Greenwater Road Wind Study
April 22, 2022

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Executive Summary

A wind study was conducted at 29253 Greenwater Road in Malibu CA on 11 Apr 2022.The purpose of the wind study was to evaluate the magnitude of the wind buffer that trees along the western perimeter of the property provided. The wind equipment used to perform the wind study were identical Tempest Weather Systems by WeatherFlow with sonic wind anemometers. The Tempest Weather Systems were strategically placed to evaluate both un-obstructed wind and wind buffered by trees on the western perimeter of the property. Five-minute peak wind gust data was collected/analyzed for a typical windy Spring Day in Malibu, CA. The evaluation period lasted for over 9 hours. The data clearly showed that the peak wind gusts at the tree-buffered location were considerably less than the peak wind gusts at the un-obstructed location, on average by 85%. This clearly demonstrated that the trees were a very efficient wind buffer and would result in a substantial reduction in wind gust magnitude downstream. The prevailing wind direction in this event was from the West. A wind rose from a nearby well-established (23 years) weather station showed that 40% of the time, in any given year, the wind blows from a westerly direction. Thus, the trees on the western perimeter of the property would likely act as wind buffer 40% of the time.

Introduction

I was asked to do a brief wind study of the Greenwater Road area of Malibu, CA. My specific point of interest was the property located at 29253 Greenwater Road. The property was one of many impacted by the Woolsey fire back in November 2018. One of the many impacts was the destruction of a line of trees by fire on the west side of the property. These mature trees acted as a wind buffer for the property from the frequent westerly onshore winds that occur throughout the year, given its proximity to the Pacific Ocean. The purpose of the wind study was to evaluate the magnitude of the wind buffer these trees provided.

Methodology

To perform the wind study, a typical windy day in mid-April 2022 was chosen. I arrived at the site at approximately 10 am on 11 April 2022. The wind had not yet begun to blow with any substantial velocity and the stronger winds were not anticipated until after 12 noon per the National Weather Service (NWS). I began by siting and calibrating my mobile wind equipment. This wind equipment included two identical Tempest Weather Systems by WeatherFlow[1]. Tempest Weather Systems are a complete, solar powered, weather station that include a sonic wind anemometer for measuring both wind speed and wind gust every 3 seconds. Both units (S/N ST-00052945 and S/N ST-00059553) were mounted on identical 571/2" tripods. Figure 1 is a photo of a Tempest Weather System.

Fig. 1 – A Typical Tempest Weather System

The first Tempest was located approximately midway between the house and the new line of trees. The second Tempest was located on the top of the 6' mound of dirt adjacent to the storage unit. The reason this location was chosen for the second unit is that I wanted to simulate the wind conditions away from the trees and above the temporary privacy fence that surrounds the property

[1] https://weatherflow.com/tempest-weather-system/

– unobstructed. The units were then leveled and properly oriented to magnetic North. See Figure 2 for location of Tempest Weather Systems.

Fig. 2 – Location of Tempest Weather Systems (T1/T2)

The Tempest Weather System's transmit their data every 5 mins to a hub connected to the internet which is then displayed on a personal website I created for this purpose. I then accessed the website via an iPad for viewing and recording of the data.

I began collecting and recording 5-min peak wind gust data at 1140 am. I continued collecting/recording data until 9 pm, essentially the entirety of the wind event. In addition to the collection of the 2 Tempest Weather System's data, I also collected peak wind gust data from 3 nearby publicly available weather stations for comparison.

Observations

There also was a total of 3 external weather stations considered/used in the wind study. Their metadata can be found in Table 1 along with their relative distance to the Greenwater Road point of interest.

Greenwater Road Wind Study Observations (by distance)							
Basic Metadata							
ID	Station Name	Type	Lat	Lon	Elev	Dist	Min Freq
Point of Interest			34.0087	-118.8082	223	0	
SE716	SCE Wandermere Road	SCE	34.0138	-118.8091	210	0.4N	10 Mins
AV536	KE6RLG Malibu	CWOP	34.0095	-118.8020	137	0.4E	5 Mins
LCBC1	Leo Carillo RAWS	RAWS	34.0451	-118.9360	50	7.8W	60 Mins
NOTES							
SCE = Southern California Edison							
CWOP = Cooperative Weather Observation Program							
RAWS = Remote Weather Observation System							
Elevation in Feet Above MSL							
Distance in Statute Miles							

Table 1 – Metadata for Weather Stations Used in Analysis

While these stations have different equipment and are at different locations/elevations, these stations provide additional valuable information when conducting a wind study such as this one. They provide an overall character of the wind event as well as provide insight into the overall timing. A map showing the relative location of all the external weather stations evaluated in this wind study can be found in Figure 3 below.

