# APPENDIX E

## Avila Ranch Drainage Report

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# Draft Drainage Report

# Avila Ranch
# Tentative Tract Map

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# 1. Introduction and Background

## 1.1. Introduction

Avila Ranch, LLC is proposing a new mixed-use development in the City of San Luis Obispo called Avila Ranch. A drainage study was conducted in September 2015 for the Tentative Tract Map application for the proposed project. The intent of that study was to establish the major drainage components that will be included with the proposed project, and to determine their effects on the horizontal and vertical layout of lots, roads, grading, and utilities at final buildout. This subsequent report includes that analysis and further analyzes the needed phasing of the improvements, and the extent to which the project must rely on offsite flood control improvements being implemented as part of the Chevron Remediation project.

## 1.2. Project Location and Site Description

The proposed project is located in the City of San Luis Obispo in San Luis Obispo County. The project site is located along the north side of Buckley Road, extending from Vachell Lane to approximately 4,000 feet to the east, and approximately 2,000 feet to the north. The site consists of approximately 150 acres of agricultural land. There are no existing structures on the property except for a small, dilapidated corral located along Buckley Road. The property is bisected by Tank Farm Creek, which is a seasonal creek that is a tributary to the East Fork of San Luis Obispo Creek.

## 1.3. Project Description

The project consists of the construction of a new mixed-use development, including single family residences, multi-family residences, commercial developments, and parks. There are several public streets included with the proposed development.

# 2. Stormwater Regulations and Design Criteria

There are several governing bodies that have regulations and design criteria pertaining to stormwater management for new development. This project is within the jurisdictions of the following agencies:

- City of San Luis Obispo
- Central Coast Regional Water Quality Control Board (RWQCB)
- California Department of Fish and Wildlife (CDFW)
- Federal Emergency Management Agency (FEMA)
- US Army Corps of Engineers (USACE)

## 2.1. City of San Luis Obispo

The City of San Luis Obispo has several regulations and standards that pertain to stormwater management, including:

- Municipal Code
- Waterway Management Plan (which includes the Drainage Design Manual)
- Standard Specifications and Engineering Standards

### 2.1.1. Municipal Code

There following sections of the Municipal Code pertain to stormwater management.

*Creek Setbacks (Municipal Code 17.16.025)*
The City's Creek Setback requirement applies to all creeks that are shown on Figure 9 of the Conservation and Open Space Element in the General Plan. Tank Farm Creek is shown on that figure as an "intermittent creek with degraded corridor but able to be restored or repaired." Per the code, a 20-foot setback is required for Tank Farm Creek "from the existing top of bank (or the future top of bank resulting from a creek alteration reflected in a plan approved by the city), or from the edge of the predominant pattern of riparian vegetation, whichever is farther from the creek flow line".

*Floodplain Management Regulations (Municipal Code 17.84)*
The City's Floodplain Management Regulations apply to areas of special flood hazard as identified by FEMA, which are areas that FEMA has identified as subject to inundation by the 1% annual chance flood (100-year flood). The FEMA Flood Insurance Rate Map Number 06079C1331G (Appendix A) shows a large portion of the site along the Tank Farm Creek corridor within the Zone A (areas where no base flood elevation has been determined) of the 1% annual chance floodplain boundary (100-year floodplain). Per the code, the following pertain to the proposed project:

- The proposed development is within a special floodplain management zone as defined by the City of San Luis Obispo (see requirements from Waterway Management Plan below), so the requirements in the Drainage Design Manual for those zones must be met
- Base flood elevations for the project site must be determined
- A approved Letter of Map Revision (LOMR) is required prior to issuance of building permits
- All proposed nonresidential structures require certification from a registered civil engineer or architect that they are floodproofed in accordance with Section 17.84.050(A)(3) of the Municipal Code
- All proposed residential structures require post-construction certification from a registered civil engineer or licensed land surveyor that their lowest floors are one foot above the base flood elevation
- Public utilities and facilities such as sewer, gas, electrical and water systems are to be located and constructed to minimize flood damage

### 2.1.2. Waterway Management Plan (which includes the Drainage Design Manual)

The Waterway Management Plan (WMP) is a watershed-based management plan for San Luis Obispo Creek and its tributaries. The Drainage Design Manual (DDM) is Volume 3 of the WMP, and provides design guidance and criteria intended to meet surface water management objectives. The following are some of the sections that pertain to the proposed project:

*Off-Site Facility Analysis, Design, and Mitigation (DDM 3.3)*
Runoff shall be managed to prevent any significant increase in downstream peak flows, including 2-year, 10-year, 50-year, and 100-year events. Significant generally means an increase of over 5 percent at and immediately downstream of the project site.

*Special Floodplain Management Zone Regulations (DDM 3.5.3)*
The project site is located in Special Floodplain Management Zone #2, as identified by Figure DDM 3-1 (Appendix A) in the DDM. These areas have been determined to have a potentially significant effect on downstream flooding and bank stability, and therefore development of these areas is restricted in the following ways:

- The project shall not cause the 100-year flood elevation to increase more than 2.5 inches
- The project shall not cause stream velocities to increase more than 0.3 ft/s
- The project shall not cause a significant net decrease in floodplain storage volume unless several exceptions are met.

*Erosion Control and Stormwater Quality Requirements (DDM 3.7)*
The proposed project is over 2.5 hectares in size, so a detailed erosion control plan is required and shall be prepared in accordance with Section 10.0 of the DDM.

*Channel Design Flow Requirements (DDM 5.2)*
The Tank Farm Creek watershed includes approximately 1,200 acres (4.883 $km^2$), per the City of San Luis Obispo HEC-HMS model. Per Section 5.2 of the DDM, this classifies the channel as a secondary waterway, and the new section of this creek shall be designed for a minimum storm recurrence interval of 25 years with 1 foot of freeboard.

*Open Channel Design Criteria for Major and Secondary Waterways (DDM 5.3)*
The new section of Tank Farm Creek shall be designed using a Constructed Natural Channel design. This design typically includes a two-stage, or compound, channel with a separate low-flow channel within the overall flood channel. The design shall include provisions for emulating natural channel cross-section, as well as natural channel planform shape and bedform or channel bottom features, such as pools and riffles. Additional design criteria are contained within Section 5.3 of the DDM.

*Analysis and Design of Bank Stabilization Structures (DDM 6.0)*
The new section of Tank Farm Creek shall be designed in accordance with Section 6.0 of the DDM to provide for bank stability and to minimize impacts to aquatic and riparian habitat.

*Channel and Conduit Capacity (DDM 7.2.1) and Hydraulic Gradient (7.2.10)*
This section requires that conveyance systems shall be designed to convey the peak runoff for the 10-year design storm with the hydraulic gradient a minimum of 6 inches below the elevation of the inlet grates and manhole covers. In addition, an overland conveyance shall be provided for the 100-year event such that the water surface elevation is at least 1 foot below the finish floor of adjacent structures.

*Inlets and Catch Basins (DDM 7.2.7)*
Inlets shall be spaced so that gutter flow does not exceed a depth of 6 inches at the face of the curb for a 10-year storm and so that a 100-year storm will not cause any damage and can be contained within the right of way.

*Outfalls/Open Channel & Pipe Systems (DDM 7.4.5)*
Outfalls shall be above the mean low water (2-year flow) level unless the City approves an exception.

*Erosion Control and Stormwater Quality Requirements (DDM 3.7)*
The proposed project is over 2.5 hectares in size, so a detailed erosion control plan is required and shall be prepared in accordance with Section 10.0 of the DDM.

## 2.2. Central Coast Regional Water Quality Control Board (RWQCB)

The RWQCB is responsible for administering and enforcing the National Pollutant Discharge Elimination System (NPDES) permit program, as authorized by the federal Clean Water Act. This program regulates the quality of stormwater that is discharged to surface water bodies. There are two separate permits that this project is required to obtain coverage under, one that applies to stormwater discharges during construction, and one that applies to stormwater discharges after construction is complete.

*During Construction – Construction General Permit*
Construction projects that disturb one or more acres of soil during construction are required to obtain coverage under the Construction General Permit. This permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must list Best Management Practices (BMPs) the discharger will use to protect stormwater runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program and a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs. Section A of the Construction General Permit describes the elements that must be contained in a SWPPP.

*Post-Construction – Phase II Municipal General Permit*
The Phase II Municipal General Permit applies to stormwater discharges from small Municipal Separate Storm Sewer Systems (MS4s). To comply with the requirements of the Phase II Municipal General Permit, the RWQCB approved Post-Construction Stormwater Management Requirements for Development Projects in the Central Coast Region (Post-Construction Requirements) through adoption of Resolution R3-2013-0032. The following post-construction requirements apply to the proposed project:

- *Performance Requirement No. 1: Site Design and Runoff Reduction*
  This requirement is intended to limit the disturbance creeks and natural drainage features, minimize compaction of highly permeable soils, limit clearing and grading of native vegetation, minimize impervious surfaces, and minimizing stormwater runoff by collecting it for reuse and by infiltrating it onsite.
- *Performance Requirement No. 2: Water Quality Treatment*
  This requirement is intended to provide treatment (physical, biological, or chemical) of stormwater runoff from impervious areas to reduce pollutant loads.
- *Performance Requirement No. 3: Runoff Retention*
  The requirement is intended to promote groundwater recharge. The project site is located in Watershed Management Zone 1, so the requirement is to prevent offsite discharge from events up to the 95$^{th}$ percentile 24-hour rainfall event as determined from local rainfall data.
- *Performance Requirement No. 4: Peak Management*
  This requirement states that the post-development peak flows discharged from the site shall not exceed the pre-project peak flows for the 2-though 10-year storm events.

### 2.3. California Department of Fish and Wildlife (CDFW)

A biological study was conducted to define the limits of jurisdiction for the California Department of Fish and Wildlife (CDFW) which includes the Tank Farm Creek riparian zone. Any work that is within CDFW jurisdiction will require permitting through CDFW.

### 2.4. Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) has established flood insurance zones throughout the City of San Luis Obispo. Development within these zones must be in compliance with both the City and FEMA regulations.

The FEMA Flood Insurance Rate Map Number 06079C1331G (Appendix A) shows a large portion of the project site along the Tank Farm Creek corridor within the Zone A of the 1% annual chance floodplain boundary (100-year floodplain). Zone A includes areas where no base flood elevation has been determined, and floodplains in these areas are typically determined using approximate methodologies and not a detailed hydraulic analysis.

The Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) processes will be required to modify flood insurance zones on the Avila Ranch property and, if necessary, in the area affected by the Buckley Road extension.

### 2.5. US Army Corps of Engineers (USACE)

A biological study was conducted to define the limits of jurisdiction for the US Army Corps of Engineers (USACE), which includes the creek bed below the ordinary high water mark for Tank Farm Creek. Any work that is within USACE jurisdiction will require permitting through USACE.

## 3. Existing Drainage Conditions

### 3.1. Description of Existing Drainage Conditions

The existing project site consists of approximately 150 acres of agricultural land. The site is bisected by Tank Farm Creek, which flows from north-east to south-west through the site. The creek passes through an 84" culvert on the site where an existing dirt road crosses the creek. Tank Farm Creek exits the site under a bridge at Buckley Road and joins with the East Fork of San Luis Obispo Creek approximately 550 feet downstream of the bridge. Figure 2 shows the existing drainage conditions for the site.

North of Tank Farm Creek, the site topography generally slopes toward the south. There is an existing berm along the north side of the creek through most of the site. A low ridge parallels the creek on the south side. The area north of the ridge generally slopes toward the creek and toward an existing drainage in the north-east corner of the site that connects to Tank Farm Creek. The area south of the ridge slopes toward a drainage that runs north-east to south-west toward a culvert that crosses under Buckley Road. The effectiveness of the culvert is questionable as it appears that a berm has been constructed around the culvert outlet on the south side of Buckley Road. It appears that runoff that reaches Buckley Road flows along the north side of the road to Tank Farm Creek.

The Tank Farm Creek watershed extends north to the South Hills Open Space. It is bordered on the east by the East Fork of San Luis Obispo Creek and Acacia Creek watersheds, and on the west by the San Luis Creek watershed. The land use within the Tank Farm Creek watershed is widely varied and includes undeveloped land, residential development, commercial development, industrial development, agricultural land, and land that was part of the historic tank farm in the area. The tank farm site contains approximately 140 acres of depressions that are hydrologically isolated areas. These areas were created as part of the historical oil storage operation and do not surface drain. All of the precipitation that falls onto these areas either evapotranspirates or infiltrates (Avocet 2009).

Tank Farm Creek passes through an existing headwall structure that is located approximately 950 feet upstream of the Avila Ranch property on the tank farm site. The headwall was originally constructed as part of the oil storage operation to provide emergency containment for a catastrophic release of oil, and was constructed with two 36-inch-diameter gate valves. The channel downstream of the southern gate valve has been filled in, leaving only one of the valves operational for discharging the flows in Tank Farm Creek.

Approximately 630 acres of the Tank Farm Creek watershed is upstream of the headwall (Avocet, 2009). The headwall and functioning gate valve effectively regulate the flow in Tank Farm Creek downstream of the structure, and cause ponding upstream of the structure in a series of three ponds. The existing headwall and ponds can contain storms up to the 10-year event, but larger storms will overtop the headwall (Avocet, 2009).

