APPENDIX D: SEQUESTRATION ANALYSIS

Cascadia Consulting Group ("Cascadia") used the USDA Forest Service's i-Tree Canopy software to conduct a high-level land carbon sequestration analysis to estimate potential greenhouse gas (GHG) emissions reduction benefits from Shoreline's urban forests. The software facilitates a supervised random sampling (100 samples) using Google Maps aerial photography. The analysis includes quantification of the carbon sequestration potential of Shoreline's existing tree canopy.

Results

The i-Tree Canopy analysis indicates 44% of Shoreline's land mass is covered with trees as of 2021.[7] These trees sequester an estimated 13,890 metric tons of CO_2 equivalent (MT CO_2e) from the atmosphere every year[8] and store an estimated 413,840 MT CO_2e.[9]

Tree Benefit Estimates: Carbon

Description	Carbon (kT)	±SE	CO_2 Equiv. (kT)	±SE	Value (USD)	±SE
Sequestered annually in trees	3.79	±0.43	13.89	±1.57	$646,250	±72,907
Carbon stored in trees	112.87	±12.73	413.84	±46.69	$19,249,244	±2,171,60

Tree Benefit Estimates: Air Pollution

Abbreviation	Description	Amount (T)	± SE	Value (USD)	± SE
CO	Carbon Monoxide removed annually	1.36	±0.15	$420	±47
NO_2	Nitrogen Dioxide removed annually	12.75	±1.44	$1,530	±173
O_3	Ozone removed annually	12.75	±1.44	$1,530	±173
SO_2	Sulfur Dioxide removed annually	3.87	±0.44	$63	±7

7 Value depicted as mean estimate, with 95% confidence interval of 39.04-48.96%.
8 Assumes a sequestration rate of 28,498 lbs. CO_2/acre/year. Source: i-Tree Canopy v.7.1.
9 Value depicted as mean estimate assuming a storage amount of 21,940 MT of Carbon, or 80,446 MT of CO_2, per mi^2 and rounded.

Abbreviation	Description	Amount (T)	± SE	Value (USD)	± SE
PM2.5	Particulate Matter less than 2.5 microns removed annually	4.57	±0.52	$112,510	±12,693
PM10	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	67	±2.90	$35,561	±4,012
Total		**133.12**	**±15.02**	**$182,677**	**±20,609**

Tree Benefit Estimates: Hydrological

Abbreviation	Description	Amount (Mgal)	± SE	Value (USD)	± SE
AVRO	Avoided Runoff	54.19	±6.11	$484,239	±54,630
E	Evaporation	392.58	±44.29	N/A	N/A
I	Interception	395.86	±44.66	N/A	N/A
T	Transpiration	806.74	±91.01	N/A	N/A
PE	Potential Evaporation	1,258.83	±142.01	N/A	N/A
PET	Potential Evapotranspiration	1,092.90	±123.30	N/A	N/A

Considerations

This carbon sequestration analysis represents a high-level estimate of annual land carbon sequestration in Shoreline. Data limitations and other considerations include:

- **Omission of non-tree vegetation:** This approach assumes that non-tree vegetation does not sequester carbon, which is not the case. This analysis does not include carbon benefits from non-tree vegetation such as agriculture, pasture, and shrubs.
- **Tree generalization:** This approach does not explicitly differentiate between tree types, but assumes that all trees sequester an average, representative amount of carbon every year.
- **Statistical sampling:** This approach extrapolates a statistical sampling of an area, rather than analyze the area in its entirety, which inevitably results in some level of statistical uncertainty and imprecision.

Methodology

i-Tree Canopy (version 7.1) estimates tree cover and tree benefits for a given area with a random sampling process to easily classify ground cover types. For this study, Cascadia used ground cover types "Tree" and "Non-Tree." We selected the City of Shoreline's boundaries from the pre-existing geographic boundaries in the program. The program randomly sampled 100 data points across the two ground cover types to estimate sequestration benefits. The following figures serve to visualize the study's methodology.

- **Figure 1:** Selected city boundaries for the Shoreline study using pre-defined U.S. Census Places outlines.
- **Figure 2:** Estimated tree canopy cover on Shoreline in 2021, using random sampling from the i-Tree Canopy software with 100 data points classified as Tree or Non-Tree cover.
- **Figure 3:** Selected project location and sequestration benefits for the Shoreline study. The Shoreline study used the King County pre-set feature with both rural and urban land chosen. The air pollution benefits are shown in terms of removal rate of each pollutant.
- **Figure 4:** Example of tree cover area in the random sampling classification exercise.
- **Figure 5:** Example of non-tree area in the random sampling classification exercise.