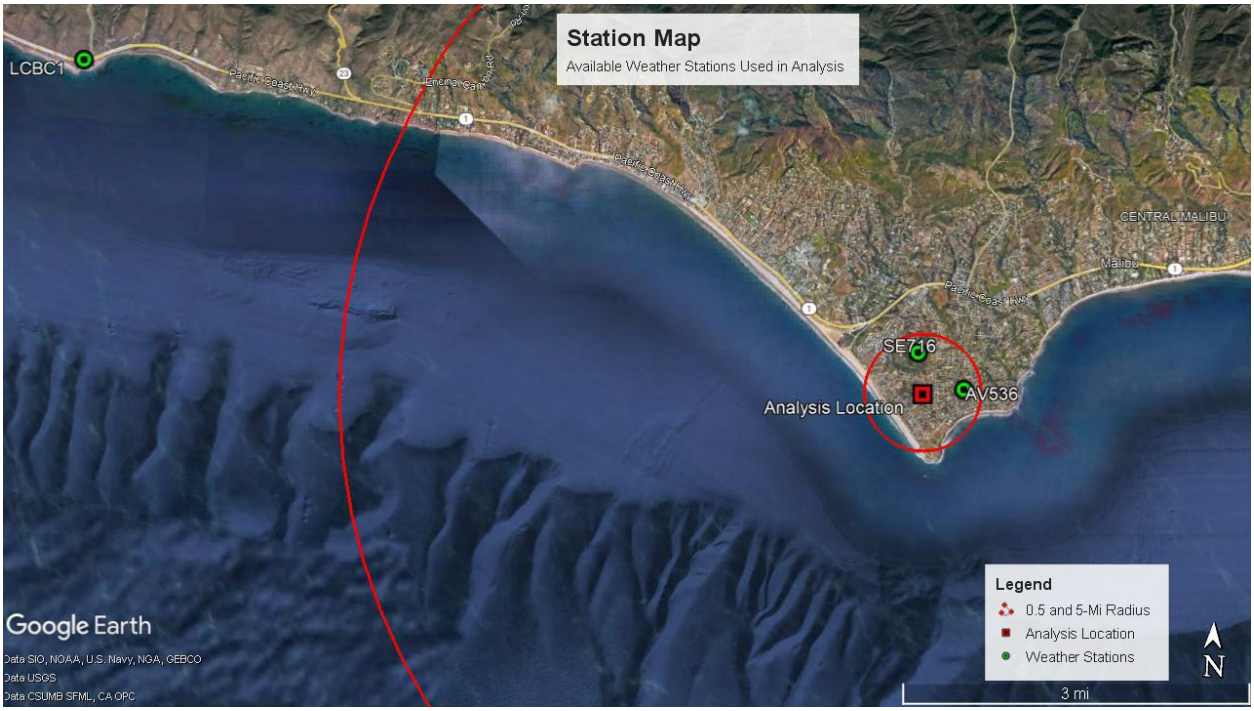

Fig. 3 – Station Map for External Weather Stations Used in Analysis

Analysis

The 5-minute peak wind gust data from both Tempest Weather Systems (T1/T2) can be found in abbreviated format in Table 2 below and in its entirety in Appendix A. The wind direction was not included as all of the directions for the entire wind study period were from a westerly direction. The data clearly show, almost throughout the entire examination period, that the peak wind gusts at T1 were considerably less than those observed at T2. In fact, on average, the peak wind gusts at T2 (in the absence of trees as a wind buffer) were 85% higher than those observed at T1. This clearly shows that trees are a very efficient wind buffer and can result in a substantial reduction in wind gust magnitude downstream.

The data also shows that during the wind study period, there were only two 5-minute periods in which the T1 peak wind gust values exceeded the T2 values. The data further shows that the T2 peak wind gust values exceeded the T1 values several times (9) by more than 200% and once by more than 300%!

