RICHARD R. HORNER, PH.D.

BOX 551, 1752 NW MARKET STREET
SEATTLE, WASHINGTON 98107

TELEPHONE: (206) 782-7400
E-MAIL: rrhorner@msn.com

December 7, 2017

John Helmer, Contract Planner
City of Escondido
201 North Broadway
Escondido, California 92025 Via email (jhelmer@escondido.org)

Dear Mr. Helmer:

On behalf of the San Pasqual Valley Preservation Alliance, I reviewed documents submitted by the proponent of the Safari Highlands Ranch development in San Diego County (the County), in a location being considered for annexation into the City of Escondido (the City). I focused primarily on the proposed stormwater management system and the project's potential effects on the waters receiving its stormwater runoff (Cloverdale Creek, San Dieguito River and its Hodges Reservoir, and San Dieguito Lagoon). This letter presents the opinions I reached.

In forming my opinions I reviewed and assessed a number of sections of the Draft Environmental Impact Report (DEIR), concentrating particularly on sections 2.08 (Hydrology/Water Quality) and 2.05 (Geology/Soils) and Appendices 2.08-1 (Drainage Study) and 2.08-2 (Priority Development Project Stormwater Quality Management Plan). I also referenced: (1) DEIR Chapter 1 (Project Description); (2) the City of San Diego's Comments on the Safari Highlands Ranch Project (SUB 15-0019, September 23, 2015); (3) the City of Escondido's Jurisdictional Urban Runoff Management Plan; Appendix B, Municipal Regulations, Grading Ordinance (2001); (4) the County of San Diego's BMP Design Manual (2016); and (5) sources from the literature of the stormwater management field cited in footnotes.

In evaluating the Safari Highlands Ranch documents I applied the experience of my 40 years of work in the stormwater management field and 11 additional years of engineering practice. During this period I have performed research, taught, and offered consulting services on all aspects of the subject, including investigating the sources of pollutants and other causes of aquatic ecological damage, impacts on organisms in waters receiving urban stormwater drainage, and the full range of methods of avoiding or reducing these impacts. Attachment A to this letter presents a more complete description of my background and experience. My full *curriculum vitae* are available upon request.

SUMMARY OF MY OPINIONS

I assert that a project put forward for approval to proceed should collect all underlying data pertinent to the required environmental assessments, conduct those assessments with the best available methods, and provide all of the information regulators and citizens need to make a full and confident evaluation of the proposal and its potential environmental effects. The Safari Highlands Ranch project documents do not meet this standard, specifically with respect to:

- Not performing sufficient topographic analyses in a setting of very steep terrain;
- Not obtaining adequate soils data through on-site testing and analysis;
- As a consequence, compromising a key analytical task, properly assessing construction-phase erosion potential and the consequent management strategies needed to prevent negative impacts to the receiving waters;
- Not preparing anything close to a complete construction-phase stormwater pollution prevention plan, a necessity before regulatory decision making in my opinion because of the steep slopes to be developed and the already impaired status of the receiving waters by the pollutants potentially released from a poorly controlled construction site;
- As a further consequence of insufficient topographic analyses, failing to adequately assess the conveyance of stormwater runoff on steep flow paths and its potential erosiveness;
- As a further consequence of inadequate soils data, running hydrologic models underlying hydromodification and water quality control with input parameters that may or may not be valid; and
- Not quantitatively analyzing the expected performance of the proposed measures for water quality control.

These flaws in the DEIR render its judgments of impact non-significance not to be well founded for the affected receiving waters. The remainder of my letter elaborates on these points.

DEFICIENCIES IN ASSESSMENT METHODS

The DEIR is compromised by defects in certain methods used in the analyses underlying its conclusions and proposals, specifically in topographic analyses and accounting for soils conditions. The shortcoming in topographic analysis in such extremely steep territory as the Safari Highlands Ranch site has implications for constructability, particularly in relation to construction-phase stormwater management, and for conveyance of stormwater runoff within and away from the finished development. Lacking sufficient definition of the soils on-site affects planning for construction-phase stormwater management and compromises the modeling performed to analyze post-construction hydromodification and runoff water quality treatment.

Topographic Analysis

The DEIR is strangely reticent on the matter of topographic slope, given that the proposed development is to occur in an area characterized by the maps and some tabulated data in the DEIR as exceedingly steep ground. I expect in these circumstances that the project proponent would forthrightly define topographic conditions in a quantitative, subarea-by-subarea fashion in both existing and final configurations. In my conception, the DEIR would lay out for each unit the area encompassed, slope range (*e.g.*, 15-25 percent), land cover, and drainage pathways in the pre-and post-development states. The document does nothing of this nature.

