



**WIND STUDY
FISHERMAN'S VILLAGE
MARINA DEL REY, CALIFORNIA**

Project Number: 04-1692A
Date: September 17, 2004
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Submitted to: Pacific Ocean Management LLC
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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was requested by Pacific Ocean Management LLC and Armbruster & Goldsmith LLP in Los Angeles to undertake a detailed wind study on the proposed Fisherman's Village in Marina del Rey, California. The study addressed the wind study requirements of the Los Angeles County Zoning Code, including an assessment of the effects of the proposed development and/or building placement on wind patterns within the marina, loss of surface winds used by sailboats and birds, and general air circulation.

2. TEST METHODOLOGY

Wind tunnel tests were conducted on a scale model of a section of Marina del Rey to determine the impact on the wind conditions resulting from the proposed Fisherman's Village. This report provides a summary of the results of these wind tunnel tests on water and land-based locations.

A 1:500 scale model of the study area and the proposed developments were assembled as shown in Figures 1a and 1b. Tests were conducted to simulate and measure wind conditions as they exist today (Figure 1a) and after the proposed Fisherman's Village (Figure 1b).

The results presented in this report pertain to the model of the proposed Fisherman's Village constructed using the architectural design drawings received by RWDI on August 18, 2004 and other in-house information, such as city maps and aerial photos. Note that some small existing buildings currently on the development site were not included in the Existing Configuration in order to assess the worst-case wind impact of the proposed development. Also, two surface parking lots on the east side of Fiji Way were interpreted from available aerial photos as low structures. These areas are farther away from the main channel and were present for both Existing and Proposed Configurations in the wind tunnel testing (Figures 1a and 1b). In addition, the predominant winds in the Marina del Rey area are from the west and southwest directions, and the easterly winds are of relatively low frequencies. Therefore, the above model variations will not alter the conclusion of the current wind study.

The wind tunnel model was instrumented with a total of 40 wind sensors at the Main Channel, Basins A, B and H, and land locations close to the proposed development. It was tested in RWDI's boundary layer wind tunnel for the predominant wind directions, which are west, west-southwest, southwest, and east. The sensors were developed by RWDI for use on scale models and are capable of measuring both changes in wind speed and wind direction.

The wind tunnel results for all predominant wind directions in the Los Angeles area have been examined in detail and are presented in this report. The west, west-southwest, southwest and east wind directions together account for winds that occur a majority of the time, as shown on Figure 2. The wind roses on Figure 2 show the percentage of the time that wind blows from each of 16 directions during spring, summer, fall and winter for the hours of 7:00 am through 9:00 pm, when most sailing would occur. All of the tests were conducted for the above four wind directions.

Information on the changes in wind speed and direction recorded at each sensor location can be obtained from Figures 3a through 3d for the four wind directions tested for the existing and proposed conditions. Each figure presents local wind data at each location for one of the four approaching wind directions that were tested. The length of the arrows is proportional to the speed of the wind at each location. In each figure there are two colour coded arrows at each sensor location: black to indicate the local wind direction for existing site conditions and red for the proposed Fisherman's Village.

The wind analysis considered if the proposed development would result in changes to the local wind direction or mean speed between adjacent sensors that are greater than the difference presently experienced between any two adjacent sensors. Until criteria are established by the County of Los Angeles, this is the best method of assessing the impact of the proposed developments on the sailing conditions in the marina.

3. EFFECTS ON SAILING CONDITIONS

3.1 Locations On Water (4 through 40)

For the southwest, west-southwest and west wind directions (Figures 3a through 3c), the red arrows (proposed conditions) are aligned closely with the black arrows (existing conditions) and have a similar length at all measurement locations on the Main Channel and Basins A, B and H. Therefore, the wind direction and speed are not affected by the addition of the proposed Fisherman's Village for these wind directions which are predominant in the Marina del Rey area.

Differences in wind speed and direction between the existing and proposed conditions occurred on the Main Channel close to the proposed Fisherman's Village (Locations 9 through 12) when winds are from the east direction (Figure 3d). Specifically, east winds were switched to the northeast at Locations 9 and 12 and a considerable wind speed reduction occurred at Locations 9, 10 and 12, as shown in Figure 3d. To a lesser extent, differences also occurred further away from the proposed development at Locations 20 through 22, and became insignificant at Locations 27 and 28. No changes in wind speed or direction were found in other locations for the east winds (Figure 3d).

As shown in Figure 2, the east winds have a relatively low frequency among the four predominant wind directions. The effect of the proposed development is limited to the Main Channel area adjacent to the Fisherman's Village. As mariners who use docks at the Fisherman's Village are in the final stages of docking, it is assumed that these localized changes in wind speed and direction will not be an issue. Other mariners sailing from or to docking basins in Marina del Rey can use the central or west half of the Main Channel, where the east winds had minimal effects.

3.2 Locations on Land

Wind sensors were installed on land (Locations 1 through 3) to measure changes in wind direction and speed in areas close to the proposed Fisherman's Village.

Generally, at Locations 1 and 3, no changes in wind speed or direction were observed for any of the test directions (Figures 3a through 3d). However, at Location 2 the proposed development was found to cause a reduction in wind speed for winds from the southwest and west-southwest directions (Figures 3a and 3b, respectively). No changes were observed for the other two test wind directions (Figures 3c and 3d). The reduction in wind speed is considered a positive effect on pedestrian wind conditions.

