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Some Comments on the

Brisbane Baylands Program EIR Wind Study

Prepared by

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Introduction and Overview

The Candlestick Preservation Association (hereafter referred to as "CPA") retained the services of EnviroComp Consulting, Inc.[1], in this case.

We understand that the proposed Baylands Project[2] may negatively affect the wind flow patterns in a region where windsurfing is extremely popular.

We have reviewed a set of documents related to the proposed Baylands Project. This report presents the current results of our investigation and opinions, based upon the materials reviewed, and the analyses performed to date. EnviroComp reserves the right to supplement this report in the event new information is presented.

Qualifications and Experience

EnviroComp is a consulting firm specialized in atmospheric sciences. Since 2001, EnviroComp has performed studies in air pollution, wind flow, and meteorology.

[1] http://envirocomp.com/

[2] http://www.ci.brisbane.ca.us/baylands-information

Paolo Zannetti

Dr. Paolo Zannetti is the President and Founder of EnviroComp Consulting, Inc.[3] and the non-profit EnviroComp Institute[4]. He is also Professor of Environmental Sciences[5] at the Wessex Institute of Technology (WIT), Ashurst, UK. Dr. Zannetti has performed studies and scientific research in atmospheric sciences for four decades. His activities have covered pure research in the fields of environmental sciences and numerical modeling, written publications, seminars and courses, project management, environmental consulting, editorial productions, and expert testimony. He has written more than 300 publications, and 40+ books and book chapters, including the book "Air Pollution Modeling"[6], completed in 1990, which was the first comprehensive book in the field and is still today a widely used textbook. A 4-volume, multi-author, revised and expanded edition of this book has been published[7] during the period 2003-2010 under Dr. Zannetti's direction and chief editorial management. This 4-volume edition includes a chapter[8] on wind tunnel modeling.

In addition to his academic and scientific achievements, Dr. Zannetti has worked on several litigation projects and provided testimony at depositions and trials in more than 35 cases.

Frank Freedman

Dr. Frank Freedman is a senior scientist at EnviroComp Consulting, Inc. and adjunct professor at the Department of Meteorology and Climate Sciences at San Jose State University. Dr. Freedman specializes in air pollution and atmospheric boundary layers, the study of the earth's lowest kilometer. His PhD work at Stanford University involved turbulence modeling, utilizing computational and wind tunnel data in his analyses. He has worked on several academic and applied consulting projects related to air pollution, surface layer wind flow, and turbulence, with emphasis on computational modeling. He has taught courses in these areas at San Jose State since 2005. Dr. Freedman received his Certified Consulting Meteorologist[9] certification in 2010.

Examined materials

- Section 2.9 Individual Responses to Comments from Organizations of the Final EIR, May 2015
- CHAPTER 3 Revisions to the Text of the Draft EIR, Final EIR, May 2015
- 4.M Recreational Resources, Draft EIR, June 2013
- APPENDIX J Recreation: Windsurfing, Draft EIR, June 2013

[3] http://www.envirocomp.com
[4] http://www.envirocomp.org
[5] http://www.wessex.ac.uk/research/wit-staff/862-dr-paolo-zannetti
[6] Zannetti, P. (1990): Air Pollution Modeling – Theories, Computational Methods, and Available Software. Computational Mechanics Publications, Southampton, and Van Nostrand Reinhold, New York. 450pp. http://www.amazon.ca/Pollution-Modeling-Theories-Computational-Available/dp/0442308051
This book can now be freely downloaded at: http://www.envirocomp.com/pops/airpollution.html
[7] http://www.envirocomp.org/aqm
[8] http://www.envirocomp.org/aqm/AQM3_flyer.pdf
[9] https://www2.ametsoc.org/ams/index.cfm/education-careers/ams-professional-certification-programs/certified-consulting-meteorologist-program-ccm/

- Public Comments on the Draft Environmental Impact Report and Other Public Planning Processes, Candlestick Preservation Association, December 2013
- Potential Wind Conditions at Brisbane Baylands Specific Plan Windsurfing Area Testing. Technical Memorandum from Environmental Science Associates to City of Brisbane, November 2, 2012
- Information presented at http://www.ci.brisbane.ca.us/baylands-information

Opinion #1 – Computer Modeling

The EIR addresses the issue of windsurfing in the area of interest. It is surprising, however, that the only scientific tool used for this purpose in the EIR is a wind tunnel. In fact, there is a very large literature available studying the interactions of buildings and wind[10]; empirical formulas have been developed[11]; computer models have been used[12]. That the EIR makes use of none of these other means of studying this issue, especially given its complexity, is surprising and does not comply with standard analysis practice from our experience.

