units annually. A small portion of this water will leave the Basin through incidental evaporation (e.g. from normal household use of hoses outside, separate from landscape ET), and human consumption. The remainder will flow through the sewer system to the Recycled Water Facility.

d) 36 af/yr – This is the expected demand for the local commercial uses, including businesses and public restrooms at parks. Because the Proposed Project does not include industry, the indoor non-residential uses are expected to all flow to the sewer system and be treated at the Recycled Water Facility.

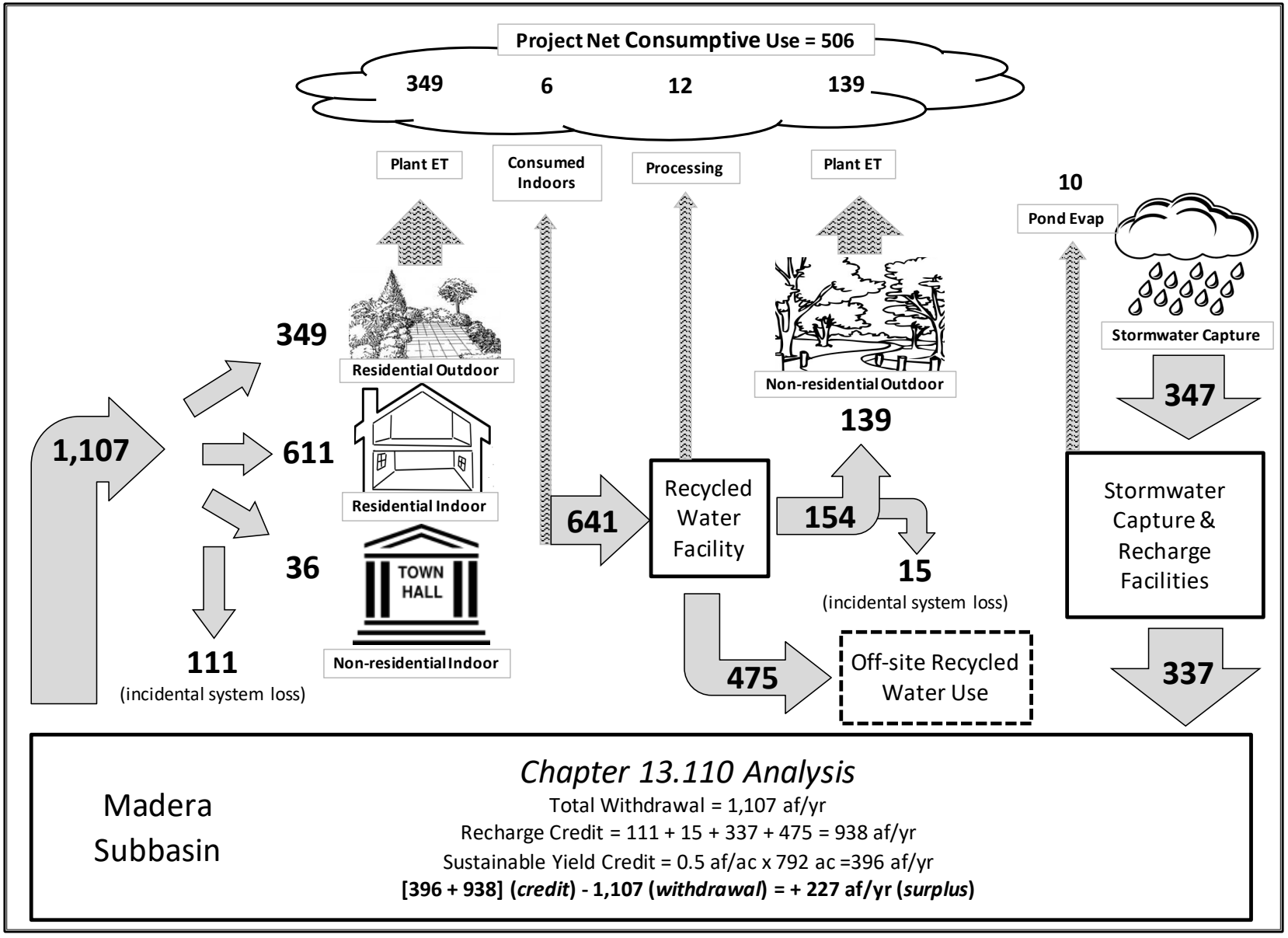
e) 6 af/yr – This is the estimated one percent of flow into residential and non-residential facilities for indoor use that is "consumed" through incidental evaporation and human consumption.[65]

f) 111 af/yr – This represents the incidental leaks in the distribution system (equal to about 10% of the extracted volume as previously discussed). Since the system is buried in the ground, leaked water will seep back down to the aquifer. If the system is more efficient, resulting in a lower value, then less water would be