4. LOSS OF SURFACE WINDS USED BY BIRDS

In order to assess the effects on birds of changes in the surface winds a report was prepared by an expert in the aerodynamics, kinematics and behavior of birds. This report has been attached as Appendix A. The author of the report considered the following issues:

- the types of birds likely to inhabit Marina del Rey
- the ability of birds to take off and land,
- soaring conditions upwind and downwind of the proposed building,
- effects on local thermal soaring conditions, and
- changes to flight efficiency due to turbulence.

From our test results, the minimal change on existing wind fields due to the proposed development will not result in changes to the birds' use of the area.

5. GENERAL AIR CIRCULATION PATTERNS

Changes in wind speed and direction were recorded only in the immediate vicinity of the proposed development. Due to the localized nature of these changes there will be no effect on the general air circulation patterns within Marina del Rey.

6. CONCLUSIONS

From the results of this wind study, it has been concluded that the proposed Fisherman's Village will not affect the existing wind conditions over a majority of the areas of Marina del Rey. There will be areas of altered wind speed and direction in the Main Channel adjacent to the proposed development when winds are from the east. This is not an issue considering the boating activities in these localized areas. Due to the localized nature of these changes and the low frequency associated with the easterly winds, there will be no significant effect on the general air circulation patterns within the Main Channel and Basins in Marina del Rey.

The overall wind conditions predicted with the proposed development in place are similar to those presently experienced in and around the marina and therefore the general air circulation patterns and the use of surface winds by birds will not be affected.



Wind Tunnel Study Model
Existing Configuration

Fisherman's Village - Marina del Rey, California

Project #04-1692

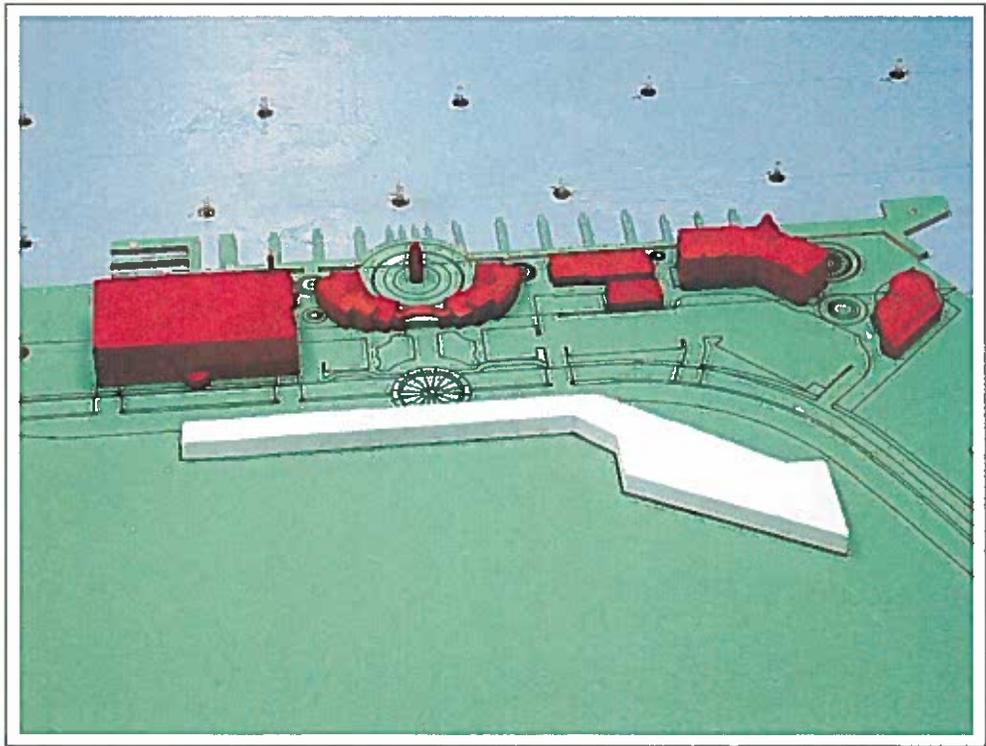
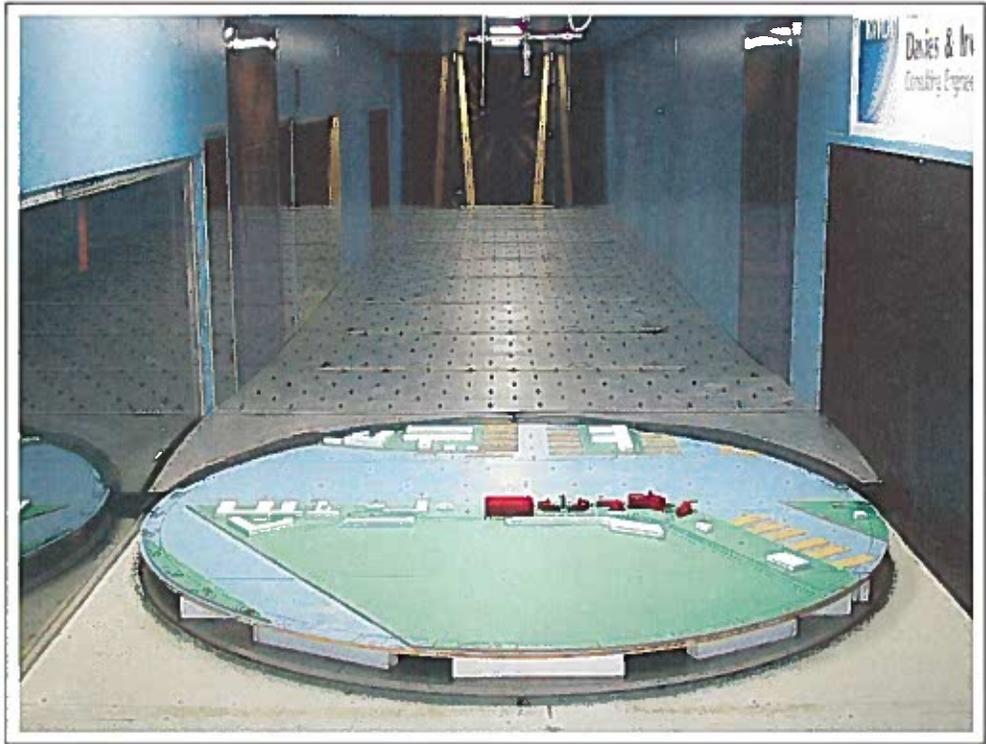
Figure No.