It appears that a large portion of the area south of Tank Farm Road and east of South Higuera Street drains onto the Avila Ranch site. There is no public storm drain infrastructure in this area except for an inlet on the south side of Tank Farm Road that discharges into a drainage ditch that extends to the south and connects to Tank Farm Creek just upstream of the project site. It appears that this ditch conveys runoff from portions of Tank Farm Road and Suburban Road, as well as from the properties that are adjacent to it. A few of the properties along the northern project property line have detention or retention ponds, but their effectiveness is unknown.

The properties that border the west side of Avila Ranch also drain onto the site. This includes two undeveloped properties and a large office building site. The office building has stormwater detention ponds that discharge along its south property line. The runoff from this site is planned to be routed through a stormwater detention pond on the Avila Ranch site, so an attempt was made to account for the detention ponds for the stormwater discharge from that site. For the purposes of this study, that site was modeled as if it were an undeveloped site to attempt to account for the effects of the onsite stormwater detention ponds. This approach, however, is probably still an overestimate of the flows from that site for most storm events as the ponds on that site were designed to limit the post-developed peak runoff for a 50-year storm event to the pre-developed peak runoff for a 2-year storm event (Cannon 2005). Runoff from the west side of Vachell Road has also been observed flowing across the road and onto the project site near the intersection with Buckley Road.

Runoff enters the project site from the adjacent properties to the east. There is a drainage ditch that enters at the north-east corner of the site and connects to Tank Farm Creek. Runoff that enters the site south of the ridge line flows toward Buckley Road, and then along the north side of Buckley Road to Tank Farm Creek.

The FEMA Flood Insurance Rate Map Number 06079C1331G (Appendix A) shows a large portion of the project site along the Tank Farm Creek corridor within the Zone A (areas where no base flood elevation has been determined) of the 1% annual chance floodplain boundary (100-year floodplain). Figure DDM 3-2C (Appendix A) in the City of San Luis Obispo's Drainage Design Manual shows only the southwest portion of the site within the 100-year floodplain, but the hydraulic model that was used to develop that figure did not include Tank Farm Creek. Flooding has been observed in the southwest corner of the site during significant storm events.

Figure WMP 3-2a in the City of San Luis Obispo's Waterways Management Plan notes that San Luis Obispo Creek could overflow south of Prado Road and enter the Tank Farm Creek watershed during a 50-year storm event assuming certain upstream conditions, but it is not clear if this is an actual scenario under current conditions. The analyses in this study do not include any overflow from San Luis Obispo Creek into the Tank Farm Creek watershed. It is recommended that additional information regarding this be obtained from the City of San Luis Obispo.

## 3.2. Hydrologic Analysis of Existing Conditions

Hydrologic analyses were performed as part of this study to estimate the magnitudes of the runoff onto and off of the project site considering the existing condition of the watershed and site. The US Army Corps of Engineers' HEC-HMS model was used to perform the hydrologic analyses and is based on the following methodology:

- Watershed Model
  - Loss Method: SCS Curve Number (CN)
  - Hydrograph Transformation Method: SCS Unit Hydrograph lag time
  - Baseflow Method: None
- Flow Routing: None
- Precipitation Model: SCS Type 1 24-hour design storm
  - 2-year rainfall depth: 2.9 inches
  - 10-year rainfall depth: 4.7 inches
  - 25-year rainfall depth: 5.7 inches
  - 50-year rainfall depth: 6.4 inches
  - 100-year rainfall depth: 7.1 inches

### Parameter Estimation

The portion of the watershed downstream of the tank farm remediation area was divided into nine sub-basins for the existing conditions. The sub-basins were delineated using a topographic map, and using the City of San Luis Obispo's storm drain utility maps. The sub-basins developed for the existing conditions for the watershed downstream of the tank farm remediation area are shown in Figure 1.

Composite curve numbers (CN's) were calculated for each sub-basin using the CN's published in Table 2-2a of TR-55 *Urban Hydrology for Small Watersheds* (NRCS 1986), and by taking into account the hydrologic soil group and land cover. The hydrologic soil groups were based on the NRCS Soil Survey for the area, and the land cover was based on aerial photography for the area.

Times of concentration were calculated for each sub-basin using the methods presented in the San Luis Obispo Drainage Design Manual and TR-55 *Urban Hydrology for Small Watersheds* (NRCS 1986). Lag times were calculated as 60% of the times of concentration (USACE 2000). The calculated parameters for each sub-basin are shown in Table 1.

**Table 1 - Parameters for existing conditions sub-basins**

| Sub-basin | Area (ac) | CN | Lag Time (min) |
|---|---|---|---|
| A1 | 31.55 | 89 | 14 |
| A2 | 22.31 | 88 | 14 |
| A3 | 27.34 | 88 | 8 |
| A4 | 6.79 | 91 | 8 |
| B | 67.96 | 84 | 21 |
| C | 70.40 | 82 | 15 |
| D | 64.56 | 84 | 30 |
| E | 5.32 | 81 | 14 |
| F | 7.16 | 85 | 13 |

Peak Flows

Peak flows were estimated for Tank Farm Creek at the confluence with East Fork San Luis Obispo Creek for the existing conditions by adding the hydrograph for the tank farm remediation area in its existing condition (Avocet 2015) to the combined hydrograph for the area downstream of the tank farm remediation area. The resulting hydrographs are included in Appendix B and a summary of the peak flows is shown in Table 2 below.

**Table 2 - Summary of peak flows from Avila Ranch for existing conditions**

| Storm Event | Peak Flow (cfs) |
|---|---|
| | Total |
| 2-year | 215 |
| 10-year | 460 |
| 25-year | 595 |
| 50-year | 689 |
| 100-year | 874 |

## 4. Proposed Drainage Conditions

### 4.1. Description of Proposed Drainage Conditions

A large-scale remediation is planned for the former tank farm site upstream of the Avila Ranch site. This remediation effort includes the construction and enhancement of several stormwater detention ponds that are expected to provide regional management of peak flows in Tank Farm Creek. The report titled *Hydrology Study Former San Luis Obispo Tank Farm, 276 Tank Farm Road, San Luis Obispo, California* prepared by Avocet Environmental in 2009 gives a detailed analysis of the expected impacts of the planned remediation.

As described in Section 3.1, the flow in Tank Farm Creek through the project site is regulated by an existing headwall structure and associated ponds located just upstream of the project site. The existing headwall and ponds can contain storms up to the 10-year event, but larger storms are expected overtop the existing headwall (Avocet, 2009).

The remediation effort includes excavating the existing storage area upstream of the headwall to provide storage and regulated outflow for storms up to and including a 100-year event. The excavation will connect three existing detention ponds into a single pond. This pond will discharge onto the Avila Ranch site at the upstream end of the proposed realignment of Tank Farm Creek, which will require a new outlet structure from the pond and decommissioning the existing headwall structure.

It is assumed that the full remediation of the tank farm site will not be completed prior to the construction of the Avila Ranch development, so the peak flow management for the Avila Ranch development was analyzed in phases of development, including (1) Phase 1-3 with no remediation of the tank farm site, and (2) Phases 4-6 with partial remediation of the tank farm site.

For the purposes of this analysis, Phases 1-3 of construction for the proposed development are assumed to occur prior to any of the remediation at the Chevron tank farm site being completed. The tank farm site would remain in its current condition and the flows from that area would be unchanged. Development of Phases 1-3 would include the buildout of the project north of Tank Farm Creek and the peak flows from the developed area would be managed with an onsite detention basin. A portion of the upper Tank Farm Creek on the project site will be realigned to connect to a detention pond that is part of the tank farm site remediation. A new outlet structure from the pond will be required and the existing headwall structure that regulates outflow from that area will need to be decommissioned. In general, flow from adjacent properties will be collected and conveyed through the site with underground pipe. Figure 6 shows a conceptual layout of the re-aligned creek and conveyance pipe for offsite flow.

Phases 4-6 of construction for the proposed development are assumed to occur after a portion of the remediation at the Chevron tank farm site was completed. These phases of the development include the buildout of the project south of Tank Farm Creek. The increase in peak flows from these phases of the Avila Ranch site would be mitigated by the partial remediation of the tank farm site, which consists of storm drainage improvements south of Tank Farm Road, along with an onsite detention basin. The partial remediation includes the area bounded by Tank Farm Road to the north, the Chevron property line to the west and south, and berms to the east (see Figure 2 from the attached Technical Memorandum from Avocet for remediation area considered).

Drainage for the proposed development is described in the following sections.

*Northwest Portion of Site (Phases 1-3)*

Phases 1-3 of the project includes the portion of the site on the northwest side of Tank Farm Creek, and consists mostly of medium-density single-family residences (approx. 4,000 sf lots) with some high-density multi-family residences. Runoff from these areas will be directed to onsite vegetated treatment facilities to meet treatment and retention requirements. For storms larger than the required onsite retention design storm, the vegetated facilities will overflow into standpipes that connect to a network of stormdrain conveyance pipes in the streets that discharge to Tank Farm Creek at various locations.

Runoff from the public sidewalks and streets is proposed to be conveyed by surface flow in the gutters and streets to vegetated treatment facilities located in the small onsite parks and along the creek bank. These facilities will overflow into standpipes that connect to the stormdrain pipe networks that discharge to the creek or a detention pond. There is currently one detention pond planned for the site. This pond will be located at the southwest corner of the site and detain the runoff from the single-family residences and streets located in that portion of the site.

Offsite runoff that enters the site from the north and west is proposed to be collected and conveyed through the project site with underground pipe.

*Southeast Portion of Site (Phases 4-6)*

Phases 4-6 of the project includes the portion of the site on the southeast side of Tank Farm Creek, and includes low-density single-family residences (approx. 5,000 sf lots), medium-density multi-family residences, commercial development, and parks. Runoff from all of the imperious surfaces, including the public sidewalks and streets, is planned to be directed to vegetated treatment facilities located at the backs of the sidewalks to meet treatment and retention requirements. For storms larger than the required onsite retention design storm, the vegetated facilities will overflow into standpipes that connect to a network of stormdrain conveyance pipes in the streets that discharge to Tank Farm Creek at various locations.

## 4.2. Hydrologic Analysis of Proposed Conditions – Phases 1-3

Phases 1-3 of construction for the proposed development includes the buildout of the project north of Tank Farm Creek would occur prior to any of the remediation at the tank farm site being completed. The tank farm site would remain in its current condition and the flows from that area would be unchanged.

A detention basin is planned at the southwest corner of the site to manage peak flows for the area, and is labeled as “Phase 1 Detention Basin” on Figure 4. This basin is designed to detain the runoff from Sub-basin Phase 1A, and runoff from Sub-basins Phase 1B, Phase 2, and Phase 3 will discharge directly to Tank Farm Creek un-detained.

Hydrologic analyses were performed as part of this study to estimate the magnitudes of the runoff from Phase 1 of the project site considering the proposed condition. The US Army Corps of Engineers’ HEC-HMS model was used to perform the hydrologic analyses and is based on the methodology described in Section 3.2. A description of the hydrologic analysis performed for this scenario is presented below.

### Parameter Estimation

The portion of the watershed downstream of the tank farm remediation area was divided into 14 sub-basins for the proposed conditions. The sub-basins were based on the sub-

basins for the existing conditions, but Sub-basin C was further divided to account for the proposed construction of the Avila Ranch project. The sub-basins developed for the proposed conditions for the watershed downstream of the tank farm remediation area are shown in Figure 4.

Composite curve numbers and lag times were calculated for each sub-basin using the same methods as for the existing conditions. The calculated parameters for each sub-basin are shown in Table 3.

**Table 3 - Parameters for proposed conditions (no remediation) sub-basins**

| Sub-basin | Area (ac) | CN | Lag Time (min) |
|---|---|---|---|
| Phase 1A | 24.16 | 91 | 6 |
| Phase 1B | 2.08 | 98 | 3 |
| Phase 2 | 4.34 | 94 | 6 |
| Phase 3 | 17.45 | 93 | 6 |
| A1 | 31.55 | 89 | 14 |
| A2 | 22.31 | 88 | 14 |
| A3 | 27.34 | 88 | 8 |
| A4 | 6.79 | 91 | 8 |
| B | 66.91 | 84 | 21 |
| C1 | 9.49 | 83 | 12 |
| C2 | 13.81 | 82 | 16 |
| D | 64.56 | 84 | 30 |
| E | 5.32 | 81 | 14 |
| F | 7.16 | 85 | 13 |

Detention Basin

The Phase 1 detention basin was modeled assuming it was initially empty, and that the tailwater at the outlet structure was constant and based on the peak flow in Tank Farm Creek for the given storm event. This assumption requires that the basin outlet include a flap gate to keep the creek from backwatering the basin. The basin volume used is summarized in Table 4 and the assumed tailwater elevations used the analyses are shown in Table 5 and are based on the HEC-RAS hydraulic model developed for the analysis of Tank Farm Creek.

**Table 4 – Phase 1 detention basin volume**

| Elevation (ft) | Area (ac) | Cumulative Volume |
|---|---|---|
| 97.00 | 0.8145 | 0 |
| 105.00 | 1.6740 | 433,592 |

**Table 5 - Assumed tailwater elevation at basin outlet (HEC-RAS model station 8+00)**

| Strom Event | Flow (cfs) | Tailwater Elevation |
|---|---|---|
| 2-year | 202 | 98.4 |
| 10-year | 421 | 100.7 |
| 25-year | 539 | 101.3 |
| 50-year | 621 | 101.9 |
| 100-year | 794 | 102.8 |

The basin outlet structure was modeled with two orifices. The parameters for the outlet structure are shown in Table 6.

