June 22, 2018

Via e-mail and U.S. mail to:

Renee A. Purdy
Regional Programs Section Chief
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Re: Comments on the proposed revision of the Rio Hondo & San Gabriel River Enhanced Watershed Management Program.

Dear Ms. Purdy:

The Natural Resources Defense Council (NRDC), Heal the Bay, and the Los Angeles Waterkeeper thank you for this opportunity to comment on the proposed revision of the Rio Hondo & San Gabriel River ("RH/SGR") Enhanced Watershed Management Program ("revised plan" or "revised EWMP"). We would also like to thank the EWMP group for their willingness to involve NGOs in the revision process before review and during the course of review going forward. Below, you will find a summary of our comments on the revised EWMP and an attachment with more detailed comments.

General Comments

Generally, the revised EWMP lacks a thorough examination of the implications of calibration defects and assumptions, both with the projects themselves and with the models used to assess their effectiveness. There is a need to quantify the uncertainty created by assumptions, and to justify conclusions. Further, this revised plan further illustrates one of the major concerns regarding the 2012 permit: that there would be little analysis up-front, leading to constant revision and little actual implementation. Without these analyses, there remains potential for continued pollution, even if the revised EWMP is fully implemented, resulting in continued impact to public and environmental health. Specific examples of this are provided below.

Additionally, the dramatic change in the proposed green streets—from 273 miles of green streets proposed in the Rio Hondo watershed to zero miles in the new revised plan—presents a missed opportunity to create multi-benefit projects in pollution-burdened cities such as Duarte and Monrovia. Further, the proposed regional projects must consider opportunities for public education and the creation of multiple community benefits.

Assumptions and Conclusions
Metals mass loading is simulated as associated with sediment erosion and transport in rainfall and irrigation water runoff; this assumption is questionable for copper and zinc, due to the variable solubility of these constituents depending on the contaminant source and on conditions of the receiving water. The validity of and support for this assumption is particularly important for zinc, as it has been selected as the limiting priority pollutant. Applicants must justify the use of this assumption.

The same is true for the assumption for water hardness; while the hardness assumption used in the revised EWMP (50^{th} percentile values measured in the receiving waters) is more protective than in previous simulations, its use is not justified and must be.

The revised plan asserts that using the 90^{th} percentile rainfall intensity in the most recent ten years of data is the most overall protective of the rainfall intensity options; however, it does not explain how or why, or provide examples. This conclusion must be justified.

The revised plan assumes that control of one pollutant will also control other target contaminants. First, it assumes that implementation of the metals TMDLs will address much of the bacteria impairment. There are instances where addressing metals did not adequately address bacteria; for example, in the Upper LA River, Reach 2. Also, it assumes that base flows and dry-weather discharges from the RH/SGR area are *not* large contributors to the impairments identified in the relevant TMDL. This assumption is unfounded, particularly for bacteria, as exceedances occur during both wet and dry-weather conditions. While the revision states that more investigation is needed, it does not examine, in any way, the current level of confidence in these vital assumptions. A discussion of these assumptions and their effects must be submitted.

Copper is the contaminant requiring the most reduction at two compliance points; however, this was dismissed on the assumption that copper will be controlled, at least to a level below zinc, by the statewide brake pad replacement program. However, this program will not be fully implemented until 2025. Again, this assumption that copper will be controlled is not justified and must be.

The revised plan does not provide an explanation of the redevelopment rates used, and again, there is no analysis of the uncertainty created by using the rate selected. The reasoning behind the redevelopment rate selected and an analysis of the effect of this assumption must be provided.

Model and Model Calibration
There are several issues with the model and the calibration of the model used in the revised plan; these issues are summarized below.

The modeling used underrepresents flows from larger events; this is particularly troublesome as climate change will undoubtedly increase the frequency of larger events. The Regional Board's recent resolution to adapt to and mitigate the impacts of climate change recognizes the substantial impacts that climate change will have on water resources, impacts which include an increase in “extreme precipitation events” and “in the occurrence of flooding.” These larger events must be accurately represented.

A number of observed points for copper, lead, and zinc concentrations fall well above the modeled values at station S10 (revised RAA Figure 2-21). Zinc especially deviates, with one observed concentration about 10 times as high as the model forecast. This deviation is particularly concerning, as zinc has been chosen as the limiting pollutant. Further, the model captures the lower range of observed concentrations at S10 and S14, but misses some peak concentrations for each of the metals at both calibration stations. (revised RAA Figures 2-22 and 25). The inability of the model to reliably predict high concentrations reduces its usefulness in demonstrating compliance with Permit concentration and mass loading limits.

Another concern with the water quality model calibrations is revealed by noting opposite trends in revised RAA Tables 2-10 (for the LAR station) and 2-11 (for the SGR station). These tables compare model-predicted metals concentrations issuing from seven different land uses versus values based on reports in the technical literature. For the 21 possible comparisons (three metals and seven land uses), the model forecasts exceeded the literature-based values in sixteen cases in the SGR case but only four in the LAR instance. The reasons for the variation between the two watersheds is not explained; the systematic tendency of a model to over- or under-predict should be consistent between two watersheds relatively close in proximity and characteristics, or at least not differ so strikingly. This is another example of the need for the assessment of model shortcomings and their effect on achieving permit objectives.