1a

Date:

September 1, 2004

RWDI



**Wind Tunnel Study Model
Proposed Configuration**

Fisherman's Village - Marina del Rey, California

Project #04-1692

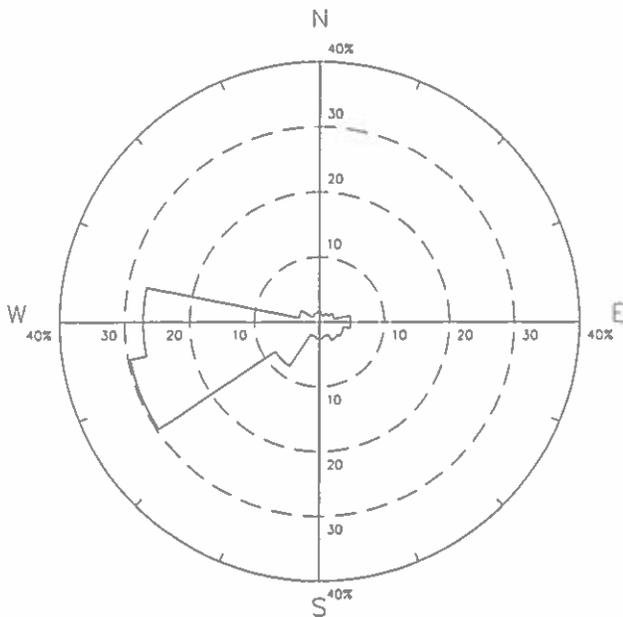
Figure No.

1b

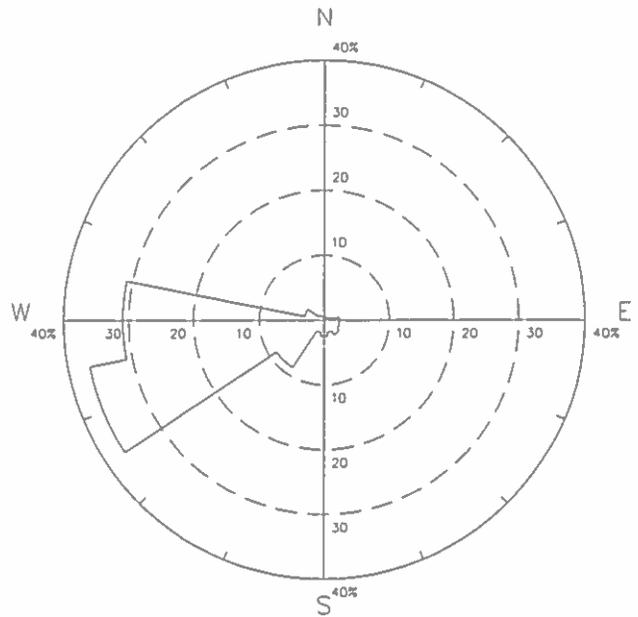
Date:

September 1, 2004

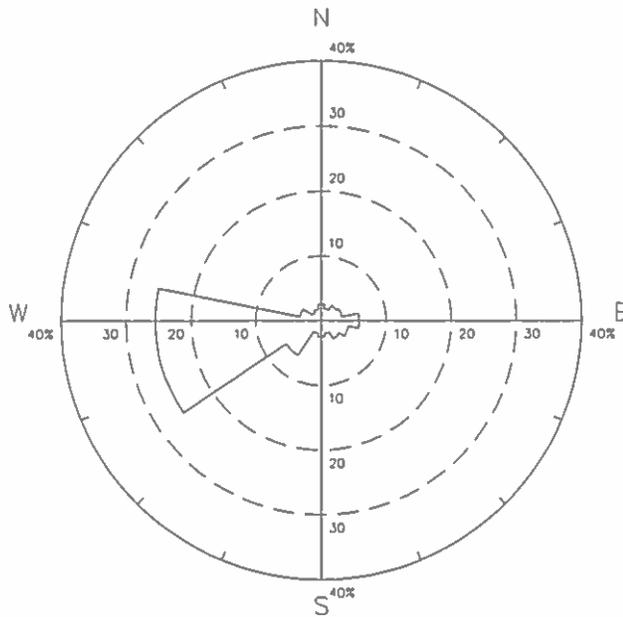
RWDI



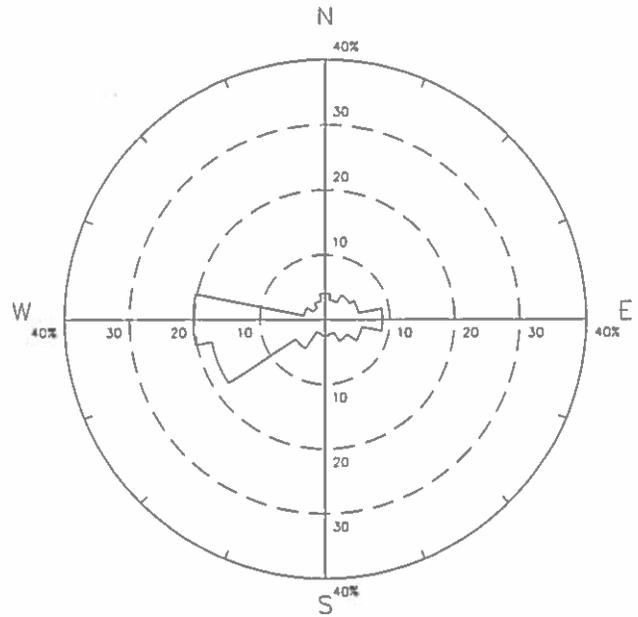
SPRING
(March, April, May)



SUMMER
(June, July, August)

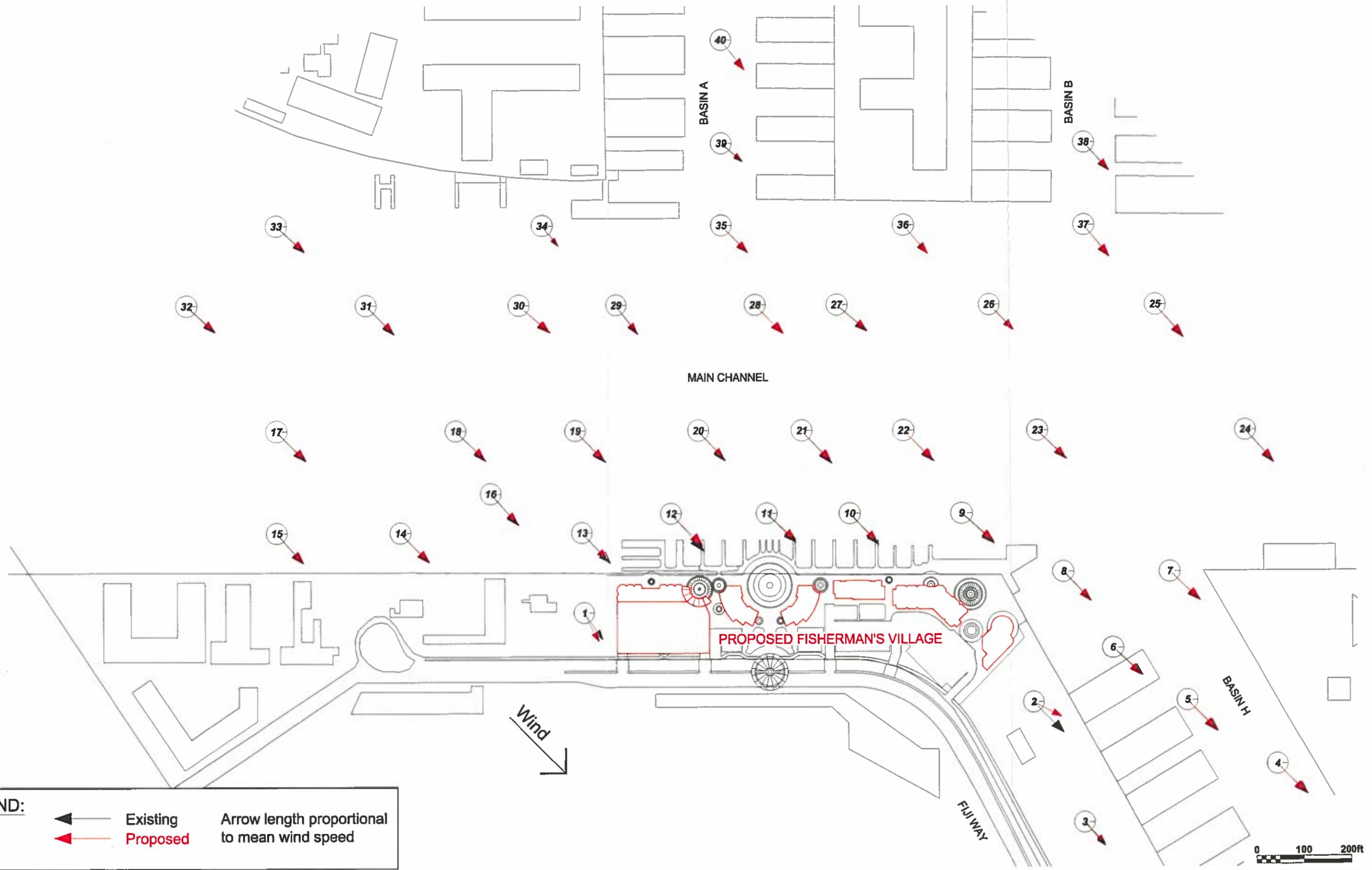


FALL
(September, October, November)



WINTER
(December, January, February)

Directional Distribution of Seasonal Winds (7:00 am - 9:00 pm) Los Angeles International Airport (1947 - 1990)	Figure No. 2	
	Date: September 3, 2004	
Fisherman's Village - Marina del Rey, California	Project #04-1692	