**Table 6 - Outlet structure parameters**

| Description | Invert Elevation (ft) | Diameter (in) |
|---|---|---|
| Orifice #1 | 97.00 | 10 |
| Orifice #2 | 100.25 | 30 |

The basin was also modeled with an overflow spillway. The spillway crest elevation used was 104.00'; the spillway length was 105.00', and the weir coefficient was 3.20.

Peak Flows

Peak flows were estimated for Tank Farm Creek at the confluence with East Fork San Luis Obispo Creek for the proposed conditions by adding the hydrograph for the tank farm remediation area (Avocet 2015) to the combined hydrograph for the area downstream of the tank farm remediation area. The resulting peak flows are summarized in Table 7. Based on this analysis, the peak flows in Tank Farm Creek after the construction of the area north of Tank Farm Creek (Phases 1-3) will be reduced from the existing condition for the design storms.

**Table 7 - Summary of peak flows for Tank Farm Creek for proposed conditions Phases 1-3 (no remediation)**

| Storm Event | Peak Flow (cfs) | | % Change | Max. Ponding Depth in Phase 1 Det. Basin (ft) |
|---|---|---|---|---|
| | Existing Condition | Proposed Condition | | |
| 2-year | 215 | 202 | -6.0% | 99.2 |
| 10-year | 460 | 421 | -8.6% | 101.5 |
| 25-year | 595 | 539 | -9.4% | 101.7 |
| 50-year | 689 | 621 | -9.8% | 102.3 |
| 100-year | 874 | 796 | -8.9% | 103.2 |

4.3. Hydrologic Analysis of Proposed Conditions – All Phases

The full buildout of the project includes a total of 6 phases. Phases 1-3 are described in the previous section, and Phases 4-6 of construction for the proposed development would occur after a portion of the remediation at the Chevron tank farm site was completed. These phases of the development include the buildout of the project south of Tank Farm Creek. The increase in peak flows from these phases of the Avila Ranch site would be mitigated by the partial remediation of the tank farm site, along with an onsite detention basin. The partial remediation includes the area bounded by Tank Farm Road to the north, the Chevron property line to the west and south, and berms to the east (see Figure 2 from the attached Technical Memorandum from Avocet for remediation area considered).

Sub-basin Phase 6A, which is a future park, will function as a detention basin for this area. There is no tributary area to this basin other than the basin itself, so it will only detain rainfall that falls directly on it.

A description of the hydrologic analysis performed for this scenario is presented below.

Parameter Estimation

The portion of the watershed downstream of the tank farm remediation area was divided into19 sub-basins for the proposed conditions. The sub-basins were based on the sub-basins for the existing conditions, but Sub-basins B, C, and D were further divided to account for the proposed construction of the entire onsite Avila Ranch project. The sub-basins developed for the proposed conditions for the watershed downstream of the tank farm remediation area are shown in Figure 5.

Composite curve numbers and lag times were calculated for each sub-basin using the same methods as for the existing conditions. The calculated parameters for each sub-basin are shown in Table 8.

**Table 8 - Parameters for proposed conditions (partial remediation) sub-basins**

| Sub-basin | Area (ac) | CN | Lag Time (min) |
|---|---|---|---|
| Phase 1A | 24.16 | 91 | 6 |
| Phase 1B | 2.08 | 98 | 3 |
| Phase 2 | 4.34 | 94 | 6 |
| Phase 3 | 17.45 | 93 | 6 |
| Phase 4 | 11.90 | 95 | 6 |
| Phase 5 | 23.23 | 93 | 6 |
| Phase 6A | 7.90 | 80 | 18 |
| Phase 6B | 7.65 | 79 | 24 |
| A1 | 31.55 | 89 | 14 |
| A2 | 22.31 | 88 | 14 |
| A3 | 27.34 | 88 | 8 |
| A4 | 6.79 | 91 | 8 |
| B1 | 28.74 | 85 | 15 |
| B2 | 10.79 | 82 | 15 |
| C1 | 9.49 | 83 | 12 |
| C2 | 13.81 | 82 | 16 |
| D | 41.25 | 83 | 30 |
| E | 5.32 | 81 | 14 |
| F | 7.16 | 85 | 13 |

Detention Basin

The same geometry and outlet structure that was used for the Phase 1 detention basin for the “no remediation” analysis was used for this analysis. The basin was modeled assuming it was initially empty, and that the tailwater at the outlet structure was constant and based on the peak flow in Tank Farm Creek for the given storm event. This assumption requires that the basin outlet include a flap gate to keep the creek from backwatering the basin. The assumed tailwater elevations used in the analyses were based on the HEC-RAS model for Tank Farm Creek are shown in Table 9.

**Table 9 - Assumed tailwater elevation at basin outlet (HEC-RAS model station 8+00)**

| Strom Event | Flow (cfs) | Tailwater Elevation (ft) |
|---|---|---|
| 2-year | 219 | 98.5 |
| 10-year | 449 | 100.8 |
| 25-year | 581 | 101.7 |
| 50-year | 674 | 102.1 |
| 100-year | 766 | 102.6 |

Sub-basin Phase 6A, which is a future park, was modeled as a detention basin for this analysis. It was assumed that the park had a storage depth of 12”. The basin volume

used is summarized in Table 10. The assumed outlet structure is a 3" orifice with an invert elevation of 118.00'.

**Table 10 – Phase 6A detention basin volume**

| Elevation (ft) | Area (ac) | Cumulative Volume |
|---|---|---|
| 118.00 | 7.0214 | 0 |
| 119.00 | 7.2339 | 310,480 |

Peak Flows

Peak flows were estimated for Tank Farm Creek at the confluence with East Fork San Luis Obispo Creek for the proposed conditions by adding the hydrograph for the upstream portion of the watershed (tank farm remediation area) to the combined hydrograph for the area downstream of the tank farm remediation area. The resulting peak flows are summarized in Table 11. Based on this analysis, the peak flows in Tank Farm Creek after the construction of the entire onsite Avila Ranch project will not increase by more than 5% from the existing condition for the design storms.

**Table 11 - Summary of peak flows for Tank Farm Creek for proposed conditions full buildout (partial remediation)**

| Storm Event | Peak Flow (cfs) | | % Change | Max. Ponding Depth in Phase 1 Det. Basin (ft) |
|---|---|---|---|---|
| | Existing Condition | Proposed Condition | | |
| 2-year | 215 | 219 | 2.0% | 99.3 |
| 10-year | 460 | 449 | -2.4% | 101.5 |
| 25-year | 595 | 581 | -2.4% | 101.9 |
| 50-year | 689 | 674 | -2.2% | 102.4 |
| 100-year | 874 | 766 | -12.3% | 103.1 |

## 4.4. Hydrologic Analysis of Proposed Conditions – Collection and Conveyance

An additional hydrologic analysis was performed as part of this study to estimate peak flow for sizing onsite stormwater collection and conveyance facilities. The Rational Method was used for this analysis and is based on the following equation in the City of San Luis Obispo's *Drainage Design Manual* (DDM):

$$Q = C * i * C_a * A$$

where

$Q$ = Peak rate of runoff in cubic feet per second (cfs)

$C$ = Runoff coefficient (DDM Table 4-1)

$i$ = Average intensity of rainfall for the time of concentration for a selected design storm in in/hr (DDM Table 4-6)

$C_a$ = Antecedent moisture factor (DDM Table 4-2)

$A$ = Drainage area in acres

Exhibits showing the onsite sub-basins and their associated peak flow calculations area included in Appendix C.

4.5. Stormwater Treatment and Retention

Stormwater treatment and retention is proposed for runoff from the new impervious areas associated with this project. Runoff from these areas will be directed to vegetated facilities that are intended to retain and infiltrate the runoff from events up to the 95$^{th}$ percentile 24-hour rainfall event. For larger events, these vegetated facilities will overflow into standpipes that connect to stormdrain conveyance pipes that discharge to Tank Farm Creek. The exhibits and calculations associated with stormwater treatment are included in Appendix D.

4.6. Floodplain Analysis

The FEMA Flood Insurance Rate Map Number 06079C1331G (Appendix A) shows a large portion of the project site along the Tank Farm Creek corridor within the Zone A (areas where no base flood elevation has been determined) of the 1% annual chance floodplain boundary (100-year floodplain). As part of this project the FEMA floodplain will be re-delineated to account for the proposed tank farm remediation and onsite improvements. The floodplain analyses performed to date are included in Appendix E.

## References

Avocet Environmental, Inc. December 1, 2015. *Technical Memorandum Additional Hydrology Support, Avila Ranch Development, San Luis Obispo, California.* Project No. 1428.002. (Attached)

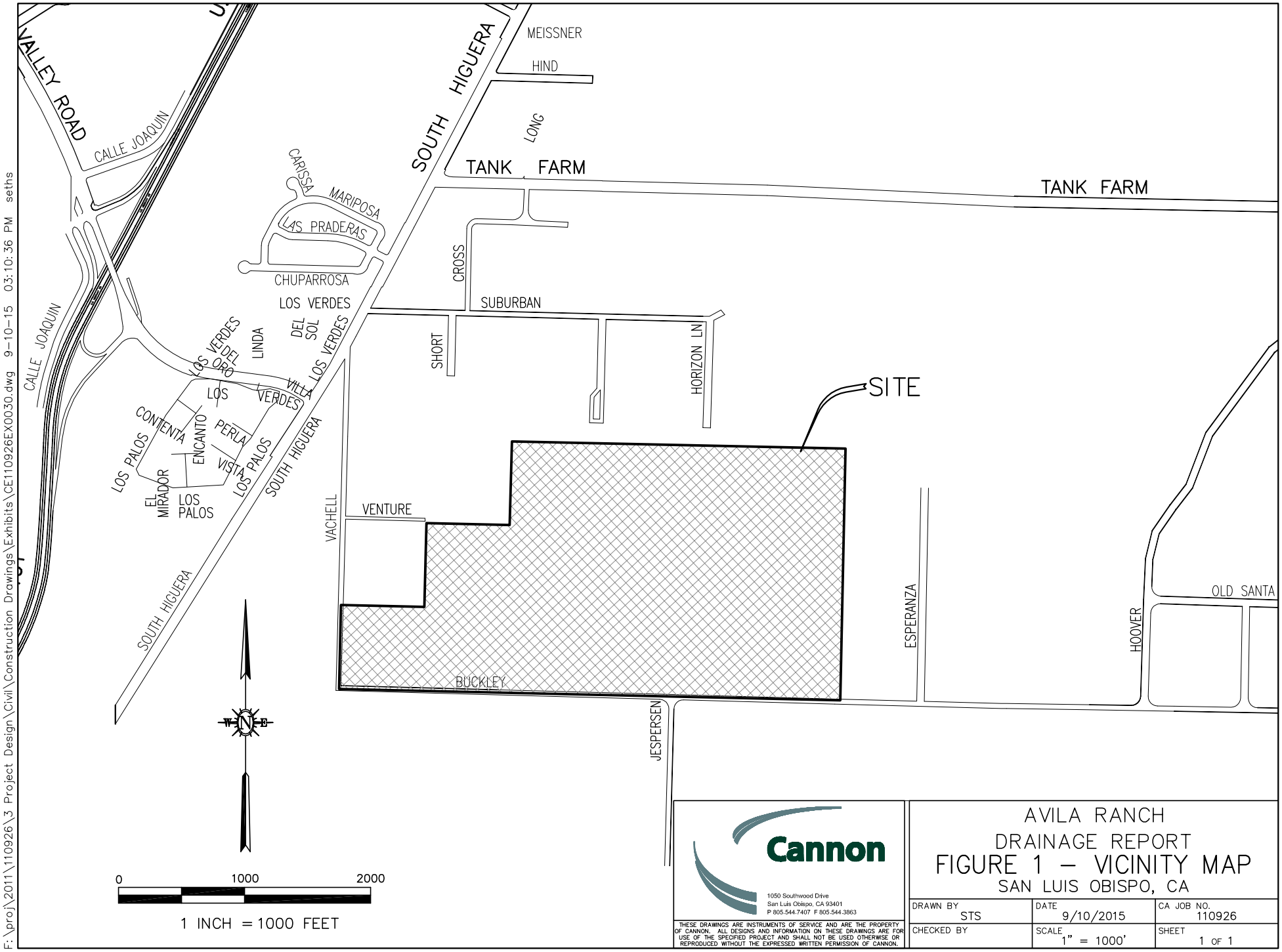
Cannon Associates. August 2005. *Dioptics Medical Products Inc. On-site Drainage Report*.

Avocet Environmental, Inc. January 26, 2009. *Hydrology Study Former San Luis Obispo Tank Farm, 276 Tank Farm Road, San Luis Obispo, California.* Project No. 1212.005

City of San Luis Obispo Department of Public Works and County of San Luis Obispo Flood Control District. February 2003. *San Luis Obispo Creek Waterway Management Plan Volume III Drainage Design Manual*.

NRCS. June 1986. *Urban Hydrology for Small Watersheds, Technical Release 55*.

