Planning Level Hydrology Study

RMV Regional Flood Control Detention Basin Strategy Program

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REGIONAL DETENTION BASIN STRATEGY – SAN JUAN CREEK
RANCHO MISSION VEJO – DEVELOPMENT MITIGATION

Introduction / Background

The analysis contained in this preliminary *Technical Memorandum* is intended to "conceptually" define a regional **Detention Basin Strategy Program** that will successfully provide the peak flowrate hydrologic mitigation within San Juan Creek for the Ranch Plan (RMV) development at a "planning level" analysis. The analysis is preliminary since the watershed hydrology results and sizes of the basin may change slightly as the watershed hydrology is refined to meet all the Orange County *Hydrology Manual* requirements. However, the intent is that the basin sizes are approximate enough from the preliminary hydrology analysis to ensure that the basin sizes and geometry could be implemented in the suggested locations in order to satisfy the mitigation requirement. In addition, that there is a sufficient safety factor to ensure that the basins could be increased to ensure that the target hydrologic impact of zero is achieved even if refinement of the hydrology results in larger hydrologic impact amounts.

The Ranch Plan project consists of planned development by Rancho Mission Viejo (RMV) for area which is partially located within the regional watershed of San Juan Creek. Hydrologic mitigation features were identified as part of the environmental document for the proposed development that address impacts associated with the development which included the construction of regional detention basins the would mitigate the increase in peak flowrates for flood control purposes. In addition, a Runoff Management Plan (ROMP) document was required with the objective to establish a framework for implementation of the project drainage facilities, which (1) satisfy current standards for flood protection, (2) minimize impacts from potential surface runoff water quality effects, (3) evaluate estimates for runoff quantities with development and mitigation requirements, (4) address stability of natural streambeds preserved as part of the development, and (5) analyze effect of development hydrology to downstream drainage features. The runoff management plan is intended to identify potential changes to the watershed from the "pre-development" condition with the proposed development, and identify appropriate mitigation measures for the post-development hydrology.

The basin strategy program will provide one of the initial planning steps for determining the peak flowrate mitigation facilities to be identified in the ROMP, but which will be further refined as the hydrology analysis is improved. The engineering analysis associated with the "basin strategy" program is preliminary and is not intended to precisely define the exact runoff flowrates and volumes since all the necessary watershed hydrology procedures have not been performed in accordance with the OCHM. However, the results of the hydrology analysis should be accurate enough to provide a reasonable assessment of the facility requirements that would provide the hydrologic mitigation. PACE has found that the calibration and other hydrology procedures have not modified the results of the hydrology analysis to any level of significance. This assessment of the accuracy is based on the previous regional watershed modeling and comparing changes in the model after all the recommended County *Hydrology Manual* procedures had been incorporated to the "complex model," including the unit hydrograph calibration. The "conceptual plan" would establish the technical foundation for the basic framework of a regional detention basin system that will assist in the future land planning efforts for the Ranch Plan and identify that there is clearly a implementable solution for mitigation, but the specific geometry and sizes of the basins may change slightly as the model is refined. The conceptual plan will allow for the initial analysis of the development hydrology and comparison to the "baseline" conditions to test the effectiveness of the detention basin program.

EIR Mitigation Requirements Related to Flood Control Detention Facilities

The environmental document prepared and approved by the County for the Ranch Plan includes specific mitigation requirements related to hydrologic mitigation. These items are important guidance requirements which define some of the minimum criteria and objectives that these facilities must achieve.

MM 4.5-5 Flood Control Detention Facilities. *As appropriate during Ranch Plan development process, the applicant will be required to construct and implement flood control detention facilities to provide hydrologic mitigation for increases in peak discharges. Detention facilities will be located at the lower end of each of the major developed planning areas as necessary within the Ranch Plan project. While the specific design and characteristics of each basin will be refined during the project design process, planning level information is provided in this section to characterize the facilities and their functions. Initial basin locations are shown on Exhibit 4.5-13 for the Ranch Plan. The specific number, size and locations of the basins will be determined during the ROMP process. Further refinement may be achieved during the design process. Table 4.5-27 provides an initial estimate of the range of storage volumes that may be required in each of the major planning areas. Refined design and analysis of the basins needs to ensure that these facilities mitigate regional flood control facility impacts and address uncertainties such as timing of hydrograph peaks and the interaction with other elements within the watershed drainage network.*

The detention basins will be designed as "off-line" from most of the major stream channels. It is initially planned that the Gobernadora detention basin would be located within the channel and designed as a "flow through" basin. Generally speaking, flow from the development areas will be routed through the basins prior to discharge to the mainstem stream channels. By contrast, flows from undeveloped areas will not be routed through the basins, but will generally follow existing drainages directly to the main channels.

The basins will be designed to include an initial forebay area for trapping of sediment, floating debris etc). The sediment forebay will be designed for easy maintenance, with an elongated shape maximize the opportunity for sediment (and pollutants adsorbed to the sediment particles) to settle out, and to allow easy sediment removal by an excavator on the access road. Maintenance standards will be established for maximum depth of accumulated sediment in the forebay basins prior to removal. An overflow weir will connect the forebay to the main detention facility. This larger facility will include the entrance zone, the main storage area and the outlet structure. The basin will have sloped, vegetated sides, a perimeter access road, and a ramp access to the basin floor. The entire detention facility will be fenced to preclude public access. The floor of the basin will likely be colonized by emergent vegetation. This can provide additional water quality improvement of urban runoff, and evaporation potential during the dry season. In addition, this vegetation will provide incidental avian and wildlife habitat. However, the primary intent of the structures is to provide sediment trapping in the forebay, and flood detention in the main basin. As such, maintenance protocols and regulatory permits should be established prior to the design process to facilitate the required periodic sediment removal and facility maintenance.

The outlet structure will be configured to control a wide range of flows, providing flow management from the 2- to 100-year flow event. It will also include an overflow spillway, designed to safely convey floods in excess of the outlet structure capacity directly to the stream.

