



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION

Sarah Berling, Kelly Brezoczky, Tamara Michie,
Gerald Montmorency and JC Myers

All meetings are held in the City Council Chambers
East Side of Monte Verde Street
Between Ocean and 7th Avenues

REGULAR MEETING Thursday, February 8, 2024

MEETING 2:30 PM

THIS MEETING WILL BE HELD IN PERSON AND VIA TELECONFERENCE. The public is welcome to attend the meeting in person or remotely via Zoom, however, the meeting will proceed as normal even if there are technical difficulties accessing zoom. The City will do its best to resolve any technical issues as quickly as possible. To view or listen to the meeting from home, you may watch the Youtube Live Stream at: <https://www.youtube.com/@CityofCarmelbytheSea/streams>, or use the link below to view or listen to the meeting via Zoom teleconference:

<https://ci-carmel-ca-us.zoom.us/j/88376779542> Webinar ID: 883 7677 9542 Passcode: 331405 Dial in: (253)215-8782

HOW TO OFFER PUBLIC COMMENT: Public comment may be given in person at the meeting, or using the Zoom teleconference module, provided that there is access to Zoom during the meeting. Zoom comments will be taken after the in-person comments. The public can also email comments to yculver@ci.carmel.ca.us. Comments must be received 2 hours before the meeting in order to be provided to the legislative body. Comments received after that time and up to the beginning of the meeting will be made part of the record.

CALL TO ORDER AND ROLL CALL

PLEDGE OF ALLEGIANCE

PUBLIC APPEARANCES - Under the Brown Act, public comment for matters on the agenda must relate to that agenda item and public comments for matters not on the agenda must relate to the subject matter jurisdiction of this legislative body. Hateful, violent, and threatening speech is impermissible public comment as it disrupts the conduct of the public meeting. This is a warning that if a member of the public attending this meeting remotely violates the Brown Act by failing to comply with these requirements of the Brown Act the meeting, then that speaker will be muted.

Members of the public are entitled to speak on matters of municipal concern not on the agenda during Public Appearances. Each person's comments shall be limited to 3 minutes, or as otherwise established by the

Commission. Matters not appearing on Commission's agenda will not receive action at this meeting but may be referred to staff for a future meeting. Persons are not required to give their names, but it is helpful for speakers to state their names so that they may be identified in the minutes of the meeting.

ANNOUNCEMENTS

CONSENT AGENDA

Items on the consent agenda are routine in nature and do not require discussion or independent action. Members of the Commission or the public may ask that any items be considered individually for purposes of Commission discussion and/ or for public comment. Unless that is done, one motion may be used to adopt all recommended actions.

1. January 11, 2024 Meeting Minutes

ORDERS OF BUSINESS

Orders of Business are agenda items that require City Council, Board or Commission discussion, debate, direction to staff, and/or action.

2. Receive a Presentation and Consider approval of a Restoration Project along the Scenic Pathway, as proposed by the Leadership Carmel Class of 2024, subject to issuance of an encroachment permit
3. Receive a presentation of two Urban Forest Master Plan (UFMP) deliverables: Tree Inventory and Species in Carmel-by-the-Sea, and the Tree Canopy and Land Cover Assessment
4. Receive a demonstration of TreeKeeper, a digital tree inventory program
5. City Forester's Report for January 2024
6. Public Works Director's Report for January 2024

FUTURE AGENDA ITEMS

ADJOURNMENT

This agenda was posted at City Hall, Monte Verde Street between Ocean Avenue and 7th Avenue, Harrison Memorial Library, located on the NE corner of Ocean Avenue and Lincoln Street, the Carmel-by-the-Sea Post Office, 5th Avenue between Dolores Street and San Carlos Street, and the City's webpage <http://www.ci.carmel.ca.us> in accordance with applicable legal requirements.

SUPPLEMENTAL MATERIAL RECEIVED AFTER THE POSTING OF THE AGENDA

Any supplemental writings or documents distributed to a majority of the Forest & Beach Commission regarding any item on this agenda, received after the posting of the agenda will be available at the Public Works Department located on the east side of Junipero Street between Fourth and Fifth Avenues during normal business hours.

SPECIAL NOTICES TO PUBLIC

In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, please contact the City Clerk's Office at 831-620-2000 at least 48 hours prior to the meeting to ensure that reasonable arrangements can be made to provide accessibility to the meeting (28CFR 35.102-35.104 ADA Title II).