Greenwater Road Wind Study - Wind Gust Comparisons						
11-Apr-22						
Time (LDT)	T1	T2	SE716	AV536	LCBC1	% Diff[1]
1140	4.9	10.6	15.0	7.0		116%
1150	6.9	11.1	15.7	10.0		61%
1155	4.9	11.0		9.0	20.0	124%
1200	4.4	11.5	16.4	7.0		161%
1205	3.9	11.9		7.0		205%
1210	5.0	12.8	17.0	5.0		156%
1215	5.6	12.8		4.0		129%
1220	6.1	11.3	16.2	9.0		85%
1225	7.8	11.7		13.0		50%
1230	3.7	9.4	16.5	11.0		154%
1235	2.7	9.8		5.0		263%
1240	4.1	9.0	15.3	9.0		120%
1245	5.8	9.7		13.0		67%
1250	4.8	9.8	15.9	9.0		104%
1255	4.7	9.8		14.0	22.0	109%
1300	7.2	9.7	17.1	5.0		35%
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2045	6.8	8.7		3.0		28%
2050	8.6	12.1	20.2	10.0		41%
2055	12.5	17.9		15.0	33.0	43%
2100	14.1	18.2	24.8	10.0		29%
Average	6.4	11.7	20	8.0	24.9	85%
NOTES						
Peak Wind Gusts in Miles per Hour						
% Diff[1] = Percent T2 value is higher than T1 value						
Positive						
Negative						

Table 2 – Abbreviated 5-minute Peak Wind Gust Data

Another way to view the T1/T2 dataset is by using a time-series plot. A time-series plot of the peak wind gusts data can be found in Figure 4 below. Again, clearly showing that the un-obstructed T2 values were consistently higher than the tree buffered T1 values.

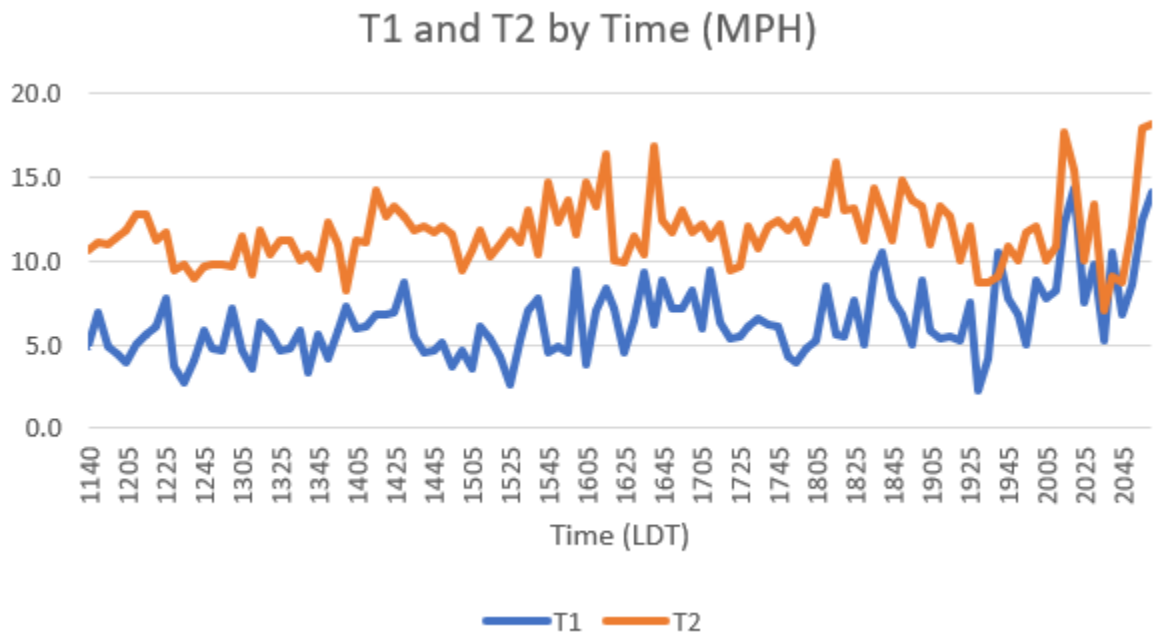

Fig. 4 – T1/T2 Time-Series Plot

On a larger scale, the wind event was widespread as seen at the other included reporting stations. When the wind gusts intensified at one station, they intensified at all stations. The SE716 and LCBC1 stations typically reported stronger peak wind gusts values but it should be noted that the equipment at these locations is mounted on 30–36-foot poles and are further away from the frictional effects of the ground and trees.