A subdrain will be provided to insure complete drainage within several days following a flow event.

A key element in the long-term effectiveness of the detention facilities is the establishment of an on-going maintenance and monitoring program. The applicant will establish both a management entity and a funding source to insure the implementation of a program to accomplish the following goals:

- *Monitoring: The monitoring program will track the performance of the detention facilities as well as the stability of the various stream channels within and downstream of the Ranch Plan project (to La Novia Bridge for San Juan Creek and to County border for San Mateo Creek). The monitoring will serve to identify the regular maintenance needs of the facilities as well as track any emerging problems with erosion or sedimentation in the stream channels. The monitoring shall be in a manner receiving the approval of the County/OCFCD.*
- *Detention basin maintenance will include:*
- *Identifying the rate of sediment buildup in the forebay or in the main facility and provision for sediment removal when the accumulated sediment reaches a specified depth. The initial sizing criteria for*

basin volume will include provision for this loss of storage during the period of sediment accumulation.

- *Emergent Vegetation Management: A vegetation management plan will be specified for all of the structural elements of the flood detention system. The applicant will work with the County to identify elements of the detention basin that can accommodate some vegetation (for example if water quality ponds are included in the facility, vegetation criteria will be developed for these). Based on County recommendations, vegetation will be precluded from the active flood detention basins to facilitate sediment removal activities.*
- *Vector/Nuisance Management: The design and maintenance of the basins will include prevention of vector problems such as mosquitoes, rodents, algal blooms etc.*
- *Structural Components: The basin inlet and outlet structures will require periodic maintenance to remove accumulated debris and replacement of damaged or aging elements. If the basins include a water recovery program (i.e., use of detained or infiltrated water for irrigation), the pumps and associated facilities (screens, pipes, valves) will require ongoing monitoring/maintenance.*
- *Facility Appearance/Landscaping: The detention basins will be large elements situated at visible locations within the development areas. As such their design and maintenance are important from an aesthetic perspective. The perimeter fencing, access roads and landscaping, on the basin side slopes will require ongoing irrigation and upkeep to insure that the basins represent visually appealing facilities. The basins will be designed to meet the County of Orange design requirements.*

MM 4.5-1 Runoff Management Plan. *Prior to the approval of the first Area Plan, or other planning level approval, for any part of the Ranch, the applicant shall prepare a detailed Runoff Management Plan ("ROMP") that shall be approved by the Manager, Flood Control Division, and the Manager, Watershed and Coastal Resources Division, and that meets the following standards and specifications:*

g. The ROMP shall analyze and demonstrate that development of the Ranch Plan will not produce adverse impacts during 2-, 5-, 10-, 25-, 50- and 100-year events, including but not limited to increases in runoff peak discharge, increases in runoff volume, channel aggradation / degradation, erosion and channel stability within the project site and off-site from the headwaters of the watershed to the La Novia Bridge for development within the San Juan Creek watershed, and to the County boundary for development within the San Mateo watershed for portions of the streamcourse potentially impacted by the project development. The analyses set forth in the ROMP shall be for existing conditions and for all phases of development, including with and without required mitigation measures.

PDF 4.5-2 ***Flood Control Detention Facilities*** **–** *Dedicated areas are to be provided throughout the project area to provide sufficient storage for runoff volumes to mitigate increases in peak discharges and to offset impacts of existing development.*

Development Watershed Hydrologic Impacts Analysis

The hydrologic impacts from the proposed Rancho Mission Viejo development (The Ranch Plan) were quantified through the comparison of regional watershed models for San Juan Creek which evaluated the (1) predevelopment watershed and (2) the proposed ultimate development conditions. The "ultimate" landuse conditions watershed model is based on the County approved complex unit hydrograph watershed hydrology prepared by PACE for the *San Juan Creek Watershed Study* which included the proposed development for the Ranch Plan. The "existing conditions" watershed model is a complex unit hydrograph model which utilized the approved *San Juan Creek Watershed Study* model, but the landuse within the Ranch Plan boundary was adjusted to existing or undeveloped conditions. The "existing conditions" watershed model is one of the first technical analysis prepared for the Ranch Plan ROMP and will serve as a key technical foundation for the hydrologic assessments of the project impacts. The function of the hydrologic impact assessment was to evaluate the magnitude increase in "peak runoff

flowrates" from a flood control perspective using the difference in the results between the watershed models. Other hydrologic changes identified associated with the development such as increase in runoff volume and stream stability are not part of this impact assessment although they have been identified as requirements for the mitigation through the ROMP. However, the mitigation for those additional impacts is being performed through separate hydromodification facilities independent of the flood control mitigation basins.

The hydrologic impact assessment was performed in accordance with the OCHM Addendum No. 1 which recommended the use of "expected value" peak discharges for assessing development hydrologic impacts and the corresponding mitigation requirements. The "expected value" discharge correspond to 50% confidence interval rainfall values while the values used for flood control "design" purposes correspond to a 85% confidence interval. The "expected value" discharge corresponds to the statistical average discharge that would be expected and that half the time would be greater than the expected value and half the time less than that value. The flow range of storm events 2- through 100-year is required to be evaluated for hydrologic mitigation by the OCHM. This assessment was performed using the expected value discharges and the impacts of the discharges are illustrated for the "mainstem" of San Juan Creek and the Gobernadora Canyon in the following tables.