Project General Assumptions
One overarching category of assumptions pertains to all projects: the hydrogeological conditions at the sites, most instrumentally the soil types, infiltration rates, presence of confining subsurface layers, groundwater positions, and existing below-ground contamination. Soils must have sufficient porosity to store infiltrated runoff until it percolates farther down. The infiltration rate, absence of a confining soil or rock layer, and sufficient spacing to the highest water table position determine if the facility can drain rapidly enough and avoid operating problems; and legacy contamination in the percolating water path risks mobilizing and spreading pollutants.

Despite the crucial importance of these factors, there has been no geotechnical investigation to define them for *any* site. This is true of the green streets projects, in addition to the regional projects. This confirms what we feared with the 2012 permit: that there would be constant revision of proposed projects with little to no implementation. It is necessary to conduct more investigation up-front regarding whether the projects discussed are feasible and will function as stated, rather than seeking revisions once it is revealed that projects weren’t adequately considered from the beginning.

Specific Projects

Arcadia Arboretum Natural Treatment and Groundwater Recharge Project

This regional project is likely undersized as a single, 85^{th} percentile 24-hour storm event would create about 50 acre-feet of runoff whereas the wetland cell has a storage volume of 1.4 acre-feet and the recharge ponds will provide an additional 1 acre-foot.

Relatedly, the revised plan does not describe the expected treatment effectiveness for the runoff passing through the wetland and then discharging to downstream waters. This variable is subject to uncertainty, like so many other factors in the analysis and this is yet another area where uncertainty must be quantified and examined for its implications on achieving objectives.

In addition to the lack of examination of hydrogeological conditions at the site, applicants have not yet examined dry weather flows for this project. The revised plan cites dry weather flow as a potential problem at the site, and this should be examined prior to approval.

Finally, the schedule of this project allows for five years for feasibility studies followed by another five years until completion. This extended, ten-year schedule must be justified.

Rio Hondo Ecosystem Restoration Project and Arcadia Wash Water Conservation Diversion

Once again, the size of the contributing area versus the project's cited infiltration capacity call into question its functionality. The system will serve a contributing drainage area of 15,777 acres while infiltration rates of < 0.3 inch/hour, calculated by project analysts, are very limiting to recharge. Further, even if ample infiltration existed at the site, the project remains undersized for the drainage area.

Additionally, more information is needed about the proposed conveyance(s) associated with this project, including the legality of such conveyance(s).

Encanto Park Stormwater Capture Project

The proposed timeline for this project is unsupported; feasibility studies are set to take place between September 2022 and March 2023, with project completion by September 2026. The schedule provided must be justified.

Basin 3E Enhancements at Santa Fe Spreading Grounds Project

The revised plan states that sediment must be removed from the bottom of the basin to achieve the expected high infiltration rate for this project; however, it is unclear whether these removal activities are considered to be part of the project. This should be clarified.

While this project has a more compressed feasibility assessment period than the others, like the other projects discussed, the schedule is not supported. Additionally, the project's follow-up steps appear to be drawn out and also must be justified.

Green Streets
The revised plan does not go into site-by-site specifications of proposed green streets. As in the case of the regional projects, there has been no on-site geotechnical investigation. Particularly in light of the vast reduction in the amount of green streets proposed, the revised plan must have more details regarding feasibility and location. Without these specifics, these numbers can be regarded only as goals, goals which could be revised at any time with little to no implementation, as demonstrated by this revision. Again, this is a manifestation of our original fear with the 2012 permit: constant revision with little to no projects installed.

The Effect of Assumptions on the Model
Table 4-8 in the revised RAA shows that there is little margin at any compliance point between the total expected and required decreases in zinc mass loading. The differentials range from 0.4 to 6.2 percent; these are extremely small margins in light of the uncertainties introduced by the assumptions, calibration deviations, and project constraints discussed above.

The two regional projects in the Rio Hondo Drainage Area are being relied on for 73.4 percent of the required reduction. Both of those projects, especially the Peck Park Lake spreading grounds, pose significant questions about infiltration and sizing. These issues, discussed above and below, must be addressed prior to approval of the revision.

It is fair to say that it is unlikely these regional projects will function exactly as planned, as such, additional distributed projects should be analyzed and included in the revision. Because of this, and the small margin (.4 to 6.2 percent depending on the compliance point) between the expected and required decreases, additional projects must be adequately considered in the revised plan.

Finally, the revised RAA gives no estimates of the relative certainty of either the mass loading reductions or CTR compliance. Failure to quantify potential deviations and potential error magnitudes and failure to determine which projects are necessary for a certain level of assurance of achieving compliance seems contrary to the permit requirement in VI.C.5.b.iv.(5), which states that "…data shall be statistically analyzed to determine the best estimate of performance and the confidence limits on that estimate for the pollutants to be evaluated."

Recommendations
We make the following recommendations for the revised plan:

- Applicants must justify the assumptions used, quantify uncertainties, and support conclusions.
- Peak metals concentrations and flows from large rain events are both underestimated; this must be remedied.
- On-site investigations of potential regional and distributed project sites must be conducted prior to approval of the revised plan.
- Additional distributed projects should be included to create a larger margin between expected and required decreases.
- Proposed Regional Project timelines must be justified.

Below, you will find more detailed comments on the revised plan, which are incorporated by reference. Thank you again for this opportunity to comment. NRDC, Heal the Bay, and the Los Angeles Waterkeeper welcome the opportunity to work with the Board to ensure that water quality is protected for present and future generations, and for the survival and well-being of humans, plants, and wildlife.