[65] Data regarding this percentage is not readily available. However, this estimate would represent water that is consumed by residents and visitors – either in locally made foods or drink – and taken offsite. Using a larger percentage would just add to the estimated net consumptive use, but would not affect the gross withdrawal or the sustainability calculation.

extracted (e.g. if this value was 80 af/yr, then the extracted value would be 1,076 af/yr instead of 1,107 af/yr).

Figure 4-3: Demonstrating Compliance with Groundwater Balance Ordinance


Project Net Consumptive Use = 506
349
6
12
139
Plant ET
Consumed Indoors
Processing
Plant ET
10
Pond Evap
Stormwater Capture
349
Residential Outdoor
Non-residential Outdoor
139
347
1,107
611
Residential Indoor
641
Recycled Water Facility
154
Stormwater Capture & Recharge Facilities
36
TOWN HALL
15
(incidental system loss)
111
(incidental system loss)
Non-residential Indoor
475
Off-site Recycled Water Use
337
Madera Subbasin
Chapter 13.110 Analysis
Total Withdrawal = 1,107 af/yr
Recharge Credit = 111 + 15 + 337 + 475 = 938 af/yr
Sustainable Yield Credit = 0.5 af/ac x 792 ac =396 af/yr
[396 + 938] (credit) - 1,107 (withdrawal) = + 227 af/yr (surplus)

g) 641 af/yr – This is the combined flow from the residential and non-residential indoor uses into the sewer system and conveyed to the Recycled Water Facility. The value reflects an estimated 6 af/yr of water consumed indoors (see Item "e").

h) 12 af/yr – This value reflects the quantity of influent into the Recycled Water Facility that remains in the treated bio-solids that are hauled offsite. This value reflects two percent of the influent to the facility. Since the facility will be expected to be a closed-system package plant, there will not be open sludge ponds or other sources for excessive evaporation of the influent. The remainder of the influent will be treated to tertiary levels and used to serve the public landscape demands or directed to offsite recycled water uses.

i) 629 af/yr – This is the recycled water quantity remaining after some of the influent remains in the bio-solids and is hauled offsite (Item "g" minus Item "h"). This water will be used for non-residential irrigation and directed to off-site recycled water use.[66]

j) 475 af/yr – This is the quantity of recycled water that is directed to off-site agricultural uses to be used in-lieu of existing groundwater use. The offset groundwater use is available as a Proposed Project credit and considered part of the groundwater balance presented in this WSA.

k) 154 af/yr – This reflects the amount of water pumped into the non-potable irrigation distribution system to serve the non-residential landscape. This water is sourced from the Recycled Water Facility and reflects water that would not otherwise be directed to off-site recycled water uses. If irrigation demands are lower, then more recycled water would be directed off-site.

l) 15 af/yr – This represents the incidental leaks in the non-potable irrigation system (equal to about 10% of the volume pumped from the recycled water facility to the various irrigation sites). Since the system is buried in the ground, leaked water will seep back down to the aquifer. If the system is more efficient, resulting in a lower value, then more of the water would be sent off-site.

m) 139 af/yr – This reflects the non-residential landscape ET at build-out. The demand is small, reflecting the Proposed Project's focus on low-water use and native plants for landscaping, and strict limits on turf. All of this is expected to leave the Basin through evapotranspiration to the atmosphere as indicated in the

[66] Recycled water generated by the Proposed Project and not needed for on-site non-residential use (e.g. street medians and parks), will be provided to local irrigated agriculture for use in-lieu of existing groundwater extractions. The applicant will work with the County to identify and develop these arrangements.

Net Consumptive Use cloud. This demand is being met with water that originally served the indoor residential and non-residential needs

n) 506 af/yr – This value represents the sum of all water that leaves the Basin, with the majority lost through evaporation and evapotranspiration.

o) 347 af/yr – This value reflects the collected stormwater runoff from the entirety of the project site. As discussed previously, this water will be directed to the MAR facility for active recharge (see **Table 4-3**).

p) 10 af/yr – This is the estimated evaporation from ponded water within the MAR Facility. During the winter and spring months, when stormwater is captured and recharged, evaporation from ponded water is expected to be minimal. Evaporation is estimated by assuming the ETo rate of 55 inches annually, multiplied by an average ponded surface area of 10 acres. This equates to 10 acre-feet of water that leaves the Basin into the atmosphere.

q) 337 af/yr – This reflects the captured stormwater that will be recharged into the basin.