Computer modeling, in particular, is nowadays a standard tool for studying wind patterns in a hypothetical setting, in this case under the possible development of new buildings. Without a computer model, results are highly questionable. Several models could and should have been used in this project to simulate 1) the wind flow in complex terrain, e.g., with the EPA-recommended[13] MM5 and WRF, and 2) the effects of buildings, with a Computational Fluid Dynamics (CFD) code, such as FLUENT[14], or public domain codes, such as OpenFOAM[15].

Especially in this case, given the complexity of the flow patterns in the area, computer modeling is indispensable. This is because with a computer model one can simulate the wind pattern applying real-world wind flow speeds, terrain, and building heights. Rather, with the wind tunnel, because the limits of its physical size, buildings and the surrounding terrain cannot both be accounted for, and much smaller values for building heights compared to actual size have to be used. Application of scaling factors (the "R-values" used by the authors) then become necessary to translate the smaller wind tunnel speeds to the higher speeds that would be experienced in the real world. While the use of such scaling factors to estimate how the low wind tunnel speeds translate to actual physical scale is applicable for simple, theoretical flows, scaling factors are highly uncertain for the complex flow situation we are dealing with

[10] http://www.sciencedirect.com/science/article/pii/S0960148198001918
http://www.sciencedirect.com/science/article/pii/095006189190060X
http://www.academia.edu/8110643/Interaction_of_Across-Wind_and_Along-Wind_with_Tall_Buildings
[11] http://www.researchgate.net/publication/263648862_Simplified_formulas_for_evaluation_of_across-wind_dynamic_responses_of_rectangular_tall_buildings
http://www.calpoly.edu/~rgordon/vent/windexh.pdf
[12] http://www.sciencedirect.com/science/article/pii/0010448582900082
http://iawe.org/Proceedings/8APCWE/A.%20K.%20Mittal.pdf
https://narac.llnl.gov/uploads/Calhoun2004_UCRL_ComplexBldgFlow_RANS_207258_eaorz.pdf
[13] http://www3.epa.gov/scram001/metmodel.htm
[14] http://www.ansys.com/Products/Simulation+Technology/Fluid+Dynamics/Fluid+Dynamics+Products/ANSYS+Fluent
[15] http://www.openfoam.com/

in this EIR. A computer model is much better equipped for this situation due to its ability to directly model the scenario to real-world scale.

In summary, the complex upwind topology and the large area to be modeled make it very difficult for wind tunnel analysis to be a comprehensive, accurate model for real-world conditions. Computer modeling is essential to provide credible results and validate the findings of a wind tunnel model. Computer modeling can easily provide a sensitivity analysis and produce error estimates whereas wind tunnels cannot easily provide this (in the case of the wind tunnel experiments in this EIR, it appears no such sensitivity or error analysis has been done). No scientific study of this type should be accepted without an estimate of the likely range of error or an analysis of the impact of the potential error on the study subject. Without full upwind topology modeling, without any validation to calibrate the findings of the wind tunnel, and without a sensitivity analysis to determine the range and impact of errors, there must necessarily be low confidence that the findings of the wind tunnel are accurate with respect to real-world conditions or the impact of the proposed development on windsurfing activity.

Opinion #2 – Wind Tunnel

The wind tunnel experiments are poorly described in the reports we examined. In the past, as part of our scientific work, we have examined dozens of publications discussing wind tunnel results. It is standard practice for authors[16] to explain how the wind tunnel experiments were performed, to present the formulas describing the similarity scales between the physical model and the real world, to discuss how the flow is generated and how the inflow is specified, to discuss the Reynolds numbers of the simulations, to explain if, and if so how, terrain features are accounted for in specifying the inflow, and to describe how the wind is measured at different locations in the tunnel. These key factors (and other important ones) are either not explained in the reports we examined[17] or are explained vaguely, poorly or in insufficient detail for us, as qualified scientists/engineers who have worked on dozens of similar projects, to understand what was actually done.