My approach is consistent with the City of Escondido's Grading Ordinance, which gives specific requirements and guidelines for development on slopes of 15-25 and 25-35 percent. It generally prohibits, with limited exceptions, grading and development on 35 percent and steeper slopes.[1] The DEIR presents no accounting of the topographic distribution of development activities, or of how construction work and the final configurations would adhere to the ordinance's prescriptions.

With the treatment I advocate, and the ordinance requires, a user of the document could see where the major challenges would lie during construction (the steepest areas experiencing clearing), the approximate quantities of grading, and the implications of conveying runoff water away from different parts of the site in the temporary and permanent conditions. The proponent should apply this information in analyses aimed at putting forth specific measures to avoid problems. I expand on this opinion below for the construction and finished phases.

Soils Definition

Soils characterization in the DEIR work relied solely on the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) soil survey. Soil survey data of this nature were generally not obtained through on-site testing, or even observation, but commonly through more remote sensing. They are, accordingly, sometimes wrong or misleading. Soils and related hydrogeologic conditions can vary extensively within short distances. Coarser, more infiltrative formations can lie among finer, more restrictive ones, to the detriment of localizing hydrologic analyses to get the most accurate estimates of runoff production. Likewise, relatively more erosive formations can be interspersed with more resistant ones; not knowing conditions locally around the site is a disadvantage to proper construction-phase stormwater control assessment.

Soil conditions are highly important in hydrologic modeling and stormwater practice selection and design. It is essential, in my opinion, for the proponent to characterize thoroughly the soils of all portions of the site that will be subject to construction. This characterization should include areally extensive soil coring to some depth below the surface, analysis of textural

---

[1] City of Escondido. 2001. Jurisdictional Urban Runoff Management Plan; Appendix B, Municipal Regulations, Grading Ordinance; Sec. 33-1067.F.

properties in the core samples, and percolation testing to determine infiltration rates (saturated hydraulic conductivities). The resulting data should be employed in reassessing the selection of practices and their placement and design, both in the construction and post-construction phases.

This long-held personal opinion agrees with the San Diego County BMP Design Manual (County Manual), where Table D.3-1[1] notes that regional soil maps are known to contain inaccuracies at the scale of typical development sites. Furthermore, the County Manual advocates, for the planning level, confirmation of mapped soil types with site observations. For the design phase, it does not consider NRCS soil survey maps to be suitable at all, unless a strong correlation is developed between soil types and infiltration rates in the direct vicinity of the site and an elevated factor of safety is used.

Similarly, a USEPA-sponsored report[2] states, "Very large errors in soil infiltration rates can easily be made if published soil maps … are used … . … it is recommended that site specific data be obtained."

Important considerations in gathering site-specific soils data are, How many spots should be tested, and how should they be distributed? A NRCS publication[3] gives the advice:

> It is recommended that a minimum of three samples or measurements be collected on any one soil type and management combination. In general, the greater the variability of the field, more measurements is needed to get a representative value at the field scale.

A strategy would be to scatter soil investigation pits throughout the entire property, guided by the apparent variability in soil types, geology, water table levels, bedrock, topography, *etc*., and then replicate them in order to narrow spacing. If replication should show little variability in some locations but more in others, it would then be reasonable to concentrate the latter set of tests in the areas of greater variability.

If stormwater infiltration is a specific consideration, as it certainly should be until its feasibility is disproven by actual data, San Diego County and California Stormwater Quality Association (CASQA) documents provide guidance generally consistent with NRCS's. The County Manual[4] specifies:

> The heterogeneity inherent in soils implies that all but the smallest proposed infiltration facilities would benefit from infiltration tests in multiple locations. … In situ

---

[1] County of San Diego. 2016. County of San Diego BMP Design Manual, Appendix D, Approved Infiltration Rate Assessment Methods for Selection of Storm Water BMPs (page D-3). County of San Diego, San Diego, CA.
[2] Pitt, R., J, Lantrip, R. Harrison, C.L. Henry, and D. Xue. 1999. Infiltration Through Disturbed Urban Soils and Compost-Amended Soil Effects on Runoff Quality and Quantity, EPA/600/R-00/016 (page 5-2). Water Supply and Water Resources Division, National Risk Management Research Laboratory, U.S. Environmental Protection Agency, Edison, NJ.
[3] Natural Resources Conservation Service. Undated. Soil Quality Measurement, Guide for Educators (page 3). Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.
[4] County of San Diego, *Ibid*., page D-13.

> infiltration/ percolation testing must be conducted at a minimum of two locations within 50-feet of each proposed storm water infiltration/ percolation BMP.

The CASQA[1] approach is generally consistent:

> At least three in-hole conductivity tests shall be performed …, two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m.

The DEIR has proposed no infiltrative stormwater management practices on the basis of the claimed dominant NRCS soil types. The truth of this assumption should be verified by actual testing and the practice selection decision be revisited when the data are available. Being the most effective means of hydromodification and water quality control, infiltrative methods should not be abandoned without well-established cause. The soils assessment results should also be employed in thorough analysis and specification of erosion and sedimentation controls pertaining to the construction phase. This letter discusses both subjects below.