US Army Corps of Engineers. March 2000. *Hydrologic Modeling System HEC-HMS Technical Reference Manual*.

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# AVILA RANCH
## DRAINAGE REPORT
## FIGURE 1 – VICINITY MAP
SAN LUIS OBISPO, CA

| | | |
|---|---|---|
| DRAWN BY: STS | DATE: 9/10/2015 | CA JOB NO.: 110926 |
| CHECKED BY: | SCALE: 1" = 1000' | SHEET: 1 OF 1 |


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0 250 500 1,000 1,500 2,000
Feet

Figure 2
**AVILA RANCH**
**EXISTING DRAINAGE CONDITIONS**
9/14/2015

SUB–BASIN A2

SUB–BASIN A3

SUB–BASIN A1

SUB–BASIN A4

SUB–BASIN C

SUB–BASIN F

SUB–BASIN B

SUB–BASIN E

SUB–BASIN D

SUB–BASIN LIMIT

0 500 1,000

1 INCH = 500 FEET

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# FIGURE 3
# DRAINAGE MAP
# EXISTING CONDITIONS
## SAN LUIS OBISPO, CA

| DRAWN BY | DATE | CA JOB NO. |
|---|---|---|
| STS | 11/23/2015 | 110926 |
| CHECKED BY | SCALE | SHEET |
| | 1" = 500' | 1 OF 1 |

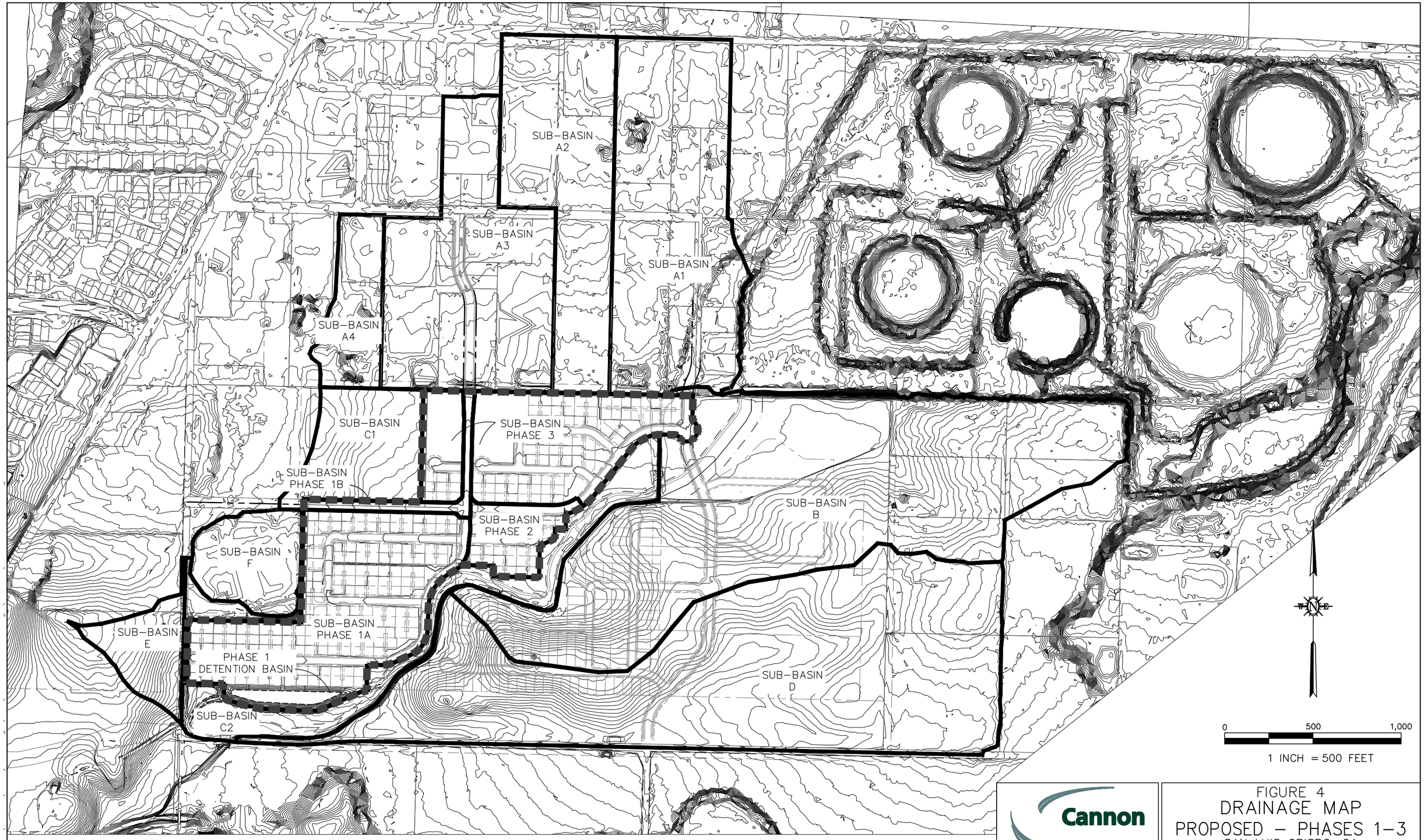


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FIGURE 4
# DRAINAGE MAP
## PROPOSED – PHASES 1–3
SAN LUIS OBISPO, CA

| DRAWN BY | DATE | CA JOB NO. |
|---|---|---|
| STS | 11/25/2015 | 110926 |
| CHECKED BY | SCALE | SHEET |
| | 1" = 500' | 1 OF 1 |

SUB–BASIN A2

SUB–BASIN A3

SUB–BASIN A1

SUB–BASIN A4

SUB–BASIN C1

SUB–BASIN PHASE 3

SUB–BASIN B2

SUB–BASIN B1

SUB–BASIN PHASE 1B

SUB–BASIN B2

SUB–BASIN PHASE 4

SUB–BASIN PHASE 2

SUB–BASIN F

SUB–BASIN PHASE 6A

SUB–BASIN E

SUB–BASIN PHASE 1A

SUB–BASIN PHASE 5

SUB–BASIN PHASE 6B

SUB–BASIN C2

SUB–BASIN D

N

0 500 1,000

1 INCH = 500 FEET

ASSUMED EXTENT OF AVILA RANCH CONSTRUCTED

SUB–BASIN LIMIT

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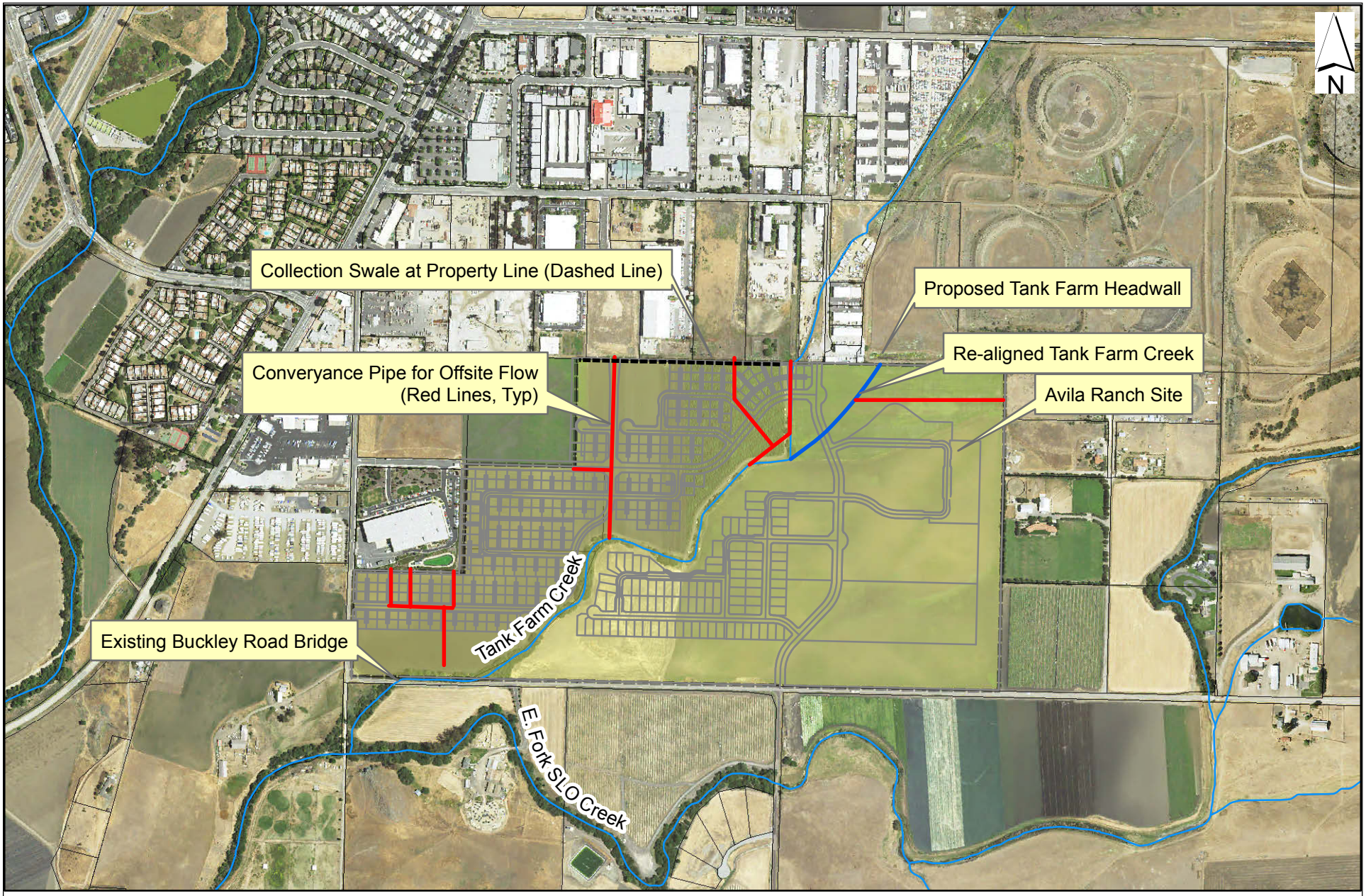
# FIGURE 5
# DRAINAGE MAP
# PROPOSED – ALL PHASES
## SAN LUIS OBISPO, CA

| DRAWN BY | DATE | CA JOB NO. |
|---|---|---|
| STS | 11/30/2015 | 110926 |
| CHECKED BY | SCALE | SHEET |
| | 1" = 500' | 1 OF 1 |



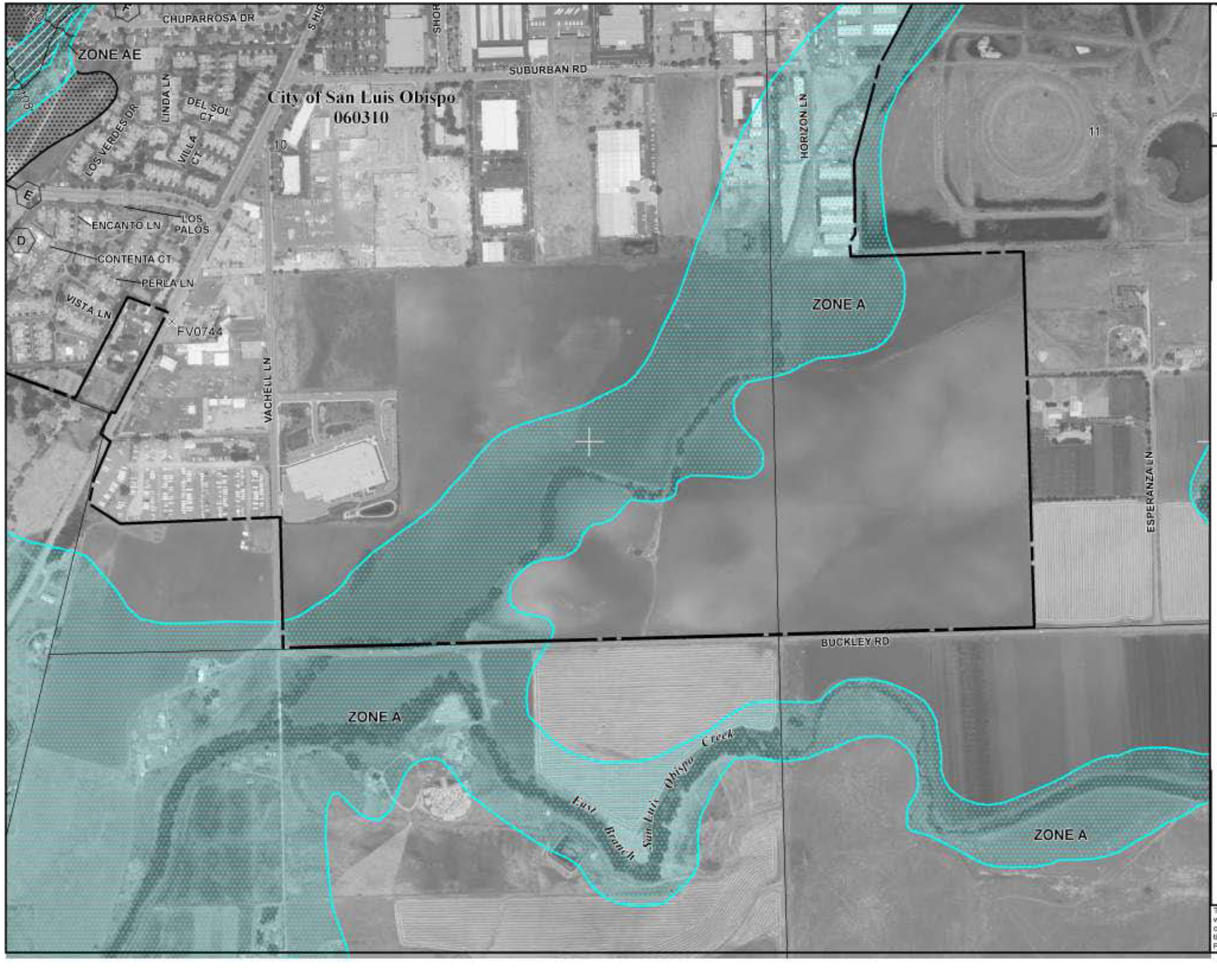

Cannon

0 250 500 1,000 1,500 2,000
Feet

Figure 6
**AVILA RANCH**
**PROPOSED DRAINAGE CONDITIONS**
9/14/2015

# Appendix A

*Site Data*




MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1331G

# FIRM

FLOOD INSURANCE RATE MAP

SAN LUIS OBISPO COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 1331 OF 2050