Regards,

/s Corinne Bell	/s Annelisa Ehret Moe	/s Arthur Pugsley
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Attch: ASSESSMENT OF RIO HONDO/SAN GABRIEL RIVER REVISED RAA AND EVALUATION OF MULTI-BENEFIT PROJECTS

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Date: June 22, 2018

To: Los Angeles Regional Water Quality Control Board

From: Richard Horner, on behalf of NRDC

Subject: ASSESSMENT OF RIO HONDO/SAN GABRIEL RIVER REVISED RAA AND EVALUATION OF MULTI-BENEFIT PROJECTS

REVISED RAA ASSESSMENT

Scope of Assessment

My principal concern in appraising the Rio Hondo/San Gabriel River (RH/SGR) Revised Reasonable Assurance Assessment (RAA) was ascertaining the soundness of its general conclusion that the 2012 Municipal Separate Storm Sewer System (MS4) Permit in-stream pollutant concentration and mass loading numeric limits actually will be met. I concentrated on the quality of application of the selected mathematical models responsible for producing the results leading to that conclusion. I did not critique the models themselves, as I agree that they are appropriate choices and substantially better ones are not available. However, even these good models cannot represent all that occurs in the real world, and they depend on assumptions by the human analysts and initial calibration on the basis of existing data previously collected in the aquatic systems at issue. I therefore first focused my review on the reasonableness of the assumptions and the success in calibration. I then critiqued the four regional BMP projects and the distributed Green Streets identified in the RAA and modeled to estimate their contributions to the loading reductions in the two watersheds, with the aim of evaluating their potential for actually making those contributions. I used my observations to judge the prospects for meeting Permit objectives and to make recommendations for future modeling and conduct of the overall RH/SGR Enhanced Watershed Management Program (EWMP).

Evaluation of Assumptions

A Catalogue of the Major Assumptions

The assumptions underlying the modeling exercise are scattered through the Revised RAA document, instead of being listed and considered in any one place. My discussion covers the most instrumental ones in more of less the order in which they appear. There are undoubtedly other assumptions embedded in the modeling but not mentioned.

A key assumption fundamental to the water quality model appears in Revised RAA section 2.1.2: metals mass loading is simulated as associated with the processes of sediment erosion and transport in rainfall and irrigation water runoff. This assumption is reasonably good for lead, which tends to be a relatively insoluble metal, but questionable for copper and zinc. Copper and zinc are generally more soluble than lead and variable in their solubility, depending on source and water conditions. The validity of the assumption is a particular issue for zinc, since it was selected as the limiting priority pollutant, the control of which within its designated limits is assumed also to control the other priority pollutants within their limits.

Metal concentration limits depend on water hardness,[1] which is discussed in section 2.2. For modeling hardness values were selected as the 50th percentile (median) values measured in the receiving waters. This selection was not justified with an explanation or examined; *e.g.*, investigating, for example, the ramifications of choosing conservative (in terms of maximum environmental protection) values, such as the 25th or the 5th percentile. The strategy for establishing hardness differed from the procedure employed to select the factors to convert between total recoverable and dissolved metals.[2] Those factors were chosen on a conservative 95th percentile basis. There was no explanation for the difference in the strategies. I do acknowledge that using the 50th percentile numbers for hardness did result in reduction of the values used in the initial RAA, thus being more protective.

Section 2.3 covers the critical rainfall condition selected for modeling. The critical condition is the one believed to create the greatest challenge to meeting the EWMP's water quality objectives. The model uses this climatological variable in determining baseline pollutant mass loadings and eventual load reduction requirements. The decision was to define the critical water year as the one producing the 90th percentile rainfall intensity in the most recent 10 years of data, computed as the average rainfall per wet day. The Revised RAA states that a number of other potential critical conditions were explored, including the critical water year based on the greatest total rainfall, a representative water year based on average annual rainfall, and daily critical conditions, such as the 90th percentile load. The critical water year based on rainfall intensity was identified as the most robust, and overall protective, condition. The report does not provide the documentation for this investigation; thus, the reader can only take it at its word. It should provide an actual demonstration to buttress the assertion that the choice gives a high level of protection.

Section 2.4 takes up the issue of using one pollutant as the critical one to control with the anticipation that the required control of other target contaminants will also be achieved. First, it assumes that implementation of the metals TMDLs, with earlier compliance deadlines, is expected to address much of the bacteria impairment. Also, it assumes that base flows and dry-weather discharges from the RH/SGR area are not suspected to be large contributors to the impairments identified in the relevant TMDL. The account admits that more investigation is

[1] The calcium and magnesium ions principally constituting hardness are antagonistic to the toxicity of copper, lead, zinc, and other metals; *i.e.*, the more of the hardness-producing elements present, the lower the toxicity of the heavy metal. Accordingly, concentration limits set on these metals are a function of hardness.
[2] The available in-stream measurements are in total recoverable terms, whereas the California Toxics Rule (CTR) numeric limits are as dissolved metals.

needed but does not examine in any way the current level of confidence in this set of three assumptions.

The section goes on to cover the selection of zinc as the limiting priority pollutant, the one requiring the greatest reduction. That copper actually is the contaminant requiring the most reduction at two compliance points was dismissed on the assumption that it will be controlled, at least to a level below zinc, by the statewide brake pad replacement program. The quality of this assumption and the implications if it falls short were not examined.