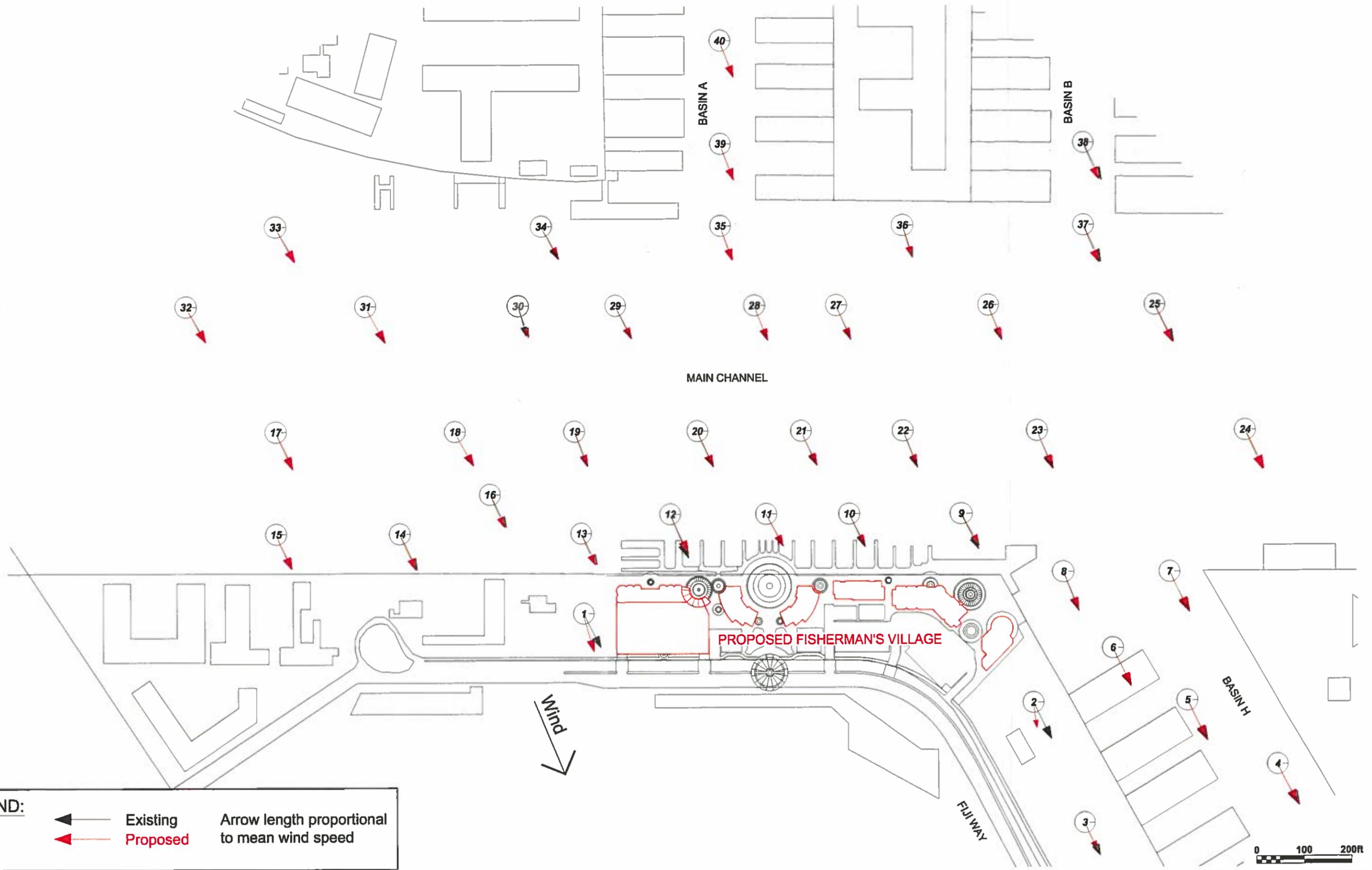
LEGEND:

	Existing	Arrow length proportional to mean wind speed
	Proposed	

<p>Local Wind Direction - Wind from 225° (Southwest)</p> <p>Fisherman's Village - Marina del Rey, California</p>	<p>True North </p>	<p>Drawn by: DJM Figure: 3a</p>
	<p>Approx. Scale: 1"=200'</p>	<p>Date Revised: Sept. 1, 2004</p>

