In [1]:
```
library(tidyverse)
library(sf)
library(mapview)
library(rvest)
library(httr)
library(ggplot2)
library(ggmap)
library(maps)
library(ggsn)
library(geosphere)
library(dplyr)
library(RColorBrewer)
library(readxl)
library(leaflet)
library(leaflet.extras)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
✔ dplyr     1.1.2     ✔ readr     2.1.4
✔ forcats   1.0.0     ✔ stringr   1.5.0
✔ ggplot2   3.4.2     ✔ tibble    3.2.1
✔ lubridate 1.9.2     ✔ tidyr     1.3.0
✔ purrr     1.0.1
── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts t
o become errors
Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE


Attaching package: ‘rvest’


The following object is masked from ‘package:readr’:

    guess_encoding


ℹ Google's Terms of Service: <https://mapsplatform.google.com>
ℹ Please cite ggmap if you use it! Use `citation("ggmap")` for details.

Attaching package: ‘maps’


The following object is masked from ‘package:purrr’:

    map


Loading required package: grid
```

In [2]:
```
Bluephone_location <- read_csv("data/Bluephone Locations My Map Downloaded with coo:
head(Bluephone_location)
```

```
Rows: 89 Columns: 4
── Column specification ────────────────────────────────────────────────────────
Delimiter: ","
chr (2): Formal_Name_and_Room, Street_Address
dbl (2): Latitude, Longitude

ℹ Use `spec()` to retrieve the full column specification for this data.
ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>

A tibble: 6 × 4

Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

In [3]:
```
Bluephone_location <- Bluephone_location |>
    mutate(across(Longitude, as.double))
```

In [4]:
```
head(Bluephone_location)
```

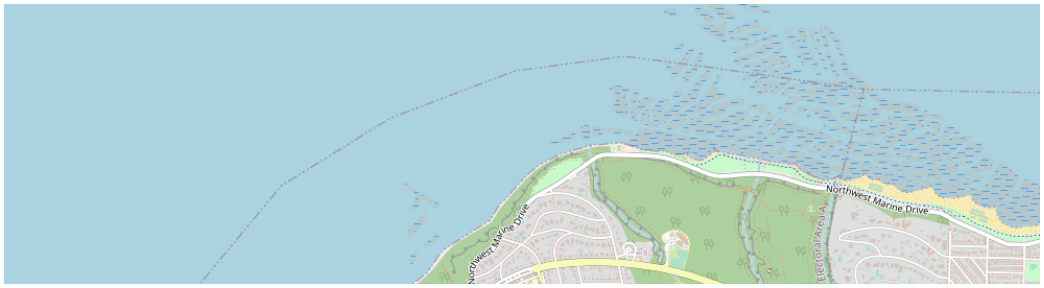
A tibble: 6 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

In [5]:
```
base_map <- leaflet() %>%
    addTiles() %>%
    fitBounds(-123.22,49.263,-123.28,49.27)

#base_map
```

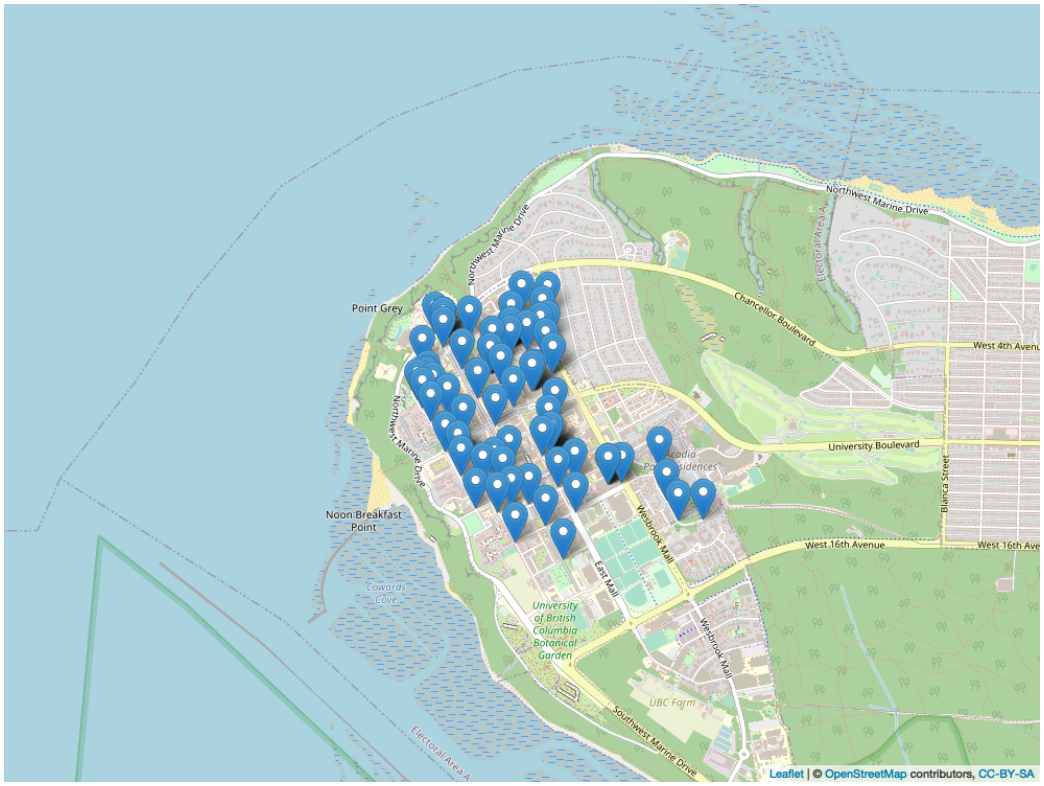
In [6]:
```
# save the map view
mapshot(base_map, file = "Map Image Save/base map.png")
```



In [7]:
```
bluephone_map <- leaflet(data = Bluephone_location) %>%
    addTiles() %>%
    fitBounds(-123.22,49.263,-123.28,49.27) %>%
    addMarkers(lng = ~Longitude,
               lat = ~Latitude,
               popup = ~Street_Address, label = ~Formal_Name_and_Room)