Node	Drainage Area			*100-Year EV*			*50-Year EV*			*25-Year EV*		
	Ultimate Condition Area (ac)	Existing Condition Area (ac)	Difference (ac)	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference
118c	46154	46154	0	19657	19657	0%	17339	17339	0%	14331	14331	0%
119	49568	49512	-57	20264	20221	0%	17728	17815	0%	15017	14999	0%
126	50538	50518	-20	20023	20284	-1%	17663	17854	-1%	14812	14798	0%
127	52986	53147	161	20339	20536	-1%	17932	17896	0%	14990	15014	0%
133u	54164	54113	-51	20465	20234	1%	18037	17837	1%	14985	14973	0%
133c	61292	61228	-64	22097	21521	3%	19457	18918	3%	16034	15923	1%
134u	62508	62471	-37	22243	21655	3%	19574	19068	3%	16129	15736	2%
134c	66608	66554	-54	23089	22515	3%	20331	19800	3%	16762	16390	2%
137	67800	67793	-7	23208	22575	3%	20423	19929	2%	16838	16424	3%
138	69104	69125	21	23367	22751	3%	20557	20038	3%	16941	16567	2%
139	69532	69553	21	23412	22843	2%	20593	20119	2%	16978	16507	3%
Tributary Nodes												
132u	3797	3797	0	2797	2948	-5%	2447	2583	-5%	2084	2199	-5%
132t	1128	1128	0	1464	1464	0%	1311	1311	0%	1141	1141	0%
132c	4924	4924	0	3627	3627	0%	3174	3174	0%	2703	2703	0%
133t	7127	7115	-13	4022	3935	2%	3485	3430	2%	2953	2900	2%
134t	4100	4083	-17	2361	2383	-1%	2075	2110	-2%	1745	1776	-2%

Node	Drainage Area			*10-Year EV*			*5-Year EV*			*2-Year EV*		
	Ultimate Condition Area (ac)	Existing Condition Area (ac)	Difference (ac)	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference	Ultimate Condition Runoff (cfs)	Existing Condition Runoff (cfs)	% Difference
118c	46154	46154	0	7053	7053	0%	2384	2384	0%	528	528	0%
119	49568	49512	-57	7165	7159	0%	2463	2462	0%	539	538	0%
126	50538	50518	-20	7109	7024	1%	2459	2340	5%	540	531	2%
127	52986	53147	161	7236	6917	5%	2448	2331	5%	608	456	33%
133u	54164	54113	-51	7172	6766	6%	2482	2345	6%	606	452	34%
133c	61292	61228	-64	7394	7115	4%	2745	2464	11%	737	576	28%
134u	62508	62471	-37	7372	7123	3%	2699	2420	12%	737	575	28%
134c	66608	66554	-54	7517	7175	5%	2796	2504	12%	770	601	28%
137	67800	67793	-7	7502	7107	6%	2811	2531	11%	769	600	28%
138	69104	69125	21	7504	7031	7%	2839	2529	12%	741	598	24%
139	69532	69553	21	7536	7042	7%	2810	2516	12%	769	597	29%
Tributary Nodes												
132u	3797	3797	0	1434	1522	-6%	636	692	-8%	290	310	-7%
132t	1128	1128	0	804	804	0%	364	364	0%	159	159	0%
132c	4924	4924	0	1860	1860	0%	825	825	0%	376	376	0%
133t	7127	7115	-13	1964	1846	6%	872	776	12%	413	333	24%
134t	4100	4083	-17	1066	1024	4%	409	385	6%	148	124	19%

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Alternative Basin Locations Evaluated

Multiple locations for regional flood control hydrologic mitigation facilities have been evaluated as part of this initial assessment which meets the specific mitigation objective within the mainstem San Juan Creek. The localized hydrologic impacts associated with development outflows into the smaller tributaries and natural canyons will be mitigated through smaller localized combined hydromodification/flow control/water quality mitigation basins that are not considered regional facilities. The benefits of these facilities have not been considered in assessing the regional mitigation requirements for the main stem San Juan Creek, so there is a safety factor or "over-mitigation" if these facilities would be considered in the overall regional watershed operation. This assessment focuses on the "flood control" mitigation facilities that will be regional in nature and will meet the objective hydrologic mitigation objective as defined in the conditions for development and environmental requirements.

The alternative formulation process as part of the detention basin strategy program development considered a total of four different locations for regional flood control mitigation facilities for the Ranch Plan development within the RMV property. A single basin could not provide the required mitigation so combinations of multiple basins were evaluated. The different alternative always utilized the proposed Gobernadora Basin in combination with either two or three additional basins along the main stem of San Juan Creek. The initial determination and assessment of the locations for the three additional basins along the main stem involved assuming that the runoff volume from the associated tributary areas of these basins was completely "retained" or the entire drainage area was removed from the watershed model in order to determine the maximum peak attenuation benefits from the basin on the main stem flow rate.

Gobernadora Basin – The Gobernadora Multipurpose Basin project is located within an unincorporated portion of southeastern Orange County and the perimeter footprint of the basin surface area encompasses approximately **33.3 acres**. This regional detention basin is intended as multi-function facility since it would be designed for flood control mitigation as well as stormwater quality treatment / non-potable water reclamation. The proposed basin is located along the Gobernadora Creek downstream of its confluence with Wagon Wheel Creek. Canada Gobernadora is a major tributary of San Juan Creek located in south Orange County, California. The upper portion of the watershed, approximately 7.8 square miles upstream of its confluence with Wagon Wheel Creek, has been developed over the past two decades primarily as the private community of Coto de Caza. The ability to provide flood control mitigation at this location within the watershed is limited by the amount and geometry of the available land, groundwater tables, existing creek / floodplain hydraulics.

Planning Area 4 (PA-4) – Two potential basins located adjacent to the main stem of San Juan Creek have been identified within this development planning area associated with two different watersheds on the south side of San Juan Creek.

S19.2 – This **742 acre watershed area** is a tributary to Verdugo Canyon near the confluence with the main stem of San Juan Creek.

S26.2 – This **745 acre watershed** area adjacent to Verdugo Canyon and directly tributary to San Juan Creek within PA-4.

Planning Area 5 (PA-5) – A single basin site has been identified within this planning area along the south side of San Juan Creek.

S28 – This **1033 acre watershed** area encompasses the majority of Trampas Canyon with the proposed PA-5 development area.