RWDI

Project #04-1692

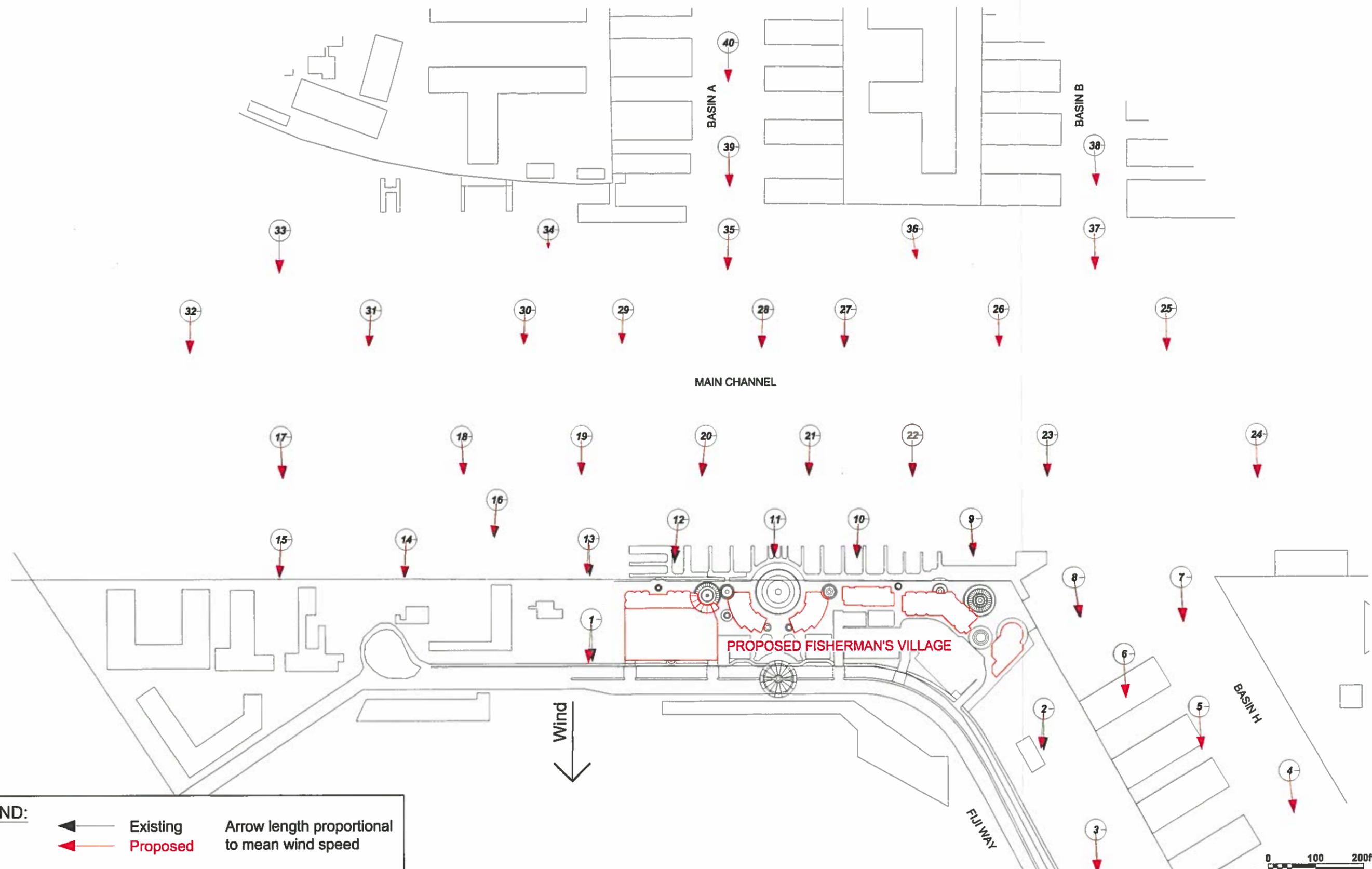


LEGEND:

	Existing	Arrow length proportional to mean wind speed
	Proposed	

<p>Local Wind Direction - Wind from 90° (West-southwest)</p> <p>Fisherman's Village - Marina del Rey, California</p>	<p>True North </p>	<p>Drawn by: DJM Figure: 3b</p>
	<p>Approx. Scale: 1"=200'</p>	<p>Date Revised: Sept. 1, 2004</p>

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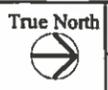


LEGEND:

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	Proposed	

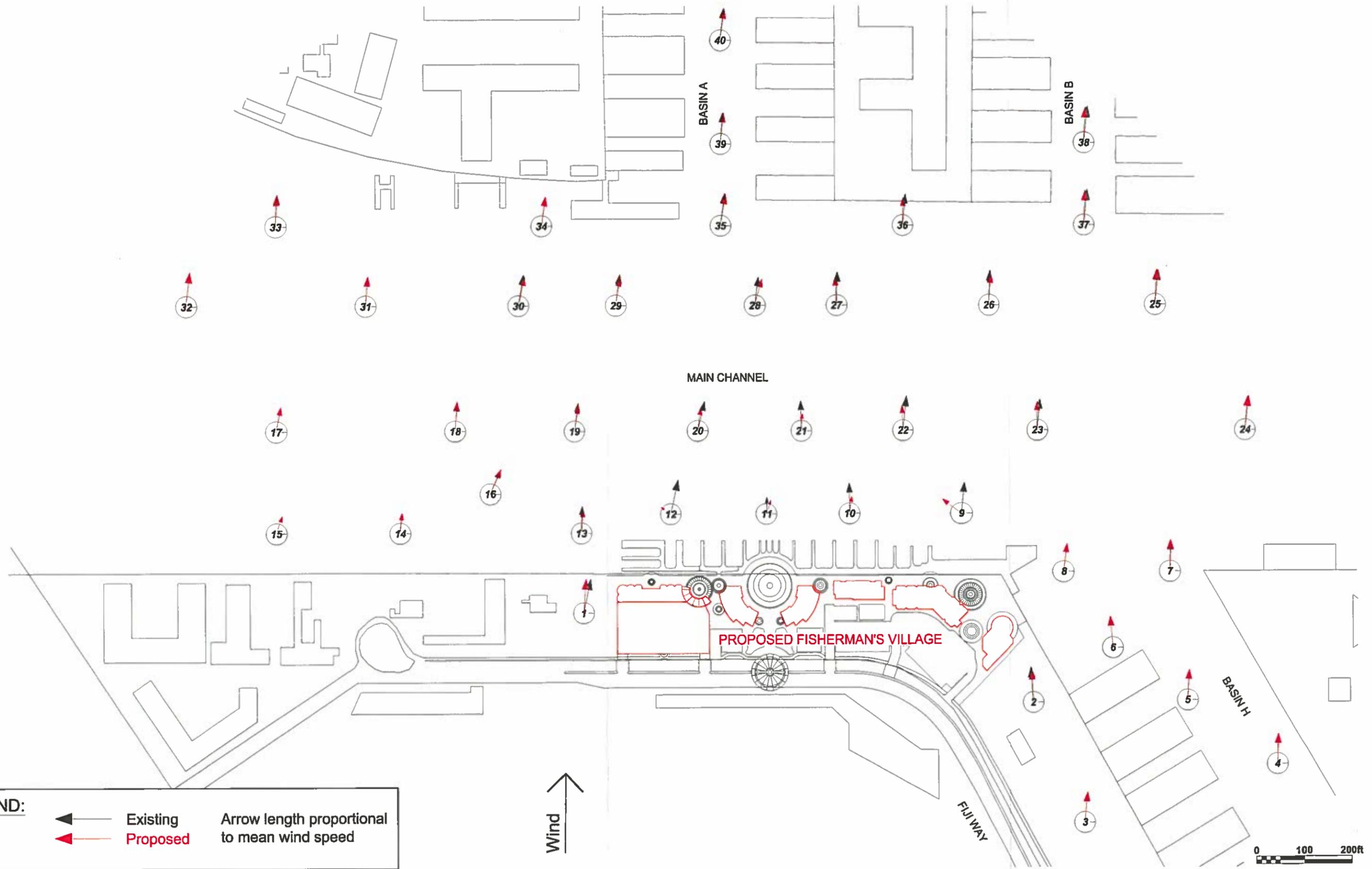
Local Wind Direction - Wind from 270° (West)