Section 3.1.1 exposes two key assumptions pertaining to the BMP program intended to meet objectives: (1) enhanced minimum control measures (MCMs) will achieve 5 percent of the required control, and (2) all redevelopment projects will include low impact development (LID) BMPs required by the MS4 Permit providing a loading reduction based on capturing the runoff volume associated with the 85th percentile, 24-hour rainfall. As with other assumptions covered above, these premises are not justified with any documentation (*e.g.*, data on actual achievements since Permit adoption) or investigated in terms of their repercussions if not borne out. For various reasons, regulatory requirements are usually not completely fulfilled. Furthermore, there is no attention given to an enhanced institutional framework and programs to advance application of the present Permit requirements. I refer, for example, to specific functions being established within each municipal stormwater program and development permitting department to implement MCMs and ensure that redevelopments actually install the required LID BMPs. Without such a structure, actual achievement is unlikely in my opinion.

BMPs added through redevelopment, in the past and projected in the future, are based on redevelopment rate data pertinent to the region. There is no explanation of the rates used. On the presumption that they are statistical means over some period, they have some statistical variance, particularly because the period over which they were likely to be derived experienced substantial economic fluctuations inevitably affecting redevelopment. This variance is one more source lending uncertainty to predictions.

Additional Points Regarding Assumptions

Assumptions are inescapable in analytical work involving complex systems in general and mathematical modeling in particular. My complaint is not that assumptions were made but, for the most part, they were not justified by documentary evidence; and, furthermore, their effects on conclusions and achievement of objectives were not examined. After covering model calibration and the proposed regional BMP projects, I return to this subject and how the examination should be conducted relative to assumptions, calibrations, and regional project issues.

<u>Model Calibration Success</u>

Introduction

The RAA process relies entirely on the output of a linked set of mathematical models representing the land cover, hydrology, water quality, and best management practice (BMP) performance in the EWMP area. The quality of the results depends heavily on the ability of the analyst to calibrate the various models to produce output agreeing closely with actual data and, ideally, to verify the calibration by comparing additional model runs to independent data (*i.e.*, data not used in the calibration). The Revised RAA presents calibration results for hydrology in Table 2-5 and Figures 2-8 to 2-13; for pollutant mass loadings (lbs./day) in Figures 2-14, 16, 17, 19, 20, 22, and 23; and for pollutant concentrations (mg/L) in Figures 2-15, 18, 21, and 24.

Hydrology Modeling

A general inspection of the hydrologic modeling data indicates generally good calibrations, but with some key exceptions. Table 2-5 compares hydrologic model calibrations at six flow stations to criteria expressing goodness of fit, which are given in Table 2-4. Four stations met the total volume prediction criterion; two deviated from it by less than 4 percent. Five stations met the criterion for predicting the 10 percent highest flows, but one deviated by more than 30 percent. Only one station met the Nash-Sutcliffe Efficiency Statistic criterion, two deviated by less than 3 percent, and two were off by more than 12 percent.

In the midst of this fairly good hydrologic model calibration success overall, however, there are some indications in the graphs that the model misses the peak average flow rates in the larger rainfall events. Evidence can be seen in some blue traces representing observed values projecting well above the orange traces representing modeled flows on four of the six flow versus date graphs (top graphs in Figures 2-8 to 2-11). Also, the plots of average modeled flow versus average observed flow exhibiting the lower R^2 values (deviating most from 1.0)[1] tend to be model underestimates in the larger events (lower left plots in Figures 2-9 and 11).

Water Quality Modeling

Water quality model calibrations, as for hydrology, are generally fairly good but with some exceptions that could be instrumental in compromising the analysis. It may be seen in Figure 2-21 that a number of observed points for copper, lead, and zinc concentrations fall well above the modeled values at station S10. Zinc, especially, deviates, with one observed concentration about 10 times as high as the model forecast. This result is a particular concern, with zinc being limiting priority pollutant.

Furthermore the R^2 values for modeled copper, lead, and zinc mass loadings at station S14 (San Gabriel River, SGR; Figure 2-23) are very low (0.05-0.23), far beneath those at station S10 (Los Angeles River, LAR; Figure 2-20). In addition, the pollutant load-duration plots (mass loading versus flow exceedance percentile;[2] Figures 2-22 and 25) show the model captures the lower range of observed concentrations but misses some peak concentrations for each of the metals at

[1] R^2, the coefficient of determination, is usually defined as the proportion of the statistical variance in the dependent variable (on the vertical axis of a graph of the two associated variables) that is explained by the variance in the independent variable (on the horizontal axis). It expresses how many data points fall on the line plotted using the computed regression equation. For example, $R^2 = 0.80$ would signify that 80 percent of the variance in the dependent variable is explained by the variance in the independent variable, and that 80 percent of the data points used in deriving the equation fall on the line representing the equation.

[2] Flow exceedance percentile is percentage of flow rates that exceed all flow rate values recorded in the full set of measurements. For example, a flow rate at the 90th percentile is equal to or greater than 90 percent of the measured rates.

both calibration stations. Inability of the model to reliably predict high concentrations reduces its usefulness in demonstrating compliance with Permit concentration and mass loading limits.

The Revised RAA on page 31 states that peaks observed to fall above model forecasts seem to be random and are likely due to processes that cannot be captured by the model. I agree that no available mathematical model, even the most comprehensive and sophisticated, can represent all of the processes and variability inherent in any actual aquatic physicochemical system. However, as I expand on below, I advocate thorough examination of the implications of the deficiencies in model structure and calibration for achieving the legally mandated numerical objectives of the EWMP. My call applies to the hydrologic, water quality, and BMP models, for none of which has the RAA performed such an analysis.