#bluephone_map
```

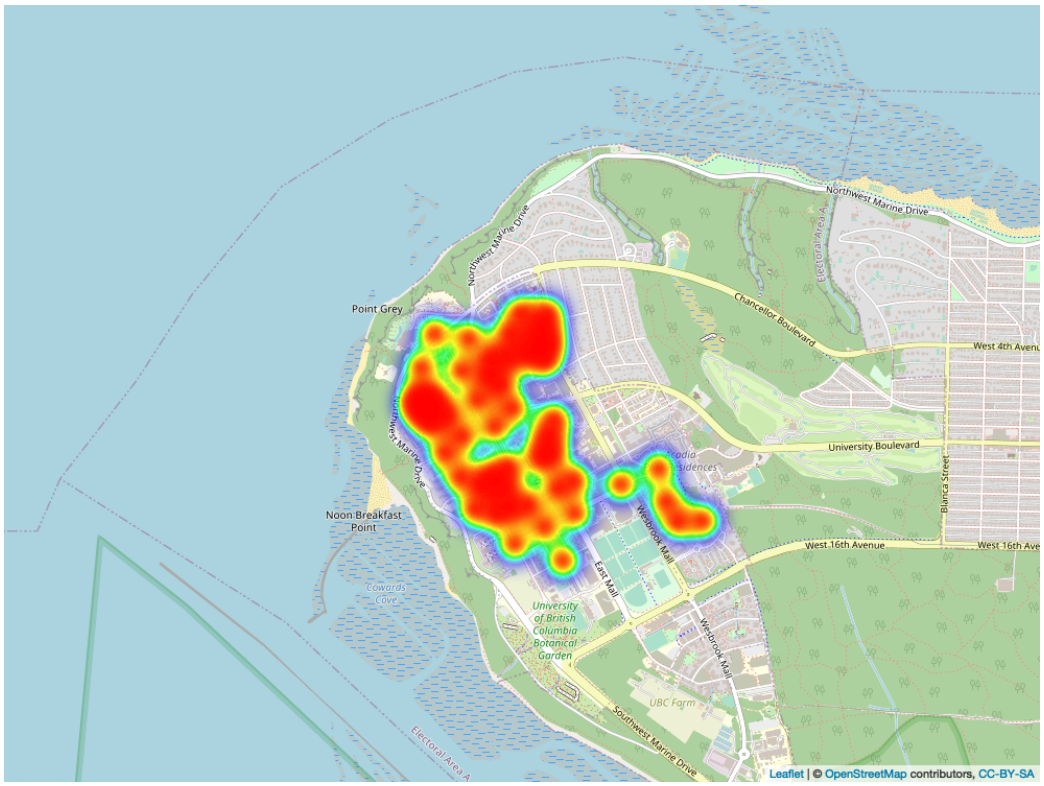
In [8]:
```
# save the map view
mapshot(bluephone_map, file = "Map Image Save/bluephone map.png")
```



In [9]:
```
# heatmap of bluephone density
bluephone_heatmap <- addHeatmap(base_map, lng = ~Longitude, lat = ~Latitude,  intens
    layerId = NULL, group = NULL, minOpacity = 0.05, max = 0.05,
    radius = 20, blur = 25, gradient = NULL, cellSize = 10,
    data = Bluephone_location)

