David Magney Environmental Consulting

WETLAND FUNCTIONAL ASSESSMENT OF THE REINKE DEVELOPMENT PROJECT MITIGATION PLAN, THOUSAND OAKS, CALIFORNIA

Prepared for:

RUDY REINKE

Mission Statement

To provide quality environmental consulting services with integrity that protect and enhance the human and natural environment

November 2000

DMEC

Wetland Functional Assessment of the Reinke Development Project Mitigation Plan, Thousand Oaks, California

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BACKGROUND

PROJECT PURPOSE

Rudy Reinke has obtained approvals from the County of Ventura to build a single-family residence at the corner of Rimrock Road and Rolling Oaks Drive, near Thousand Oaks, California. The house is nearly completed as of mid-October. As part of the development, the landowner must install a septic system leach field, which Ventura County requires to be protected from floods. Mr. Reinke removed native riparian vegetation from the low-laying areas of the property, cleaned out an old clogged culvert crossing, and excavated a channel to direct surface flows to the western edge of the property. These actions were performed without the benefit of necessary permits from the United States Army Corps of Engineers (Corps), Los Angeles Regional Water Quality Control Board (RWQCB), or the California Department of Fish and Game (CDFG).

A minor amount of fill still needs to be placed within waters of the U.S. to accommodate a driveway, and a small span-type bridge needs to be installed to access the house over the streambed from Rolling Oaks Drive.

David Magney Environmental Consulting (DMEC) previously conducted a delineation of jurisdictional waters/wetlands onsite (DMEC 2000a), and prepared a detailed wetland mitigation and monitoring plan for proposed work within waters of the U.S. (DMEC 2000b).

Since the proposed wetland mitigation is less (in area) than the total area of jurisdictional wetlands to be impacted, the Corps and RWQCB have requested a wetland functional assessment using the Hydrogeomorphic Rapid Assessment Method (HGM) to demonstrate that the proposed wetland mitigation in fact improves wetland functions onsite.

PROJECT LOCATION

The Reinke property is located in the Conejo Valley, at the southern edge of the City of Thousand Oaks in Ventura County, at the northeast corner of Rimrock Road and Rolling Oaks Drive, just south of U.S. 101, and west of Rancho Road (Figure 1, Project Site Location Map). As shown in Figure 1, an unnamed tributary to Arroyo Conejo drains the property area to be developed.

The stream flows directly north of the property's south edge, with two branches converging at the southwest corner of the property (Figure 2, Aerial Photograph of Reinke Project Site). The property, which was investigated as part of this wetland delineation, consists of approximately 2 acres.

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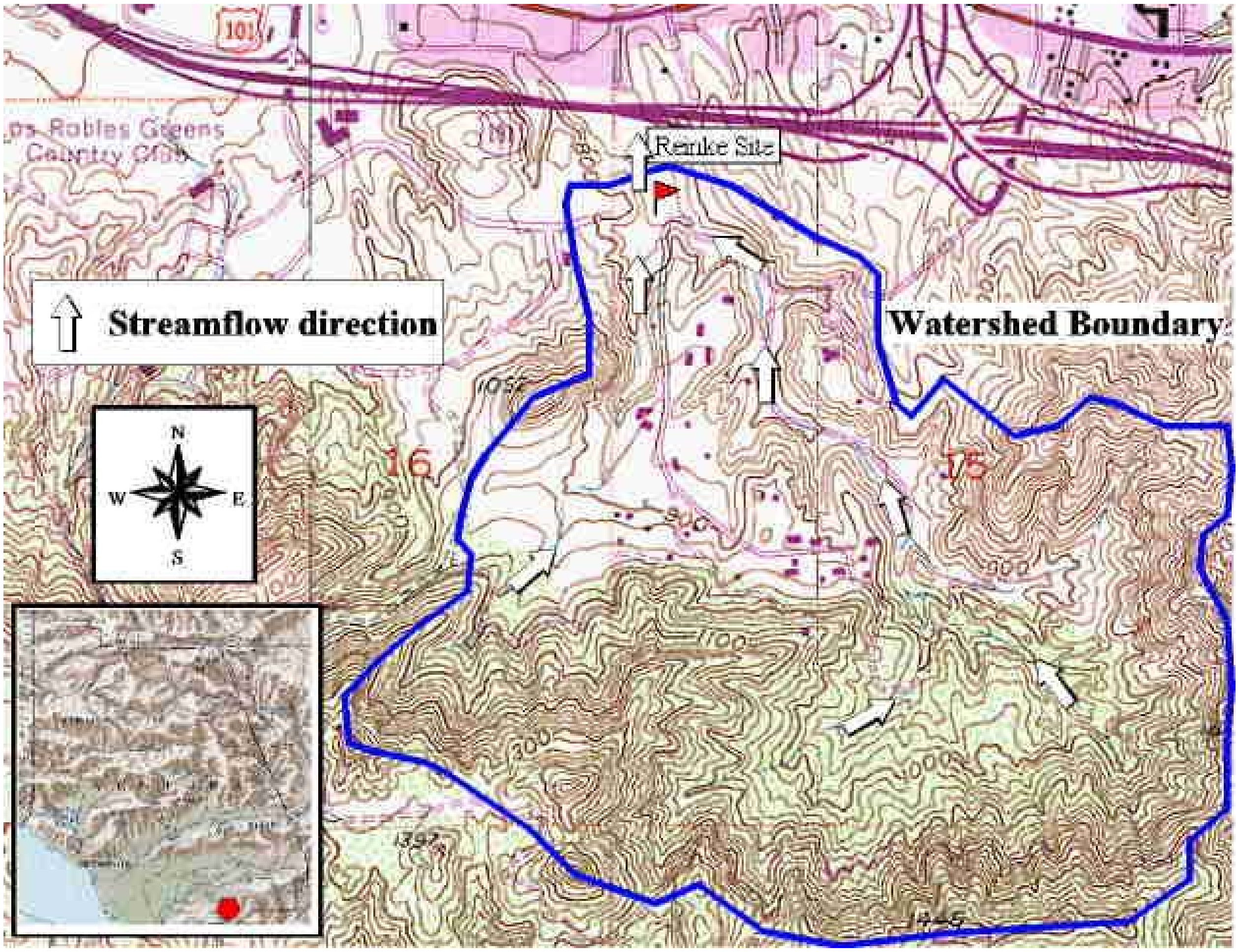
Figure 1. Project Site Location Map



Scale 1:15,840 USGS 7½-minute Thousand Oaks, California Quadrangle

PROJECT BACKGROUND

On 4 May 2000, DMEC conducted a delineation of jurisdictional waters of the U.S., including wetlands, that were expected to be directly or indirectly affected by the project. Prior to grading activities, the site consisted of a considerable section of riparian scrub along the western and southern portions of the property, within the channel bed and banks and surrounding flood prone areas. Due to previous grading activities performed in early 2000, the riparian habitat was reduced to disturbed and successional annual herbaceous vegetation, which includes several water obligate herbaceous plant species, and as of 4 May 2000, the disturbed areas appear to be in succession towards the original riparian scrub habitat. The property is surrounded by segments of annual grassland/wildflower field, coastal scrub (upland) habitat, and rock outcrops on the slopes that border the low-laying areas of the property.

Figure 2. Aerial Photograph of Project Site

JURISDICTIONAL WATERS DETERMINATION

DMEC found that approximately 0.96 acre of jurisdictional waters of the U.S. and wetlands were present at the Reinke property site. The results are based on findings for each of the three wetland criteria as required by the Corps wetland delineation manual.

Waters of the U.S.

For the purposes of this project, areas of waters of the U.S., under Corps jurisdiction, include the bed and banks of the unnamed tributaries of Arroyo Conejo and the associated riparian wetland vegetation. These areas are considered to be jurisdictional waters of the U.S, including wetlands. This also meets the CDFG wetland jurisdictional criteria.