Total recharge to the Basin is the sum of the collected and percolated stormwater – 337 acre-feet, plus the distribution system leakage – 111 acre-feet and 15 acre-feet for the potable and recycled water systems, respectfully, plus the offsite recycled water – 475 acre-feet, for a total credit of 938 acre-feet annually.

4.2.4 Existing On-site Water Demand

Currently, nearly 800 acres of almonds and figs are growing on the property, irrigated with groundwater from multiple on-site deep wells. A conservative estimate places the existing consumptive demand of the applied irrigation water at about 1,800 acre-feet annually.[67] More water could be extracted, depending on the efficiency of the irrigation system, and some of the trees' demands are met by effective rainfall. Upon construction of the Proposed Project, this water demand will cease.

4.3 SUFFICIENCY ANALYSIS CONCLUSIONS

As detailed in this WSA, sufficient groundwater resources exist to meet the forecast demand of the Proposed Project as described in Section 1. While the Proposed Project

[67] The value is based upon a conservative estimate of 720 net acres of tree crops (almonds and figs) at an annual ET of over 48 inches, of which a very conservative estimate of 30 inches is assumed to be pumped from the groundwater to meet a portion of the ET. The rest is assumed to be met with precipitation of with deficit irrigation (affecting crop production). The actual pumped volume will be greater than the assumed 30 inches of consumptive use based upon the efficiency and management of the irrigation system. The estimated consumptive use reflects a conservative value derived from UC Davis as found at this website: http://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/Almonds/

anticipates a total annual extraction of just over 1,100 acre-feet, the net consumptive use is only about 500 acre-feet. This value represents the amount of groundwater extracted that will primarily leave the basin through evapotranspiration and evaporation.

Also, during single and multiple dry years, the Proposed Project's demands are expected to increase extraction to as much as 1,162 acre-feet as a result of increased demand for irrigation water, but also decrease to as low as 996 acre-feet when temporary shortage provisions are instituted. Even absent the Proposed Project's efforts to achieve the County's required groundwater balance, the reduced consumption compared to the existing consumption on the parcel demonstrates that there is sufficient groundwater in the Basin to meet the estimated net consumptive demand of about 500 acre-feet annually as considered under WSA Law. With the addition of the Proposed Project's efforts to achieve the County's required groundwater balance, the conclusion of sufficiency is further bolstered. The conclusion that sufficient water is available to meet the Project water demands rests on the following:

- The Proposed Project is constructed following the water-efficiency design and low-water use objectives articulated in the Castellina Specific Plan.
- Actual groundwater conditions match the representations by DWR and the County (see Section 3), including the freshwater base existing about 1,500 feet below the project site, with freshwater occurring at about 300 feet below the project site. This offers over 1,200 feet of usable aquifer depth.
- Managed aquifer recharge facilities, including deep dry wells, are successfully constructed and operations implemented to capture stormwater from the entire development, recharging the stormwater as appropriate.
- The wastewater treatment and recycling facility will direct all effluent to meet non-residential irrigation demands or to offset groundwater use at existing off-site irrigated agriculture – depending on the Proposed Project's non-residential irrigation demands that will vary throughout the year.
- The County and authorized GSAs will meet the long-term sustainability objectives articulated under SGMA such that current groundwater levels in the Basin are maintained or improved.[68]

[68] California Water Code Section 10727.2(b)(4) establishes that groundwater conditions as of January 1, 2015 become the baseline from which "undesirable results" will be assessed and objectives for improved sustainability will be measured. This essentially sets conditions as of January 2015 as being the point from which improvements will be made (although groundwater levels may fluctuate periodically below this baseline as may be determined in a GSP, but should not measurably continue downward from this point).

- The County's defined Sustainable Yield value is consistent with this WSA's assumed value of 0.5 acre-feet per acre per year, as derived from recent GSA presentations and anticipated to be documented in the forthcoming GSP (expected during summer of 2019. And, given the positive groundwater balance calculation presented previously, the Proposed Project should still meet the groundwater balance provisions.

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