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

February 8, 2024
CONSENT AGENDA

TO: Forest and Beach Commissioners

SUBMITTED BY: Robert M. Harary, P.E., Director of Public Works

SUBJECT: January 11, 2024 Meeting Minutes

RECOMMENDATION:

Approve the January 11, 2024 Meeting Minutes.

BACKGROUND/SUMMARY:

FISCAL IMPACT:

ATTACHMENTS:

FBC Meeting Minutes January 12, 2023

**FOREST AND BEACH COMMISSION
REGULAR MEETING
Thursday, January 11, 2024**

Tour Time 1:30 PM

TOUR OF INSPECTION

- A. Northwest Corner of Lincoln Street and Santa Lucia Avenue
- B. Monte Verde Street 3 Northeast of Ninth Avenue
- C. North Dunes site - Ocean and San Antonio Avenues

MEETING TIME 2:30 PM

CALL TO ORDER AND ROLL CALL

PRESENT:	Berling, Brezoczky, Michie, Myers
ABSENT:	None
STAFF PRESENT:	Robert Harary, P.E., Director of Public Works Rob Culver, Public Works Superintendent Justin Ono, City Forester Mary Bilse, Environmental Programs Manager Yvette Culver, Commission Secretary Mark Shurvinton-Bradley, Forestry Support

PLEDGE OF ALLEGIANCE

Chair Myers led the public in the Pledge of Allegiance.

PUBLIC COMMENT

Ken White
Melanie Billig
Dale Byrne

ANNOUNCEMENTS

Public Works Director Harary announced:

- Gerald Montmorency, who was in attendance at the meeting, will be the new Forest and Beach Commissioner. He was appointed by City Council on Tuesday, January 9, 2024 and will complete the term of former Commissioner Sours which expires on May 30, 2025. Justin and I will be meeting with him in the next few weeks to help get him up to speed.
- Mark Shurvinton-Bradley is a temporary forestry administrator who came to Public Works in March of 2023 to help out during one of the worst storm seasons. Mark has taken a fulltime job with Sonoma County as a Planner. He did a great job here and will greatly missed, and we wish him well on his journey.

CONSENT AGENDA

Item 1: December 14, 2023 Meeting Minutes

Item 2: Final Forest and Beach Commission Rules of Procedure

Commissioner Michie moved to approve the Meeting Minutes for December 14, 2023 and moved to approve the Final Forest and Beach Commission Rules and Procedures, seconded by Commissioner Berling, and carried by the following roll call vote:

AYES: Berling, Brezoczky, Michie, Myers
NOES: None
ABSENT: None
ABSTAIN: None

PUBLIC HEARINGS

Item 3: Consider the pruning of two coast live oak trees in the public right-of-way at the Northwest Corner of Lincoln Street and Santa Lucia Avenue (Tree Permit Application 23-201)

This item was on the last Forest and Beach Agenda in December 2023. However, because the City Forester was not present at that meeting, the Commission approved a motion to continue this Public Hearing until the January 11th meeting.

City Forester Ono presented the Staff Report and emphasized that the two oak trees are healthy and do not require pruning at this time. He stated that the pruning performed two years ago was not done according to industry standards and recommended denying the pruning of the two coast live oak trees because of the potential violation of the City Code prohibiting pruning for views. Should this Application be approved, all tree work must be done by a licensed tree service company under the supervision of the City Forester, and at the Applicant's expense. City Forester Ono answered questions of the Commission.

Applicant Stephen Yu stated that he understands that the city does not authorize pruning for views. He stated that he is not trying to enhance the view, but rather he is trying to reverse the encroachment of the City trees into the viewshed from his property. He is trying to maintain the status quo. Mr. Yu stated that he accepts the City Forester's suggestion to wait until the end of 2024 or even 2025 for pruning. The pruning that he is contemplating would be less invasive than the pruning done two years ago. The Applicant answered questions of the Commission.

PUBLIC COMMENT

Melanie Billig
 Cindy Lloyd

Chair Myers motioned to approve the pruning of Tree #2 only for structural integrity and health. All work must be done by a licensed tree service company under direct supervision of the City Forester, and at the Applicant's expense. Seconded by Commissioner Berling and carried out by the following roll call vote:

AYES: Berling, Brezoczky, Michie, Myers
NOES: None
ABSENT: None
ABSTAIN: None

Item 4: Consider the release of a Stop Work Order at Monte Verde Street 3 Northeast of Ninth Avenue.