Proposed Detention Basin Characteristics

The resulting analysis that there a potentially two different combinations or "systems" of detention basins that will be required in order to perform the regional peak flow rate mitigation associated with the

hydrologic impacts. The two different system alternatives include: (1) a **three basin alternative** which utilizes Gobernadora, S26.2, and S28, and (2) a **four basin alternative** which uses Gobernadora, S19.2, S26.2, and S28. Fairly detailed preliminary engineering studies have been completed for the Gobernadora Basin which has defined the facilities and geometry required for the basin while the other basins are very conceptual in nature with no specific grading studies performed for those facilities. These other three basins, S19.2, S26.2, and S28, were developed assuming a rectangular basin footprint with 3:1 side slopes in order to define an envelope for planning purposes of the basin area requirements.

Gobernadora Basin – This basin is designed as a "flow-by" detention basin system for flood control mitigation, but also has a nuisance flow water quality treatment element. The includes features to allow the basin to intercept low-flows from the adjacent Gobernadora Creek and discharge into multiple water quality treatment cells in the proposed basin for potential reuse and recharge. The layout of the basin is divided into an upper and lower basin with the upper basin having a storage volume of 30 acre-feet and the lower basin having a storage volume of 100-acre feet. Multiple basins were utilized in order to maximize the storage potential because of the physical site constraints associated with the topography and high groundwater elevations.

Side weir will intercept the peak flow rate when the water surface elevation in the adjacent natural Gobernadora Creek exceeds the weir crest elevation. When the lower rubber dam is completely inflated. The hydrology analysis shows the side weir will intercept roughly 2000 cfs out of the 6213 cfs peak flow during 100-year storm event. All the nuisance flow from the upstream watershed will be diverted into the water quality basin through a separate diversion intake structure from the channel. The design of the basin is intended to be an offline basin so it functions as a scalping basin in optimize attenuating the peak flowrate with limited storage volume.

Upper basin will store the flow intercepted by the side weir. The basin will hold the flow until the volume exceeds the dead storage, which is about 10 acre-feet. Once the water table goes above the flood control spillway, the flow will overtop the primary spillway between the upper and lower basin. The maximum effective storage volume of the upper basin is 30 acre-feet, when the water depth is 3 feet above the spillway crest and the outflow rate is 2702 cfs. The main flood control purpose of this upper basin is to provide additional storage besides the lower basin.

Lower basin provides the major flood storage, which has approximately 100 acre-feet of volume. The water coming from the upper basin over the spillway will be stored in this lower basin and released by a pipe outlet slowly back to the Creek. The hydrologic analysis shows the water intercepted by the side weir will be routed through the lower basin without overtopping the emergency spillway.

Water Quality Basin function will be provided since the nuisance flow from upstream watershed will be intercepted and discharged into the water quality basin by the nuisance flow diversion structure. The water quality basin is divided into five treatment cells which are connected by small pipes. The cells will keep the water within the water quality basin longer and thereby remove the pollutants more efficiently. The slope of the flow path through the water quality basin is about 0.2%. After the water is treated by the basin, the required amount of flow rate will be released to the Creek through the nuisance flow outlet structure. The excessive amount of flow will be intercepted by the rack intake adjacent to the outlet structure and be pumped to the reclamation system.

Non-Potable Water Reclamation Function will be provided by the basin intercepting a significant portion of the Creek flow for source of recycled water supply. Also the excessive groundwater can be drawn as water supply. Both surface water and groundwater will be lift by pump station, discharged into existing pipe line, and released into Portola Non-Potable Water Reservoir, which is located upstream of the Coto De Caza community. The diverting the nuisance flow into the water quality basin, a series of wetland treatment cells. The required amount of flow will be released through a 24" pipe back to Gobernadora Creek downstream of the lower

inflatable dam. The excessive water will be intercepted by a rack intake placed adjacent to the outlet, and lifted by pump station and discharged to the non-potable reservoir. Excessive groundwater can be used as non-potable water, and the groundwater underlying the basin can be simplified as two-layer aquifer system. The groundwater will be pumped and discharged to the non-potable reservoir located upstream of the Gobernadora Watershed.

S19.2, S26.2, and S28 Basin Characteristics

The following table summarizes the general characteristics used for the development of the other three basin geometries since these are at a very conceptual planning stage. The **three basin analysis** maximized the attenuation and storage volume in basins S26.2 and S28 so that the release rate from the basins is only **5% of the inflow**. This provided very little safety factor if the hydrology was modified or the model adjusted. The **four basin alternative** used a target outflow from the basins of 25% of the inflow for S19.2, S26.2, and S28. This provided a larger safety factor for future adjustments to the hydrology.

Summary of Four Basin System – Planning Level Characteristics					
Basin	**Tributary Area**	**Footprint Area**	**Depth / Side - Slope**	**Total Available Volume**	**Outlet Orifice**
S19.2	742 ac	8.3 ac	10 ft 4:1	77 AF	30 inch
S26.2	745 ac	7.7 ac	10 ft 4:1	72 AF	30 inch
S28	1033 ac	10.0 ac	10 ft 4:1	94 AF	36 inch

Summary of Three Basin System – Planning Level Characteristics					
Basin	**Tributary Area**	**Footprint Area**	**Depth / Side - Slope**	**Total Available Volume**	**Outlet Orifice**
S19.2	Not Used				
S26.2	745 ac	13.4 ac	10 ft 4:1	128 AF	15 inch
S28	1033 ac	19.2 ac	10 ft 4:1	184 AF	15 inch