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

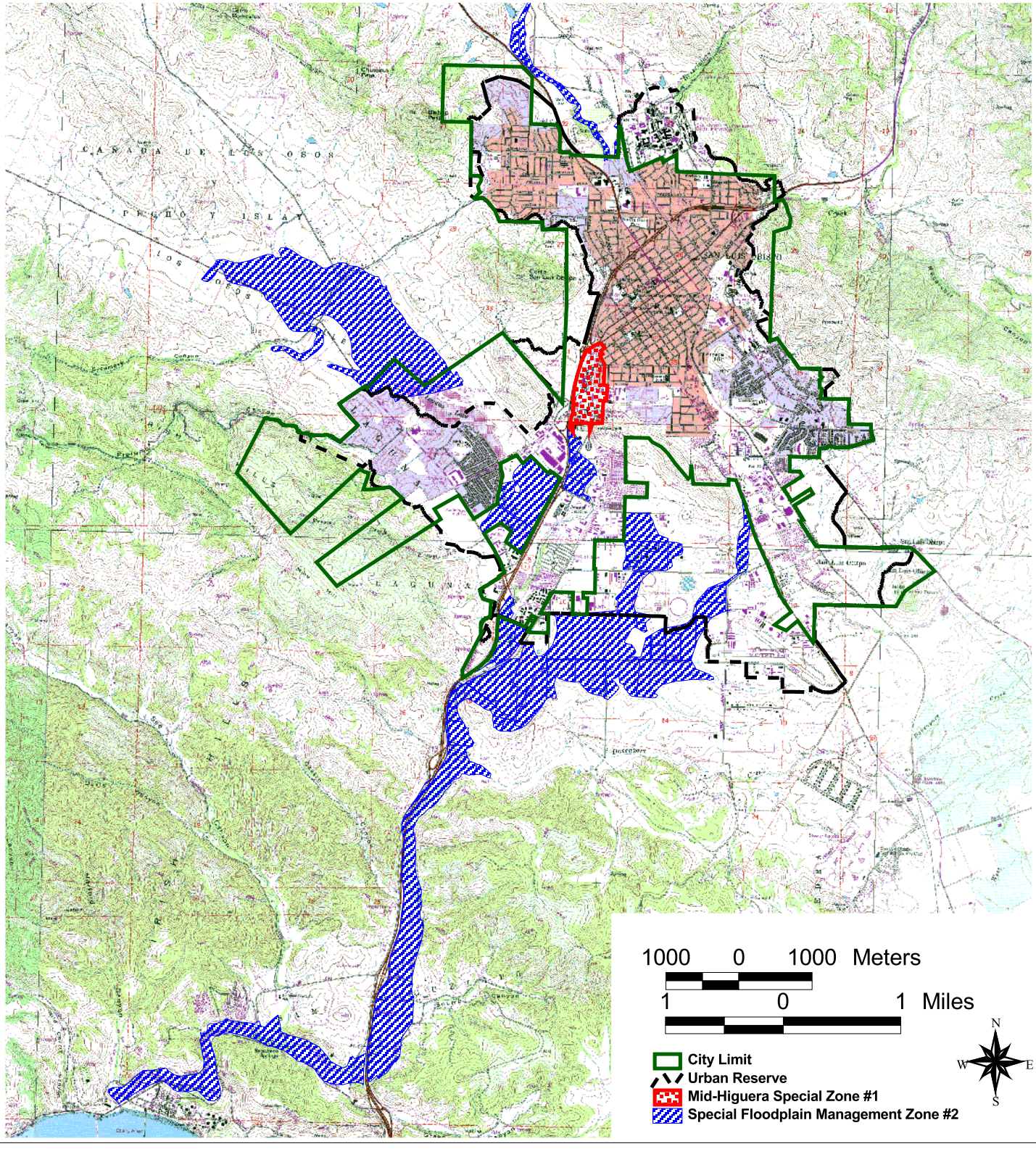
| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| SAN LUIS OBISPO COUNTY | 060304 | 1331 | G |
| SAN LUIS OBISPO, CITY OF | 060310 | 1331 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06079C1331G

MAP REVISED
NOVEMBER 16, 2012

Federal Emergency Management Agency




city of san luis obispo

PUBLIC WORKS DEPARTMENT

# Special Floodplain Management Zones

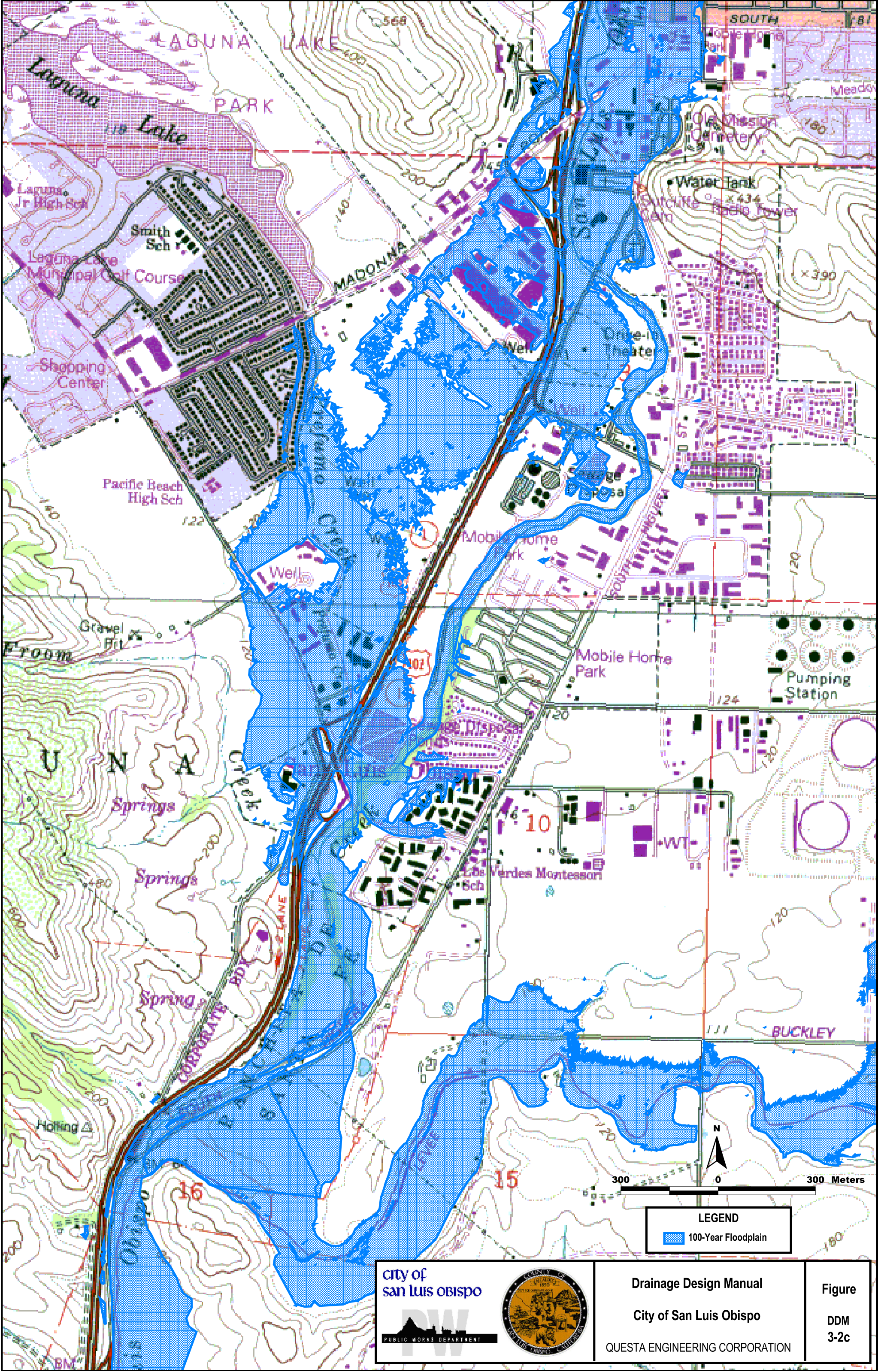
**Drainage Design Manual**
**City of San Luis Obispo**

QUESTA ENGINEERING CORPORATION

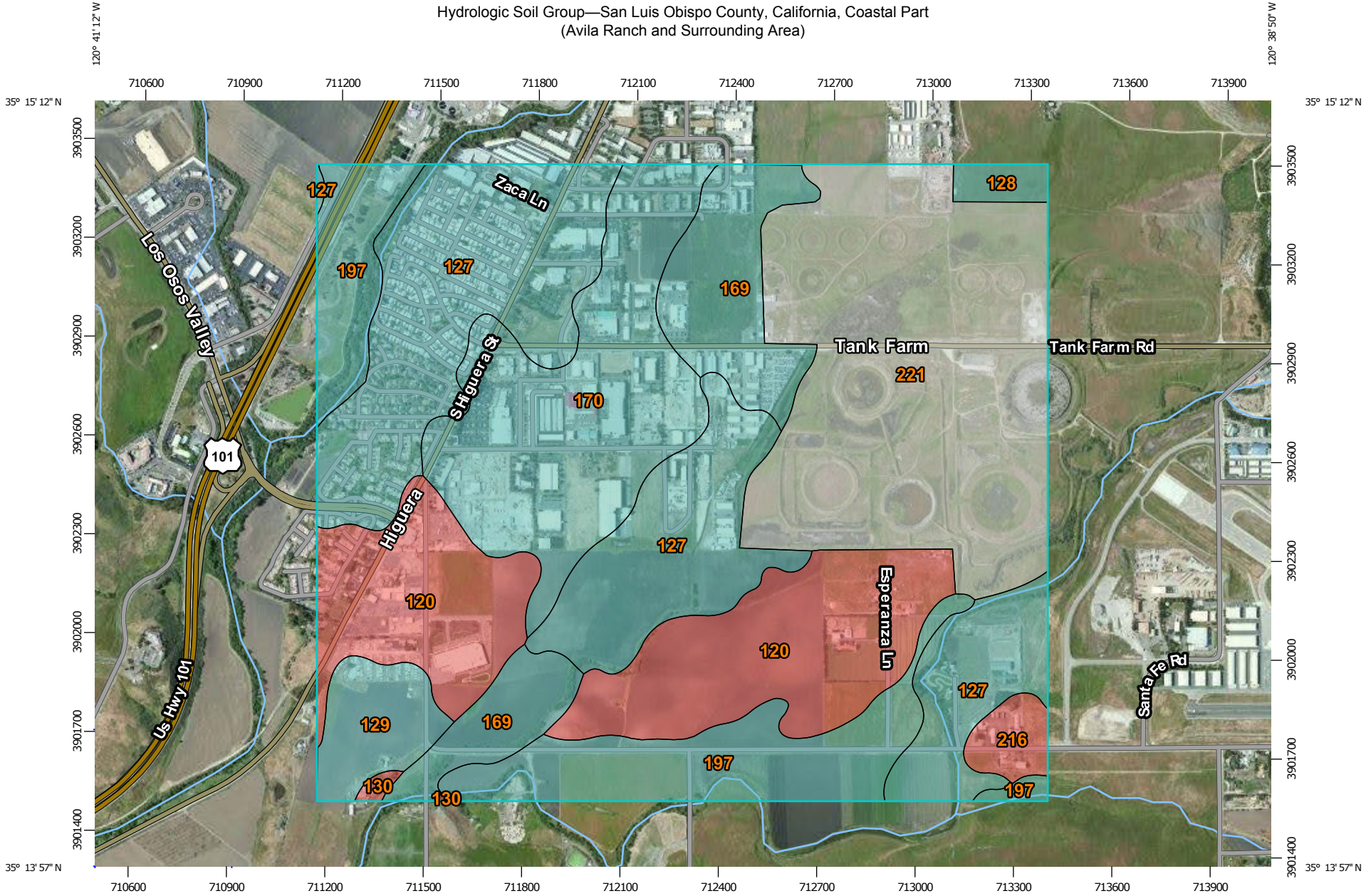
**Figure**

**DDM**
**3-1**

FILE REFERENCE: c:\arcview projects\98202 slo phase ii\98202_floodplain_management.apr
LAYOUT: 8.5x11
DATE: Nov 26, 2001 4:32 PM