City Forester Ono presented the Staff Report. He noted that on October 9, 2023, he found Central Coast Landscaping crews heavily over pruning two holly oak trees and one coast live oak tree, all owned by the City, and without a permit to do

so. An independent arborist assessed these trees and found all three trees are now in poor condition. Forester Ono recommended allowing the release of the Stop Work Order issued on October 9, 2023 and requiring the Responsible Party to pay the City \$620 for the Stop Work Order investigation fee, \$1,330 for double the Tree Removal Permit fee, \$1,529 for the cost of the City's consulting arborist, and \$5,660.92 for the depreciated value of the trees after the pruning, totaling \$9,139.92.

Ruth Gupta, the homeowner and Responsible Party, addressed the Commission. Ms. Gupta pointed out that Edgar Baltazar, the owner of Central Coast Landscaping whose workers pruned these trees, has worked for her since 1987 and was with her today to answer questions. Ms. Gupta said that in early spring 2023, a door hanger from PG&E stated that pruning was needed on trees near the power lines, but it provided no other details or dates. She stated that PG&E never did the pruning work, and with winter fast approaching, she was concerned about the trees potentially bringing down the wires in a storm. She requested Central Coast Landscape to perform a "little twig snip" so that the branches were not near the electrical wires. She fully understands now that she should have obtained a tree pruning permit but did not realize that she needed one for such minor pruning.

Ms. Gupta then went on to say that while the work was underway and when she was not at home, a neighbor that lives behind her pulled into her driveway and acted as if he were in charge. He directed the crew to do the heavy pruning which resulted in the decline of the trees. She was shocked at the awful condition of these trees when Forester Ono notified her that day.

Edgar Baltazar of Central Coast Landscaping explained that he performs landscaping maintenance work at the Gupta property. That morning while on site of the Gupta residence, he instructed the crews about the minor pruning and noted that his company does not perform tree work – that work is contracted out separately - but this was intended to be very minor pruning. He came back to the site around 10:00 AM because the crew reached out to him because a gentleman who lived behind the Gupta residence came down the driveway and asserted himself as the homeowner and instructed the crew to improve his view of the ocean and instructed them on what to cut. Mr. Baltazar was not aware that these were City trees nor that he needed a permit to do this work. He answered questions of the Commission and Staff.

Director Harary asked Mr. Baltazar if he had a City Business License to which he admitted that he does not have a current business license. Director Harary informed him that his firm has not had an active business license since June of 2020, and that he must take care of that before he does any further work with the city. Director Harary also asked him if his crews would be willing to help the City's Police and Public Works Departments identify the neighbor. He also suggested that Central Coast Landscaping consider sharing the cost of these fines with Ms. Gupta.

PUBLIC COMMENT

Melanie Billig

Chair Myers motioned to approve the Forester's recommendation as written, seconded by Commissioner Michie and carried by the following roll call vote:

AYES:	Berling, Brezoczky, Michie, Myers
NOES:	None
ABSENT:	None
ABSTAIN:	None

ORDERS OF BUSINESS

Item 5: Consideration of the installation of a Split Rail Fence at North Dunes Habitat Restoration area at Ocean and San Antonio Avenues

Environmental Programs Manager Mary Bilse presented the staff report and recommended approving the installation of a three-rail, cedar split rail fence to define the boundaries of the North Dunes Habitat Restoration area adjacent to Ocean and San Antonio Avenues. The fence would replace the existing post and cable fencing, and the wood fence would have intermediate openings at designated trails. Ms. Bilse answered questions of the Commission.

PUBLIC COMMENT

Gerald Montmorency

Commissioner Berling motioned to approve building the fence as proposed, adding to make the sidewalk as wide as possible along Ocean Avenue, seconded by Commissioner Michie and carried by the following roll call vote:

AYES: Berling, Brezoczky, Michie, Myers
NOES: None
ABSENT: None
ABSTAIN: None

Item 6: City Forester's Report for December 2023

City Forester Ono presented the Forester's Report for December 2023 as follows:

- Compared to 2022, last year, 2023, resulted in a significant increase in the number of City tree removals, permit applications received and processed, and private trees removed and replanted. We also began to track the number of City stumps removed, and the number of communications (calls, visitors, emails) received as well as resolved. 2023 was also notable for the significant winter storms and tree damage in January and March, and a change in the City Forester.
- Forestry goals for 2024 include: completing the Urban Forest Master Plan including public outreach, significantly reducing the backlog of stump removals, implementing a more robust tree planting program, continuing to streamline contracting task orders for tree and landscaping services, and expanding on professional training of forestry staff to include getting another certified arborist on staff.
- Davey Resource Group is finalizing the last few technical reports for development of the Urban Forest Master Plan. The first draft of the UFMP was expected in December but is now anticipated for January. Following review by staff, the draft UFMP will be presented to the Forest and Beach Commission/Steering Committee.
- A \$20,000 task order was issued to West Coast Arborists to remove a portion of the large pile of tree logs that accumulated in the Rio Park material storage site. Apparently, some of the logs were illegally dumped off the side of Irish Canyon Road in the City of Monterey. The Monterey City Forester contacted us, and we traced the logs to this task order. The Contractor promptly resolved the matter.
- As requested by the Traffic Safety Committee, the overgrowth of vegetation at the northwest and southwest corners of Santa Rita Street and Fourth Avenue were pruned to improve driver visibility.

PUBLIC COMMENT

None

Item 7: Public Works Director's Report for December 2023.

Director Harary presented the Public Works Report for December 2023 as follows:

Forestry, Parks and Beach-related Capital Improvement Projects

- For the Mission Trails Nature Preserve 3 Drainage Projects, the design plans, specifications, and bidding documents were finalized. Advertising for construction bids is anticipated by mid-January.
- For the Electrical Panels Projects, Advanced Design Consultants submitted a final technical report for the electric panel in the Ocean Avenue median near Junipero Street that powers the Christmas tree. This electric panel will be reconstructed in the near future.

Update on Volunteer Organizations

- At the February 2024 meeting, the City Council will be asked to accept the donations from Carmel Cares for 2023 that totaled approximately \$149,000 and 6,000 labor hours.
- The Friends of Mission Trails Nature Preserve upgraded the Martin Road entrance into the Preserve by adding wood chips to the trailhead and landing and clearing the trailhead. They also regraded the Doolittle Trail to repair an uneven switchback, trimmed and shaped Cypress trees, and removed a stump near the Lester Rowntree Native Plant Garden. The project cost was split evenly between the Friends and the City at \$4,500 each.
- We also met with the Friends of MTNP to coordinate new entry map displays, placement of additional clean up after your pet signs, and plan for a future Laiolo footbridge and trail realignment.

Miscellaneous Forestry, Parks, and Beach-related Public Works items:

- During and following several storm events throughout December, Public Works crews cleared out storm drains, picked up fallen branches, and filled in potholes. We recorded 2.26 inches of rain over the last week of December. No flooding nor significant erosion problems were reported.
- However, strong waves pounded the shoreline for several days following the Christmas holiday. In concert with the Monterey County emergency operations and the City's Police Department, all beach access stairs were temporarily closed.
- The waves also heavily damaged beach access stairs at Tenth Avenue, Twelfth Avenue, and Martin Way. Damage included broken handrails and wooden railings, missing treads, drop offs at the bottoms, etc. These stairs will be closed until further notice.
- The beach access equipment ramp between Eighth and Ninth Avenues was washed out in the storms last March. The sand was coming back since then, although not enough to re-establish the ramp. Unfortunately, the strong waves in late December again washed out the sand leaving a 14- foot drop off. Caution tape and delineators are in place.
- In an effort to continue to upgrade park restrooms, we ordered new steel doors to replace deteriorated doors at the Devendorf and First Murphy Park restrooms.
- Replaced a backflow device at Vista Lobos Park.

PUBLIC COMMENT

Shirley Moon

FUTURE AGENDA ITEMS

- Draft Urban Forest Master Plan
- Chief Tomasi to provide an overview of emergency beach closures and funding sources
- Timeline for beach infrastructure repairs
- Coastal Engineering Study Tasks 3 and 4 regarding sea level rise impacts and adaptation strategies

ADJOURNMENT

Respectfully submitted,

Yvette Culver Administrative Coordinator, Commission Secretary

Approved by:

JC Myers, Chair



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

February 8, 2024
ORDERS OF BUSINESS

TO:	Forest and Beach Commissioners
SUBMITTED BY:	Robert M. Harary, P.E., Director of Public Works
SUBJECT:	Receive a Presentation and Consider approval of a Restoration Project along the Scenic Pathway, as proposed by the Leadership Carmel Class of 2024, subject to issuance of an encroachment permit

RECOMMENDATION:

Receive a Presentation and Approve a Restoration Project along the Scenic Pathway, as proposed by the Leadership Carmel Class of 2024, with or without minor modifications, and subject to issuance of an encroachment permit.