Fisherman's Village - Marina del Rey, California



Drawn by: DJM	Figure: 3c
Approx. Scale: 1"=200'	
Date Revised: Sept. 1, 2004	





LEGEND:

	Existing	Arrow length proportional to mean wind speed
	Proposed	

Local Wind Direction - Wind from 90° (East)

Fisherman's Village - Marina del Rey, California

 True North	Drawn by: DJM	Figure: 3d
	Approx. Scale: 1"=200'	
	Date Revised: Sept. 1, 2004	

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APPENDIX A

**Effect of a proposed structure at Marina Del Rey, California on surface winds
used by local birds.**

A report prepared For Rowan Williams Davies & Irwin Inc.

**Wayne Bezner Kerr
Migratory Bird Research Group**

Attn: Colin Williams
Principal,
Rowan, Williams, Davies and Irwin Inc.

From: Wayne Bezner Kerr
Migratory Bird Research Group

Re: **Effect of a proposed structure at Marina del Rey, California on surface winds used by local birds.**

The proposed structure at Marina del Rey appears to be fairly straight forward, insofar as use of surface winds by local and/or transient populations of birds are concerned. In response to your request I have undertaken a literature search on the aerodynamics, kinematics and behaviors of flying birds. Combined with my own observations from four seasons of experimental work with flying birds of different weights, wing loadings and Reynolds numbers (Re), I have formed some basic conclusions regarding the project under discussion. My conclusions are presented under five general subheadings.

1. Changes to surface winds on open water:

The concept of "surface winds" does not necessarily apply to birds in powered flight, at least as far as wind strength and direction are concerned. Unlike humans who experience wind relative to a fixed frame of reference on the ground, birds in flight always experience a direct headwind exactly equal to their airspeed and heading. Thus, a gull in steady state flight at 21 knots on a heading of 090 degrees will always experience a 21 knot east wind, regardless of actual wind strength and direction at the time of observation. The actual track described by a bird in flight will be the vector of the birds heading less the vector of the wind at that moment. Birds in translational, foraging and migratory flight may fly with wind speeds equal to or greater than their actual flying speed at angles greater than 90 degrees to their intended course (Kerlinger 1989). By altering airspeeds and headings, birds are able to complete flights along a desired ground track in a range of winds much greater than the expected changes to winds measured at the surface at Marina Del Rey.

In our experiments with migratory waterfowl and wading birds, we have seen that changes to

wind direction and strength can create problems for birds when taking off or landing in confined areas. For the few moments while a bird is accelerating during takeoff or decelerating during landing it is generally limited to headings that take it directly against the wind. On open water such as the channel found at Marina Del Rey, birds are able to takeoff and land in almost any direction, allowing unrestricted flight in winds from any direction. In my opinion, predicted changes to surface winds at Marina Del Rey are unlikely to have a measurable negative effect on local birds.

2. Changes to ridge soaring conditions downwind of the structure:

Some species commonly observed at Marina Del Rey exploit winds deflected upwards against vertical structures in a behavior known as "ridge soaring". Ridge soaring birds minimize the energy expended to remain aloft while in translational, foraging and migratory flight. The energy savings gained through the use of ridge lift are proportional to wind speed and the proportion of wind directed perpendicular to the obstruction (Kerlinger 1989). Ridge soaring birds may use lift provided by wind deflecting over and around towers, buildings, boats, hills and other structures. In my opinion, the predicted changes in wind speed and direction as a result of the proposed structure at Marina Del Rey are unlikely to significantly affect ridge soaring birds exploiting flows directed upwards along the downwind shore of the channel.