Figure 1. Selected city boundaries for the Shoreline study using pre-defined U.S. Census Places outlines.

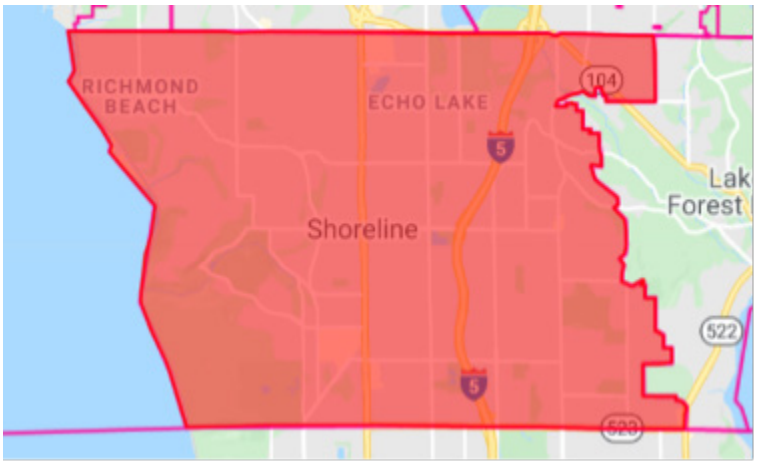
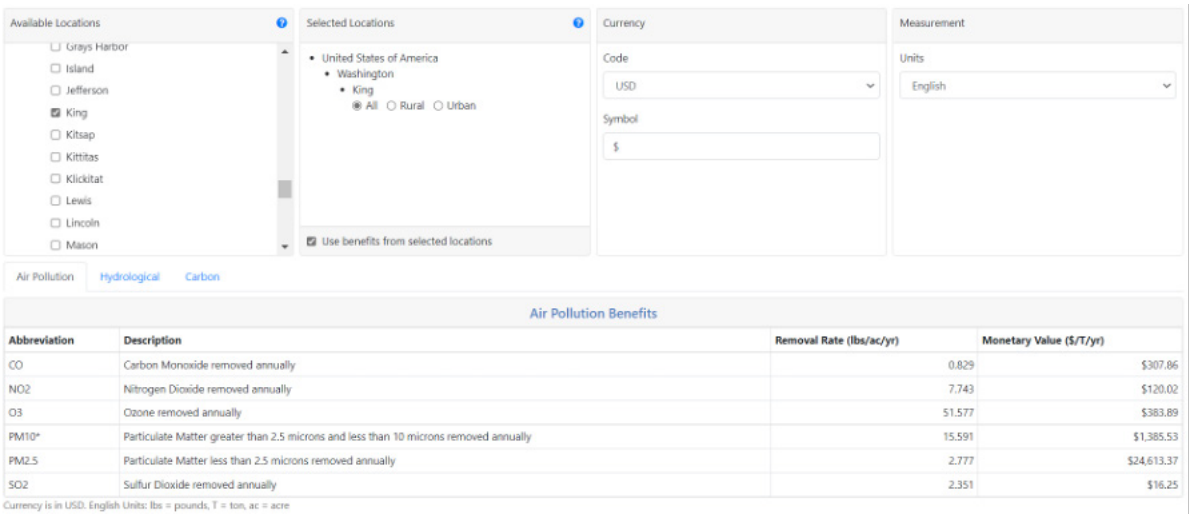


Figure 2. Estimated tree canopy cover in Shoreline in 2021, using random sampling from the i-Tree Canopy software with 100 data points classified as Tree or Non-Tree cover

Abbr.	Cover Class	Description	Points	% Cover ± SE	Area (mi²) ± SE
NT	Non-Tree	All other surfaces	56	56.00 ± 4.96	6.55 ± 0.58
T	Tree	Tree, non-shrub	44	44.00 ± 4.96	5.14 ± 0.58
Total			**100**	**100.00**	**11.69**