Wetlands

Jurisdictional wetlands, pursuant to Section 404 of the Clean Water Act, at the project site are located within the unnamed tributary to Arroyo Conejo, which is dominated by hydrophytes. These areas are referred to as Mulefat Scrub. Figure 3 (Delineation of Jurisdictional Wetlands at the Reinke Project Site) illustrates the location of each field data point. Figure 3 also includes the suggested jurisdictional wetland boundary at the project site, as well as the wetland impact area, which has been verified by the Corps.

SITE CHARACTERISTICS

The Reinke property includes the confluence of the two main streams that drain a 0.54 square mile subwatershed (see Figure 1). The two streams flow along the south property boundary, one entering from the south and the other entering from the east. Under the current, post-graded conditions, the two streams meet just north of the south property boundary and flow north by northwest near the west property boundary. Just north of the north property boundary, the stream flows under an earthen roadbed through three 24-inch corrugated metal pipes.

The Reinke property stream is typical of streams on alluvial fans in the Calleguas Creek Watershed. Streams on alluvial fans in the Calleguas Creek Watershed typically are Strahler Stream Order 2-4 (1:24,000) (Strahler 1952) with watershed areas that range from less than 1 to 50 square miles (DMEC 2000b). Comparatively, the Reinke property stream is Strahler Stream Order 2 (1:24,000) with a watershed area of 0.54 square miles. Thus, the Reinke property stream is a small example of this stream type.

The Reinke property stream is relatively unconfined by local relief, even though the property is inset in a dissected alluvial fan. Under the current graded condition, the Reinke property stream has a width of 25.7 feet, a mean depth of 1.22 feet, and a slope of 0.012 (i.e. 1.2 percent) (Table 1, Existing Channel Morphology on 1 August 2000; Figure 4, Cross-Section of the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000).

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Figure 3. Delineation of Jurisdictional Wetlands at the Reinke Project Site

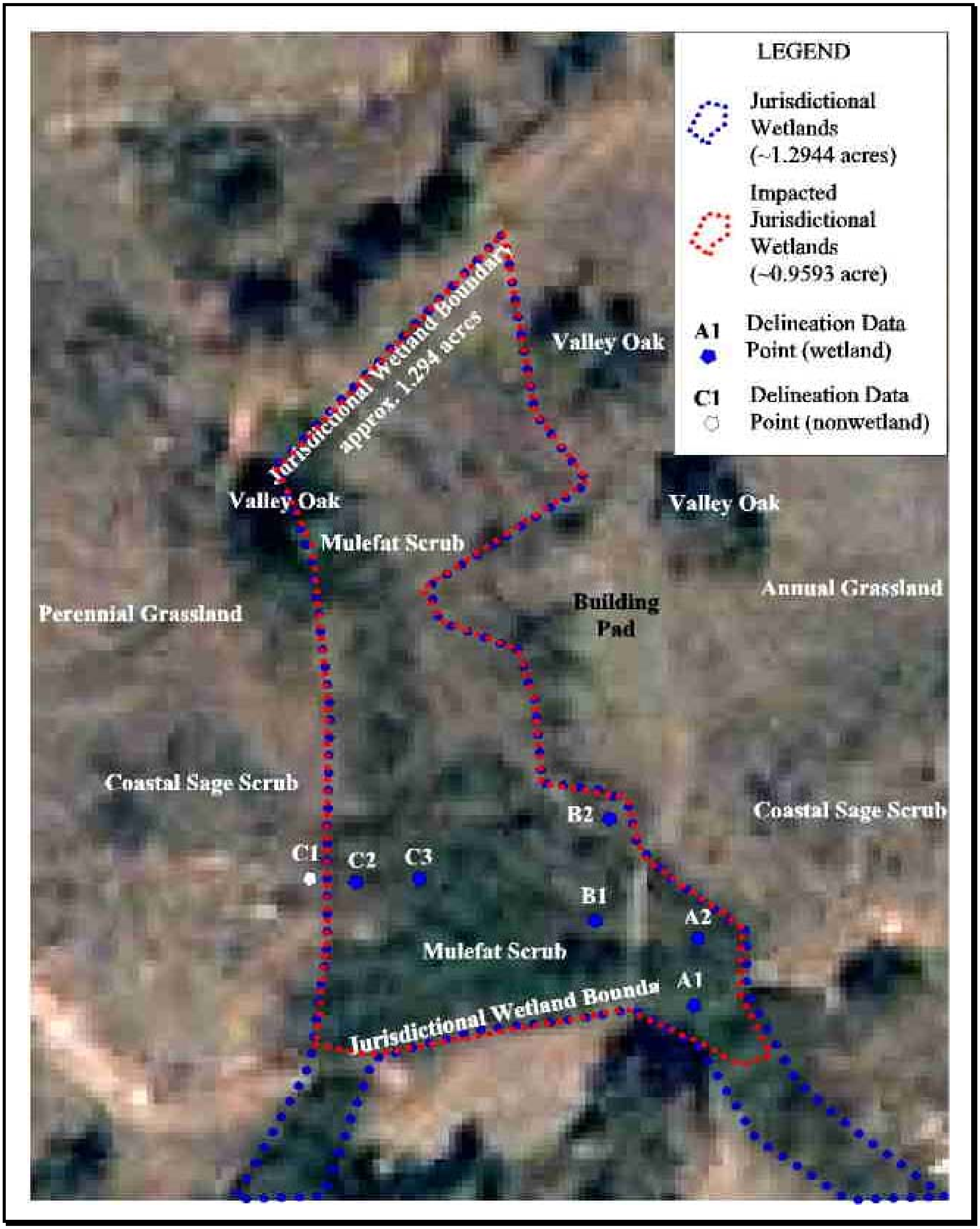
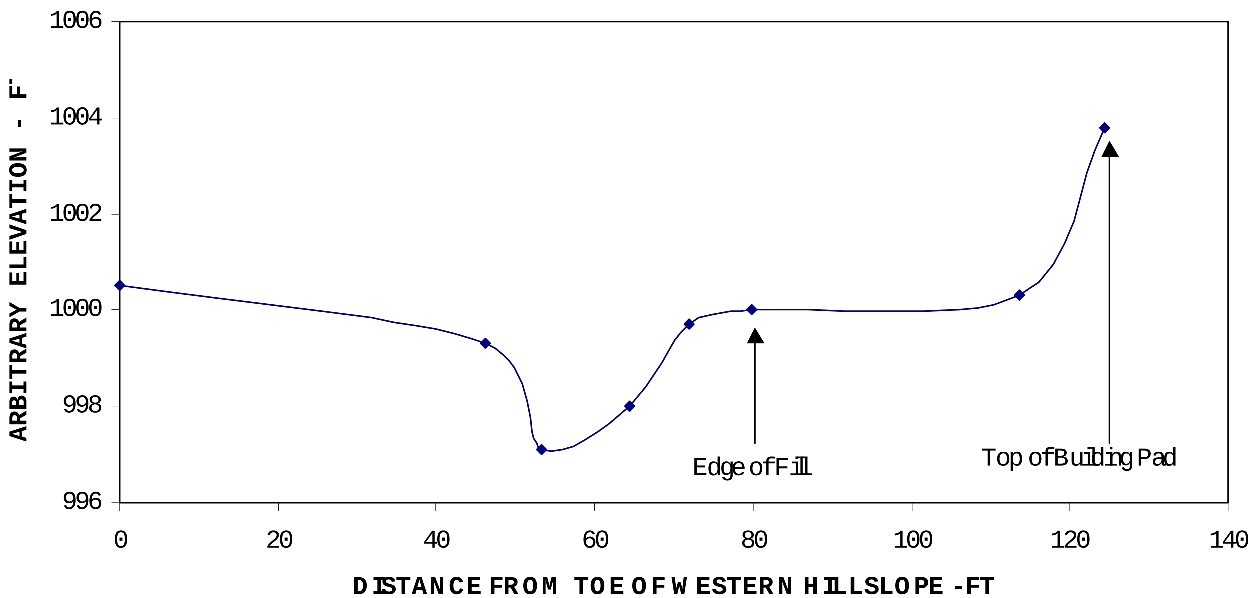