CONSTRUCTION-PHASE STORMWATER MANAGEMENT DEFICIENCIES

The documents demonstrate little analysis of the impending construction environment and present proposed best management practices (BMPs) in only the most generic fashion. San Diego County has discretion to require the submittal and approval of a stormwater pollution prevention plan (SWPPP) to address construction-related stormwater issues prior to site development, preceding and in addition to the requirement for preparation of a SWPPP under a state-issued Construction General Permit. The relevant page of the City's website[2] states that projects subject to the state construction permit are required to submit a copy of the SWPPP and WDID number (when issued) to the City during the project review process [emphasis added]. The agencies should require SWPPP submittal and approval before advancing the proposed project through any actions. This step is essential to provide government staff and citizens with sufficient information to make informed judgements about the proposed development. The following paragraphs present my reasoning for this position.

Topographic Considerations

The Safari Highlands Ranch site is characterized in many parts by extremely steep topographic slopes, including in areas where extensive ground disturbance and building will occur. Slope is a leading factor in soil erosion and sediment loss from a construction site. Thus, it is especially crucial to comprehensively address means of avoiding sediment transport from this site or, at the very least, holding it to a *de minimis* level. Achieving this goal requires careful, detailed analysis and development of a SWPPP incorporating superior BMPs tailored to the site's circumstances.

---

[1] California Stormwater Quality Association. 2003. California Stormwater BMP Handbook, New Development and Redevelopment (BMP TC-11, page 4). California Stormwater Quality Association, Menlo Park, CA.
[2] https://www.escondido.org/bmps-for-construction-activities.aspx (accessed on November 20, 2017).

Construction zones cleared of vegetation and not otherwise stabilized yield much more sediment compared to the original area well covered with plants and to the same area restablized with vegetative cover following construction. Measurements and estimates using a mathematical model (Revised Universal Soil Loss Equation Version 2, RUSLE2) indicate 30 to more than 1000 times as much soil loss after compared to before clearing. Therefore, one year of construction with no or inferior erosion controls can release into the environment as much sediment loading as occurred over decades or even centuries before the piece of land was cleared.

Going further into the matter of slope as an important determinant of erosion, RUSLE2 estimates soil loss potential according to variables representing rainfall characteristics, soils, slope length, vegetation cover, BMPs, and contributing area, in addition to slope steepness. All other factors being equal, the equation predicts the approximate increases in soil loss at different slope gradients given in Table 1. It can be seen that the rate of soil loss escalates greatly with increasing gradient. Slopes in the upper ranges of Table 1, and perhaps higher, do exist in the areas to be disturbed for development at Safari Highlands Ranch. Their presence and the related high potential soil loss further support my position that, before the project moves forward, there should be full analysis and construction SWPPP development, followed by assessment by the government agencies and the public.

Table 1. Comparison of Estimated Soil Loss as Slope Increases from 3 Percent

Slope (%)	Estimated Soil Loss Compared to 3% Slope[a]
6	1.8 times
10	3.0 times
14	4.7 times
20	7.0 times
25	8.9 times
30	10.7 times

[a] From Table4-3 of Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder. 1997. Predicting Soil erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Agricultural Handbook No. 703, U.S. Department of Agriculture, Washington, DC. The example is for a slope 50 ft in length.

Soils and Hydrology

Beyond paying little attention to the topographic challenges to limiting sediment export during construction, the applicant has likewise given little emphasis to the site's soils, specifically to their relative erosiveness. RUSLE2 takes soils and their erosivity property into account with a variable termed the K Factor, an index that quantifies the relative susceptibility of the soil to sheet and rill erosion. Values range from 0.02 for the least erodible soils to 0.64 for the most erodible.[1] Thus, the challenge of erosion on a construction site can vary by more than 30 times due to soils alone. Soil properties affecting K Factor include texture, organic matter content,

[1] Natural Resources Conservation Service. Undated. Updated T and K Factors, Questions & Answers. U.S. Department of Agriculture, Washington, DC. file:///C:/Users/Rich/Downloads/SOILS_K+T-FACTORS%20(2).pdf (accessed November 22, 2017).

structure, and saturated hydraulic conductivity. These characteristics must be known for a proper analysis of erosion potential and effective strategizing to defeat it.

As pointed out earlier, soils information has been derived only from the NRCS soil survey, and site-specific soils characterization is entirely lacking. Without thorough attention to the exact soils that will be disturbed and their relevant characteristics, it is impossible to make a proper assessment of erosiveness and the BMPs that will be necessary to prevent or mitigate it. The soils investigation outlined above should be performed and fully taken into account in site analysis and SWPPP development.