Hydrology Analysis Procedures

General Overview of County Recommended Hydrology Analysis Procedures

The hydrologic analysis and watershed modeling used to evaluate the preliminary performance of the conceptual regional detention basin locations within the Ranch Plan development followed the majority of the required procedures described the OCHM dated October 1986 and Addendum No. 1 dated 1996. However, not all the OCHM recommended hydrology procedures had been applied which involved (1) the "complex model" calibration with unit hydrograph values, (2) multi-day storm analyses, (3) Addendum No. 1 to the OCHM requires the use of expected value discharges for hydrologic mitigation purposes. The entire San Juan Creek watershed, which is larger than 640 acres, is required to be analyzed by Synthetic Unit Hydrograph (UH) methods and the 2-year through 100-year Expected Value (EV) UH analysis will be used for "hydrologic mitigation" analysis. The Complex UH model with detention basins is used to simulate the runoff through these basins. The schematic of the complex model (also known as *link-node model*) links the subareas by channel routing. Before basin routing is simulated in the study, complex UH models without detention basins, or free-draining models, are compared to single area UH models. If the

peak flow rate from the free-draining model is greater than the single area model, then the free-draining model peak flow rate is to be used as the design flow rate. The use of a higher flow rate for design purposes aids in accommodating for the increased uncertainty in the complex model. If the peak flow rate from the free-draining model is less than the single area model, then the design storm for the free-draining model is to be modified by uniformly increasing the rainfall used in the design storm until the peak flow rate matches the single area model. The best peak rate estimate is derived from the single area model. In the complex models, all the natural areas, which will never be developed, are analyzed using single area models and then routed through the downstream channels. After the calibration process is completed, the detention basins are added into the model. The final step is to evaluate the multi-day storm analysis routed through the basin in order to verify effects on the basin and influence to the main stem hydrograph.

Complex Watershed Modeling Procedures & Basin Analysis
• Rational method watershed delineation • GIS watershed parameter determination (pervious percentage, soil type) • Rational method model development • Unit hydrograph basin delineation and concentration points • Unit hydrograph watershed characteristics (lag time, loss rates, rainfall) • Unit hydrograph analysis • Free draining complex unit hydrograph model development • Calibration of free draining complex model to unit hydrograph • Insert detention basin routing elements into calibrated free-draining model • Multi-day storm analysis

Watershed Modeling Background and Process

The previous approved watershed model prepared by PACE from the *San Juan Creek Watershed Study* was used as the basis for developing a comprehensive model to test the effective of regional detention basins for hydrologic mitigation of the development impacts. This model is a “complex” UH model which had been calibrated to single area unit hydrographs so no additional calibration is required. Several of the subwatersheds within The Ranch development boundary were further subdivided to correspond to the tributary area and drainage patterns associated with the potential detention basin locations. The hydrologic characteristics for these revised subwatersheds were accurately evaluated based digital hydrologic mapping similar to the original watershed study analysis. The only procedure that of the OCHM that was not applied as part of the detention basin evaluation was the multi-day storm analysis. However, the previous modeling prepared by PACE indicated that the first day storm dominated the analysis so the multi-day storm more than likely will have little effect.

Hydrologic Parameters - The maximum loss rates are calculated based on soil type. The low loss rates are calculated based on curve number and 24-hour rainfall depth. The curve number is a function of land use and soil type that are overlaid together by GIS software. For expected value storm events, the pervious area loss rate is a unique value for all soil groups, as specified in Addendum No.1. Table 1 specifies the pervious area loss rate is 0.30 inch/hour for 10-year through 100-year expected value storm events

Rainfall Data - Weighted-average rainfall data is calculated for each regional watershed and node. This preliminary mitigation analysis has been initially performed for the 100-year EV rainfall in order to determine the maximum size of the basin and that mitigation can be provided for the largest storm event. The smaller EV storm events will be evaluated in subsequent analysis since the mitigation will involve adjusting the outlet conditions. Rainfall data specified in the OCHM yields high confidence peak discharge. The conversion of high confidence rainfall to expected value rainfall is shown in Table 1 and 2 of Addendum No. 1. 5-year, 10-year, 15-year and 25-year high confidence rainfall are used as 10-year, 25-year, 50-year and 100-year expected value rainfall, respectively. For expected value storm events,

Addendum No.1 specifies AMC-II should be used for all storm events. The AMC calibrated by Addendum No.1 is more applicable for developed areas.

Channel Routing / Model Hydrologic Links - GIS determines channel routing characteristics, such as upstream and downstream elevations, as well as channel length. Manning's 'n' value and channel cross-sections are determined based on as-built plans or field verification.

Lag Time Estimates – The Rational Method models are built to estimate lag times for each regional watershed and each regional node for the individual hydrographs which compose the "complex" unit hydrograph model.

Single Area Unit Hydrograph - With lag times estimated for each regional watershed and node, single area, free-draining, and complex UH models are generated for regional nodes.

Complex Unit Hydrograph Model Calibration - Single area UH models and free-draining Complex UH models are compared. The higher flow rates based on the two models are used as peak flow rates. For the ultimate condition analysis, if the single area UH model flowrate is higher, the free-draining model has to be calibrated to match the single area UH flow by increasing rainfall depth. After the free-draining model is calibrated, the detention basins are added into the model. The UH model with detention basins is defined as a complex UH model. If there is no detention basin within the watershed, the best estimate of peak discharge is from the single area UH model.

Rational Method with Detention Basin - The RM model with retarding basins needs be conducted for a complex UH model as well as a free-draining RM analysis to estimate lag time for the free-draining UH model. First, the free-draining model lag time is used to build the complex UH model. The maximum flow rate from each detention basin could be determined by routing the hydrograph through basin. The maximum flow rate from each detention basin is then input into the RM model to build the RM model with basins. This RM model is built to determine the lag time for the watersheds downstream of the detention basins since the flow rate in the main course of that watershed is reduced as a result of the retarding effects of the basin. The complex UH model is updated with the lag time from the RM model with basins for the watershed downstream of the detention basin. This complex UH model is the same as the initial complex UH model except for the lag time being defined during the second iteration of the complex UH model.