Table 1. Existing Channel Morphology on 1 August 2000

Parameter	Measured Value
Width (ft)	25.7
Mean Depth (ft)	1.22
Cross-Sectional Area (sq ft)	31.35
Width:Graded Depth	21
Bank Height (ft)	1.7
Wetted Perimeter (ft)	26.1
Hydraulic Radius (ft)	1.2
Bed Slope	0.012
Valley Slope	0.012
Sinuosity (Channel Length/Valley Length)	1.0
Belt Width (ft)	124.4
Meander Width Ratio (Belt Width/Channel Width)	4.8

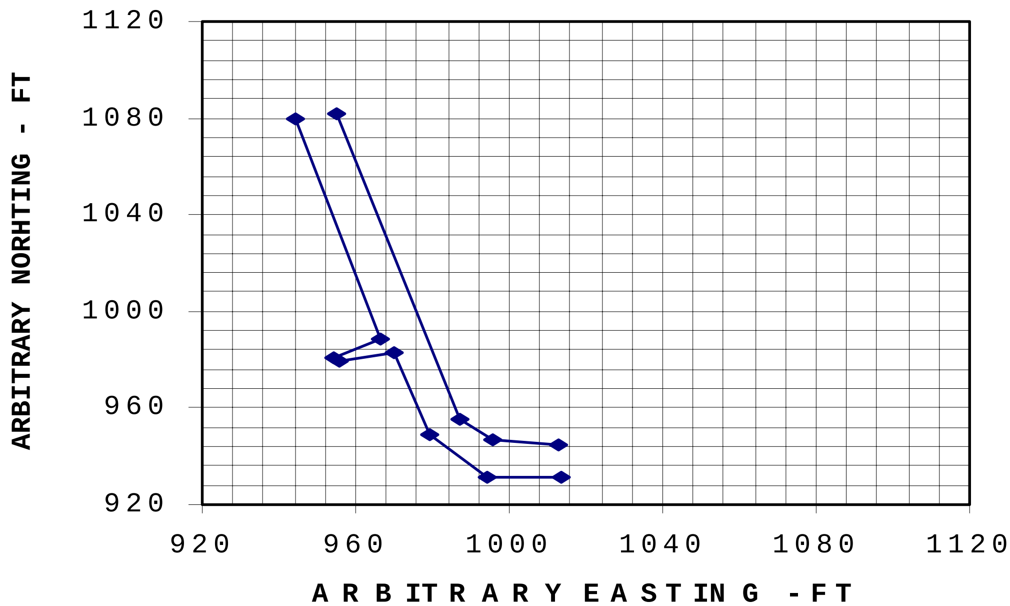
Figure 4. Cross-Section of the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000



The sinuosity – defined as the stream length divided by the valley length – is 1.0 throughout much of the site since the stream was straightened during grading activities (Figure 5, Plan View of the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000). Flows are ephemeral to seasonal. The specific stream power is low to moderate, although locally high specific stream powers occur during extremely high flows.

The channel substrate is typical of recently graded channels. The particle size distribution analyses show that there are abundant fines intermixed with coarse deposits. The D_{16}, D_{50}, and D_{84} are the particle sizes that are greater than or equal to 16, 50, and 84 percent of the particles, respectively.

Figure 5. Plan View of the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000



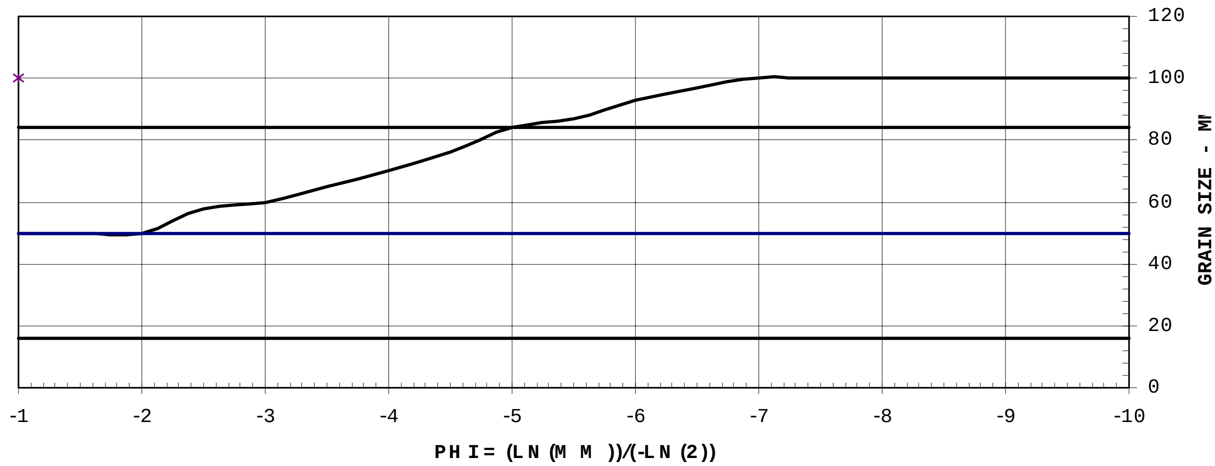
The D_{50} is the most commonly reported number. The D_{16} often is reported to gage the size of the fine particles that can clog interstitial spaces, while the D_{84} often is reported to gage the size of the largest particles that can have a substantial effect on flow resistance. The D_{16} and D_{50} on the Reinke property stream are 1 mm and 2 mm, respectively, while the D_{84} is 32 mm.

This distribution is caused by a strong bimodal distribution with one mode at less than 2 mm and another mode at greater than 23 mm to 32 mm (Figure 6, Cumulative Particle Size Distribution Function for the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000). This distribution results in an uncharacteristic “flat” cumulative particle size distribution function. Typical particle size distributions are not so strongly bimodal, resulting in the more typically observed “s-shaped” cumulative particle size distribution functions (Figure 7, Cumulative Particle Size Distribution Function for the Ventura River near Oak View under Undisturbed Conditions).

Surface water recharge to unconfined aquifers is a function of three parameters:

a) the amount of surface water that is not lost to evapotranspiration or runoff;
b) the vertical hydraulic conductivity of the recharge zone; and
c) the transmissivity and the potentiometric gradient of the unconfined aquifer which determines the rate at which the recharge zone is evacuated of recently recharged water. Surface water recharge to confined aquifers occurs as a function of these same three parameters in locations where confining layers are absent (e.g. at outcrops)(Fetter 1994).

Figure 6. Cumulative Particle Size Distribution Function for the Reinke Property Stream in the Existing, Post-Graded Condition on 1 August 2000



The Reinke property is located on an alluvial fan at the edge of the Thousand Oaks Groundwater Basin, a small groundwater basin that, apparently, is poorly studied and relatively undeveloped (Bookman-Edmonston Engineering, Inc. 1998). Typically, alluvial fans are excellent recharge zones, since coarse-grained alluvial and colluvial deposits are abundant and may form upper outcrops of confined aquifers. Thus, the Reinke property could contribute to groundwater recharge in the Thousand Oaks Groundwater Basin. However, streams tend to be most closely linked to shallow semiperched and unconfined aquifers, particularly in near channel areas. These aquifers are recharged by precipitation, stream runoff, irrigation return flows, and urban water runoff so water quality is poor and there is little groundwater development.

VEGETATION TYPES

Four predominant plant communities currently exist (or existed) within the drainage-ways, or adjacent areas, in the immediate vicinity of the proposed development site, one of which is considered to be a wetland habitat. The four plant communities onsite include:

- California Annual Grassland-Scrub;
- Purple Needlegrass Grassland;
- Coastal Sage Scrub (Coast Prickly-pear Scrub and California Sagebrush Scrub); and
- Mulefat Scrub.