Producing a truly site-specific SWPPP will require hydrologic modeling of flows to be generated during construction; passed through on-site conveyances; probably held in basins or tanks for flow control, sedimentation and possibly other treatment; and then discharged. This modeling should be performed with the San Diego Hydrologic Model (SDHM) or U.S. Environmental Protection Agency's Storm Water Management Model (SWMM). Resource protection demands that flows are estimated as well as possible to avoid erosion of conveyance channels, to size equipment correctly, and to protect the receiving waters from high discharges during construction.

The agencies with approval responsibilities should not move further with this project until these construction-phase soils and hydrology assessments occur. They must then be incorporated in a project-specific SWPPP, along with the topographic considerations, for proper judgment of an Environmental Impact Report by County staff and citizens.

Negative Aquatic Ecological Effects of Increased Sediment Transport

Increased sediment transport into streams and estuaries has numerous ecological consequences, including:

- Covering and seeping into the gravels where fish spawn and eggs develop; in filling the pore spaces, sediments restrict the flow of water carrying dissolved oxygen, resulting in asphyxiation of the young;
- Covering the stones serving as habitat for fish food sources (e.g., insects, algae);
- Filling pools where fish rest and feed;
- Reducing visibility, making it harder for fish to find food and avoid predators;
- Reducing light penetration to underwater plants and algae;
- Abrading the soft tissues of fish, especially gills; and
- Transporting other pollutants present in the soil or picked up in transport.

Soils generally contain nutrients such as phosphorus and nitrogen that fertilize plants and algae. These nutrients are transported along with eroded soil. When they enter natural water bodies and raise the amounts of these substances present in the water, they can stimulate increased growths of algae and aquatic plants, a process known as eutrophication. In these circumstances the forms of algae tend to change from single-celled organisms to filamentous forms, which are less desirable for several reasons. They are generally an inferior food source for wildlife; clog water intakes, conveyances, and boat motors; and foul beaches when they wash up on them. When the increased masses of algae die, bacteria decomposing them exert a large demand on the oxygen dissolved in the water and reduce the amount available for fish. It is not unusual for a eutrophic lake or estuary to have little or no oxygen in the colder waters at the bottom and reduced oxygen even near the surface.

Cloverdale Creek is listed under CWA Section 303(d) as impaired for phosphorus, a nutrient transported by eroded soil particles. San Dieguito River is listed for both nitrogen and phosphorus under the same authority. Hodges Reservoir, located along the river, is a potable water supply source subject to eutrophication, which increases water treatment requirements and costs. Sediment transport from Safari Highlands Ranch will aggravate those conditions if the construction site is not very well controlled.

Additional Construction-Phase Considerations

The information available indicates that Safari Highlands Ranch will be a construction challenge from the standpoint of steep topography. It is not known with the available information how much challenge soils and hydrology will present. The topographic considerations alone merit strong consideration of extraordinary sediment control methods during construction. All of these options, described immediately below, should be seriously considered in developing the SWPPP.

Strategic construction management offers cost-effective potential options, such as: (1) performing all ground-disturbing work in the dry season, stabilizing disturbed surfaces, and then working off the ground in the wet season; (2) greatly limiting the area disturbed at any one time; and (3) self-containing disturbed areas so that they cannot possibly flow out. The latter strategy can be applied at different space and time scales. For example, on the large scale, an entire area can be channeled to a large depression for evaporation and infiltration of runoff. On the small scale, a short slope above a completed curb can drain to a recess below the curb level. On the medium level, soil stockpiles can be placed within a recess sufficient to contain drainage from them. These measures can be established briefly, until an area is stabilized, or for a longer period while extensive work occurs in the contributing drainage area. Appropriate hydrologic analysis is needed to be sure that containment areas are large enough not to drain out during foreseeable conditions.

Another measure that should be strongly considered at Safari Highlands Ranch is active treatment of any sediment-laden runoff that will discharge from the site. Active treatment goes beyond passive solids settlement to apply physical and/or chemical agents to capture particles. Two methods are widely utilized in the Pacific Northwest and found to be highly effective in reducing solids and other pollutants encountered in construction: (1) chitosan-enhanced sand

filtration (CESF), and (2) electrocoagulation (EC). CESF uses a natural polymeric material derived from shellfish waste to flocculate particles to a denser form for improved success in settling and filtering. EC employs electric charge for the same purpose. Both can be, and frequently are, fitted with additional treatment units to target special pollutants, such as carbon adsorption to reduce organic pollutants in dewatering flows from contaminated groundwater.

The preceding discussion has emphasized the sediment that may issue from the construction site and compromise receiving water quality and aquatic life. Just as the DEIR is incomplete in covering this area, it is equally vague on construction site pollutants besides sediments. These sources include construction materials; wastes produced; and pollutants associated with vehicles and other mechanized equipment, such as fuels, lubricants, and cleaning materials. These substances can introduce toxic pollutants to storm runoff. The SWPPP that I have recommended be produced and evaluated before further project consideration should fully detail the BMPs that will be used to control pollutants from these sources.