3. Changes to ridge soaring conditions upwind of the structure.

It is reasonable to expect that some ridge soaring behavior will occur on the upwind facing side of the structure under discussion. A new structure with a face oriented within 45 degrees to the prevailing wind direction will generate lift on days when winds are sufficiently strong. Soaring birds moving across the area can derive energetic benefits by diverting slightly to pass through the area of rising air. In my opinion, several species of birds observed at Marina Del Rey will likely utilize ridge lift created by the proposed structure at least occasionally.

4. Changes to local thermal soaring conditions:

Some species present at Marina Del Rey utilize small columns of rising warm air known as thermals to reduce the energy expended while climbing. Thermal conditions are relatively rare in coastal areas, especially at sites surrounded by water where stable marine air suppresses thermal

activity (Lindsay 1988). Thermal lift at Marina Del Rey is most likely found over larger built up or constructed areas such as docks, parking lots and buildings. In my opinion, a microscale change to the total built horizontal area at Marina Del Rey such as the addition or removal of a single building is unlikely to result in a measurable change to thermal frequency, size or distribution.

5. Changes to flight efficiency due to turbulence.

Birds, like miniature aircraft are subject to basic laws of aerodynamics. Generally speaking, birds of the weights and speeds observed at Marina Del Rey operate at Reynolds numbers (Re) between approximately 70,000 and 250,000 (Pennycuik 1989). Like artificially constructed airfoils, bird wings can be adversely affected by turbulence (Lissaman 1983), at least hypothetically reducing lift by a large degree. It is important to note that atmospheric turbulence occurs over a broad range of scales. Low speed airfoils operating at Re similar to birds observed at Marina Del Rey are most likely to suffer reduced aerodynamic performance where turbulence occurs at scales approximately 1/4 the average wingspan. Microscale turbulence in this range is short lived in the atmosphere, and is more typical of flows around small, complicated structures such as sailboat rigging or tree branches than larger solid structures. Larger scale wake vortices and eddies typical of flow downwind of large buildings is likely experienced by birds as long period changes to the free stream air, rather than aerodynamically disruptive turbulence *per se*. In my opinion, turbulence created by the proposed structure is unlikely to result in reduced aerodynamic efficiency of birds flying at Marina Del Rey.

Conclusion:

The addition or removal of a building at Marina Del Rey will undoubtedly result in changes to local winds in the altitudes and areas utilized by birds. However, due to the relatively minor nature of the changes expected, the wide variety of airspeeds birds are capable of flying at, the diverse flight strategies employed by birds and the relatively small percentage of total area where measurable impacts will be observable, it is my opinion that the proposed structure will not result in major changes to birds' use of surface winds at Marina Del Rey.

Related Readings:

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1989 **Bird Flight Performance. A Practical Calculation Manual**. Oxford University Press. 153 pp.

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Spedding GR

1992 **The Aerodynamics of Flight In Mechanics of Animal Locomotion** ed. RN Alexander Adv. Comp. Physiol. 11:59-78

Tobalske, B. W. and Dial, K. P.

1996. **Flight kinematics of black-billed magpies and pigeons over a wide range of speeds**. The Journal of Experimental Biology 199, 263-280

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Van den Berg, C. and Rayner, J. M. V.

1995. **The moment of inertia of bird wings and the inertial power requirement for flapping flight**. The Journal of Experimental Biology 198, 1655-1664

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Recent Work and Research Experience:

1998 - Present	M.Sc. Candidate.	Dept of Zoology University of Guelph Guelph, Ontario
1996 - 1999	Coordinator	Trumpeter Swan Migration Project Migratory Bird Research Group Guelph, Ontario
1995	Researcher	Sandhill Crane Induced Migration - Experiment Operation Migration Blackstock, Ontario

Publications:

- 1999 W. Bezner Kerr. **Imprinting techniques and the development of in flight following behavior in migratory trumpeter swans.** North American Swans 28 (3) (in press).
- 1998 W. Bezner Kerr. **No Swan Songs Here.** FAI AirSports International. Vol 1.
<http://airsports.fai.org/>
- 1997 W. Bezner Kerr. **Swan Songs.** Dofasco Illustrated News. Dec. Pp 12-13
- 1996 Lishman, W.A., T.L. Teets, J. Duff, W.J.L. Sladen, G.G. Shire, K. Goolsby, W.A. Bezner Kerr, and R.P. Urbanek. 1997. **A reintroduction technique for migratory birds: Leading canada geese and isolation-reared sandhill cranes with ultralight aircraft.** Proc. North Am. Crane Workshop 7:114-122

Wayne Bezner Kerr, *continued* ...

Presentations:

September 1999 **The Use of Induced Migration Techniques in the Restoration of Migratory Populations of Trumpeter Swans (*Cygnus buccinator*)**. 17th Trumpeter Swan Society Conference. Idaho Falls (scheduled)

July 1999 **The Use of Ultralight Aircraft in Waterfowl Restoration and Research**. COPA Annual Convention. North Bay

March 1998 **Trumpeter Swan Migration Project Overview**. North Bay Naturalists Association.

Awards, Scholarships and Research Support:

1999 Ontario Graduate Scholarship in Science and Technology
1999 Trumpeter Swan Society Certificate of Special Appreciation.
1999 USUA Public Service Award.
1999 Elgin Card Scholarship in Terrestrial Ecology
1999 University of Guelph Graduate Scholarship.
1998 Canada Trust Friends of the Environment Grant
1998 - 99 EcoAction 2000 Grant
1998 University of Guelph Graduate Scholarship.
1998 University of Guelph Graduate Scholarship.
1998 OFAH Waterfowl Ecology Grant.
1998 Conrad N Hilton Foundation Research Grant