Mulefat Scrub is the community considered as a wetland habitat and is mapped in Figure 3, Delineation of Jurisdictional Wetlands at the Reinke Project Site. The Mulefat Scrub wetland vegetation onsite was once well represented and established; however, due to recent grading activities for the project site, the Mulefat Scrub is now reduced to successional California Annual Grassland, which has a significant ground cover association with several successional hydrophytic herbs and scattered successional shrubs. The natural vegetation of the project site is described in detail in previous reports on the project site by DMEC (2000a and 200b).

SOILS

The Soil Conservation Service (SCS, now the Natural Resource Conservation Service) Soil Survey for the Ventura Area (Edwards et al. 1970) mapped the property soils, including the unnamed tributary to Arroyo Conejo, as Croply clay, 2-9 percent slopes, and Riverwash map units. The field investigations onsite confirmed both Croply clay and Riverwash. These soils, and their inclusions, are described briefly below as they relate to this wetland delineation.

Croply clay, 2-9 percent slopes, is classified as a fine, montmorillonitic, thermic, Chromic Pelloxererts of the Vertisols order. Croply Series includes gently sloping to moderately sloping soils of alluvial fans and plains. Croply Series consists of well-drained clays that are very hard, firm, sticky, and plastic to 60 or more inches deep, overlaying sedimentary rocks. Croply clay, 2-9 percent slopes, surface runoff is slow to medium, and the erosion hazard is slight to moderate. The surface layer is very dark gray, neutral, and mildly alkaline by stratified, very dark grayish-brown, strongly calcareous clay, silty clay loam, and silt loam. (Edwards et al. 1970.)

Riverwash, which typically consists of highly stratified, water-deposited layers of stony and gravely sand that contain relatively small amounts of silt and clay, is frequently inundated during and immediately following storms and is subject to scouring and deposition, and essentially unvegetated. (Edwards et al. 1970.)

Riverwash soils onsite ranged from sand to loamy sand with cobbles, to loamy sand. A test pit dug onsite confirmed the Riverwash map unit, and consisted of excavated material from 0 to 16 inches, resulting from grading activities, and cobbly loamy sand from 17 to 28 inches (matrix color undeterminable). Hydric soils are present onsite.

The soils of the Reinke project site are more completely described by DMEC (2000a, 2000b) in previous reports on the site.

JURISDICTIONAL AREA

The areas within the well-defined bed and banks of the two ephemeral drainages, tributaries to Arroyo Conejo, meet criteria as jurisdictional waters of the U.S. and of the state (see Figure 2, Delineation of Jurisdictional Wetlands at the Reinke Project Site). The total area of jurisdictional waters of the U.S. within the project site and adjacent upstream areas, is approximately 1.294 acres, primarily consisting of Mulefat Scrub (Palustrine Evergreen Scrub-Shrub Wetland) jurisdictional wetland, which includes small areas of the drainages beyond the Reinke property. Of the 1.294 acres of jurisdictional wetlands, grading activities impacted approximately 0.96 acre (see Figure 3). In this instance, the jurisdictional wetland areas for both the Corps and CDFG are the same and are not delineated separately on Figure 3.

WETLAND ASSESSMENT

WETLAND ASSESSMENT METHODS

DMEC assessed the project site wetlands to determine what functions the Reinke site wetlands were present before vegetation removal, and what levels each of the wetland functions were operating. Since the functions of wetlands can be complex and sometimes difficult to accurately assess, DMEC used an existing draft wetland assessment model. The functions of the wetlands considered under this assessment were based on a rapid assessment method currently under development nationwide by the Corps, known as the Hydrogeomorphic (HGM) approach (Smith et al. 1995). The HGM approach depends on development of local models for each biogeographic region for each general wetland type: riverine, estuarine, lacustrine fringe, depressional, slope, and flat.

Two regional riverine wetland HGM models are currently under development in California coastal areas that may be applicable to the Santa Barbara region:

- Draft Guidebook to Hydrogeomorphic Functional Assessment of Riverine Waters/Wetlands in the Santa Margarita Watershed (Santa Margarita HGM), and
- Draft Guidebook to Functional Assessments in 3rd and 4th Order Riverine Waters/Wetlands of the Central California Coast (Central Coast HGM).

In addition, DMEC has gathered wetland reference data from 49 sites within the Calleguas Creek Watershed, in which the Reinke project site occurs. DMEC staff have previously been used the Central Coast HGM model on the Los Osos Sewer Project EIR (Fugro West, Inc. 1996) in the Morro Bay area of San Luis Obispo County and the Cohan Development Wetland Mitigation and Monitoring Plan (ENSR 1997) in Thousand Oaks, Ventura County; however, the creeks of the Reinke project site are 1st and 2nd order streams. Therefore, use of the Central Coast HGM model may not be suitable and the Santa Margarita Watershed HGM model may be more appropriate. Furthermore, the U.S. Environmental Protection Agency (EPA) and Los Angeles District of the Corps is currently considering use of this model for the south coast region of Southern California from Point Conception to Mexico (Butterwick pers. comm. 1997, Stein pers. comm. 1997). DMEC (1997) used the Santa Margarita HGM model in assessing project-related impacts for the proposed Bridle Ridge project in Santa Barbara County.

Arroyo Conejo Creek and its tributaries are considered Riverine wetlands under the HGM wetland assessment approach. The Santa Margarita Watershed HGM model (Lee et al. 1997), developed for the EPA, used here to assess and compare original wetland functions of the Reinke development project site with projected post-mitigation project conditions.

The Santa Margarita HGM model identified fourteen critical functions that streams such as Arroyo Conejo Creek and tributaries fulfill:

1. Maintenance of characteristic channel dynamics;
2. Dynamic surface water storage and energy dissipation;
3. Long-term surface water storage;
4. Dynamic subsurface water storage;
5. Nutrient cycling;
6. Detention of imported elements and compounds;
7. Detention of particulates;
8. Organic carbon export;
9. Maintain characteristic plant community;
10. Maintain characteristic detrital biomass;
11. Maintain spatial structure of habitat;
12. Maintain interspersion and connectivity;
13. Maintain taxa richness of aquatic macroinvertebrates; and
14. Maintain spatial distribution of vertebrates.

Methods to rapidly assess Functions 13 and 14 have not yet been developed for the Santa Margarita HGM and are not directly evaluated in this wetland assessment. The HGM functional assessment approach was used to determine the index for each function for both pre- and post-project conditions. The wetland functions can be grouped into three general functions: hydrologic (Functions 1-4), biochemical (Functions 5-8), and habitat (Functions 9-12 [-14]).

Riverine wetlands in the Calleguas Creek Watershed can be characterized as performing various hydrology/geomorphology, biogeochemistry, plant habitat, and wildlife habitat functions (Table 2, Ecosystem Functions of Riverine Wetlands in the Calleguas Creek Watershed) (DMEC 2000c). The performance of these functions is largely dependent upon the maintenance of natural channel morphology and native plant communities, both of which have been and will be altered by the proposed project. Thus, the completion of the proposed project will have negative effects on the overall ecosystem function of the Reinke property stream and the associated riparian wetlands.

The HGM model considers the state of eighteen variables that are assessed in various combinations to measure the level of functioning for each of the 12 wetland functions, to come up with an index score. Each index is scaled based on reference standards that were established for the Santa Margarita River Watershed, located in San Diego, Orange, and Riverside Counties (Lee et al. 1997). Lee et al. (1997) cautions, however, that the model may not be accurate in all aspects outside the reference domain, the Santa Margarita River watershed. With this caveat in mind, the Santa Margarita HGM model is applied to this project.

What the model does for this project is provide a systematic method to measure the relative change in wetland functions the proposed project will have, identifying those specific variables and functions that are expected to change, and providing the permitting agencies a relative numerical measurement of pre- and post-project mitigation conditions. Table 3, Santa Margarita Riverine HGM Model Variables, lists the 18 variables that were used to scale the index for each wetland function.