DEFICIENCIES IN POST-CONSTRUCTION STORMWATER MANAGEMENT MEASURES

The general tasks for planning stormwater management for the finished development concern conveyance of water across and away from the site, providing sufficient controls to avoid hydromodification impacts on the receiving waters, and preventing or limiting the transport of pollutants associated with human occupancy and activities to waters downstream. The major tools used by analysts in performing these tasks are hydrologic models, algorithms that predict the rates and volumes of runoff resulting from received precipitation and its routing from the point of generation to ultimate discharge. The categories of variables in these models are precipitation quantities and patterns and the characteristics of the land receiving the rainfall. Within the latter category, key variables are topography, surficial land cover, and soils. I have criticized the DEIR's submersion of topographic considerations in a landscape of steep slopes and reliance on soils data not collected on the ground. These deficiencies have negative implications for post-construction stormwater management, which I explore in this portion of my letter.

Deficiencies in Assessment of Stormwater Runoff Conveyance

While the DEIR does not lay out in a clear and distinct manner what the final configurations affecting runoff flows will be, it is apparent that some quite steep slopes will remain within the finished development. According to the Manning's Equation commonly used in hydraulics, flow velocity varies as a function of the square root of the slope of the flow path, all other relevant variables being equal. To take two examples from Table 1, above, compared to the velocity on a 3 percent slope, velocity would be approximately 2.6 and 3.3 times as fast on 20 and 30 percent slopes, respectively. According to the Darcy-Weisbach Equation of fluid mechanics, the shear stress at a boundary wall in an open flow channel is proportional to the square of the velocity.[1]

---

[1] Chaudhry, M.H. 2013. *Applied Hydraulic Transients*, 3rd Ed. Springer Publishing Company, New York, NY.

Therefore, the respective shear stress levels exerted by flows on 20 and 30 percent slopes would be approximately $2.6^2 = 6.8$ and $3.3^2 = 10.9$ times the shear stress at 3 percent.

Shear stress is responsible for erosion of the bed and banks of channels and streams. The examples given signify how the challenge of maintaining conveyance channels is compounded in steep terrain. At discharge points of these channels (*e.g.*, natural streams) high velocities can do additional erosion damage. The DEIR does not examine these issues, other than making the single statement in the Drainage Study that, "Rip rap or other energy dissipaters will be positioned at outfall locations in order to mitigate discharge velocities." Those reviewing this large and complex development proposal in a difficult setting deserve much more extensive and thoughtful analysis.

The DEIR's Project Description states that large slopes will be supported and retained with geogrid or retaining walls. The account briefly discusses visual impacts of these structures but says nothing about their relationship to drainage conveyance. There is, of course, a definite connection between drainage and the presence of such major formations, and the associated land reshaping. This is yet another area of concern in which the DEIR is highly deficient, or totally silent, where it should examine all implications. This construction strategy is probably necessary to build a large community in variable, steep slope-valley terrain but does compromise applying the site design BMP, "Maintain existing drainage patterns," one of the measures specified in the DEIR, "…to ensure that water quality is maintained over the long-term."

Deficiencies in Modeling for Hydromodification and Water Quality Control

Extensive hydrologic modeling lies at the heart of the DEIR's provisions for both post-construction hydromodification and water quality control. Soils data are important inputs to the computerized, quantitative models. As already pointed out, though, no site-specific soils data have been collected. Earlier in this letter I have given reasons why these data should be gathered and used in analyzing the project's potential environmental impacts, developing strategies to avoid or greatly limit negative impacts, and specifying practices to do so. The documents are considerably more complete in these respects for post-construction hydromodification and water quality control than for construction-phase stormwater management. In the end, though, the prescriptions rest on soils data that may or may not well represent the site. Allowing verification of their utility to actually reduce impacts to non-significance is another reason why the soils investigations I have described should be performed. The results should be used in model reruns and output interpretation to finalize practice selections for hydromodification and water quality control.

Deficiencies in Proposed Treatment for Stormwater Runoff Water Quality Control

Both hydromodification and water quality control for Safari Highlands Ranch rest largely on 11 large basins, termed by the DEIR "biofiltration basins" (plus some smaller, localized features for water quality control alone). The biofiltration basins will have detention capacity and outlet structures to regulate the stormwater runoff release rates to accomplish hydromodification control. For water quality treatment, runoff quantities produced by rainfall up to and including

the water quality design storm will percolate through 18 inches of soil engineered to enhance pollutant capture. The pollutant removal mechanisms in the soil are additional to particle settling in the detention zone and filtering and biological actions provided by vegetation contact. The basins will be lined to isolate them from the lower soil, and the percolating water will be collected in perforated underdrain piping and discharged through the surface drain system to the receiving waters downstream.