Multi-Day Storm Events - Multi-day storm event studies are conducted for the complex UH model to evaluate the impact of detention basins. For multi-day UH models, the 24-hour rainfall depth is different for each day, so the low loss rate will be calculated for each day.

Technical Issues "Basin Strategy" Hydrology Analysis	
Issues	**Discussion**
Mitigation complex model does not reflect the same watershed structure and number of subwatersheds as the "existing" condition model for exact comparison	Several of the subwatersheds were divided into additional subwatersheds in order delineate the exact watershed boundary for the area tributary to the basins. This results in splitting sub-watershed S19 and S26 into an onsite and offsite watershed area. The mitigation model does not reflect the exact structure as the "existing" condition model because additional sub-watersheds have now been added, and does this provide a reasonable comparison to assess impacts. However, when adding additional subwatershed or further breaking up the watershed will generally increase the flow so this should provide over-mitigation.
Calibration of the rainfall used in the mitigation	The mitigation complex hydrograph model may

complex model reflects the adjustments from the previous calibration of the complex model in the *Watershed Study* model	require additional calibration, but it does reflect the adjustments in the rainfall previously performed which were relatively small, on the order of less than 2%.
Basin modeling analysis does not reflect the multi-day storm routing analysis of the basin per the OCHM	Multi-day storm analysis will be completed as the preliminary planning is further refined. However, the previous analyses prepared by PACE indicated that the first day of the multi-day storm dominated the analysis.

Results of Hydrologic Mitigation Analysis

The hydrologic mitigation of the development impacts from the Rancho Mission Viejo development can be provided by through the combined effects of the **three or four regional detention basin "systems"** located with the Ranch as discussed. The complete mitigation of the peak flowrates requires implementation of all three basins, since just one basin will not provide all the required mitigation. These are regional hydrologic "detention" facilities designed to temporarily store runoff volume with reduced release rates downstream that will attenuate the peak flow rate for flood control purposes.

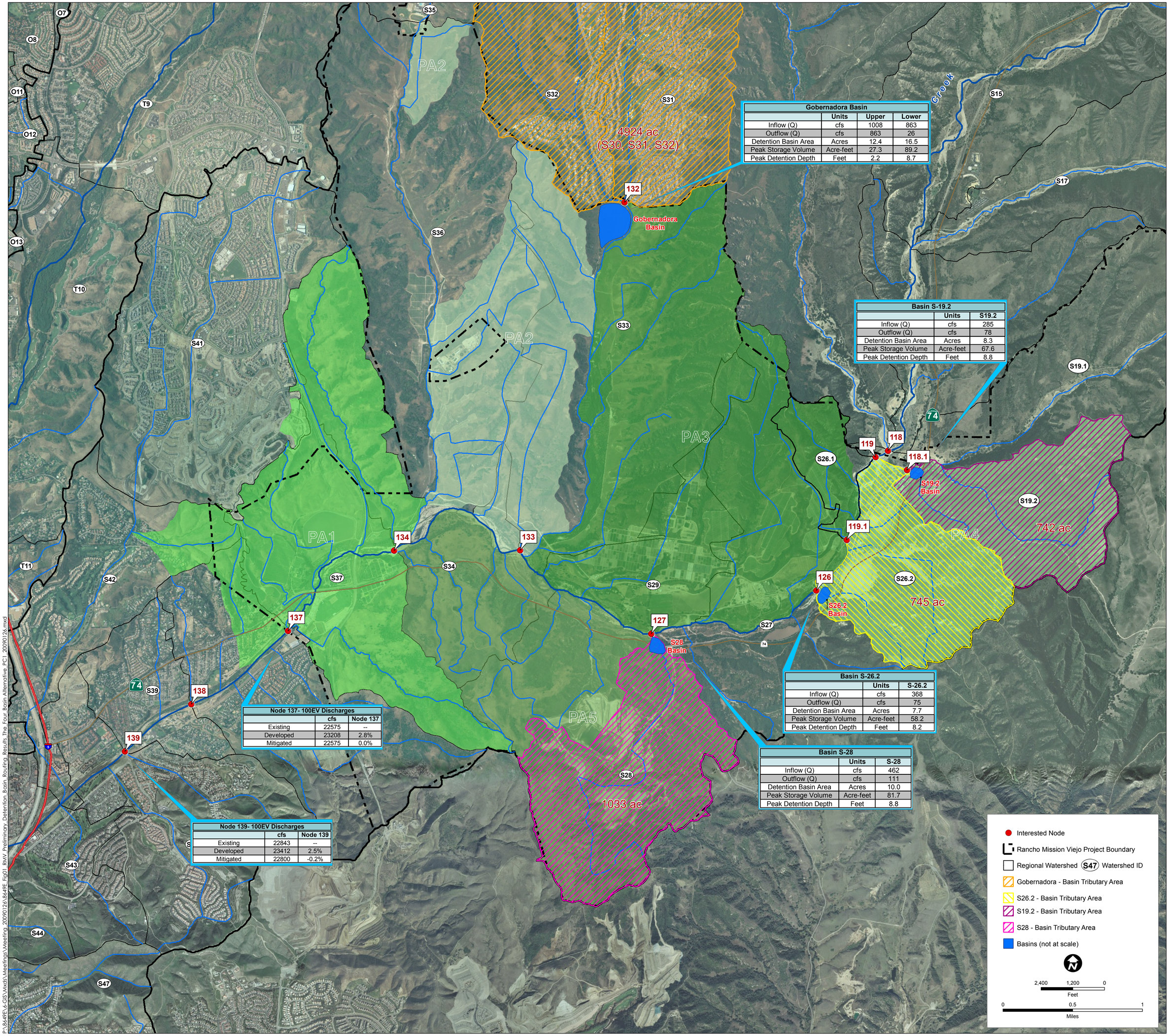
Node	*100-Year EV*				
	ROMP Free-Draining Discharges			*Mitigation via GB*	
	Existing Condition	Ultimate Condition	Change	Gobernadora Basin	Change
	(cfs)	(cfs)	(%)	(cfs)	(%)
119	20221	20264	0.2%	-	-
126	20284	20023	-1.3%	-	-
127	20536	20339	-1.0%	-	-
133t	3935	4022	2.2%	3184	-19.1%
133c	21521	22097	2.7%	21837	1.5%
134c	22515	23089	2.6%	22864	1.6%
137	22575	23208	2.8%	22984	1.8%
138	22751	23367	2.7%	23154	1.8%
139	22843	23412	2.5%	23195	1.5%