A final concern with the water quality model calibrations is revealed by noting opposite trends in Tables 2-10 (for the LAR station) and 2-11 (for the SGR station). These compilations compare model-predicted metals concentrations issuing from seven different land uses versus values based on reports in the technical literature. For the 21 possible comparisons (three metals and seven land uses), the model forecasts exceeded the literature-based values in 16 cases in the SGR case but only four in the LAR instance. I normally expect that a systematic tendency of a model to over- or under-predict would be consistent between two watersheds relatively close in proximity and characteristics, or at least not to differ so strikingly. This is another point justifying my call for meaningful assessment of what the model shortcomings mean in relation to achieving the program objectives.

Additional Points Regarding Calibration

The calibrated models were not verified by comparing additional model run outputs to independent data. This important step probably was skipped because data sets were insufficient to split, and all available data had to be used for calibration. As data accumulate in the future, though, the models should be revisited and verified or, if unverified, recalibrated and applied to reevaluate compliance with Permit objectives.

By pointing out imperfections in calibration and lack of verification, I am not casting fatal aspersions on the modeling exercise underlying this RAA. Models are never perfectly calibrated, and it is not unusual for data to be too scant to conduct a robust calibration and follow it with verification. What I believe should occur in these circumstances, though, is thorough examination of the implications of the calibration defects (as well as the assumptions) for the conclusions reached. I expand on that view in the final section of this memorandum.

EVALUATION OF REGIONAL AND GREEN STREETS PROJECTS

Introduction

EWMP Attachment B covers four proposed regional BMP projects and, in its Appendix B.5, potential Green Streets projects. In my evaluation I was mainly concerned with the assumptions underlying these projects, constraints to their successful execution, their prospective contributions to realizing the EWMP's water quality objectives, and the prospects for providing these contributions in the face of the assumptions and constraints.

One overarching category of assumptions pertains to all projects: the hydrogeological conditions at the sites, most instrumentally the soil types, infiltration rates, presence of confining subsurface layers, groundwater positions, and existing below-ground contamination. All of the proposed projects will rely on substantial infiltration of influent runoff, and these hydrogeological conditions govern how effective that strategy will be. Soils must have sufficient porosity to store infiltrated runoff until it percolates farther down; the infiltration rate, absence of a confining soil or rock layer, and sufficient spacing to the highest water table position determine if the facility can drain rapidly enough and avoid operating problems; and legacy contamination in the percolating water path risks mobilizing and spreading pollutants.

Despite the crucial importance of these factors, there has been no geotechnical investigation to define them for any site. There is some evidence to characterize them for basic planning purposes; but until the actual investigations are performed, substantial uncertainties bar developing strong confidence that all of the projects will achieve what they must to meet the objectives. At this point, soil conditions are based on the National Resource Conservation (NRCS) soil surveys. Soil survey data of this nature were generally not obtained through on-site testing, or even observation, but commonly through 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 infiltration. The NRCS reports give incomplete information about confining layers and none at all on legacy contamination. The only way to obtain the needed information is to perform on-site soil borings and associated analyses, conduct infiltration testing, and find any available records on past disposal of hazardous contaminants.

Arcadia Arboretum Natural Treatment and Groundwater Recharge Project

This regional BMP system will divert runoff from Arcadia Wash to a sediment forebay for pre-treatment, with flows then entering a wetland for treatment and overflowing from there into two surrounding groundwater recharge ponds. It is estimated that these ponds will supply approximately 100 acre-ft/year of groundwater recharge. Flow at a rate of 1 cubic ft/second (cfs) will be extracted from the wetland to supply Baldwin Lake. Flows above the design rate will bypass the system. The wetland cell will have a storage volume of 1.4 acre-ft, and the recharge ponds will provide an additional 1.0 acre-ft. The project overall is estimated to provide 35.7 lbs./year of zinc reduction in the Rio Hondo Drainage Area.

The system will serve a contributing drainage area of 1633 acres. Arcadia receives an average of 18 inches of rain per year.[1] If designed to treat runoff from the 85th percentile, 24-hour event, it would receive roughly 60 percent of the annual precipitation (~ 40 percent would bypass).[2] Assuming a runoff coefficient (ratio of runoff produced to rainfall received) of 50 percent for the watershed, the BMP would receive approximately 735 acre-ft/year of runoff.[3] Even at a runoff coefficient of 25 percent, a runoff volume of 368 acre-ft would be well above the cited recharge capacity. Any excess over an estimated 100 acre-ft/year would receive treatment in the wetland but would then discharge downstream. A single 85th percentile, 24-hour storm of 0.75 inch would produce about 51 acre-ft assuming a 50 percent runoff coefficient,[4] or 25.5 acre-ft with a 25 percent assumption. These are large quantities relative to the system's storage capacity, which calls into question its ability to function well in retention (*i.e.*, avoiding surface discharge to downstream waters) and treatment of the water that is discharged. I performed this analysis because the dimensions cited in Attachment B struck me as quite small relative to the size of the watershed. I continue to have that concern.

The NRCS data for the location of the BMP gives the soils as gravelly sandy loam to very cobbly sand in Hydrologic Soil Groups A and B (A is the most infiltrative, D the least). Well logs show groundwater at > 20 ft below the ground surface. These characteristics are favorable for infiltration if borne out in on-site investigations. When those data are available, the groundwater recharge capacity of the system should be reevaluated. Ability to infiltrate considerably more than 100 acre-ft/year would fully or partially alleviate my concern with the size of the facility. At this point, though, I am doubtful that it is large enough to do the intended job.