LAGUNA LAKE PARK
Laguna Lake
Laguna Jr High Sch
Smith Sch
Laguna Lake Municipal Golf Course
MADONNA
Shopping Center
Pacific Beach High Sch
Well
Well
Well
Well
Well
Well
Mobile Home Park
Mobile Home Park
Water Tank
Old Mission Cemetery
Drive-In Theater
Gravel Pit
Pumping Station
Los Verdes Montessori Sch
10
15
16
BUCKLEY
CORPORATE
Springs
Springs
Springs
Holling
N
300 0 300 Meters
LEGEND
100-Year Floodplain
city of san luis obispo
PUBLIC WORKS DEPARTMENT
Drainage Design Manual
City of San Luis Obispo
QUESTA ENGINEERING CORPORATION
Figure
DDM
3-2c

Hydrologic Soil Group—San Luis Obispo County, California, Coastal Part
(Avila Ranch and Surrounding Area)



## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Luis Obispo County, California, Coastal Part
Survey Area Data: Version 6, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 8, 2010—May 21, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — San Luis Obispo County, California, Coastal Part (CA664) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| 120 | Concepcion loam, 2 to 5 percent slopes | D | 179.9 | 16.8% |
| 127 | Cropley clay, 0 to 2 percent slopes | C | 253.5 | 23.7% |
| 128 | Cropley clay, 2 to 9 percent slopes | C | 8.2 | 0.8% |
| 129 | Diablo clay, 5 to 9 percent slopes | C | 30.3 | 2.8% |
| 130 | Diablo and Cibo clays, 9 to 15 percent slopes | D | 2.1 | 0.2% |
| 169 | Marimel sandy clay loam, occasionally flooded | C | 81.8 | 7.7% |
| 170 | Marimel silty clay loam, drained | C | 143.0 | 13.4% |
| 197 | Salinas silty clay loam, 0 to 2 percent slopes | C | 113.9 | 10.7% |
| 216 | Tierra sandy loam, 2 to 9 percent slopes | D | 12.9 | 1.2% |
| 221 | Xererts-Xerolls-Urban land complex, 0 to 15 percent slopes | | 243.3 | 22.8% |
| **Totals for Area of Interest** | | | **1,068.8** | **100.0%** |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

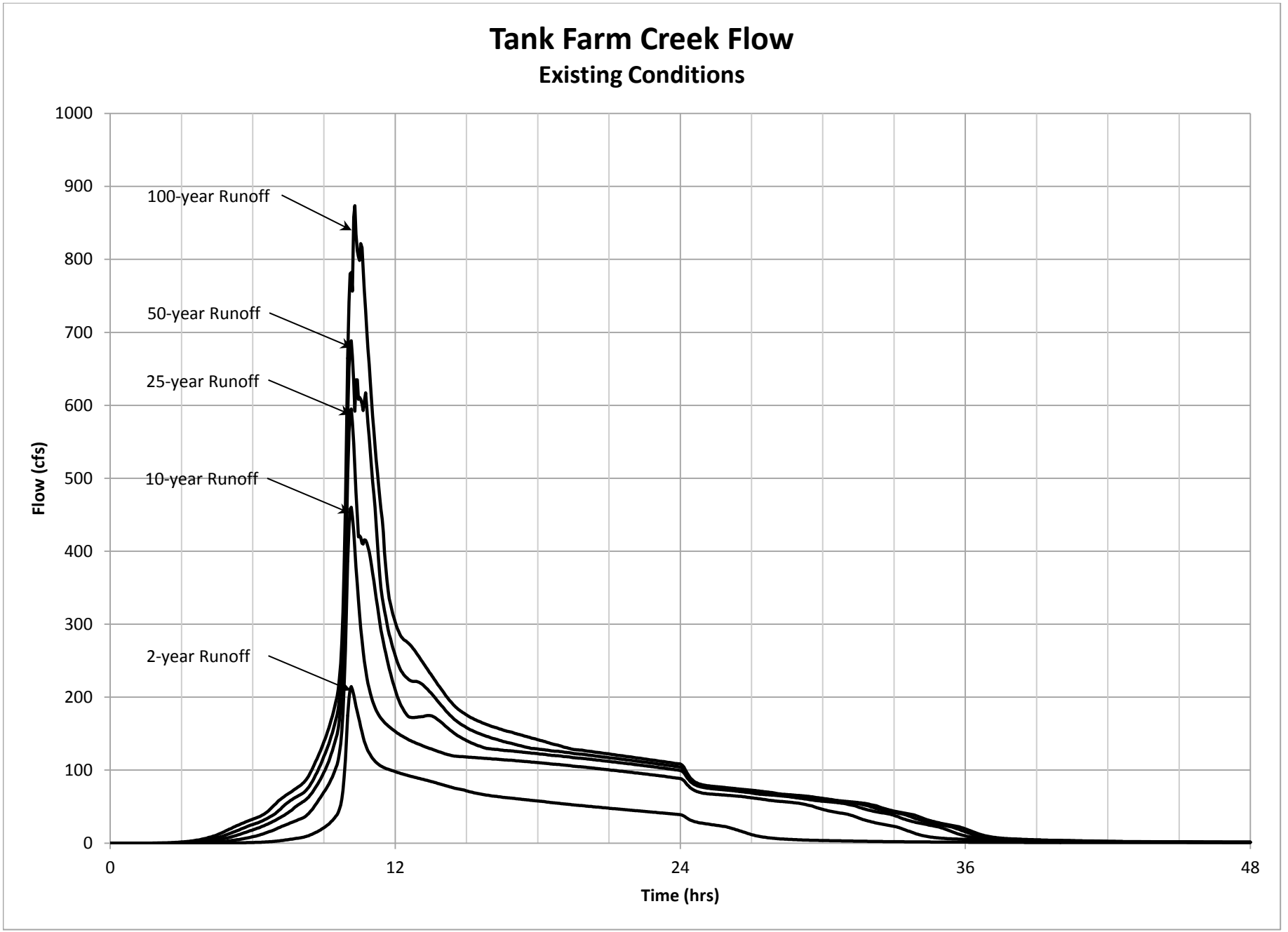
*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

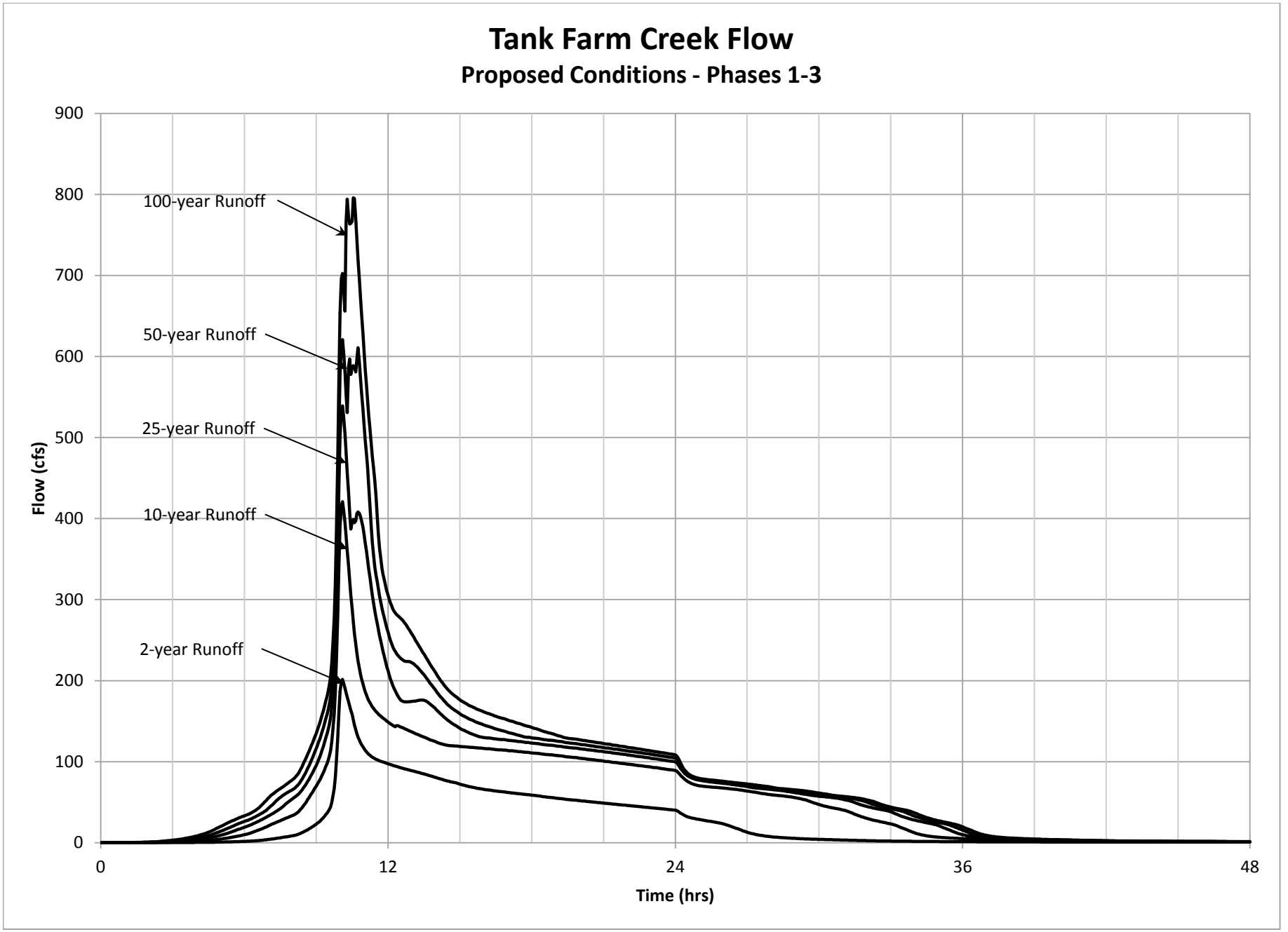
# Appendix B

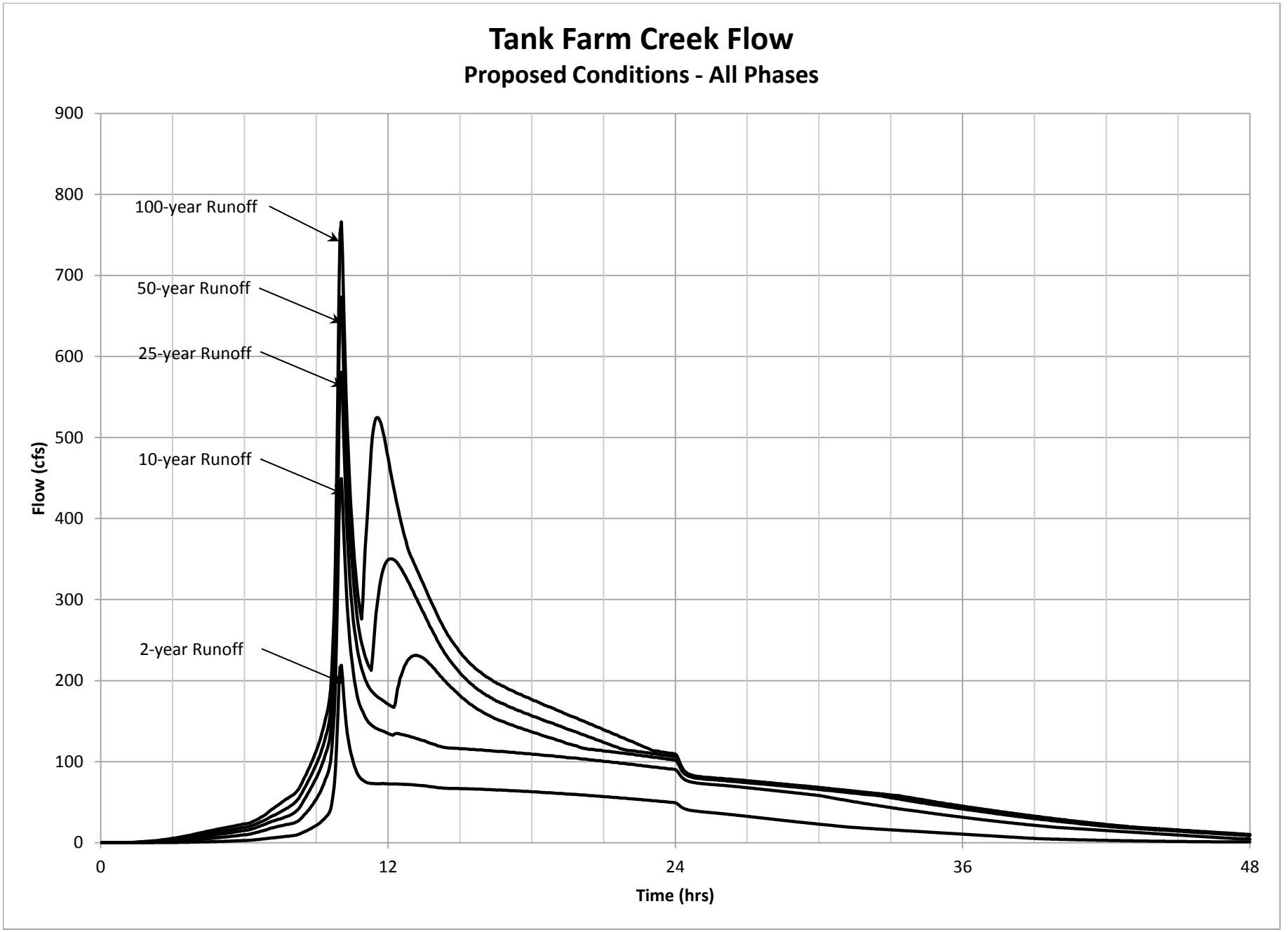
*Hydrologic Analyses of Existing Conditions*