Node	*100-Year EV*								
	ROMP Free-Draining Discharges			*Mitigation via Retention and GB*					
	Existing Condition	Ultimate Condition	Change	GB with S19.2 Area Removed (-742 ac)	Change	GB with S26.2 Area Removed (-745 ac)	Change	GB with S28 Area Removed (-1033 ac)	Change
	(cfs)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)
119	20221	20264	0.2%	19924	-1.5%	-	-	-	-
126	20284	20023	-1.3%	-	-	19876	-2.0%	-	-
127	20536	20339	-1.0%	20118	-2.0%	20138	-1.9%	20082	-2.2%
133t	3935	4022	2.2%	-	-	-	-	-	-
133c	21521	22097	2.7%	21620	0.5%	21646	0.6%	21585	0.3%
134c	22515	23089	2.6%	22643	0.6%	22677	0.7%	22610	0.4%
137	22575	23208	2.8%	22766	0.8%	22799	1.0%	22735	0.7%
138	22751	23367	2.7%	22934	0.8%	22969	1.0%	22903	0.7%
139	22843	23412	2.5%	22980	0.6%	23013	0.7%	22949	0.5%

Node	100-Year EV								
	ROMP Free-Draining Discharges			Mitigation via GB		Mitigation via Detention and GB			
	Existing Condition	Ultimate Condition	Change	Gobernadora Basin	Change	ALT 1: GB, S26.2 Basin & S28 Basin	Change	ALT 2: GB, S19.2 Basin S26.2 Basin & S28 Basin	Change
	(cfs)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)
119	20221	20264	0.2%	-	-	-	-	20002	-1.1%
126	20284	20023	-1.3%	-	-	19894	-1.9%	19895	-1.9%
127	20536	20339	-1.0%	-	-	19924	-3.0%	19937	-2.9%
133t	3935	4022	2.2%	3184	-19.1%	3184	-19.1%	3184	-19.1%
133c	21521	22097	2.7%	21837	1.5%	21428	-0.4%	21436	-0.4%
134c	22515	23089	2.6%	22864	1.6%	22456	-0.3%	22456	-0.3%
137	22575	23208	2.8%	22984	1.8%	22575	0.0%	22575	0.0%
138	22751	23367	2.7%	23154	1.8%	22752	0.0%	22749	0.0%
139	22843	23412	2.5%	23195	1.5%	22800	-0.2%	22800	-0.2%

Discussion and Recommended Mitigation Basin Strategy

The analyses provided in this planning level study identifies potential feasible solutions to mitigate the peak flowrate hydrologic impacts associated with the Ranch Plan development and also provides the technical foundation to support these conclusions. The recommended solution is to provide the **four basin system** because this would allow providing an additional safety for more peak mitigation if required because of changes or adjustments with the hydrology modeling since the peak attenuation can be further reduced in the basins. There is also some opportunity to optimize the hydrologic operation of the Gobernadora Basin to slightly increase the peak flow mitigation through adjustments in the basin grading configuration. The four basin solution includes the Gobernadora Basin, S19.2, S26.2, and S28. The Gobernadora basin would provide a 19% reduction in the 100-year EV peak flowrate, while the other three basins would reduce the peak 100-year EV inflow by approximately 75%. The results of the complex modeling indicate that the peak 100-year EV flowrate at both the La Novia Bridge and the downstream RMV boundary would be reduced to below the estimated existing conditions.



Gobernadora Basin			
	Units	Upper	Lower
Inflow (Q)	cfs	1008	863
Outflow (Q)	cfs	863	26
Detention Basin Area	Acres	12.4	16.5
Peak Storage Volume	Acre-feet	27.3	89.2
Peak Detention Depth	Feet	2.2	8.7

Basin S-19.2		
	Units	S19.2
Inflow (Q)	cfs	285
Outflow (Q)	cfs	78
Detention Basin Area	Acres	8.3
Peak Storage Volume	Acre-feet	67.6
Peak Detention Depth	Feet	8.8

Basin S-26.2		
	Units	S-26.2
Inflow (Q)	cfs	368
Outflow (Q)	cfs	75
Detention Basin Area	Acres	7.7
Peak Storage Volume	Acre-feet	58.2
Peak Detention Depth	Feet	8.2

Basin S-28		
	Units	S-28
Inflow (Q)	cfs	462
Outflow (Q)	cfs	111
Detention Basin Area	Acres	10.0
Peak Storage Volume	Acre-feet	81.7
Peak Detention Depth	Feet	8.8

Node 137- 100EV Discharges		
	cfs	Node 137
Existing	22575	--
Developed	23208	2.8%
Mitigated	22575	0.0%

Node 139- 100EV Discharges		
	cfs	Node 139
Existing	22843	--
Developed	23412	2.5%
Mitigated	22800	-0.2%

TITLE
PRELIMINARY DETENTION BASIN ROUTING RESULTS
THE FOUR BASIN ALTERNATIVE 100Yr EV

JOB
SAN JUAN CREEK WATERSHED
ORANGE COUNTY CA

SCALE 1" = 1200'
DESIGNED CD
DRAWING CD
CHECKED CD
DATE 01/28/09
JOB NO. 8649-E

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17744 SKY PARK CIRCLE, SUITE 200
IRVINE, CALIFORNIA 92614
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7399