The account does not make clear what treatment effectiveness is expected for the runoff passing through the wetland and then discharging to downstream waters. That efficiency variable is subject to uncertainty, like so many other factors in the analysis. Also like those, that uncertainty should be quantified and examined for its implications on achieving objectives.

Two constraints are cited as potential problems for implementing the BMP: excavation costs and insufficient dry weather flow both to maintain a wetland and serve Baldwin Lake. In my experience, wetland vegetation can withstand lack of inflow for three or four months but not longer. The dry weather flow should be monitored now to determine the seriousness of this constraint.

The schedule shows feasibility study from January 2018 through January 2023, with project completion in January 2028. There are no reasons given for such an extended schedule. It does not appear that the cited constraints justify it.

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[1] https://www.bestplaces.net/climate/city/california/arcadia.

[2] 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. Report to U.S. Environmental Protection Agency by Natural Resources Defense Council. Table 3.

[3] 1633 acres x 1.5 ft rain/year x 0.50 runoff coefficient x 0.60 to BMP = 735 acre-ft/year.

[4] 1633 acres x (0.75 inch/12 inches/ft) x 0.50 runoff coefficient = 51.0 acre-ft.

Rio Hondo Ecosystem Restoration Project and Arcadia Wash Water Conservation Diversion

This project will proceed in two phases. The first phase will divert runoff from Arcadia Wash to a pre-treatment device and then convey it to Sawpit Wash and into the Peck Park Lake spreading basin to recharge the San Gabriel Groundwater Basin. This phase is regarded as a benefit to water supply primarily, although extracting water from the surface discharge system will also offer a water quality benefit. In the second phase, Sawpit Wash water will be diverted into a pre-treatment, 3.3 acre-ft sediment basin before entering an 8.3-acre constructed wetland with 33.1 acre-ft volume capacity. The wetland will discharge to Peck Park Lake for infiltration. A temporary inundation area adjacent to the wetland will allow for additional groundwater recharge as well. All flows exceeding what can be infiltrated will drain downstream to Rio Hondo Reach 3.

The system overall is expected to provide approximately 1000 acre-ft/year of recharge and reduce zinc loading in the Rio Hondo Drainage Area by 818.3 lbs./year, a major contribution to meeting the objectives for that area if the BMPs function as intended. Peck Park Lake is also being counted upon to manage dry-weather flows from Santa Anita Wash. Well logs indicate that groundwater, lying > 42 ft below the surface, will not be a constraint.

The system will serve a contributing drainage area of 15,777 acres. On the same basis as the analysis above for the Arboretum BMP, the BMP would receive approximately 7100 acre-ft/year of runoff with the assumption of a 50 percent runoff coefficient, or 3550 acre-ft/year with a 25 percent assumption. The 85th percentile, 24-hour storm (0.75 inch) would produce about 493 acre-ft assuming a 50 percent runoff coefficient, or 246 acre-ft with a 25 percent assumption. Once again, the size of the contributing area versus the BMP and its cited infiltration capacity call into question its functionality.

Of particular concern in this case is the questionable infiltration capability of the Peck Park Lake spreading basin. The NRCS report gives the local soils as fine sandy loam. Infiltration rates of < 0.3 inch/hour were calculated by the project analysts, which would be very limiting to recharge. The site is known to have fill installed after mining activity ended. The analysts note that it was an "uncontrolled" fill and give the opinion that such a fill would be looser and more infiltrative than an engineered fill. I believe that the evidence and this opinion are extremely weak reeds to grasp in putting forth a project that relies on infiltration, and appears to be undersized even if an ample infiltration rate could be counted upon. It is already known that the water collected in the spreading basin recharges the groundwater solely through infiltration into the sidewalls, because of sediment build up at the bottom of the lake.

The report cites two project constraints: acquisition of land now in commercial use and potential soil liquefaction requiring sufficient setbacks of infiltration zones from structures. I regard these as factors potentially threatening to at least the schedule of the project. Still, in my view the unpromising infiltration is the major constraint on this project.

The schedule shows feasibility study from January 2021 through July 2024 and project completion in January 2028. Again, there was no justification given. Because of the serious question about infiltration, I believe that investigation of this issue should start immediately.

This project, and its large expected contribution to pollutant loading reduction, may have to be replaced; or major work may have to be performed to make it feasible.

Encanto Park Stormwater Capture Project

The Encanto Park project will divert runoff from an existing storm drain to a hydrodynamic pre-treatment device and then to an underground infiltration gallery 1.3 acre-ft in volume. The project will serve a drainage area of 180 acres. It is intended to reduce zinc loading in the San Gabriel River Drainage Area by 2.2 lbs./year.

On the same basis as the analysis above for the Arboretum BMP, the BMP would receive approximately 81 acre-ft/year of runoff with the assumption of a 50 percent runoff coefficient, or 40.5 acre-ft/year with a 25 percent assumption. A single 85^{th} percentile, 24-hour storm of 0.75 inch would produce about 5.5 acre-ft.

The soils in this case, according to the NRCS survey, are very cobbly to extremely cobbly sand in Hydrologic Soil Group A. If this report turns out to be correct with on-site testing, the capacity appears to be sufficient to accommodate the inflow.

The only possible constraint cited in the report is a temporary impact to the park and its recreational functions. This has been a manageable situation in other stormwater BMP installations in parks.