Historical Perspective

As mentioned earlier, the prevailing wind direction in this event was from a westerly direction and all 5-min peak wind gusts were from a westerly direction. It should be understood that winds at this location can and do blow from all different directions at different times and under different meteorological situations.

Wind climatologies or wind roses are developed for stations with a long period of record. This allows for the creation of a climatology of the wind at that location – also known as a wind rose. The only station in the wind study with a long enough history to develop a wind rose is the LCBC1 station, located 7.8 miles west of the point of interest in this study. There are 23 years of wind gust data at this location. While 7.8 miles away, it is worth looking at this stations wind rose as it would be similar to one at the point of interest if one existed. The wind rose for LCBC1 (or Leo Carrillo RAWS) can be seen in Figure 5 below.

Leo Carrillo California

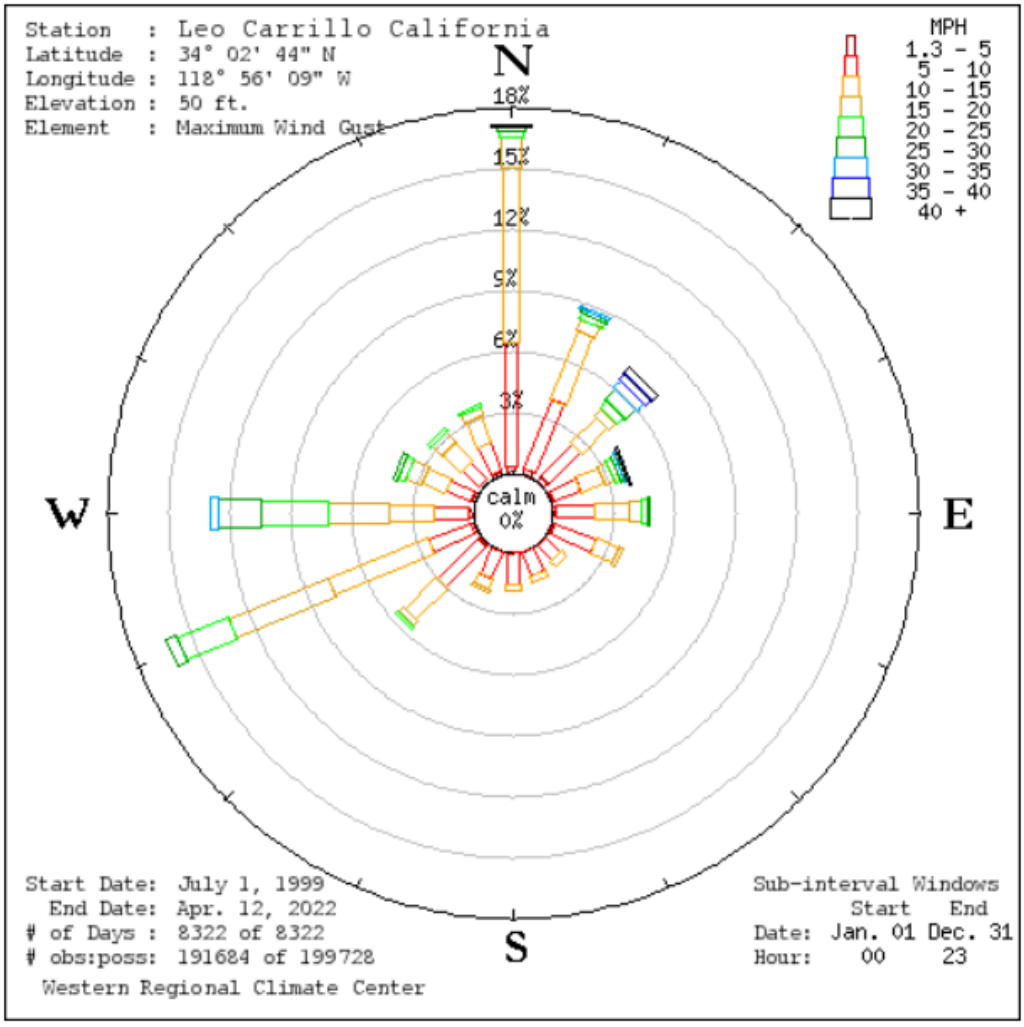

Fig. 5 – Wind Rose for LCBC1[2]