To explain this operational plan further, the water quality design storm encompasses the more frequent, smaller storms but not the large ones producing more runoff per event but occurring less often. In work that I have done in the past I estimated that the design storm used in the DEIR analysis (the 85th percentile, 24-hour event) represents approximately 62 percent of the average annual rainfall quantity for San Diego.[1] Therefore, about 38 percent of the runoff generated over time at Safari Highlands Ranch would bypass to the discharge without passing through treatment. The water percolating through the basin to the bed (a portion of the 62 percent receiving treatment, reduced in quantity by whatever fraction evaporates and transpires to the atmosphere as vapor) would still discharge. A North Carolina study of a treatment system of the type planned for Safari Highlands Ranch, lined and fitted with an underdrain, measured the evapotranspiration (ET) fraction as 21-29 percent.[2] In my judgment ET in the San Diego area during the wet season would tend to be on the high side of this range. For my analysis I took the maximum in the study's range and rounded to 30 percent. The mass of a contaminant in a runoff stream is the multiplication product of the flow volume and pollutant concentration (mass/unit volume). Using these data, the total pollutant mass generated by a storm event (M_T) and the mass remaining to discharge (M_D) can be expressed in equation form, respectively, as:

$$M_T = [(V)(C_{in})]$$

M_D = Total pollutant mass generated – Mass removed by evapotranspiration – Mass removed by treatment processes

$$M_D = M_T - [(1 - f_1)(f_2)(V)(C_{in})] - [(1 - f_1)(1 - f_2)(V)(C_{in} - C_{out})]$$

Where: M_T = Total pollutant mass generated
M_D = Pollutant mass discharged
f_1 = Fraction of flow larger than design storm (0.38)
V = Flow volume
f_2 = Fraction of flow evaporated and transpired as a vapor (0.30)
C_{in} = Pollutant concentration entering treatment
C_{out} = Pollutant concentration exiting treatment

The pollutant loading reduction efficiency (E, %) is then $E = [(M_T - M_D)(100)]/ M_T$.

---

[1] Horner, R.R. and J. Gretz. 2011. Investigation of the Feasibility and Benefits of Low-Impact Site Design Practices Applied to Meet Various Potential Stormwater Runoff Regulatory Standards. Natural Resources Defense Council, Santa Monica, CA.

[2] Sharkey, L.J. 2006. The Performance of Bioretention Areas in North Carolina: A Study of Water Quality, Water Quantity, and Soil Media. Thesis, North Carolina State University, Raleigh, NC.

To estimate the effectiveness of the proposed Safari Highlands Ranch treatment system, I drew on the International Stormwater Best Management Practice Database[1] to obtain concentration data for C_{in} and C_{out}, using the median values from the full data set for treatment of the type planned. I used a unit volume, which is not a factor since volume appears in every term in the efficiency equation and thus cancels out. Table 2 gives the results.

Table 2. Estimated Pollutant Mass Removal Efficiencies of Proposed Safari Highlands Ranch Biofiltration Basins

Pollutant	Unit	C_{in}[a]	C_{out}[a]	Efficiency
Total suspended solids	mg/L	40.6	10.0	51.3%
Enterococci	Most probable number/100 mL	590	220	45.8%
Escherichia coli	Most probable number/100 mL	1200	240	53.3%
Total recoverable copper	µg/L	9.20	5.70	35.1%
Total recoverable zinc	µg/L	49.8	12.0	51.5%
Total phosphorus	mg/L	0.13	0.24	-18.1%
Total nitrogen	mg/L	1.24	1.04	25.6%

[a] C_{in} = Concentration of pollutant entering treatment; C_{out} = Concentration of pollutant exiting treatment (both in the unit in the unit give).

It may be seen that the system designed to treat runoff produced by events up to and including the 85th percentile, 24-hour storm would reduce by about half, compared to the development with no treatment, the mass discharge of total suspended solids, zinc, and the bacterial indicators enterococci and *Escherichia coli*. The copper and nitrogen reductions would be less, and phosphorus would actually be expected to increase after treatment. These results point out the main shortcoming of underdrained biofiltration systems built with compost-amended soils, relatively poor or even negative removal of the nutrients responsible for eutrophication. These nutrients come from vegetation decomposition and the compost itself. Unlined systems without underdrains avoid this problem by infiltrating the water.