#bluephone_heatmap
```

In [10]:
```
# save the map view
mapshot(bluephone_heatmap, file = "Map Image Save/bluephone heatmap.png")
```



In [11]:
```
head(Bluephone_location)
```

Formal_Name_and_Room <chr>	Street_Address <chr>	Latitude <dbl>	Longitude <dbl>
A tibble: 6 × 4			
Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

In [12]:
```
library(geosphere)
```

In [13]:
```
bluephone_lon_lat <- Bluephone_location |>
    select(Longitude, Latitude)
```

In [14]:
```
first_bluephone <- Bluephone_location[89, ]
first_bluephone
first_bluephone_lon_lat <- select(first_bluephone, Longitude, Latitude)
```

```
first_bluephone_lon_lat <- select(first_bluephone, Longitude, Latitude)
first_bluephone_lon_lat
rest_bluephone <- Bluephone_location |>
        filter(Latitude != pull(first_bluephone, Latitude))

Bluephone_distance <- rest_bluephone |>
        group_by(Formal_Name_and_Room, Latitude, Longitude) |>
        summarize(distance = distGeo(first_bluephone_lon_lat, c(Longitude, Latitude
        arrange(distance) |>
        head(1) |>
        mutate(Bluephone_origin = pull(first_bluephone, Formal_Name_and_Room)) |>
        select(Bluephone_origin, Formal_Name_and_Room, Latitude, Longitude, distanc

colnames(Bluephone_distance) <- c("Formal_Name_and_Room", "closet_Bluephone", "Lati

Bluephone_distance
```

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>

A tibble: 1 × 4

Blue Phone 89	Saltwater Octopus House	49.27075	-123.248

Longitude	Latitude
<dbl>	<dbl>

A tibble: 1 × 2

-123.248	49.27075

```
`summarise()` has grouped output by 'Formal_Name_and_Room', 'Latitude'. You can
override using the `.groups` argument.
```

Formal_Name_and_Room	closet_Bluephone	Latitude	Longitude	distance
<chr>	<chr>	<dbl>	<dbl>	<dbl>

A grouped_df: 1 × 5

Blue Phone 89	Blue Phone 88	49.27007	-123.2484	80.77666

In [15]:

```
bluephone_closest_distance <- as_tibble(filter(Bluephone_distance, Latitude == 1))
bluephone_closest_distance
```

Formal_Name_and_Room	closet_Bluephone	Latitude	Longitude	distance
<chr>	<chr>	<dbl>	<dbl>	<dbl>

A tibble: 0 × 5

In [16]:

```
bluephone_closest_distance <- filter(Bluephone_distance, Latitude == 1)

options(dplyr.summarise.inform = FALSE) #disable dplyr messages in code

for (i in 1:89){
    first_bluephone <- Bluephone_location[i, ]
    first_bluephone_lon_lat <- select(first_bluephone, Longitude, Latitude)
    rest_bluephone <- Bluephone_location |>
        filter(Latitude != pull(first_bluephone, Latitude))

    Bluephone_distance <- rest_bluephone |>
        group_by(Formal_Name_and_Room, Latitude, Longitude) |>
        summarize(distance = distGeo(first_bluephone_lon_lat, c(Longitude, Latitude
        arrange(distance) |>
        head(1) |>
        mutate(Bluephone_origin = pull(first_bluephone, Formal_Name_and_Room)) |>
        select(Bluephone_origin, Formal_Name_and_Room, Latitude, Longitude, distanc
```

```
    colnames(Bluephone_distance) <- c("Formal_Name_and_Room", "closet_Bluephone", "
    bluephone_closest_distance <- bind_rows(bluephone_closest_distance, Bluephone_d
}

head(bluephone_closest_distance)
```

Formal_Name_and_Room	closet_Bluephone	Latitude	Longitude	distance
<chr>	<chr>	<dbl>	<dbl>	<dbl>
A grouped_df: 6 × 5				
Blue Phone 01 ANSOC @ Northwest Marine Drive	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	55.42414
Blue Phone 03 Flagpole Plaza @	Blue Phone 62 Rose Garden	49.26945	-123.2566	56.72429

Lower Mall & Pedestrian Path	Parkade South West Level 1			
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	49.26497	-123.2575	103.17813
Blue Phone 07 Hennings @ East Mall & Agricultural Road	Blue Phone 41 Thunderbird Park pedestrian pathway near Soccer Centre	49.26753	-123.2527	87.78280

In [17]:
```
write_csv(bluephone_closest_distance, file = "data/Each Bluephone Distance with Clo
```

In [18]:
```
#rename from the formal name to index
bluephone_closest_distance_renamed <- bluephone_closest_distance |>
    mutate(Bluephone_No = substr(Formal_Name_and_Room, 11, 13)) |>
    mutate(across(Bluephone_No, as.integer)) |>
    select(Bluephone_No, closet_Bluephone, Latitude, Longitude, distance)