The schedule is to perform the feasibility work from September 2022 through March 2023 and complete the project by September 2026. Once again, no reasons are given for the scheduling.

Basin 3E Enhancements at Santa Fe Spreading Grounds Project

This regional BMP system will enhance the existing flood control detention basin at the Santa Fe Spreading Grounds by constructing a 1.1 ac-ft sediment forebay with an energy dissipating mechanism for pre-treatment. Flows from the sediment basin will spill over a concrete weir to a secondary basin where water will be filtered through a sand filter, 11.4 acre-ft in volume, with a geotextile bottom and perforated underdrains to convey treated flows to the San Gabriel River. There will be a second concrete weir with overflow that will drain into a 5.0 acre-ft basin that will provide additional treatment as well as utilize the downstream portion of the basin that is not needed for the water quality sizing. The project will serve a drainage area of 2137 acres. It is intended to reduce zinc loading in the San Gabriel River Drainage Area by 62.1 lbs./year.

On the same basis as the analysis above for the Arboretum BMP, the BMP would receive approximately 962 acre-ft/year of runoff with the assumption of a 50 percent runoff coefficient, or 481 acre-ft/year with a 25 percent assumption. A single 85^{th} percentile, 24-hour storm of 0.75 inch would produce about 96 acre-ft.

The spreading grounds have long existed and presumably have exhibited effective infiltration. They lie in coarse quarry material classified as Hydrologic Soil Group B. The report notes that sediment must be removed from the bottom of the basin to achieve the expected high infiltration rate. It implies but does not directly state that this operation will be a part of the project, as it should be. Groundwater in local wells was not encountered until > 128 ft below the ground surface.

The cited constraints are confinement by the surrounding spreading grounds and lack of a recreational component to help in funding the project. Confinement will be a problem if the hydrogeologic investigation shows the soils and infiltration rate are limiting and the units must be larger. If the project is needed to meet the Permit objectives, funding should be provided in any circumstances.

The project has a more compressed feasibility assessment period than the others, March to September 2019, with completion in September 2026. The feasibility schedule seems to be reasonable but the follow-up steps exceedingly drawn out in my opinion. Here, as with the other regional projects, the schedule provided needs to be justified.

Big Dalton and Eaton Wash Green Streets

Green Streets, a term for locally distributed stormwater control measures generally along urban streets, are required to meet the pollutant reduction targets of the EWMP in areas not draining to regional projects (specifically, in the Big Dalton Wash watershed and portions of the EWMP area that drain downstream from the Rio Hondo compliance point via Eaton Wash). The BMP types being considered for implementation are: biofiltration (lined, non-infiltrating), bioinfiltration (unlined, infiltrating), infiltration galleries, and infiltrating dry wells. Attachment B states criteria to select projects, maps opportunities according to those criteria, and shows proposed locations. However, it does not go into site-by-site specifications of what exactly would be installed. As in the case of the regional projects, there has been no on-site geotechnical investigation; and, while not specifically stated, the development of these projects to date is presumably based on NRCS data.

The Green Streets are intended to remove 54.7 lbs. zinc/year from Big Dalton Wash and 59.5 lbs. zinc/year from Eaton Wash. Without the specifics on actual applications, these numbers can be regarded only as goals. The potential for achieving them must be examined after the BMP specifics are available.

ASSESSING THE EFFECTS OF IMPERFECT ASSUMPTIONS AND CALIBRATIONS ON PREDICTIONS

Introduction

Up to this point in this memorandum I have critiqued the assumptions and calibration procedures underlying the modeling exercise employed to demonstrate how the Permit's objectives will be achieved, and the BMP projects intended to provide a portion of the pollutant reduction necessary for that achievement. At their current state of definition, those projects themselves entail assumptions, particularly regarding the soil conditions and associated infiltration rates at the sites.

Relative to the Permit's concentration objectives, modeling predicts that implementation of the BMPs cited will meet the CTR criteria on 96.0 and 94.5 percent of all wet days at the Rio Hondo and San Gabriel River compliance points, respectively. Revised RAA Tables 4-8 and 4-9, reproduced here as Table 1, summarize the zinc mass loading reductions required and expected to be provided by the various stormwater management actions.

It can be seen in Table 1 that there is little margin at any compliance point between the total expected and required decreases. The differentials range from 0.4 to 6.2 percent. These are extremely small margins in light of the uncertainties introduced by the assumptions, calibration deviations, and BMP project constraints. The two regional projects in the Rio Hondo Drainage Area are being relied on for 73.4 percent of the required reduction. As I pointed out above, both of those projects, especially the one using the Peck Park Lake spreading grounds, pose significant questions about infiltration potential and sizing.

Table 1. Zinc Mass Loading Reductions (in lbs./year) Provided by Three BMP Types and in Total, Compared to Required Reductions

Control Measure	Compliance Point			
	Rio Hondo	San Gabriel River	Big Dalton Wash	Eaton Wash and Rio Hondo Downstream
Enhanced MCMs and Redevelopment LID	333	52.2	79.8	17.4
Multi-Benefit Regional Projects	854	64.3	--	24.0
Green Streets	--	--	54.8	59.5
Total	**1187**	**116.5**	**134.6**	**100.9**
Required	**1163**	**109.3**	**134.1**	**98.1**

The Revised RAA gives no estimates of relative certainty of either the mass loading reductions or CTR compliance. Failure to quantify potential deviations from assumptions and potential error magnitudes and determining what BMPs are necessary to give some set level of assurance of achieving compliance is likely contrary to the Permit, which states [at VI.C.5.b.iv.(5)], "These data shall be statistically analyzed to determine the best estimate of performance and the confidence limits [emphasis added] on that estimate for the pollutants to be evaluated." The next section of this memorandum outlines how that analysis could and should be performedQuantifying and Managing Uncertainty

Introduction

There are several ways to investigate the implications of uncertainty on the results of a predictive exercise such as the modeling performed for the RH/SGR Revised RAA. It is often appropriate to employ more than one in a relatively complex assessment such as this.