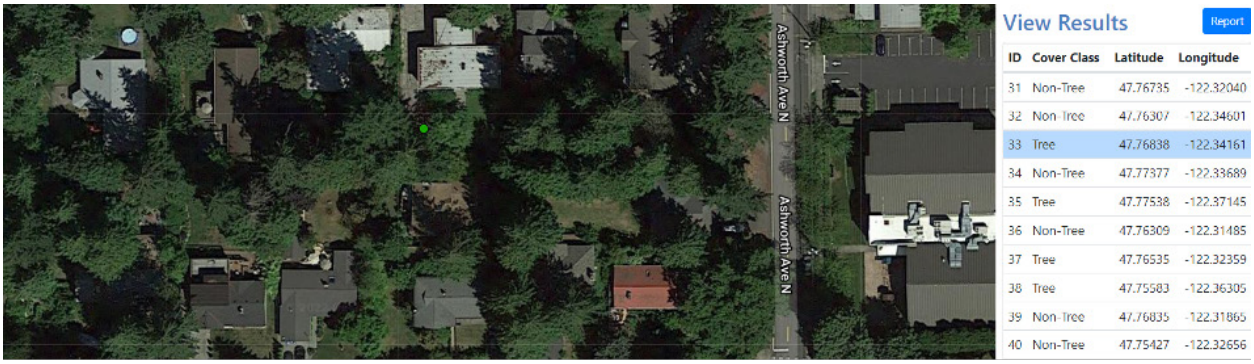
Figure 3. Selected project location and sequestration benefits for the Shoreline study. The Shoreline study used the King County pre-set feature with both rural and urban land chosen. The air pollution benefits are shown in terms of removal rate of each pollutant.



Abbreviation	Description	Removal Rate (lbs/ac/yr)	Monetary Value ($/T/yr)
CO	Carbon Monoxide removed annually	0.829	$307.86
NO2	Nitrogen Dioxide removed annually	7.743	$120.02
O3	Ozone removed annually	51.577	$383.89
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	15.591	$1,385.53
PM2.5	Particulate Matter less than 2.5 microns removed annually	2.777	$24,613.37
SO2	Sulfur Dioxide removed annually	2.351	$16.25

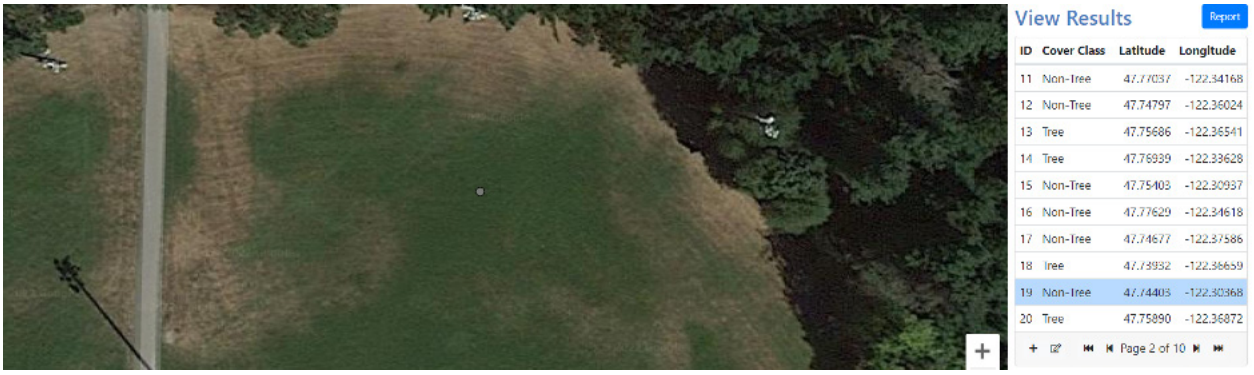
Currency is in USD. English Units: lbs = pounds, T = ton, ac = acre

Figure 4. Example of tree cover area in the random sampling classification exercise.



ID	Cover Class	Latitude	Longitude
31	Non-Tree	47.76735	-122.32040
32	Non-Tree	47.76307	-122.34601
33	Tree	47.76838	-122.34161
34	Non-Tree	47.77377	-122.33689
35	Tree	47.77538	-122.37145
36	Non-Tree	47.76309	-122.31485
37	Tree	47.76535	-122.32359
38	Tree	47.75583	-122.36305
39	Non-Tree	47.76835	-122.31865
40	Non-Tree	47.75427	-122.32656

Figure 5. Example of non-tree area in the random sampling classification exercise.



ID	Cover Class	Latitude	Longitude
11	Non-Tree	47.77037	-122.34168
12	Non-Tree	47.74797	-122.36024
13	Tree	47.75686	-122.36541
14	Tree	47.76939	-122.33628
15	Non-Tree	47.75403	-122.30937
16	Non-Tree	47.77629	-122.34618
17	Non-Tree	47.74677	-122.37586
18	Tree	47.73932	-122.36659
19	Non-Tree	47.74403	-122.30368
20	Tree	47.75890	-122.36872

