APPENDIX A

HYDROLOGIC/HYDRAULIC MODELS RELATED TO DRAINAGE AND FLOOD CONTROL

HYDROLOGIC/HYDRAULIC MODELS RELATED TO DRAINAGE AND FLOOD CONTROL FOR THE NORTH VINEYARD STATION SPECIFIC PLAN AREA

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INTRODUCTION

This discussion is prepared to provide a general background on the *hydrologic* and *hydraulic* models used for floodplain delineation and for determining the *hydraulic* capacity for storm drainage and flood control facilities as related to the North Vineyard Station Specific Plan (NVSSP) area. For purposes of this discussion, *hydrology* and *hydraulics* are defined as follows:

Hydrology — *Hydrology* is related to the study of rainfall and runoff within a watershed or basin. Items of particular interest with respect to the runoff are the maximum flow and the variation in flow over time (hydrograph), which provides volume. The total amount of rainfall in a storm, the intensity, duration of the rainfall, and the amounts lost to infiltration and evaporation will affect the amount and timing of the runoff.

Hydraulics — *Hydraulics* relates to the study of water flowing in a channel or stream. The depth or stage at which the water flows in a channel or how high it will pond will be influenced by the geometry of the channel or pond, the maximum flow and volume of runoff determined from the *hydrologic* analysis of the watershed or basin, as well as bridge or culvert openings.

HYDROLOGIC/HYDRAULIC MODELS

Various *hydrologic* and *hydraulic* computer models have been developed to aid in analyses related to storm drainage and flood control. The two types of *hydrologic* and *hydraulic* models utilized for the NVSSP area and greater watershed are commonly used for floodplain delineation and design of storm drainage and flood control facilities. A brief description of each follows.

Hydrologic Models

HEC-1 is a computer program developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (USACE) to aid in modeling rainfall-runoff processes of storm events in watersheds of varying sizes and complexity. HEC-1 has the capability to perform calculations using parameters characterizing the rainfall-runoff process to estimate the runoff from a watershed.

The output from HEC-1 is a hydrograph showing flow in relation to time, thus, the hydrograph will provide a maximum or peak flow and volume for use in mapping floodplains and in evaluating and sizing storm drainage and flood control facilities. HEC-1 is accepted by the Federal Emergency Management Agency (FEMA) for flood insurance studies under the National Flood Insurance Program.

Hydraulic Models

Two commonly used *hydraulic* computer models have been utilized in the NVSSP area, HEC-2 and UNET. Each is described below:

- HEC-2 is a computer program developed by the Hydrologic Engineering Center of the USACE to aid in calculating water surface profiles for one-dimensional steady, or constant, flows in natural or constructed channels. Typically, the peak flow estimated from HEC-1 is used as input for the *hydraulic* analysis. HEC-2 is accepted by FEMA for flood insurance studies under the National Flood Insurance Program.

- UNET is a computer program developed by Dr. Robert L. Barkam, Ph.D., and modified and distributed by the Hydrologic Engineering Center of the USACE. UNET is a one-dimensional unsteady flow model that can be used to estimate flows and stages in a complex network of open channels, floodplain, and detention storage areas. UNET, unlike HEC-2, accounts for differences in timing between inflow hydrographs. UNET also accounts for changes in floodplain and detention pond storage as the water level rises and falls. Typically, runoff hydrographs from HEC-1 are used as input for the *hydraulic* analysis. UNET is accepted by FEMA for flood insurance studies under the National Flood Insurance Program.

  UNET has been used extensively for *hydraulic* analyses related to floodplain mapping and for planning and designing storm drainage facilities. Examples of its application, both within and outside the Sacramento region, are noted below.

Agency	Purpose
City of West Sacramento	Southport Drainage Master Plan
Sacramento Area Flood Control Agency	Natomas East Main Drain Floodplain Investigation/Pump Station Design
County of Sacramento	Laguna Creek Flood Control Project
	Strawberry Creek Detention Design
	Unionhouse Creek Detention Design

U.S. Army Corps of Engineers	Sacramento Valley Comprehensive Study
	Sacramento/American Rivers Flood Control Project
	UNET Model of Antelope Creek Lincoln, Nebraska
	Floodplain Management Assessment of the Upper Mississippi and Lower Missouri Rivers and Their Tributaries
Chehalis, Washington Department of Public Works	Chehalis River Basin Flood Reduction Project

NVSSP AREA FLOODPLAIN DELINEATION

There are two delineations of the existing floodplain in the vicinity of the NVSSP area.

The first delineation is shown on the effective Flood Insurance Rate Map (FIRM) produced by FEMA. It is Borcalli & Associates, Inc. (B&A) understanding that floodplain delineation on the FIRMs is based upon HEC-1 and HEC-2 models. This work was completed without the benefit of stream flow data for calibration of the models and detailed topographic mapping for delineating the floodplain. Currently, the Sacramento County Department of Water Resources (DWR) has the HEC-2 model for the FIRM for Elder Creek and Gerber Creek; however, it does not have the HEC-1 models that were used as input for the HEC-2 models for floodplain mapping of the FIRMs. B&A has contacted FEMA representatives to determine if the HEC-1 models were available. Although a formal request could be submitted to FEMA to research available information, the FEMA representative stated locating HEC-1 models was unlikely.

The second delineation is based upon results of a *hydrologic* and *hydraulic* analysis (UNET) prepared by Mr. Douglas Hamilton for DWR. Unsteady flow and detention storage are known important features for handling storm drainage and flood control for the NVSSP. UNET was selected to use in planning and designing the NVSSP conveyance and detention facilities due to its capability to best represent those features. The UNET model developed for Elder Creek and Gerber Creek, completed in January 1997, utilizes DWR's HEC-1 models developed methodology and procedures outlined in the Sacramento City/County Drainage Manual, and cross sections from DWR. DWR's HEC-1 model was calibrated with data from storms occurring in January 1982 and March 1983. As part of Mr. Hamilton's work in developing the UNET model for DWR, Mr. Hamilton had the opportunity to calibrate the UNET model using data obtained by DWR from the storm that occurred on January 10, 1995. It is worthy to note that it is highly desirable to have

data available from which to calibrate a model. Often, such data is not available. A calibrated model provides an additional level of confidence that the results from the model are reasonable.

The existing floodplain delineations, based upon DWR's UNET model and FEMA's FIRM, are different. Generally, the floodplain shown on the FIRM is greater than the floodplain delineated using results from the UNET model. The difference in the floodplain delineations are attributed to different levels of *hydrologic* and *hydraulic* analyses and detail in the topographic data utilized for mapping the results from FEMA's and Sacramento County's work.

SUMMARY

In summary, UNET is widely used for handling complex *hydraulic* systems and is preferred over HEC-2 for representing the affect of floodplain storage and detention. DWR's UNET model is an effective tool and incorporates the best available data for evaluating flooding from Elder Creek and Gerber Creek and for designing conveyance and detention features for storm drainage and flood control. Accordingly, the UNET model should be the basis for submittals to FEMA for Conditional Letter of Map Revisions as well as subsequent submittals for Letter of Map Revisions for NVSSP.