Table 2. Ecosystem Functions of Riverine Wetlands in the Calleguas Creek Watershed

Function	Definition
Hydrology/Geomorphology	
Maintain Alluvial Corridor Integrity	Maintenance of physical attributes and processes that result in characteristic channel width, depth, slope, and roughness.
Maintain Surface Water Hydrology	Maintenance of a characteristic hydrograph, including the amount and time of water delivery to the channel network.
Maintain Subsurface Water Hydrology	Maintenance surface and ground water interactions between the channel and the local and regional aquifers.
Sediment Mobilization, Transport, and Storage	Maintenance of a characteristic sediment regime through the maintenance of a hydrograph and sediment delivery to the stream network.
Biogeochemistry	
Element and Compound Cycling	Abiotic and biotic processes that convert elements and compounds from one form to another.
Organic Carbon Export	Export of dissolved and particulate carbon, primarily through leaching and flushing.
Plant Habitat	
Maintain Native Plant Association	Maintenance of characteristic plant associations in terms of species composition of trees, saplings, seedlings, shrubs, and herbs.
Maintain Spatial Structure of Plant Association	Maintenance of the structural characteristics required for supporting native plant habitat and their animal associates.
Maintain Characteristic Detrital Biomass	The production, accumulation, and dispersal of dead plant biomass of all sizes. The sources may be up slope, up gradient, or on site.
Maintain Interspersion and Connectivity for Plant Populations	Maintenance of characteristic spatial relationships between plant habitats such that native plant species are capable of completing their life cycles.
Wildlife Habitat	
Maintain Native Vertebrate Associations	Maintenance of the diversity, density, and spatial distribution of aquatic and terrestrial vertebrates.
Maintain Native Invertebrate Associations	Maintenance of the diversity, density, and spatial distribution of aquatic and terrestrial invertebrates.
Maintain Interspersion and Connectivity for Animal Populations	Maintenance of characteristic spatial relationships between animal habitats such that native animal species are capable of completing their life cycles.

Table 3. Santa Margarita Riverine HGM Model Variables

Variable	Acronym
Stand Age Distribution	VAGEDIST
Contiguous Vegetation Cover	VCONTIG
Coarse Woody Debris	VCWD
Stage of Decay of Coarse Woody Debris	VDECAY
Floodprone Area	VFPA
Litter/Detrital Layer	VLITTER
Soil Organic Matter	VORGAN
Soil Pore Space	VPORE
Alterations of Hydroregime	VQ
Ratio of Native to Nonnative Vegetation	VRATIO
Saplings	VSAP
Sediment Delivery to Waters/Wetland	VSED
Shrubs	VSHRUB
Subsurface Flow Into the Waters/Wetlands	VSUBIN
Surface Water Persistence	VSURWAT
Macro/Micro Topographic Complexity	VTOPO
Trees	VTREE

Index formulas have been developed by Lee et al. (1997) to capture the components (variables) of each wetland function. These formulas are then used to scale the level at which the wetland is functioning, for each function. Table 4, Santa Margarita Riverine HGM Model Index Formulas, lists the index formulas used for this assessment. Some functions have more than one index formula that are used, depending on the location of the assessment site on the hydrologic gradient (i.e. higher gradient vs. lower gradient); however, only one was eventually used for each function to make the assessment.

DMEC took visual measurements or estimates on the condition of each of the 17 wetland variables and recorded them onto field data sheets for each assessment area to determine each variable's score. This was performed for baseline "existing" conditions and for post-project conditions. Post-project conditions for each variable represents an estimate of environmental conditions and cannot be accurately measured until after the project has been constructed and in place. The HGM model allows the modeler to estimate future conditions based on comparisons with other reference sites.

Table 4. Santa Margarita Riverine HGM Model Index Formulas

Index Formulas for Each Function (1st and 2nd Order Streams)	
1	(VQ+VFPA+VSED+(VTREE+VSAP+VSHRUB)/3)/4
2	(VFPA+VTOPO+VSHRUB)/3 OR (VFPA+VTOPO+VSHRUB+VFWD)/4 OR (VFPA+VTOPO+VSHRUB+VSAP+VTREE+VCWD)/6
3	(VFPA+((VTOPO+VSURWAT)/2))SQRT
4	(VFPA+VSUBIN+VPORE)/3

Index Formulas for Each Function (1st and 2nd Order Streams)
5 (VSHRUB) OR (VLITTER+VORGAN)/2 OR (VFWD+VLITTER+VORGAN)/3 OR (VTREE+VSAP+VSHRUB)/3 OR ((VCWD+VDECAY)/2+VFWD+VLITTER+VORGAN)/4 [Note: Use lowest score for the submodel]
6 (VFPA+VSUBIN+VSHRUB+(VLITTER+VORGAN)/2)/4 OR (VFPA+VSUBIN+VTREE+VSAP+VSHRUB+((VCWD+VDECAY)/2+VFWD+VLITTER+VORGAN)/4)/7
7 (VFPA+VTOPO+VSED+VSHRUB)/4 OR (VFPA+VTOPO+VSED+VSHRUB+VTREE+VSAP+VCWD)/7
8 ((VFPA+VSUBIN+VPORE)/3*(VSHRUB+VLITTER+VORGAN)/3)SQRT OR ((VFPA+VSUBIN+VPORE)/3*(VSHRUB+VFWD+VLITTER+VORGAN)/4)SQRT OR ((VFPA+VSUBIN+VPORE)/3*(VTREE+VSAP+VSHRUB+(VCWD+VDECAY)/2+VFWD+VLITTER+VORGAN)/7)SQRT
9 (VSHRUB+VRATIO)/2 OR (VTREE+VSAP+VSHRUB+VAGEDIST+VRATIO)/5
10 (VLITTER) OR (VFWD+VLITTER)/2 OR ((VCWD+VDECAY)/2+VFWD+VLITTER)/3
11 (VSHRUB+VLITTER+VTOPO)/3 OR (VSHRUB+VFWD+VLITTER+VTOPO)/4 OR (VTREE+VSAP+VAGEDIST+(VCWD+VDECAY)/2+VFWD+VLITTER+(VTOPO+VSURWAT)/2)/8
12 (VFPA+VTOPO+VCONTIG)/3 OR (VFPA+VTOPO+VSURWAT+VCONTIG)/4

Several of the functions have two or more index formulas available to the modeler, depending on landscape position or condition that is driven by the HGM model. The HGM model will require use of only one of the index formulas; however, if two or more formulas are calculated, the index formula resulting in the lowest index score is then used in the final wetland functional assessment scoring. The results of the HGM wetland functional assessment at the Reinke development site is presented below in Wetland Function Assessment Results.

REGULATORY CONTEXT

This plan is prepared to meet regulatory requirements, issued by the Corps and the CDFG, to mitigate for unavoidable impacts to waters of the U.S., including wetlands, incurred during the development of a single-family residence of the Reinke property.

Historically, the effectiveness of restoration of waters/wetlands has been measured using an area metric alone. However, the Clinton Administration Wetlands Policy (1993) mandates that:

- "...all wetlands are not the same...";
- a fair, flexible approach should be encouraged that allows restoration of waters/wetland functions; and
- a hydrogeomorphic approach to restoring waters/wetlands functions should be used.

The restoration of functions is a preferable alternative to habitat enhancement and/or creation (Kusler and Kentula 1989). This is reflected in the Memorandum of Agreement (MOA) on Mitigation of 6 February 1990 that guides policy nationally for the U.S. Environmental Protection Agency (EPA), the Corps, and the U.S. Fish and Wildlife Service (USFWS). The MOA sets forth specific guidelines to

> "...restore and maintain the chemical, physical, and biological integrity of the Nation's waters, including wetlands".

Consistent with these directives, the approach presented herein involves the restoration of physical, chemical, and biological attributes and processes to the impacted waters of the U.S., including wetlands, on the Reinke property. Although the overall area of waters/wetlands is reduced by approximately 0.23 acre, overall ecosystem function will be restored by restoring natural stream morphology and revegetating with a more compositionally and structurally diverse assemblage of plant communities.