Safari Highlands Ranch's receiving waters are vulnerable to the pollutants that would not be removed at high levels, and in some cases are listed as impaired by these contaminants. The San Dieguito River, in particular, is at issue, with listings for enterococci, fecal coliforms (a group containing *Escherichia coli*), and the nutrients nitrogen and phosphorus, major components of fertilizers. The drinking water supply in Hodges Reservoir along that river would be negatively affected by more bacteria and nutrient loading and would require more treatment to retain the same quality. The DEIR is thus incorrect that the development poses less than a significant impact to water quality. In preparing the report the authors did no quantitative analysis of the type I present in this letter to show how much the proposed treatment system actually could mitigate the pollutants associated with the conversion of open land to a community with all the activity that human presence entails.

---

[1] International Stormwater BMP Database, 2016 Summary Statistics, http://www.bmpdatabase.org/Docs/03-SW-1COh%20BMP%20Database%202016%20Summary%20Stats.pdf (last accessed November 27, 2017).

I have made no attempt to quantitatively evaluate the impacts of pesticide applications in the development. I can say, though, that pesticide chemicals tend to be associated with the solids in fluid transport. Reduction of total suspended solids by about 50 percent would probably reduce pesticides entrained by stormwater flows by a similar amount, but not more. Therefore, the downstream waters, including the drinking water reservoir, would receive more of these pollutants too.

The City of San Diego has expressed concern about the proposed development's effects on both the surface water and groundwater resources it owns and operates in the drainage area of Safari Highlands Ranch.[1] The City of San Diego's letter stated particular concern with pesticides and fertilizers entering the alluvial groundwater basin and Hodges Reservoir, cumulatively increasing the salt and nutrient load and affecting the quality of surface and groundwater. My analysis demonstrates that this concern is well taken and should be addressed.

Potential Improvements in Treatment for Stormwater Runoff Water Quality Control

Above I presented and justified an argument that the proposed treatment system will still allow large quantities of various pollutants associated with urban development to flow downstream. Some possibilities exist to improve the system to increase pollutant capture, in general by:

- Retaining runoff on-site through infiltration and evapotranspiration;
- Retaining runoff on-site through harvesting water and putting it to a water supply use; and
- Enlarging the system to provide treatment to a larger fraction of the incident rainfall.

The DEIR dispensed with the first option by citing the soil survey to show that most soils are in Hydrologic Soil Group D, the formation most resistant to infiltration. I have recommended actual on-site soil testing to confirm or modify this conclusion. I accept that it may turn out to be true and that infiltration cannot be relied upon. Still, though, the DEIR has not considered dispersing flows from roofs, driveways, sidewalks, etc. over pervious surfaces to reduce runoff through evapotranspiration and at least minor infiltration. The area's climate favors this practice, because warm periods usually follow rains.

Harvesting can be performed at different scales, using relatively large cisterns and smaller rain barrels. In the United States cisterns have been used almost entirely in office and commercial buildings and multi-family residences for supply of water for toilet flushing and irrigation, with rain barrels placed at single-family homes. This development will be almost entirely single-family structures. Rain barrels can make only a very limited contribution to irrigation water supply. Cisterns are theoretically possible at single-family homes but outside the mainstream in current U.S. construction practice. Neighborhood cisterns for irrigation supply, though not

[1] Letter from Tara Lieberman, City of San Diego, Planning Department to City of Escondido, Planning Division, Attn: John Helmer, September 23, 2015.

common, are more practical. There is admittedly a substantial cost to the tankage required, but this alternative still should be evaluated and only rejected with justification. A final harvesting possibility, sometimes offered in the San Diego area, is to convey runoff into an existing or planned recycled water system. The DEIR does not mention any such system in the vicinity, but the Safari Highlands Ranch developer could always take a leadership role in establishing one.

The point of the third option listed above would be to lift the fraction not bypassing treatment above 62 percent. Using as the water quality design storm the 95th percentile, 24-hour event, for example, would increase the volume fraction captured to an estimated 83 percent.[1] This treatment would cost more, of course. Volume, and therefore costs, can be reduced, though, by using a combination of these measures: dispersing as much flow overland as possible, infiltrating wherever feasible, and harvesting some water before considering how large the treatment system must be to actually achieve less than significant impact.

SUMMARY AND CONCLUSIONS

The DEIR has not adequately justified its declarations of non-significant impacts to the downstream waters that will receive stormwater runoff from Safari Highlands Ranch. My reaching this opinion begins with the inadequacy of analysis of the highly challenging topographic setting and the failure to perform any site-specific soils characterization at all. These two considerations are fundamental to proper impact assessment in both the construction phase and the finished condition of the development. Attention to managing construction site stormwater runoff is particularly lacking, and the DEIR gives me little confidence that this period will be appropriately controlled to avoid the extensive downstream impacts that could occur. Proposals for hydromodification and water quality controls to be built into the development rely on hydrologic modeling. That modeling in turn depends on, among other input variables, soils data, which have not been collected. Finally, the potential effectiveness of the water quality control scheme was not examined. My own analysis persuades me that it will allow transport downstream of large fractions of the pollutant loadings I expect to be generated, to waters already impaired by some of the pollutants at issue.