The most important fact in this wind rose is the fact that 40% of the time over the last 23 years the wind direction observed is from a westerly direction (SW-NW). One can assume then that the prevailing wind direction at the point of interest in this wind study is also similarly from a westerly direction. Thus, the trees on the western perimeter of the property would likely act as a wind buffer 40% of the time.

[2] https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCLEO

Summary/Takeaways

- A wind study was conducted at 29253 Greenwater Road in Malibu CA on 11 Apr 2022.
- The purpose of the wind study was to evaluate the magnitude of the wind buffer that trees along the western perimeter of the property provided.
- The wind equipment used to perform the wind study were identical Tempest Weather Systems by WeatherFlow with sonic wind anemometers.
- The Tempest Weather Systems were strategically placed to evaluate both un-obstructed wind and wind buffered by trees on the western perimeter of the property.
- Five-minute peak wind gust data was collected/analyzed for a typical windy Spring Day in Malibu, CA. The evaluation period lasted for over 9 hours.
- **The data clearly showed that the peak wind gusts at the tree-buffered location were considerably less than the peak wind gusts at the un-obstructed location, on average by 85%. This clearly demonstrated that the trees were a very efficient wind buffer and would result in a substantial reduction in wind gust magnitude downstream.**
- **The prevailing wind direction in this event was from the West. A wind rose from a nearby well-established (23 years) weather station showed that 40% of the time, in any given year, the wind blows from a westerly direction. Thus, the trees on the western perimeter of the property would likely act as wind buffer 40% of the time.**

Appendix A

Greenwater Road Wind Study - Wind Gust Comparisons						
11-Apr-22						
Time (LDT)	T1	T2	SE716	AV536	LCBC1	% Diff[1]
1140	4.9	10.6	15.0	7.0		116%
1150	6.9	11.1	15.7	10.0		61%
1155	4.9	11.0		9.0	20.0	124%
1200	4.4	11.5	16.4	7.0		161%
1205	3.9	11.9		7.0		205%
1210	5.0	12.8	17.0	5.0		156%
1215	5.6	12.8		4.0		129%
1220	6.1	11.3	16.2	9.0		85%
1225	7.8	11.7		13.0		50%
1230	3.7	9.4	16.5	11.0		154%
1235	2.7	9.8		5.0		263%
1240	4.1	9.0	15.3	9.0		120%
1245	5.8	9.7		13.0		67%
1250	4.8	9.8	15.9	9.0		104%
1255	4.7	9.8		14.0	22.0	109%
1300	7.2	9.7	17.1	5.0		35%
1305	4.6	11.5		14.0		150%
1310	3.6	9.2	20.1	7.0		156%
1315	6.3	11.8		10.0		87%
1320	5.7	10.4	15.1	4.0		82%
1325	4.7	11.2		14.0		138%
1330	4.8	11.2	17.2	7.0		133%
1335	5.8	10.0		4.0		72%
1340	3.3	10.4	19.0	5.0		215%
1345	5.6	9.6		5.0		71%
1350	4.2	12.3	20.2	12.0		193%
1355	5.9	11.0		6.0	21.0	86%
1400	7.3	8.2	18.6	9.0		12%
1405	6.0	11.2		7.0		87%
1410	6.1	11.1	19.8	5.0		82%
1415	6.8	14.3		13.0		110%
1420	6.8	12.7	17.3	11.0		87%
1425	6.9	13.3		6.0		93%
1430	8.7	12.7	14.9	5.0		46%
1435	5.5	11.8		6.0		115%
1440	4.5	12.1	15.8	10.0		169%
1445	4.7	11.7		5.0		149%
1450	5.1	12.1	14.3	11.0		137%