Statistical Procedures

A very widely used statistical procedure is to compute the confidence limits surrounding an estimate. Confidence limits define an interval within which the true value is expected to lie with a particular level of assurance. For example, the 95 percent confidence limits signify a range with only 5 percent chance of the true value being either larger or smaller. This procedure would be appropriate to apply to estimates derived from the RH/SGR calibrations. Instead of a single line representing the calibration on graphs of modeled versus observed quantities, bands representing the upper and lower confidence limits would also be plotted. In addition to the direct result from the calibrated mathematical expression, the model results would be expressed in terms of minimum and maximum quantities according to the confidence limits.

There are other statistical methods of quantifying uncertainty, generally more complex and less frequently used than confidence limits. For example, a logistic regression analysis expresses the probability of a result being within or outside of an interval.

Once the confidence limits or the probability of an estimate are known, the analysts and those interested in their work can evaluate the risks associated with decisions made on the basis of results. There would be a very different reaction to an outcome with a narrow versus a wide confidence interval, or to a 90 percent probability of reaching an objective than to a 30 percent probability. The first scenario in each pair would signify relatively low risk of not reaching the objective, and the second a higher risk. The Revised RAA does not provide the means to make that assessment, because there has been no attempt to quantify uncertainty.

Sensitivity Analysis

Another procedure is to conduct a sensitivity analysis on variables known or suspected to harbor uncertainty. Sensitivity analysis in a modeling context involves assigning different numerical values to a variable, running them through the model, and seeing how the results change. Little change would signify that the variable does not exert much control over the outcome and can be dropped from concern. On the other hand, substantial change would identify an instrumental variable. In that situation, further effort could be put into establishing its magnitude. If that effort could not be made or was not fruitful, the model output and its interpretation should be expressed in relation to a reasonable range of the variable in question.

An example application of sensitivity analysis in the RH/SGR case would be to use different points in the frequency distribution of hardness values to test the sensitivity of results to the assumption of the median (50^{th} percentile). Another example would be to examine the contributions of redevelopment LID BMPs with variations in the assumed rate of redevelopment.

Margin of Safety

A third method for managing uncertainty is to apply a margin of safety (MOS) to assumptions and numerical assignments to uncertain variables. Two ways of incorporating a MOS are: (1) using conservative model assumptions and assignments, known as an “implicit” MOS; and (2) setting aside a portion of the model result (*e.g.*, 15 percent of the pollutant mass loading reduction) as the MOS and operating with the remainder, termed an "explicit" MOS.

Neither option is perfect. The implicit alternative, using a series of worst-case conditions, not all of which are actually likely to be worst case, may lead to an overly conservative solution. Assigning an explicit MOS could be arbitrary, unless there was some good basis to know (*e.g.*, from historical data on a similar case) what the degree of uncertainty is likely to be. Judicious and careful use of this suite of statistical, sensitivity analysis, and MOS procedures, though, would provide a more useful RAA than completely disregarding uncertainty.

SUMMARY AND CONCLUSIONS

My evaluation of the RH/SGR Revised RAA and the proposed regional and Green Streets projects led me to the following opinions:

- Modeling and project development are subject to a host of assumptions that have not been adequately justified or evaluated for their appropriateness.

- Hydrologic model calibrations exhibit a tendency to underestimate flows in relatively large rain events at some flow calibration stations.

- Water quality model calibrations exhibit a tendency to underestimate peak metals concentrations at both calibration stations, a shortcoming that reduces confidence in the ability of the prescribed measures actually to achieve the MS4 Permit-mandated objectives regarding CTR limits and pollutant mass loading reductions.

- There has yet been no on-site hydrogeologic investigation at regional and Green Streets project locations to characterize various aspects of the soils and infiltration potential, despite heavy reliance on infiltration for meeting the objectives.

- Two of the four regional projects, both in the Rio Hondo Drainage Area, may be too small in relation to their ability to retain runoff by infiltrating. This concern applies especially to the Rio Hondo Ecosystem Restoration Project and Arcadia Wash Water Conservation Diversion, which relies on Peck Park Lake, already known to be infiltration-limited. Together these two projects are to provide 73.4 percent of the zinc loading reduction in the Rio Hondo Drainage Area, most from the project at Peck Park Lake, an outcome much in doubt.

- There has been no quantification of uncertainties introduced by assumptions; calibration issues with the hydrologic, water quality, and BMP models; and BMP projects. Not having this analysis has prevented examination of the effects of uncertainties on modeling results and conclusions regarding the prospects for actually achieving the Permit's objectives. Failing to include this analysis is likely contrary to the Permit.

- A variety of procedures exist to quantify uncertainties and assess the risk of not achieving Permit compliance. Appropriate procedures should be used in the Revised RAA and

BMP project developments to provide an objective portrait of the prospects for meeting the Permit's limits.