I would be pleased to answer any questions you may have and invite you to contact me if you wish.

Sincerely,

Richard R. Horner

Richard R. Horner

Attachment: Background and Experience; Richard R. Horner, Ph.D.

---

[1] Horner, R.R. and J. Gretz. *Ibid.*

Background and Experience

RICHARD R. HORNER, PH.D.

I have 51 years of professional experience, 45 teaching and performing research at the college and university level. For the last 40 years I have specialized in research, teaching, and consulting in the area of storm water runoff and surface water management.

I received a Ph.D. in Civil and Environmental Engineering from the University of Washington in 1978, following two Mechanical Engineering degrees from the University of Pennsylvania in 1965 and 1966. Although my degrees are all in engineering, I have had substantial course work and practical experience in aquatic biology and chemistry.

For 12 years beginning in 1981, I was a full-time research professor in the University of Washington's Department of Civil and Environmental Engineering. From 1993 until 2011, I served half time in that position and had adjunct appointments in two additional departments (Landscape Architecture and the College of the Environment's Center for Urban Horticulture). I spent the remainder of my time in private consulting through a sole proprietorship. My appointment became emeritus in late 2011, but I continue university research and teaching at a reduced level while maintaining my consulting practice.

My research, teaching, and consulting embrace all aspects of stormwater management, including determination of pollutant sources; their transport and fate in the environment; physical, chemical, and ecological impacts; and solutions to these problems through better structural and non-structural management practices.

I have conducted numerous research investigations and consulting projects on these subjects. Serving as a principal or co-principal investigator on more than 40 research studies, my work has produced three books, approximately 30 papers in the peer-reviewed literature, and over 20 reviewed papers in conference proceedings. I have also authored or co-authored more than 80 scientific or technical reports.

In addition to graduate and undergraduate teaching, I have taught many continuing education short courses to professionals in practice. My consulting clients include federal, state, and local government agencies; citizens' environmental groups; and private firms that work for these entities, primarily on the West Coast of the United States and Canada but in some instances elsewhere in the nation.

Over a 17-year period beginning in 1986 I spent a major share of my time as the principal investigator on two extended research projects concerning the ecological responses of freshwater resources to urban conditions and the urbanization process. I led an interdisciplinary team for 11 years in studying the effects of human activities on freshwater wetlands of the Puget Sound lowlands. This work led to a comprehensive set of management guidelines to reduce negative effects and a published book detailing the study and its results. The second effort involved an analogous investigation over 10 years of human effects on Puget Sound's salmon spawning and rearing streams. These two research programs have had broad sponsorship, including the U.S.

Environmental Protection Agency, the Washington Department of Ecology, and a number of local governments.

I have helped to develop stormwater management programs in Washington State, California, and British Columbia and studied such programs around the nation. I was one of four principal participants in a U.S. Environmental Protection Agency-sponsored assessment of 32 state, regional, and local programs spread among 14 states in arid, semi-arid, and humid areas of the West and Southwest, as well as the Midwest, Northeast, and Southeast. This evaluation led to the 1997 publication of "Institutional Aspects of Urban Runoff Management: A Guide for Program Development and Implementation" (subtitled "A Comprehensive Review of the Institutional Framework of Successful Urban Runoff Management Programs").

My background includes 23 years of work in California, where I have been a federal court-appointed overseer of stormwater program development and implementation at the city and county level and for two California Department of Transportation districts. I was directly involved in the process of developing the 13 volumes of Los Angeles County's Stormwater Program Implementation Manual, working under the terms of a settlement agreement in federal court as the plaintiffs' technical representative. My role was to provide quality-control review of multiple drafts of each volume and contribute to bringing the program and all of its elements to an adequate level. I have also evaluated the stormwater programs in San Diego, Orange, Riverside, San Bernardino, Ventura, Santa Barbara, San Luis Obispo, and Monterey Counties, as well as a regional program for the San Francisco Bay Area. At the recommendation of San Diego Baykeeper, I have been a consultant on stormwater issues to the City of San Diego, the San Diego Unified Port District, and the San Diego County Regional Airport Authority.

I was a member of the National Academy of Sciences-National Research Council ("NAS-NRC") committee on Reducing Stormwater Discharge Contributions to Water Pollution. NAS-NRC committees bring together experts to address broad national issues and give unbiased advice to the federal government. The present panel was the first ever to be appointed on the subject of stormwater. Its broad goals were to understand better the links between stormwater discharges and impacts on water resources, to assess the state of the science of stormwater management, and to apply the findings to make policy recommendations to the U.S. Environmental Protection Agency relative to municipal, industrial, and construction stormwater permitting. My principal contribution to the committee's final report, issued in October 2008, was the chapter presenting the committee's recommendations for broadly revamping the nation's stormwater program.