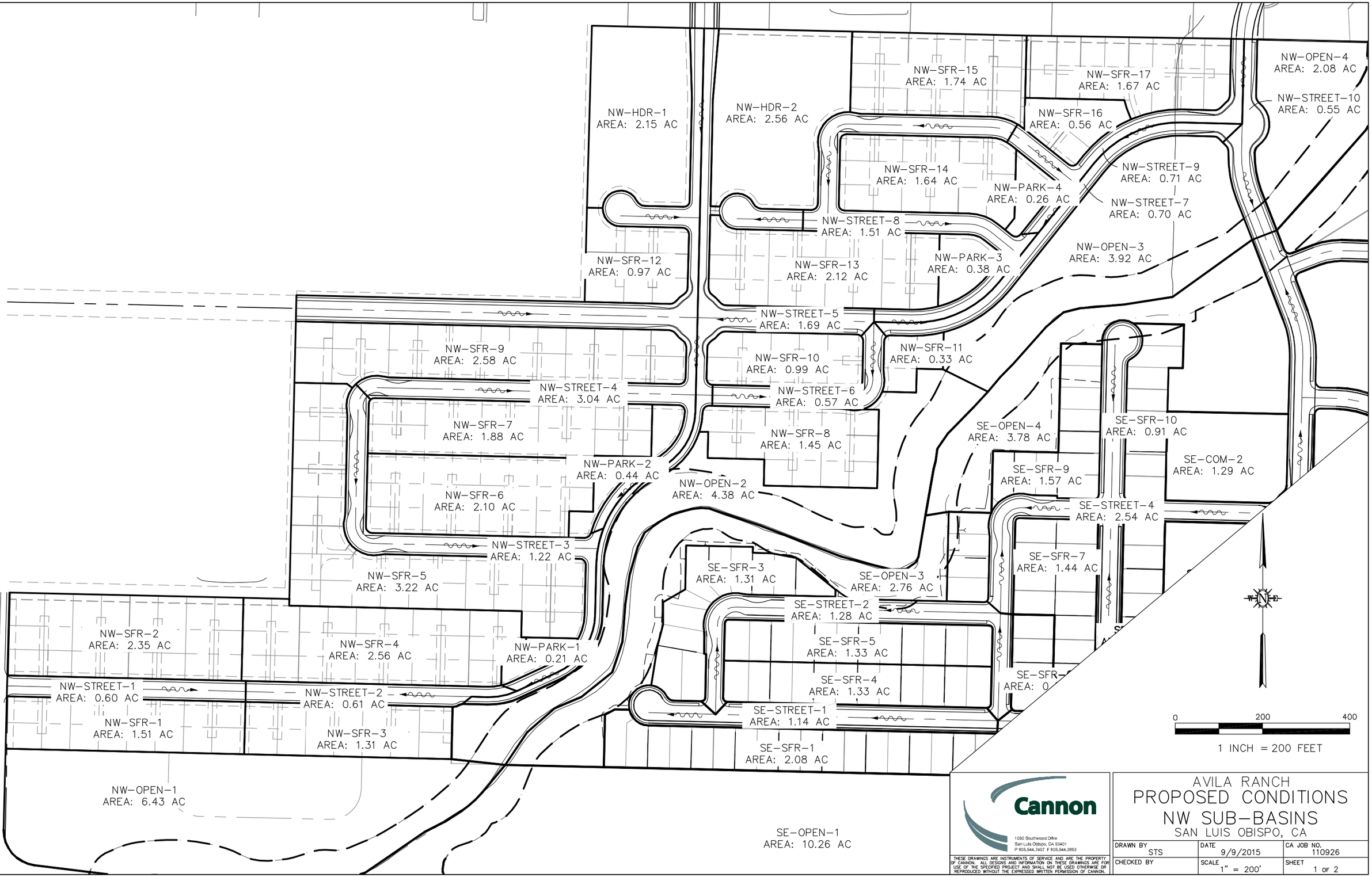

Tank Farm Creek Flow
Existing Conditions
1000
900
800
700
600
500
400
300
200
100
0
Flow (cfs)
100-year Runoff
50-year Runoff
25-year Runoff
10-year Runoff
2-year Runoff
0
12
24
36
48
Time (hrs)

# Appendix C

*Hydrologic Analyses of Proposed Conditions*


Tank Farm Creek Flow
Proposed Conditions - Phases 1-3
900
800
700
600
500
400
300
200
100
0
Flow (cfs)
100-year Runoff
50-year Runoff
25-year Runoff
10-year Runoff
2-year Runoff
0
12
24
36
48
Time (hrs)


Tank Farm Creek Flow
Proposed Conditions - All Phases
900
800
700
600
500
400
300
200
100
0
Flow (cfs)
100-year Runoff
50-year Runoff
25-year Runoff
10-year Runoff
2-year Runoff
0
12
24
36
48
Time (hrs)

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Cannon

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# AVILA RANCH
# PROPOSED CONDITIONS
# NW SUB-BASINS
SAN LUIS OBISPO, CA

| DRAWN BY | DATE | CA JOB NO. |
|---|---|---|
| STS | 9/9/2015 | 110926 |
| CHECKED BY | SCALE | SHEET |
| | 1" = 200' | 1 OF 2 |

NW-HDR-1
AREA: 2.15 AC

NW-HDR-2
AREA: 2.56 AC

NW-SFR-15
AREA: 1.74 AC

NW-SFR-17
AREA: 1.67 AC

NW-SFR-16
AREA: 0.56 AC

NW-STREET-10
AREA: 0.55 AC

SE-OPEN-5
AREA: 12.04 AC

NW-SFR-14
AREA: 1.64 AC

NW-PARK-4
AREA: 0.26 AC

NW-STREET-9
AREA: 0.71 AC

NW-STREET-7
AREA: 0.70 AC

NW-STREET-8
AREA: 1.51 AC

NW-SFR-12
AREA: 0.97 AC

NW-SFR-13
AREA: 2.12 AC

NW-PARK-3
AREA: 0.38 AC

NW-OPEN-3
AREA: 3.92 AC

SE-STREET-5
AREA: 2.88 AC

NW-STREET-5
AREA: 1.69 AC

SE-MDR-1
AREA: 5.05 AC

NW-SFR-11
AREA: 0.33 AC

NW-SFR-10
AREA: 0.99 AC

STREET-4
A: 3.04 AC

NW-STREET-6
AREA: 0.57 AC

SE-OPEN-4
AREA: 3.78 AC

SE-SFR-10
AREA: 0.91 AC

NW-SFR-8
AREA: 1.45 AC

NW-PARK-2
AREA: 0.44 AC

SE-SFR-9
AREA: 1.57 AC

SE-COM-2
AREA: 1.29 AC

NW-OPEN-2
AREA: 4.38 AC

SE-STREET-4
AREA: 2.54 AC

SE-PARK-2
AREA: 7.90 AC

3
AC

SE-SFR-7
AREA: 1.44 AC

SE-SFR-3
AREA: 1.31 AC

SE-OPEN-3
AREA: 2.76 AC

SE-COM-1
AREA: 1.39 AC

SE-STREET-2
AREA: 1.28 AC

K-1
1 AC

SE-SFR-5
AREA: 1.33 AC

SE-SFR-8
AREA: 0.97 AC

SE-PARK-1
AREA: 1.33 AC

SE-SFR-4
AREA: 1.33 AC

SE-SFR-6
AREA: 0.48 AC

SE-STREET-1
AREA: 1.14 AC

SE-STREET-3
AREA: 1.67 AC

SE-SFR-1
AREA: 2.08 AC

SE-SFR-2
AREA: 0.83 AC

SE-OPEN-2
AREA: 19.53 AC

SE-OPEN-1
AREA: 10.26 AC

0 200 400

1 INCH = 200 FEET

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San Luis Obispo, CA 93401
P 805.544.7407 F 805.544.3863



# AVILA RANCH
# PROPOSED CONDITIONS
# SE SUB-BASINS
SAN LUIS OBISPO, CA

| DRAWN BY | DATE | CA JOB NO. |
|---|---|---|
| STS | 9/9/2015 | 110926 |
| CHECKED BY | SCALE | SHEET |
| | 1" = 200' | 2 OF 2 |

F:\proj\2011\110926\3 Project Design\Civil\Construction Drawings\Exhibits\CE110926EX0029.dwg 9-10-15 08:04:29 AM seths

## Peak Flow Calculations for NW Portion of Site

Updated: 9/10/2015

***Parameters for Peak Flow Calculations***

| Recurrence Interval (years) | Antecedent Moisture Factor[1], $C_a$ | Rainfall Intensity[2], $i$ (in/hr) |
|---|---|---|
| 2 | 1.00 | 2.1 |
| 10 | 1.00 | 3.6 |
| 25 | 1.10 | 4.0 |
| 50 | 1.20 | 4.6 |
| 100 | 1.25 | 5.0 |

***Peak Flow Calculations for NW Area of Site***

| Sub-basin | Area (sf) | Area, $A$ (ac) | Runoff Coefficient[3], $C$ | Time of Conc. $T_c$ (min) | Peak Flow (cfs) ($Q=C*i*C_a*A$) | | | | | Creek Outlet |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 10-yr | 25-yr | 50-yr | 100-yr | |
| NW-SFR-1 | 65,638 | 1.51 | 0.50 | 5 | 1.57 | 2.70 | 3.33 | 4.16 | 4.71 | 1 |
| NW-SFR-2 | 102,165 | 2.35 | 0.50 | 5 | 2.45 | 4.20 | 5.18 | 6.48 | 7.33 | 1 |
| NW-SFR-3 | 57,000 | 1.31 | 0.50 | 5 | 1.37 | 2.34 | 2.89 | 3.62 | 4.09 | 1 |
| NW-SFR-4 | 111,382 | 2.56 | 0.50 | 5 | 2.67 | 4.58 | 5.65 | 7.07 | 7.99 | 1 |
| NW-SFR-5 | 140,289 | 3.22 | 0.50 | 5 | 3.36 | 5.77 | 7.11 | 8.90 | 10.06 | 1 |
| NW-SFR-6 | 91,372 | 2.10 | 0.50 | 5 | 2.19 | 3.76 | 4.63 | 5.80 | 6.56 | 1 |
| NW-SFR-7 | 81,834 | 1.88 | 0.50 | 5 | 1.96 | 3.37 | 4.15 | 5.19 | 5.87 | 2 |
| NW-SFR-8 | 63,183 | 1.45 | 0.50 | 5 | 1.51 | 2.60 | 3.20 | 4.01 | 4.53 | 3 |
| NW-SFR-9 | 112,356 | 2.58 | 0.50 | 5 | 2.69 | 4.62 | 5.70 | 7.13 | 8.06 | 2 |
| NW-SFR-10 | 43,289 | 0.99 | 0.50 | 5 | 1.04 | 1.78 | 2.19 | 2.75 | 3.11 | 3 |
| NW-SFR-11 | 14,507 | 0.33 | 0.50 | 5 | 0.35 | 0.60 | 0.74 | 0.92 | 1.04 | 3 |
| NW-SFR-12 | 42,429 | 0.97 | 0.50 | 5 | 1.02 | 1.74 | 2.15 | 2.69 | 3.04 | 2 |
| NW-SFR-13 | 92,493 | 2.12 | 0.50 | 5 | 2.22 | 3.80 | 4.69 | 5.87 | 6.64 | 4 |
| NW-SFR-14 | 71,566 | 1.64 | 0.50 | 5 | 1.71 | 2.94 | 3.63 | 4.54 | 5.13 | 4 |
| NW-SFR-15 | 75,688 | 1.74 | 0.50 | 5 | 1.81 | 3.11 | 3.84 | 4.80 | 5.43 | 4 |
| NW-SFR-16 | 24,488 | 0.56 | 0.50 | 5 | 0.59 | 1.01 | 1.24 | 1.55 | 1.76 | 5 |
| NW-SFR-17 | 72,816 | 1.67 | 0.50 | 5 | 1.74 | 2.99 | 3.69 | 4.62 | 5.22 | 5 |
| NW-STREET-1 | 26,259 | 0.60 | 0.80 | 5 | 1.01 | 1.73 | 2.13 | 2.67 | 3.01 | 1 |
| NW-STREET-2 | 26,561 | 0.61 | 0.80 | 5 | 1.02 | 1.75 | 2.15 | 2.70 | 3.05 | 1 |
| NW-STREET-3 | 53,147 | 1.22 | 0.80 | 5 | 2.04 | 3.50 | 4.31 | 5.40 | 6.10 | 1 |
| NW-STREET-4 | 132,495 | 3.04 | 0.80 | 5 | 5.08 | 8.72 | 10.75 | 13.45 | 15.21 | 1 |
| NW-STREET-5 | 73,757 | 1.69 | 0.80 | 5 | 2.83 | 4.85 | 5.98 | 7.49 | 8.47 | 2 |
| NW-STREET-6 | 24,999 | 0.57 | 0.80 | 5 | 0.96 | 1.64 | 2.03 | 2.54 | 2.87 | 3 |
| NW-STREET-7 | 30,326 | 0.70 | 0.80 | 5 | 1.16 | 2.00 | 2.46 | 3.08 | 3.48 | 4 |
| NW-STREET-8 | 65,934 | 1.51 | 0.80 | 5 | 2.53 | 4.34 | 5.35 | 6.69 | 7.57 | 4 |
| NW-STREET-9 | 31,072 | 0.71 | 0.80 | 5 | 1.19 | 2.04 | 2.52 | 3.15 | 3.57 | 4 |
| NW-STREET-10 | 23,869 | 0.55 | 0.80 | 5 | 0.91 | 1.57 | 1.94 | 2.42 | 2.74 | 5 |
| NW-PARK-1 | 9,035 | 0.21 | 0.10 | 5 | 0.04 | 0.07 | 0.09 | 0.11 | 0.13 | 1 |
| NW-PARK-2 | 18,992 | 0.44 | 0.10 | 5 | 0.09 | 0.16 | 0.19 | 0.24 | 0.27 | 1 |
| NW-PARK-3 | 16,520 | 0.38 | 0.10 | 5 | 0.08 | 0.14 | 0.17 | 0.21 | 0.24 | 4 |
| NW-PARK-4 | 11,344 | 0.26 | 0.10 | 5 | 0.05 | 0.09 | 0.12 | 0.14 | 0.16 | 4 |
| NW-HDR-1 | 93,473 | 2.15 | 0.50 | 5 | 2.24 | 3.84 | 4.74 | 5.93 | 6.71 | 2 |
| NW-HDR-2 | 111,408 | 2.56 | 0.50 | 5 | 2.67 | 4.58 | 5.65 | 7.07 | 7.99 | 2 |
| NW-OPEN-1 | 280,111 | 6.43 | 0.15 | 5 | 2.01 | 3.46 | 4.26 | 5.33 | 6.03 | 1 |
| NW-OPEN-2 | 190,952 | 4.38 | 0.15 | 5 | 1.37 | 2.36 | 2.90 | 3.63 | 4.11 | 3 |
| NW-OPEN-3 | 170,860 | 3.92 | 0.15 | 5 | 1.23 | 2.11 | 2.60 | 3.25 | 3.68 | 5 |
| NW-OPEN-4 | 90,396 | 2.08 | 0.15 | 5 | 0.65 | 1.12 | 1.38 | 1.72 | 1.95 | 11 |