Therefore, in addition to our general reservation that computer modeling, in place or in conjunction with wind tunnel, should have been the major tool for this assessment, we also have strong reservation on the validity of wind tunnel results.

We note that the wind tunnel literature is clear on the danger of producing erroneous results. For example, see NIST Technical Note 1655, "Toward a Standard on the Wind Tunnel Method"[18], stating that serious errors can result from improperly running wind tunnel experiments and that the adequacy of the performance of the simulation needs to be validated against certified test results.

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[16] See, for example: http://weather.ou.edu/~pkklein/texte/description.pdf
http://www.ruhr-uni-bochum.de/imperia/md/content/asib/ws08_09/boundary_layer_windtunnel.pdf
http://dspace.library.colostate.edu/webclient/DeliveryManager/digitool_items/csu01_storage/2010/08/27/file_1/85170

[17] The reports we examined included the Draft Environmental Impact Report, Master and Individual Responses to public comments to the DEIR, and the Wind Tunnel Testing Technical Memorandum from Environmental Science Associates to the City of Brisbane, dated November 2, 2012.

[18] http://www.itl.nist.gov/div898//winds/pdf_files/NISTTN1655.pdf

On the issue of windsurfing, the main conclusion of the EIR is "These incremental changes in wind speed and turbulence in the launch and sailing areas are expected to be undetectable to most windsurfers". This does not appear to be a valid scientific statement. The scientific method would require, first, to establish what is "detectable" for the average wind surfer (or for average, beginner, and advanced wind surfers). Afterwards, calculations may be performed to verify if, when, and where detectable variations are found. The scientific method also requires determining the uncertainty of these calculations; in fact, results without uncertainty analysis can be highly misleading.

Moreover, the real issue here is not "detectability" but "impairment". The real question is whether or nor the variations in wind speed and turbulence caused by the urban developments will impair windsurfing in the area, and to which degree in different locations. This basic question has not been answered, in our opinion, in the EIR, and much more scientific work is needed to properly address this issue.

In addition, we found the combination of 2012 and 2009 data in the wind tunnel results extremely confusing. The explanation for this "combination" is reported below.

> Due to the configuration of the Baylands site in relation to the Bay, the size of the Baylands site, the size of the windsurfing area, and the physical limitations of the ABL Wind Tunnel, the wind tunnel testing had to be conducted in strips because the site model would not fit into the wind tunnel as a complete unit. Therefore, testing occurred in up to four strips approximately 2,100 scale feet wide and the results compiled for each of the four measured wind directions that could interact with the Baylands site and the windsurfing area: West (W), West-northwest (WNW), Northwest (NW), and West-southwest (WSW). Wind from the WNW and NW could not result in any effect on test points in some areas of the northern portion of the test grid because the Baylands site is more or less directly west of the Bay. Therefore, in order to provide a complete picture of the effect of wind on the windsurfing area in those areas closer to the CPSRA launch site, measurements for those test points unaffected by development in the Baylands site were incorporated from the 2009 Executive Park windsurfing study. Approximately 40 test points were used for each scenario under both the WNW and NW wind directions. To account for any differences between the 2009 test and the 2012 test, 13 test points were compared for both tests under the Existing scenario for the West wind. On average, the 2012 test wind speed ratios were approximately 7% faster for the 2012 test in comparison to the 2009 test. These differences fall generally within the inherent uncertainty of the two sequential tests, so permit the use of the 2009 test data for those test points that would be unaffected by Project development at the Baylands site.

The sentences above are not encouraging concerning the accuracy of the wind tunnel experiments. How can we trust results produced "in strips" because the test model would not fit into the wind tunnel? Why was the test model not designed to fit? According to the engineering consultant who executed the wind tunnel study, the test areas were segmented to complete physical measurements because the geographic areas were so large. In their words, "such segmenting is common practice, and does not introduce appreciable error into the measurement process." This is incorrect. Any "segmentation" of the region will introduce errors, which may be very large and difficult to quantify.

Moreover, the figures with the wind tunnel results indicate many areas within the windsurfing area where wind tunnel results yielded "no data" (see for example Figure 20 of Technical Memorandum). Finally, the wind tunnel experiments did not provide results in a critical area near the shore which is the region of maximum interest for wind surfing[19].