OBJECTIVES

Riparian ecosystems that were, or will be, disturbed or eliminated as a result of installation, repair, regrading, or restoration activities will be restored onsite and in-kind. The overall mitigation objective is to have no net loss of wetland extent or **functions** resulting from project implementation.

This project targets the restoration of ecosystem functions through the restoration of geomorphic and biological attributes and processes on the Reinke property. Specifically, this project will restore natural channel morphology and native plant communities and, therefore, will restore the entire suite of riparian ecosystem functions to the Reinke property (Table 5, Design Channel Parameters and Wetland Functions Improved) (DMEC 2000b).

Table 5. Design Channel Parameters[1] and Wetland Functions Improved

Parameter	Median	Wetland Functions Improved
Bankfull Discharge and Velocity	3.8 cfs; 1.25 fs	1, 2, 4, 5, 8, 9, 10, 11, 12
Bankfull Width and Mean Depth	7.8 ft.; 0.39 ft.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Bankfull Cross-Sectional Area	3.04 sq. ft.	1, 2, 3, 4, 5, 8, 9, 10, 11, 12
Bankfull Width : Bankfull Mean Depth	20	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Bankfull Wetted Perimeter	8.6 ft.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Bankfull Hydraulic Radius	0.35 ft.	1, 2, 3, 4, 6, 7, 8, 10, 12
Bankfull Manning's n	0.059	1, 2, 3, 4, 5, 6, 7, 10, 11
Bed Slope	<0.01	1, 2, 3, 4, 5, 6, 7, 9, 10, 11
Sinuosity	>1.0 - ≤1.5	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12
Meander Wavelength	87 ft.	1, 2, 3, 4, 5, 6, 7, 9, 10, 12
D_{16}, D_{50}, D_{84} (mm)	No Specifications	1, 2, 3, 4, 5, 7, 9, 10, 11
Species Richness		5, 8, 9, 10, 11, 12
Habitat (Structural) Diversity	5 layers	5, 6, 7, 8, 9, 10, 11, 12
Ratio of Native to Nonnative Plants	10:1	5, 9, 10, 11, 12

[1] Based Upon Median Design Discharge, from DMEC (2000b).

APPROACH

The general technical approach to the restoration by DMEC is to focus on the physical and biological processes related to stream flow and sediment mobilization, transport, and deposition. Trying to enforce constraints on a river, even in a restoration context, often results in the failure of the effort (Gilvear and Bradley 1997). Thus, DMEC works with the natural physical and biological processes rather than fighting against them.

Some rivers are resilient to perturbation and can restore to pre-perturbed conditions in relatively short periods of time (Hecht 1984, Gilvear and Bradley 1997). However, removing the perturbation and not assisting in the restoration often results in incomplete restoration of the physical and biological attributes and processes of the ecosystem (Kondolf 1993). Therefore, the general approach to this restoration is to work with the physical attributes and processes to guide the restoration, but to rely upon the natural physical and biological processes of the river system to complete the project.

Each impact site will be planted at varying densities, with suitable indigenous riparian trees and shrubs, and affected sites will also receive selective erosion-control treatment, using bioengineering techniques and materials. These treatments will provide greater erosion protection than planting alone, which is only intended to provide limited protection of proposed nearby residences.

Specifically, the approach for the restoration at the Reinke property sites includes, but is not necessarily limited to:

- Recontouring portions of the restoration area to mimic natural conditions;
- Installing sediment retaining devices made of natural materials (e.g. coir rolls and blankets), if necessary;
- Removing existing nonnative, exotic plants from the restoration area;
- Collecting cuttings and seeds, if necessary, and propagating wetland/riparian plants;
- Installing temporary irrigation systems, where appropriate;
- Planting with native plant material (pole cuttings and seeds) and nursery-grown plants;
- Monitoring the work of the grading and planting contractors; and
- Monitoring the mitigation plantings for a 5-year period.

CONSTRAINTS

The episodic nature of weather and, therefore, stream discharge and sediment supply bears discussion. Flood events are episodic on the South Coast of California. For example, over a 29-year period (water years 1960-1988), annual peak flows in the Ventura River near Meiners Oaks varied from 38 cfs to 28,000 cfs (USGS Gage #11116550). Daily variations in flows also can be highly variable. During the 12 February 1992 flood, discharge in the Ventura River near Ventura increased from 100 cfs to 46,700 cfs in a period of three hours (Keller and Capelli 1992).

High sediment flux events also are episodic and often are related to wildfires coupled with high flows. Sediment rating curves may shift upwards 10 to 20 percent following significant wildfires, resuming their pre-fire relationships after two to five years (Wells and Brown 1982, Taylor 1983, Hecht 1984). A specific example is the Sisquoc River near Santa Maria, California where more than half of the bed load transported during a 60-year period was probably associated with the 1966 fire that burned approximately 35 percent of the watershed and the January to February 1969 high flows (Hecht 1993).

Fluvial geomorphologists have long recognized the unique geomorphic responses to episodic flood/high sediment flux events. Short-term variations in flow can result in a channel morphology that is adjusted to high flows but is not in equilibrium with subsequent low flows (Schumm and Lichty 1963). For example, the channel morphology created during high flows on alluvial fans may be completely reconfigured during low-flow events. The result is that subsequent high flows may not follow the previous paths and kinetic energy may be dissipated in previously unaffected areas (Dawdy 1979).

The episodic nature of flows and sediment fluxes cannot be controlled in stream restoration efforts. Thus, restoration in episodic stream systems must account for this inherent uncertainty. The episodic paradigm is based on episodic cycles of perturbation and recovery, not on the development of equilibrium landforms and mature habitats. Concepts and tools that are useful in other systems, such as channel-forming discharge dimensions, are less useful and must assume less significant roles. Similarly, design specifications and success criteria must be flexible to allow the natural physical processes to operate on the landscape.

WETLAND FUNCTION ASSESSMENT RESULTS

HGM WETLAND ASSESSMENT OF BASELINE AND POST-PROJECT CONDITIONS

The HGM wetland assessment was conducted for the drainage within the Reinke project site. Data sheets and calculations used for this HGM assessment are included as Appendix A.

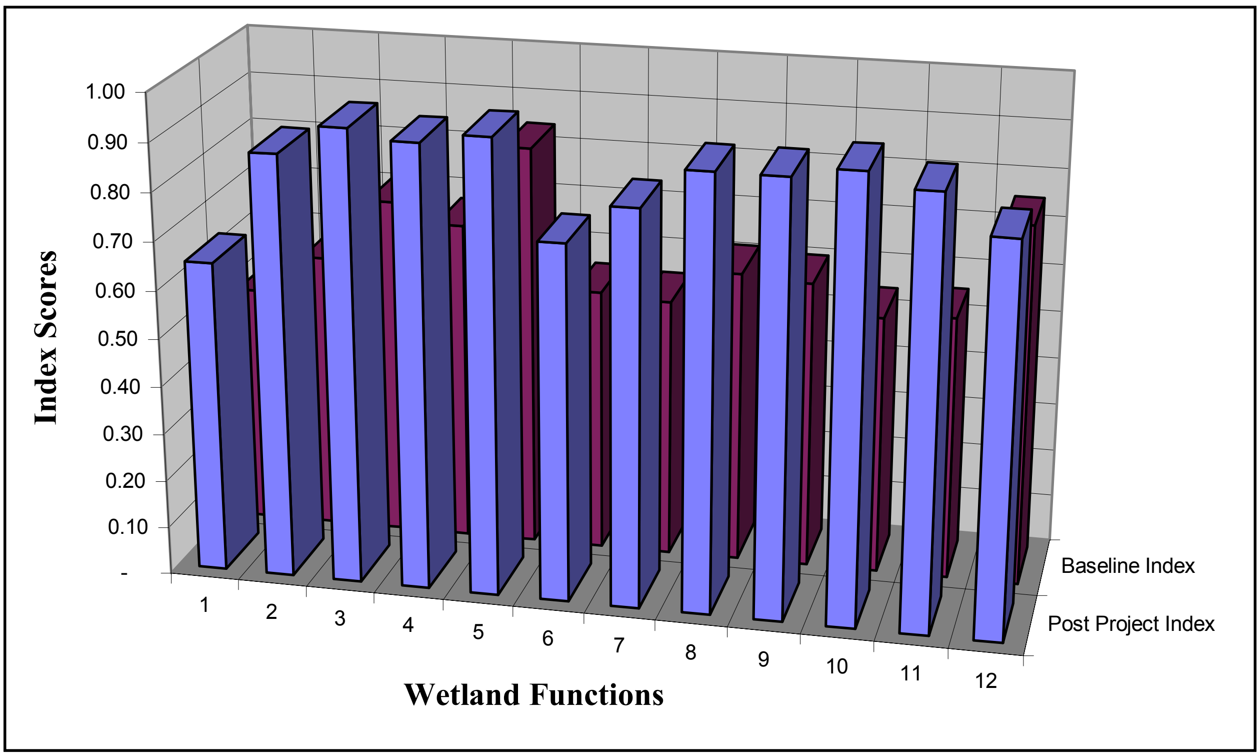
Using the HGM rapid assessment methods described in the previous section, the Reinke portion of the unnamed tributary to Arroyo Conejo was found to be functioning below reference standards for all of the twelve wetland functions (Table 6, Comparison of Pre- and Post-Project Wetland Function Index Scores for the Reinke Project), significantly lower for most functions. Functions 3 and 4, Long-term Surface Water Storage and Dynamic Subsurface Water Storage, respectively, where operating at reference standard levels (i.e., 1.00). The remaining ten functions were operating at somewhat lower levels, ranging from a high of 0.95 for Function 9 (Maintain Characteristic Plant Community) to a low of 0.50 for Function 5 (Nutrient Cycling). The chart attending Table 6 graphically illustrates the wetland function indices for baseline (existing) conditions and compares them to projected post-project indices.