***Notes***

[1]Antecedent Mositure Factors from Table 4-2 in City of SLO Drainage Design Manual

[2]Rainfall Intensities from Table 4-6 in City of SLO Drainage Design Manual, assumes Time of Concentration <=10 min.

[3]Runoff Coefficients from Table 4-1 in City of SLO Drainage Design Manual, assumes Hydrologic Soil Group of C

## Peak Flow Calculations for SE Portion of Site

Updated: 9/10/2015

***Parameters for Peak Flow Calculations***

| Recurrence Interval (years) | Antecedent Moisture Factor[1], $C_a$ | Rainfall Intensity[2], $i$ (in/hr) |
|---|---|---|
| 2 | 1.00 | 2.1 |
| 10 | 1.00 | 3.6 |
| 25 | 1.10 | 4.0 |
| 50 | 1.20 | 4.6 |
| 100 | 1.25 | 5.0 |

***Peak Flow Calculations for NW Area of Site***

| Sub-basin | Area (sf) | Area, $A$ (ac) | Runoff Coefficient[3], $C$ | Time of Conc. $T_c$ (min) | Peak Flow (cfs) ($Q=C*i*C_a*A$) | | | | | Creek Outlet |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2-yr | 10-yr | 25-yr | 50-yr | 100-yr | |
| SE-SFR-1 | 90,396 | 2.08 | 0.50 | 5 | 2.17 | 3.72 | 4.58 | 5.74 | 6.49 | 7 |
| SE-SFR-2 | 36,221 | 0.83 | 0.50 | 5 | 0.87 | 1.49 | 1.84 | 2.30 | 2.60 | 6 |
| SE-SFR-3 | 56,972 | 1.31 | 0.50 | 5 | 1.36 | 2.34 | 2.89 | 3.61 | 4.09 | 8 |
| SE-SFR-4 | 57,999 | 1.33 | 0.50 | 5 | 1.39 | 2.39 | 2.94 | 3.68 | 4.16 | 7 |
| SE-SFR-5 | 57,999 | 1.33 | 0.50 | 5 | 1.39 | 2.39 | 2.94 | 3.68 | 4.16 | 8 |
| SE-SFR-6 | 20,971 | 0.48 | 0.50 | 5 | 0.50 | 0.86 | 1.06 | 1.33 | 1.50 | 8 |
| SE-SFR-7 | 62,914 | 1.44 | 0.50 | 5 | 1.51 | 2.59 | 3.19 | 3.99 | 4.51 | 9 |
| SE-SFR-8 | 42,366 | 0.97 | 0.50 | 5 | 1.01 | 1.74 | 2.15 | 2.69 | 3.04 | 9 |
| SE-SFR-9 | 68,592 | 1.57 | 0.50 | 5 | 1.64 | 2.82 | 3.48 | 4.35 | 4.92 | 9 |
| SE-SFR-10 | 39,454 | 0.91 | 0.50 | 5 | 0.94 | 1.62 | 2.00 | 2.50 | 2.83 | 9 |
| SE-STREET-1 | 49,661 | 1.14 | 0.85 | 5 | 2.02 | 3.47 | 4.28 | 5.36 | 6.06 | 7 |
| SE-STREET-2 | 55,852 | 1.28 | 0.85 | 5 | 2.27 | 3.90 | 4.81 | 6.02 | 6.81 | 8 |
| SE-STREET-3 | 72,574 | 1.67 | 0.85 | 5 | 2.95 | 5.07 | 6.26 | 7.83 | 8.85 | 6 |
| SE-STREET-4 | 110,499 | 2.54 | 0.85 | 5 | 4.50 | 7.72 | 9.52 | 11.92 | 13.48 | 9 |
| SE-STREET-5 | 125,370 | 2.88 | 0.85 | 5 | 5.10 | 8.76 | 10.81 | 13.52 | 15.29 | 10 |
| SE-PARK-1 | 58,078 | 1.33 | 0.15 | 5 | 0.42 | 0.72 | 0.88 | 1.11 | 1.25 | 6 |
| SE-PARK-2 | 344,320 | 7.90 | 0.15 | 5 | 2.47 | 4.25 | 5.24 | 6.55 | 7.41 | 10 |
| SE-MDR-1 | 219,839 | 5.05 | 0.60 | 5 | 6.32 | 10.85 | 13.38 | 16.74 | 18.93 | 10 |
| SE-COM-1 | 60,705 | 1.39 | 0.65 | 5 | 1.89 | 3.25 | 4.00 | 5.01 | 5.66 | 6 |
| SE-COM-2 | 56,091 | 1.29 | 0.65 | 5 | 1.75 | 3.00 | 3.70 | 4.63 | 5.23 | 10 |
| SE-OPEN-1 | 447,062 | 10.26 | 0.20 | 5 | 4.28 | 7.35 | 9.07 | 11.35 | 12.83 | 6 |
| SE-OPEN-2 | 850,610 | 19.53 | 0.20 | 5 | 8.15 | 13.99 | 17.25 | 21.59 | 24.41 | 6 |
| SE-OPEN-3 | 120,098 | 2.76 | 0.20 | 5 | 1.15 | 1.98 | 2.44 | 3.05 | 3.45 | 9 |
| SE-OPEN-4 | 164,852 | 3.78 | 0.20 | 5 | 1.58 | 2.71 | 3.34 | 4.18 | 4.73 | 10 |
| SE-OPEN-5 | 524,318 | 12.04 | 0.20 | 5 | 5.02 | 8.62 | 10.63 | 13.31 | 15.05 | 11 |

***Notes***

[1]Antecedent Mositure Factors from Table 4-2 in City of SLO Drainage Design Manual

[2]Rainfall Intensities from Table 4-6 in City of SLO Drainage Design Manual, assumes Time of Concentration <=10 min.

[3]Runoff Coefficients from Table 4-1 in City of SLO Drainage Design Manual, assumes Hydrologic Soil Group of D

# Appendix D

*Stormwater Treatment Calculations*

# Stormwater Control Plan for Post Construction Requirements

***Application Submittal***

## Project Information

***Step 1***

| | | | | |
|---|---|---|---|---|
| Applicant Name: | Avila Ranch, LLC | | | |
| Application No: | TR 3089 | | | |
| Project Name: | Avila Ranch | | | |
| Location Address: | Buckley Road, San Luis Obispo, CA | | | |
| Location APN: | 053-259-004/005/006 | | | |
| Site Zoning: | R-1, R-2, R-3, R-4, NC, Parks, Open Space | | | |
| Project Type: ✓ | ✓ | Commercial | ✓ | Detached Single Family Residential |
| | | Industrial | ✓ | Multi-unit Residential |
| | | Mixed Use | ✓ | Public |
| Project Phase: | Tentative Tract Map | | | |
| Project Description: | Development of single family residential, multi-family residential, affordable housing, neighborhood commercial, public and private roads, utilities, parks and open space. | | | |
| Total Project Site Area = | 151.9 acres | | | |

## Your project is NOT subject to Post Construction Requirements if…

***Step 2***

☐ Area (c) of project is < 2,500 square feet – ***Done***

***OR***

☐ Area (c) of project is ≥ 2,500 square feet, ***and*** is a project type listed below (✓ type) – ***Done***

- ☐ Road & parking surface repair – slurry & fog & crack seal, pothole & spot patching, overlay & resurfacing & other damage repair with no expansion
- ☐ Road & parking shoulder grading
- ☐ Road & parking cleaning, repairing, maintaining, reshaping, regarding drainage systems
- ☐ Sidewalk & bike path / lane project – no other impervious service created and runoff is directed to vegetated area
- ☐ Curb & gutter improvement or replacement – no other impervious created
- ☐ Underground utility project – surface replaced in kind
- ☐ Utility vaults – Ex: lift stations, backflows
- ☐ Fuel storage – above ground with spill containment
- ☐ Photovoltaic systems – on existing impervious surface, over pervious surface with vegetated cover, buffer strip at the most down gradient row of panels
- ☐ Second story – no increase in building footprint
- ☐ Decks & stairs & walkways – raised with space below for drainage
- ☐ Temporary structures – in place less than 6 months

## Otherwise, your project is subject to the Post Construction Requirements

## Project Site Details

***Step 3***

| | | | | |
|---|---|---|---|---|
| Watershed Management Zone: | 1 (see WMZ map attached) | | | |
| Urban Sustainability Area Name: | n/a | | | ✓ Meet USA Conditions |
| **Areas** | | | | |
| **(a)** | Total **New** Impervious Surface Area = | 57.4 AC | | |

| | | |
|---|---|---|
| **(b)** | Total **Replaced** Impervious Surface Area = | 0 |
| **(c)** | Total **Existing** Impervious Area = | 0 |
| **(d)** | Total Impervious Area of **Completed** Project = | 57.4 AC |
| **(e)** | Net Impervious Area: (a+b) – (c-d) =<br>**OR** where (c-d) is a negative number: (a+b) = | 57.4 AC |

- *See Area calculations in Step 3 to compare to thresholds in each Step below*
- *Where directions state "**Go To**", fill out and attach the referenced Form and any supporting documents*

***Step 4***

| |
|---|
| Project is ≥ 2,500 square feet |
| ☑ Yes - ***Go To*** Requirement 1 – Site Design & Runoff Reduction - Form 1 ***AND THEN***<br>***Go To*** Step 5 |

***Step 5***

| |
|---|
| Detached single family residential project where Area (e) is ≥ 15,000 square feet ***OR***<br>Project where Area (e) ≥ 5,000 square feet |
| ☑ Yes - ***Go To*** Requirement 2 – Water Quality Treatment - Form 2 ***AND THEN***<br>***Go To*** Step 6 |
| ☐ No - ***Done*** |

***Step 6***

| |
|---|
| Detached single family residential project where Area (e) ≥ 15,000 square feet ***OR***<br>Project where Area (a+b) ≥ 15,000 square feet<br><br>***AND*** is in Watershed Management Zone 4,7,10 over a ground water basin OR in Zone 1,2,5,6,8,9 |
| ☑ Yes - ***Go To*** Requirement 3 – Runoff Retention - Form 3 ***AND THEN***<br>***Go To*** Step 7 |
| ☐ No - ***Done*** |

***Step 7***

| |
|---|
| Project where Area (a+b) ≥ 22,000 square feet ***AND*** is in Watershed Management Zone 1,2,3,6,9 |
| ☑ Yes - ***Go To*** Requirement 4 – Peak Management - Form 4 |
| ☐ No - ***Done*** |

**Attachments**

1. Watershed Management Zones
2. Groundwater Basins