EXHIBIT
1

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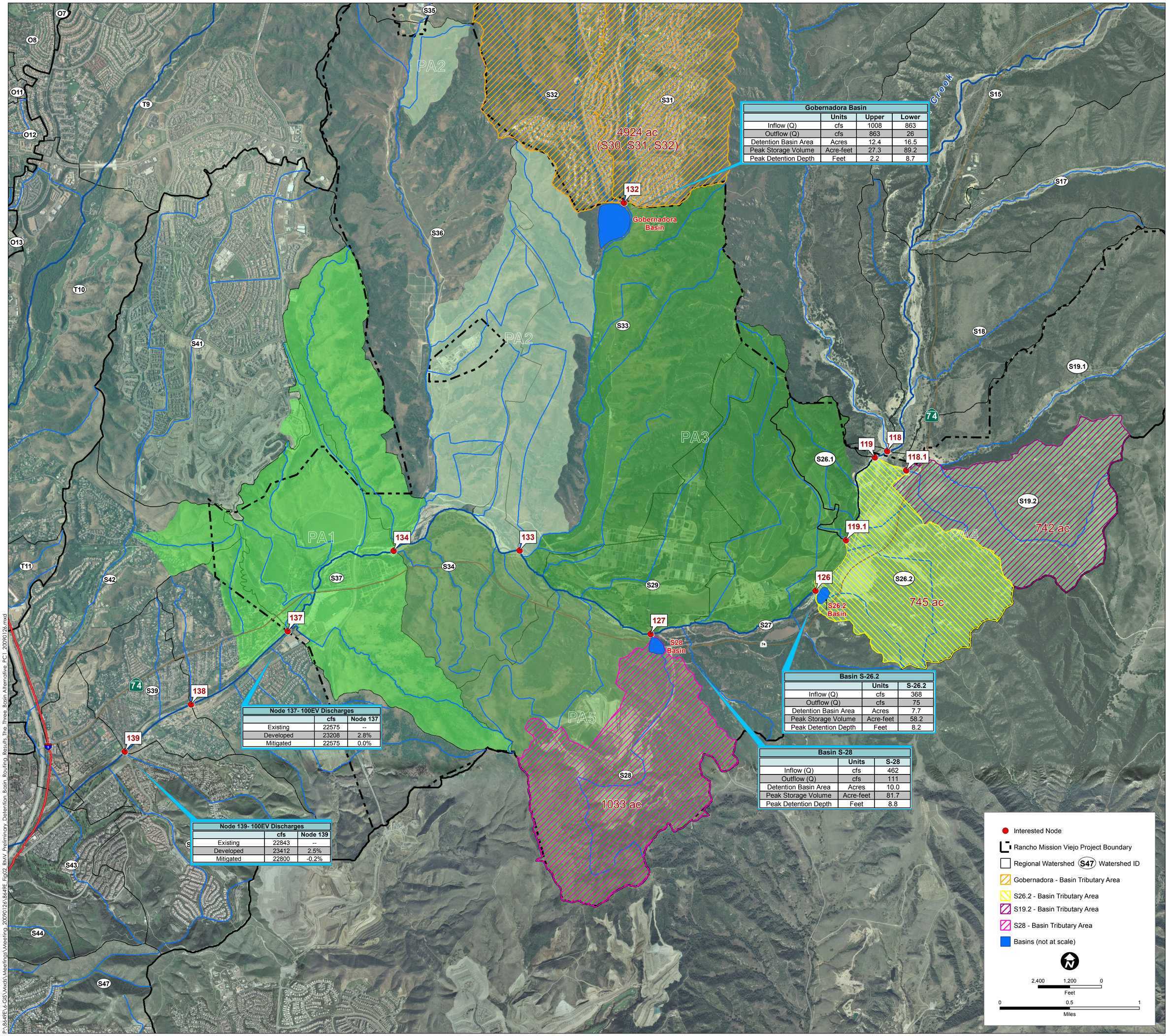

Gobernadora Basin			
	Units	Upper	Lower
Inflow (Q)	cfs	1008	863
Outflow (Q)	cfs	863	26
Detention Basin Area	Acres	12.4	16.5
Peak Storage Volume	Acre-feet	27.3	89.2
Peak Detention Depth	Feet	2.2	8.7

Node 137- 100EV Discharges		
	cfs	Node 137
Existing	22575	--
Developed	23208	2.8%
Mitigated	22575	0.0%

Node 139- 100EV Discharges		
	cfs	Node 139
Existing	22843	--
Developed	23412	2.5%
Mitigated	22800	-0.2%

Basin S-26.2		
	Units	S-26.2
Inflow (Q)	cfs	368
Outflow (Q)	cfs	75
Detention Basin Area	Acres	7.7
Peak Storage Volume	Acre-feet	58.2
Peak Detention Depth	Feet	8.2

Basin S-28		
	Units	S-28
Inflow (Q)	cfs	462
Outflow (Q)	cfs	111
Detention Basin Area	Acres	10.0
Peak Storage Volume	Acre-feet	81.7
Peak Detention Depth	Feet	8.8

TITLE
PRELIMINARY DETENTION BASIN ROUTING RESULTS
THE THREE BASIN ALTERNATIVE 100Yr EV

SAN JUAN CREEK WATERSHED

JOB
ORANGE COUNTY
CA

SCALE 1" = 1200'
DESIGNED CD
DRAWING CD
CHECKED CD
DATE 01/28/09
JOB NO. 8649-E

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EXHIBIT
2

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NO	BY	DATE		DATE	APP.

JOB

GOBERNADORA MULTIPURPOSE BASIN

SANTA MARGARITA WATER DISTRICT, CA

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SCALE	AS SHOWN
DESIGNED	D.S.
DRAWN	P.A.A.
CHECKED	B.M.P.
DATE	MAY 2006
JOB NO.	8407E

TITLE

BASIN PLAN VIEW

FIGURE

D1

JOB NO. 8407E

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ISSUED FOR CONSTRUCTION

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