Page 2 of 10

Appendix: Sampled Coordinates

ID	Class	Latitude	Longitude
1	Non-Tree	47.75227	-122.35110
2	Non-Tree	47.75443	-122.32719
3	Non-Tree	47.76202	-122.34578
4	Non-Tree	47.76230	-122.37907
5	Tree	47.76939	-122.34754
6	Tree	47.75256	-122.37072
7	Non-Tree	47.75494	-122.35635
8	Non-Tree	47.75775	-122.34500
9	Non-Tree	47.75399	-122.31516
10	Non-Tree	47.73477	-122.30868
11	Non-Tree	47.77037	-122.34168
12	Non-Tree	47.74797	-122.36024
13	Tree	47.75686	-122.36541
14	Tree	47.76939	-122.33628
15	Non-Tree	47.75403	-122.30937
16	Non-Tree	47.77629	-122.34618
17	Non-Tree	47.74677	-122.37586
18	Tree	47.73932	-122.36659
19	Non-Tree	47.74403	-122.30368
20	Tree	47.75890	-122.36872
21	Tree	47.75886	-122.35052
22	Non-Tree	47.76919	-122.34571
23	Non-Tree	47.73637	-122.29924
24	Tree	47.74524	-122.31104
25	Tree	47.76984	-122.31888
26	Tree	47.74830	-122.31458
27	Tree	47.76621	-122.38582
28	Non-Tree	47.74105	-122.29642
29	Non-Tree	47.75027	-122.36719
30	Tree	47.76774	-122.35119
31	Non-Tree	47.76735	-122.32040
32	Non-Tree	47.76307	-122.34601
33	Tree	47.76838	-122.34161
34	Non-Tree	47.77377	-122.33689
35	Tree	47.77538	-122.37145
36	Non-Tree	47.76309	-122.31485
37	Tree	47.76535	-122.32359
38	Tree	47.75583	-122.36305
39	Non-Tree	47.76835	-122.31865
40	Non-Tree	47.75427	-122.32656
41	Non-Tree	47.73510	-122.29974
42	Tree	47.76821	-122.32923
43	Tree	47.76691	-122.38668
44	Tree	47.74570	-122.31391
45	Non-Tree	47.76411	-122.33661
46	Non-Tree	47.75433	-122.37608
47	Non-Tree	47.73858	-122.36341
48	Tree	47.77042	-122.29971

ID	Class	Latitude	Longitude
49	Tree	47.73922	-122.32178
50	Non-Tree	47.75946	-122.31160
51	Tree	47.76812	-122.32809
52	Non-Tree	47.74879	-122.30346
53	Tree	47.73963	-122.31777
54	Non-Tree	47.74421	-122.32513
55	Non-Tree	47.75509	-122.31918
56	Tree	47.74099	-122.35558
57	Non-Tree	47.76183	-122.33812
58	Tree	47.73673	-122.29528
59	Tree	47.76844	-122.35633
60	Tree	47.73631	-122.35552
61	Tree	47.74690	-122.29771
62	Tree	47.74663	-122.32337
63	Non-Tree	47.74999	-122.31822
64	Tree	47.74543	-122.35559
65	Non-Tree	47.77240	-122.39368
66	Tree	47.76966	-122.31415
67	Non-Tree	47.77181	-122.34855
68	Non-Tree	47.74847	-122.33404
69	Tree	47.75096	-122.37087
70	Tree	47.74439	-122.29867
71	Tree	47.77443	-122.36146
72	Tree	47.77371	-122.32364
73	Non-Tree	47.76509	-122.33062

ID	Class	Latitude	Longitude
74	Tree	47.73739	-122.33188
75	Non-Tree	47.75615	-122.37473
76	Tree	47.73656	-122.30615
77	Non-Tree	47.76401	-122.32806
78	Non-Tree	47.73490	-122.33761
79	Non-Tree	47.73462	-122.31469
80	Non-Tree	47.74428	-122.34125
81	Non-Tree	47.77384	-122.33905
82	Non-Tree	47.73923	-122.34387
83	Tree	47.76123	-122.36061
84	Tree	47.74340	-122.37836
85	Tree	47.75484	-122.35869
86	Tree	47.74572	-122.31141
87	Non-Tree	47.74814	-122.33546
88	Non-Tree	47.75756	-122.35650
89	Tree	47.74638	-122.29862
90	Tree	47.74076	-122.35855
91	Non-Tree	47.73948	-122.31915
92	Non-Tree	47.75225	-122.31188
93	Tree	47.76907	-122.35208
94	Non-Tree	47.77778	-122.35142
95	Non-Tree	47.73602	-122.29411
96	Non-Tree	47.77588	-122.38189
97	Non-Tree	47.74387	-122.31526
98	Non-Tree	47.77176	-122.38827

ID	Class	Latitude	Longitude
99	Non-Tree	47.75181	-122.36816
100	Non-Tree	47.77053	-122.32272