[19] Public Comments on the Draft Environmental Impact Report and Other Public Planning Processes, Candlestick Preservation Association, December 2013, page 28.

All this is disconcerting regarding the suitability of the wind tunnel for this work. A computational modeling approach would have none of these limitations.

Opinion #3 – Literature

The effects of buildings on wind flow, and the effects of winds on buildings, is a topic well studied in the literature[20]. We note that no efforts appear to have been made in the EIR to perform proper literature review and study past effects of urban developments.

The potential damage to windsurfing activities by construction of new buildings is an issue debated in other locations[21]. A serious literature review on this subject should have been performed.

For example, there is much literature on the minimum distance *D* downwind of structures where the wind is unaffected (distances shorter than *D* experience wind speed reduction and wind direction changes). See for example literature on building wake effects[22], wind breaks[23], wind turbines[24], and other things. Generally, this downwind distance is about 10-30 times the height of the structures, but of course, the precise value depends on the situation.

Opinion #4 – Lack of Scientific Basis for Significance Criteria

The Draft EIR p. 4.M-9 states that "The CEQA Guidelines indicate that a project would have a significant effect on the environment if it would… Substantially degrade the existing windsurfing recreational resource at CPSRA". We were surprised to find no effort to establish objective, scientific parameters for assessing whether a substantial degradation is expected. Only by defining in advance, and quantifying in an objective manner, what a "substantial degradation" is, can we then calculate whether future developments will create an adverse impact.

The task is relatively simple. We know that there are optimal days for wind surfing at the site[25]; we also know that there are moderately good days, difficult days, and days when wind surfing is practically impossible. A simple analysis of the meteorological parameters (including wind speed and turbulence) during different conditions would lead to the identification of those wind flow changes that are critical and may transform a "good" surfing day into a "bad" one, based on a pre-defined degradation level.

A meteorological station should have been installed at the site. Data should have been collected and analyzed to identify and categorize wind flow scenarios, from those most favorable to wind surfing to

[20] E.g.: http://www.ibpsa.org/proceedings/BS2013/p_1148.pdf
http://www.calpoly.edu/~rgordon/vent/windexh.pdf
http://www.cpom.org/people/jcrh/ptrsA.pdf
http://www.ijerd.com/paper/vol4-issue9/D04092126.pdf
[21] E.g., Aruba:
http://www.pwaworldtour.com/index.php?id=35&tx_news_pi1%5Bnews%5D=292&cHash=30010f78dea2a3d540e0a9d3edf0b3a5
[22] http://www.sciencedirect.com/science/article/pii/0167610592900186
[23] http://extension.psu.edu/plants/plasticulture/production-details/windbreaks
[24] https://renewables.gepower.com/wind-energy/turbines.html
[25] The Candlestick Preservation Association reported an average of 85 windsurfing days annually.

those less favorable. After these scientific efforts, it would have been possible to determine in a scientific, objective way whether or not expected variations in wind and turbulence, caused by the new buildings, can cause "substantial degradation". Even the word "substantial" needs to be expressed in proper terms. Is a degradation of windsurfing in the area substantial if it occurs 10% of the days? 5%? 1%

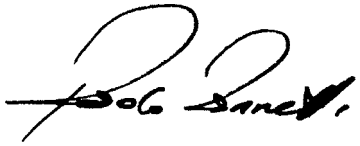
Without a well-defined scientific approach and without objective, a-priori quantifications, conclusions are impossible and remain highly subjective and uncertain. In our opinion, conclusions in the EIR, such as "These incremental changes in wind speed and turbulence in the launch and sailing areas are expected to be undetectable to most windsurfers", are not based on sound science.

In fact, the Draft EIR page 4.M-11 states that "There are no known critical thresholds in wind speed or wind speed reduction that cause a substantial degradation of the CPSRA windsurfing resource". It is mandatory, as a prerequisite for any study such as this one, to identify these critical thresholds.

Conclusions

The current EIR study has enough methodological problems, questionable assumptions, insufficient accuracy, excessive margin of error, and other factors such that further studies should be required in order to adhere to basic sound engineering principles and the requirements of CEQA.

More studies are certainly needed. Current studies are highly uncertain and incomplete. Current results are not trustworthy.



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