1455	3.7	11.6		4.0	24.0	**214%**
1500	4.7	9.4	15.1	3.0		**100%**
1505	3.6	10.6		11.0		**194%**
1510	6.1	11.8	15.4	2.0		**93%**
1515	5.4	10.3		5.0		**91%**
1520	4.3	11.0	16.4	2.0		**156%**
1525	2.6	11.8		2.0		**354%**
1530	5.2	11.1	17.9	5.0		**113%**
1535	7.0	13.1		6.0		**87%**
1540	7.8	10.4	20.9	2.0		**33%**
1545	4.5	14.7		5.0		**227%**
1550	4.9	12.3	20.2	6.0		**151%**
1555	4.5	13.6		10.0	27.0	**202%**
1600	9.5	11.6	21.6	9.0		**22%**
1605	3.8	14.7		4.0		**287%**
1610	7.0	13.3	23.4	3.0		**90%**
1615	8.4	16.4		10.0		**95%**
1620	7.2	10.0	21.5	15.0		**39%**
1625	4.5	9.9		16.0		**120%**
1630	6.5	11.5	21.3	13.0		**77%**
1635	9.3	10.4		15.0		**12%**
1640	6.2	16.9	23.9	10.0		**173%**
1645	8.8	12.5		7.0		**42%**
1650	7.2	11.7	22.5	9.0		**63%**
1655	7.2	13.1		7.0	28.0	**82%**
1700	8.3	11.7	21.3	15.0		**41%**
1705	6.0	12.2		11.0		**103%**
1710	9.4	11.4	17.5	9.0		**21%**
1715	6.3	12.2		4.0		**94%**
1720	5.4	9.4	22.1	12.0		**74%**
1725	5.5	9.7		9.0		**76%**
1730	6.1	12.1	21.1	6.0		**98%**
1735	6.6	10.8		14.0		**64%**
1740	6.2	12.1	21.3	13.0		**95%**
1745	6.1	12.4		2.0		**103%**
1750	4.3	11.9	20.5	2.0		**177%**
1755	4.0	12.5		3.0	26.0	**213%**
1800	4.8	11.1	23.4	13.0		**131%**
1805	5.2	13.1		13.0		**152%**
1810	8.5	12.8	28.5	5.0		**51%**
1815	5.6	15.9		9.0		**184%**
1820	5.5	13.0	24.7	6.0		**136%**
1825	7.6	13.2		5.0		**74%**
1830	5.0	11.3	20.2	13.0		**126%**
1835	9.3	14.4		9.0		**55%**
1840	10.5	13.1	23.5	10.0		**25%**
1845	7.8	11.3		4.0		**45%**

1850	6.8	14.8	27.0	3.0		**118%**
1855	5.0	13.7		11.0	24.0	**174%**
1900	8.8	13.3	20.7	6.0		**51%**
1905	5.9	11.0		5.0		**86%**
1910	5.4	13.3	18.5	10.0		**146%**
1915	5.5	12.7		5.0		**131%**
1920	5.3	10.0	18.2	5.0		**89%**
1925	7.5	12.1		6.0		**61%**
1930	2.3	8.7	19.5	6.0		**278%**
1935	4.2	8.7		5.0		**107%**
1940	10.5	9.1	14.2	4.0		**-13%**
1945	7.8	10.9		6.0		**40%**
1950	6.8	10.1	15.7	9.0		**49%**
1955	5.0	11.7		9.0	24.0	**134%**
2000	8.8	12.1	22.2	10.0		**38%**
2005	7.8	10.0		9.0		**28%**
2010	8.3	10.9	22.9	9.0		**31%**
2015	12.2	17.7		15.0		**45%**
2020	14.4	15.4	27.3	12.0		**7%**
2025	7.5	10.0		7.0		**33%**
2030	9.8	13.4	26.6	11.0		**37%**
2035	5.3	7.0		3.0		**32%**
2040	10.5	9.1	22.1	7.0		**-13%**
2045	6.8	8.7		3.0		**28%**
2050	8.6	12.1	20.2	10.0		**41%**
2055	12.5	17.9		15.0	33.0	**43%**
2100	14.1	18.2	24.8	10.0		**29%**
Average	**6.4**	**11.7**	**20**	**8.0**	**24.9**	**85%**

NOTES

Peak Wind Gusts in Miles per Hour

% Diff[1] = Percent T2 value is higher than T1 value

Positive

Negative

Date: 22 Apr 2022