Table 6. Comparison of Pre- and Post-Project Wetland Function Index Scores

Wetland Function	Post Project Index	Baseline Index	Rate of Change	Function Description
1	0.65	0.50	15%	Maintenance of characteristic channel dynamics
2	0.88	0.58	30%	Dynamic surface water storage & energy dissipation
3	0.94	0.71	23%	Long-term surface water storage
4	0.92	0.67	25%	Dynamic subsurface water storage
5	0.94	0.84	10%	Nutrient cycling
6	0.74	0.55	19%	Detention of imported elements & components
7	0.82	0.54	28%	Detention of particulates
8	0.90	0.61	29%	Organic carbon export
9	0.90	0.60	30%	Maintain characteristic plant community
10	0.92	0.54	38%	Maintain characteristic detrital biomass
11	0.89	0.55	34%	Maintain spatial structure of habitat
12	0.81	0.75	6%	Maintain habitat interspersion & connectivity
Average rate of function change			24%	

Figure 7, Rate of Change Comparison Chart of Wetland Functions at Reinke Project Site, includes calculations between baseline and post-project conditions for each wetland function, and illustrates the percent changes in the attending chart.

Figure 7. Rate of Change Comparison Chart of Wetland Functions at Reinke Project Site



The HGM assessment indicates that, in general, the wetlands associated with the unnamed tributary to Arroyo Conejo at the project site operates at levels below the reference standards, based primarily on historic adverse anthropogenic changes to the assessment area. Notable conditions that caused downward scaling of individual functions from optimal levels were the:

- presence of development upstream;
- presence of development (small road culvert over creek and freeway) downstream; and
- presence of rural urban development in the area.

Regardless, the assessment area was found to be providing significant wetland functions for all functions. Several wetland functions (i.e. 1, 2, 6, 7, 10, and 11) were functioning below 60% of their potential, with the remaining six functions operating at or above 60%.

The HGM model is intended to be used independently for each wetland function, without summing the index scores for the twelve functions (Smith et al. 1995). Regardless, if a simple comparison of the percent increase in wetland functions (24%) is made with the percent decrease in wetland area (-24%) as a result of the project, physical, chemical, and biological functions of the 24 percent smaller wetland would function 24 percent better. A comparison for each wetland function, as recommended by Smith et al. (1995), is described and assessed briefly below.

Some variables have greater importance to various wetland functions either because they are used as part of the measurement of many functions or because they are one of only two or three variables used in a function. The variables used repeatedly (i.e. more than six functions) include V_{CWD}, V_{FPA}, V_{SAP}, V_{SHRUB}, and V_{TREE}. The variables that have higher relative importance because they are one of only a few variables used to calculate wetland functions include V_{CONTIG}, V_{FPA}, V_{SHRUB}, V_{SURWAT}, and V_{TOPO}. The result is that changes to these variables have a greater affect on one or more of the wetland functions at a given site. For example, changes to the assessment area that significantly affect the floodprone area (V_{FPA}) will result in substantial changes in Functions 1, 2, 3, 4, 6, 7, 8, and 12. Fortunately for the Reinke project, no changes are expected to the floodprone area variable, which is scored as operating at reference standard levels for both existing and post-project conditions. See the tables and charts in Appendix A for a comparison of expected changes in each wetland variable.

Function 1 - Maintenance of Characteristic Channel Dynamics

This function captures the physical processes and structural attributes that maintain characteristic channel dynamics. These include water flow characteristics, bedload, in-channel coarse woody debris and potential coarse woody debris inputs, channel dimensions, and other physical features, such as bank vegetation and slope. Six variables are used to capture this function and include: floodprone area (V_{FPA}), alterations of hydroregime (V_{Q}), saplings (V_{SAP}), sediment delivery to water/wetland (V_{SED}), shrubs (V_{SHRUB}), and trees (V_{TREE}) (Lee et al. 1997).

The proposed project-related wetland mitigation is expected to increase the functionality of maintaining characteristic channel dynamics from and index score of 0.50 to 0.65 (Table 10), or by 15% (see Table 6 and Figure 7), as a result of projected improvements of the hydroregime (V_{Q})

by regrading the channel, increasing the number of saplings (VSAP), improving sediment delivery to onsite wetlands (VSED), and increasing tree cover (VTREE).

Function 2 - Dynamic Surface Water Storage and Energy Dissipation

Function 2 captures the assessment area's dynamic surface water storage and dissipation of energy at bankfull and greater discharges, which are a function of channel width, depth, bedload, bank roughness, presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels. Seven variables are used to measure this function: coarse woody debris (VCWD), VFPA, fine woody debris (VFWD), saplings (VSAP), VSHRUB, macro/micro topographic complexity (VTOPO), and VTREE.

The proposed project is expected to increase the wetland's dynamic surface water storage and energy dissipation capabilities from an index score of 0.58 to 0.88, or by approximately 30% (see Table 6 and Figure 7), because the site will have more coarse woody debris, the floodprone area topography will be improved somewhat, fine woody debris will be increased, the number of saplings will be increased, cover and macro/micro topographic complexity will be increased, and the number of trees will be increased.

Function 3 - Long-term Surface Water Storage

Function 3 measures a wetlands capability to temporarily store (retain) surface water for long durations (one or more days); associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow or channelized flow from uplands, or direct precipitation. Only three variables are used to capture this wetland function: VFPA, surface water persistence (VSURWAT), and VTOPO (Lee et al. 1997). Note: Lee et al. (1997) states that this function is sometimes not operating in some 1^{st} and 2^{nd} Order streams.

The proposed project is projected to increase the site's ability to provide long-term surface water storage from and index score of 0.71 to 0.94, or by 23% (Table 6 and Figure 7), primarily as a result surface changes within the floodprone area that affect surface complexity and variation, as well as improvements in the floodprone area and surface water persistence over baseline conditions.

Function 4 - Dynamic Subsurface Water Storage

Function 4 captures the availability of water storage beneath the wetland surface, with capacity becoming available after periodic drawdown of the water table. Again, only three variables are used to measure this function: VFPA, soil pore space (VPORE), and subsurface flow into the water/wetland (VSUBIN) (Lee et al. 1997).