head(bluephone_closest_distance_renamed)
```

Bluephone_No	closet_Bluephone	Latitude	Longitude	distance
<int>	<chr>	<dbl>	<dbl>	<dbl>
A grouped_df: 6 × 5				
1	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	55.42414
3	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	56.72429
4	Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	49.26894	-123.2566	171.26136
5	Blue Phone 48 Fraser River Parkade South West Level 1	49.26568	-123.2583	94.76914
6	Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	49.26497	-123.2575	103.17813
7	Blue Phone 41 Thunderbird Park pedestrian pathway near Soccer Centre	49.26753	-123.2527	87.78280

In [19]:
```
# calculate the mean of the distance
distance_mean <- bluephone_closest_distance_renamed |>
```

```
    pull(distance) |>
    mean()

cat("The distance between each bluephone and its closet bluephone is", distance_mea
```

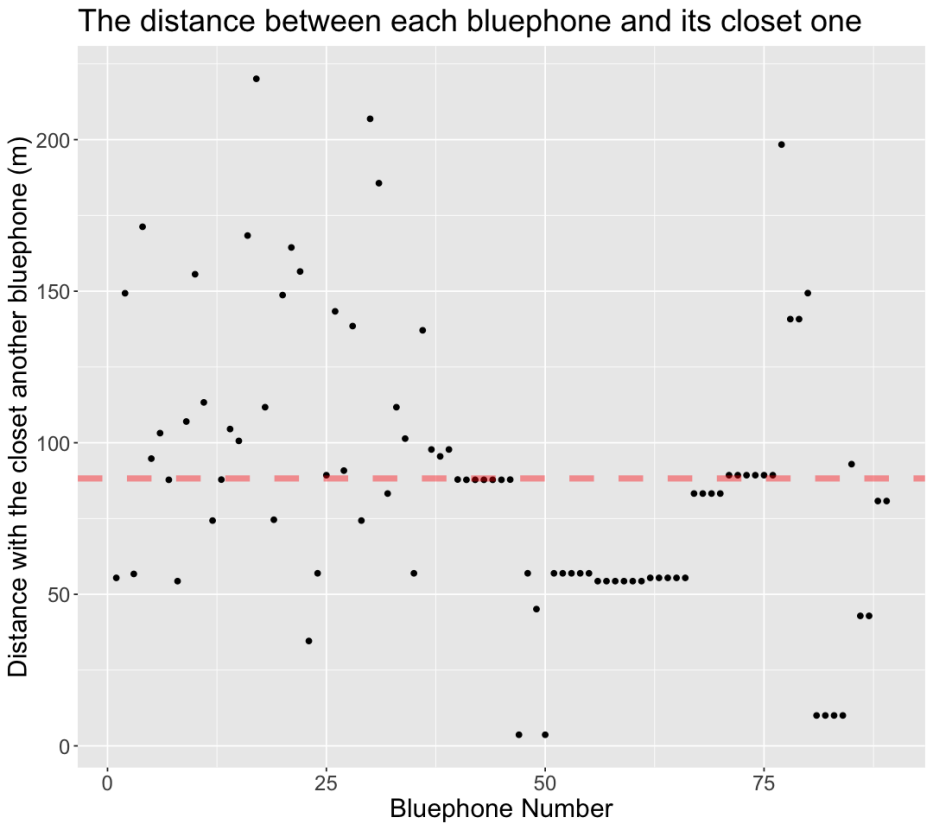
```
The distance between each bluephone and its closet bluephone is 88.23234 m.
```

In [20]:

```
#plot the distance between the current bluephone and its closet one
options(repr.plot.height = 8, repr.plot.width = 9)

bluephone_closest_distance_plot <- bluephone_closest_distance_renamed |>
    ggplot(aes(x = Bluephone_No, y = distance)) +
    geom_point() +
    geom_hline(yintercept = distance_mean, linetype = "dashed", linewidth = 2, alpha
    labs(x = "Bluephone Number",
         y = "Distance with the closet another bluephone (m)") +
    ggtitle("The distance between each bluephone and its closet one") +
    theme(text = element_text(size = 18))

bluephone_closest_distance_plot
```



In [21]:

```
#find the location of the bluephone such that has the maximum distance with another
bluephone_distance_max <- bluephone_closest_distance |>
    arrange(desc(distance)) |>
    head(1)
```