The proposed project is modeled to increase the dynamic subsurface water storage capacity of the wetland area from and index score of 0.67 to 0.92, or by 25% (Table 6 and Figure 7), resulting from improvements in surface water persistence over baseline conditions and soil suitability for subsurface water storage.

Function 5 - Nutrient Cycling

Function 5 measures (indirectly) the abiotic and biotic processes that convert elements from one form to another, primarily recycling processes. Since these processes can be complex and not easily measured in the field, the model uses eight variables to capture the nutrient cycling function, including: VCWD, stage of decay of coarse woody debris (VDECAY), VFWD, leaf litter (VLITTER), soil organic matter (VORGAN), VSAP, VSHRUB, and VTREE (Lee et al. 1997).

The proposed project is expected to increase the wetland's ability to recycle nutrients from an index score of 0.84 to 0.94, or by 10% (Table 6 and Figure 7), primarily as a result of: anticipated increases in the amount of soil organic matter; of coarse woody debris that will be allowed to accumulate; and, increases in the number of trees to be planted onsite.

Function 6 - Detention of Imported Elements and Compounds

Function 6 identifies a site's ability to detain imported nutrients, contaminants, and other elements or compounds present in the environment. Nine variables are used for this function: VCWA, VDECAY, VFPA, VLITTER, VORGAN, VSAP, VSHRUB, VSUBIN, and VTREE (Lee et al. 1997).

The proposed project is modeled to increase the project site's ability to detain imported elements and compounds onsite from an index score of 0.55 to 0.74, or by 19% (Table 6 and Figure 7), as a result of anticipated increases in all wetland variables except VLITTER, VSHRUB, and VSUBIN.

Function 7 - Detention of Particulates

Function 7 gauges the deposition and detention of inorganic and organic particulates greater than 0.45µm from the water column, primarily through physical processes. This is done by using eight variables: VCWD, VDECAY, VFPA, VSAP, VSED, VSHRUB, VTOPO, and VTREE (Lee et al. 1997).

The proposed project is anticipated to increase the site's ability to detain particulates onsite and within the existing wetland areas from an index score of 0.54 to 0.82, or by 28% (Table 6 and Figure 7), primarily as a result of anticipated increases to the amount of coarse woody debris, stages of decay of coarse woody debris, saplings and trees.

Function 8 - Organic Carbon Export

Function 8 captures a wetland's ability to export dissolved and particulate organic carbon from the wetland through mechanisms including leaching, flushing, displacement, and erosion. This function is measured through eleven variables: VCWD, VDECAY, VFPA, VFWD, VLITTER, VORGAN, VPORE, VSAP, VSHRUB, VSUBIN, and VTREE (Lee et al. 1997).

The proposed project is modeled to increase the project site's ability to detain imported elements and compounds onsite from an index score of 0.61 to 0.90, or by 29% (Table 6 and Figure 7), primarily as a result of expected increases in the amount of coarse wood debris, saplings, and trees onsite, as well as general changes in the natural vegetation in the assessment area wetlands.

Function 9 - Maintain Characteristic Plant Community

Function 9 measures the species composition and physical characteristics of living plant biomass, with emphasis on the dynamics and structure of the plant community as revealed by the species of trees, shrubs, seedlings, saplings, and herbs, and by the physical characteristics of the vegetation. The model uses six variables to capture this function: stand age distribution ($V_{AGEDIST}$), amount of adjacent natural vegetation (V_{CONTIG}), ratio of native to nonnative vegetation (V_{RATIO}), V_{SAP}, V_{SHRUB}, and V_{TREE} (Lee et al. 1997).

The proposed project is anticipated to increase the project site's ability to maintain characteristic plant communities onsite from an index score of 0.60 to 0.90, or by 30% (Table 6 and Figure 7), primarily as a result of increases in the age distribution of trees and shrubs, improvements in the ratio of native to nonnative plant species, increases in the number of saplings, and increases in the number of trees onsite.

Function 10 - Maintain Characteristic Detrital Biomass

Function 10 gauges the process of production, accumulation, and dispersal of dead plant biomass of all sizes, from onsite or upslope and upgradient sources. Two variables are used for this function: V_{FWD} and V_{LITTER} (Lee et al. 1997).

The proposed project is modeled to increase the project site's ability to maintain characteristic detrital biomass onsite from an index score of 0.54 to 0.92, or by 38% (Table 6 and Figure 7), as a result of anticipated increases to the amount of fine woody debris that will be allowed to accumulate in the assessment area wetlands.

Function 11 - Maintain Spatial Structure of Habitat

Function 11 captures the capacity of a wetland to support animal populations and guilds by providing heterogeneous habitats. Ten variables are used to measure this function: $V_{AGEDIST}$, V_{CWD}, V_{DECAY}, V_{FWD}, V_{LITTER}, V_{SAP}, V_{SHRUB}, V_{SURWAT}, V_{TOPO}, and V_{TREE} (Lee et al. 1997).

The proposed project is modeled to increase the project site's ability to maintain spatial structure of habitat onsite from an index score of 0.55 to 0.89, or by 34% (Table 6 and Figure 7), primarily as a result of anticipated increases in amounts of woody debris (fine and coarse), and soil organic matter that will be allowed to accumulate in the assessment area wetlands, and overall improvements to the conditions of the site.

Function 12 - Maintain Habitat Interspersion and Connectivity

Function 12 is intended to capture the capacity of the wetland to permit access of terrestrial or aerial organisms to contiguous areas of food and cover, and is measured through four variables: VCONTIG, VFPA, VSURWAT, and VTOPO (Lee et al. 1997).

The proposed project is anticipated to increase the project site's ability to maintain habitat interspersion and connectivity onsite from an index score of 0.75 to 0.81, or by 6 percent (Table 6 and Figure 7), as a result of anticipated improvements to the amount of coarse woody debris, floodprone area, and macro and micro topographic relief in the assessment area wetlands. This function increased the least of the 12 functions as a result of the proposed mitigation, regardless, it is expected to function better than at present. The meager increase in this function is a result of the construction of the single-family home onsite, and the presence of other residences in the neighborhood.

CONCLUSIONS

Basically, DMEC concludes through this assessment that the proposed wetland restoration and mitigation plan for the Reinke project (DMEC 2000b) will increase all wetland functions onsite over baseline ("existing") conditions. Implementation of the mitigation plan would restore 0.76-acre portion of the 0.96-acre area that was impacted during early Spring of 2000. This would result in a 0.23-acre net loss (24%) in wetland area; however, the 0.76-acre area to be restored would function at higher levels than this site did prior to impacts.

As illustrated in Figure 7, eleven of the twelve wetland functions would be improved significantly from baseline conditions if the proposed wetland restoration plan (DMEC 2000b) was implemented. (A significant improvement is defined here as a positive change of a function by at least 10 percent.) All functions are expected to increase except Function 12, as a result of the proposed mitigation, by at least 10 percent (Function 5) and as much as 38 percent (Function 10). The twelve wetland functions would be improved, on average, by 24 percent (see Table 6); however, averaging the tallies for the twelve functions together is not an intended use of the HGM model, and should be considered accordingly, which is to compare changes in wetland functions on a function by function basis. The one function that would not be increased significantly (Function 12) would still increase in function by approximately 6 percent.

Reinke is constrained in his ability to build his single-family residence onsite and provide 1:1 wetland area replacement, much less than providing additional acreage for mitigating temporal losses of wetland habitat. DMEC believes that this wetland assessment demonstrates numerically that the proposed wetland mitigation will provide better wetland habitat than existed previously. In addition, the wetland mitigation site will be preserved in perpetuity, which is not the case presently.

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This report was written by David Magney, and reviewed by Mark Cable Rains. Mr. Magney performed the onsite functional assessment and prepared the figures and tables. Tiffany Magney produced the report.

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APPENDIX

FUNCTIONAL ASSESSMENT WORKSHEETS AND GRAPHS FOR PRE- AND POST-PROJECT CONDITIONS