BACKGROUND/SUMMARY:

As part of its fourth annual session, Leadership Carmel is considering a restoration project for an outlook that is immediately adjacent to the Scenic Pathway. The project is referred to as the "Scenic Outlook Southwest of Eighth Avenue Restoration Project."

The proposed project would be orchestrated and fully funded by Leadership Carmel and donations in consultation and cooperation with both the City of Carmel and Carmel Cares. From Scenic Road, the Outlook is most readily located by its immediate proximity to two ADA parking spaces on Scenic Road and two memorial benches on the Pathway. The Project Description is provided in **Attachment #1**.

At the February 8, 2024 Forest and Beach Commission meeting, Leadership Carmel will present the proposed project, including the needs for restoration, specific improvements that are proposed, and their collaboration with an arborist, designer, City staff, Carmel Cares, and others. The preliminary Site Plan, **Attachment #2**, will also be reviewed. They are also in the process of finalizing an arborist report which will be furnished to the City Forester.

Following the presentation, any questions of the Commissioners, and public comments, the Commission may:

- 1) Approve the proposed project, subject to issuance of an encroachment permit
- 2) Approve the project with minor modifications which would be administered by City staff as part of the encroachment permit process,

- 3) Request key modifications to the proposed project and request Leadership Carmel to return to the Commission with a revised proposal
- 4) Reject the proposal

Environmental Evaluation

This action does not constitute a project within the meaning of the California Environmental Quality Act under Public Resources Code Section 21065. It has no potential to cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment and, therefore, does not require environmental review.

FISCAL IMPACT:

None. All expenses will be incurred by Leadership Carmel and donations. A no-fee encroachment permit will be issued when the plans are finalized.

ATTACHMENTS:

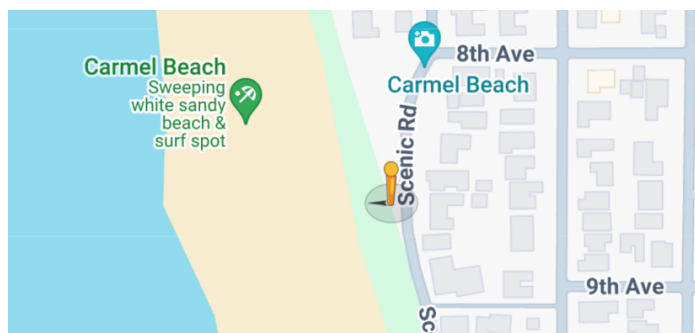
Attachment #1 - Project Description
Attachment #2-Preliminary Site Plan

Scenic Outlook SW of 8th - Restoration Project | Rev.5

As part of its fourth annual session, Leadership Carmel is considering a restoration project for an outlook that is adjacent to the Scenic Pathway along Carmel Beach in Carmel-by-the-Sea. The project was suggested by Carmel Cares and would be orchestrated by Leadership Carmel in consultation and cooperation with both the City of Carmel-by-the-Sea and Carmel Cares. This document provides an introductory summary of this potential project.

The Location

The Scenic Outlook SW of 8th (“the Outlook”) is located mid-way between 8th and 9th, immediately adjacent to Scenic Pathway (“the Pathway”). From Scenic Road, the Outlook is most readily located by its immediate proximity to Scenic Road’s two handicap parking spaces.



The Outlook is the location of a small, dirt-surface patio with two memorial benches. It provides views of Carmel Beach and the coastline. The Outlook is bordered on the east by the Pathway and on the west by ground cover, several Cypress trees, and the slope to the beach.



The Need

The Outlook area needs restoration to maintain its functionality and inherent beauty. Time and weather have eroded the ground surface, resulting in five main issues:

- (1) The erosion near the Pathway creates an abrupt drop from the Pathway border, exposing the border and making an uneven surface.
- (2) The erosion under the benches makes both benches’ seat heights unusually high. For example, a tall adult’s feet may not reach the ground when seated.
- (3) The pronounced and uneven slope from the Pathway to the edge of the Outlook along the beach side seems to make standing or walking in the Outlook area uninviting.
- (4) The erosion, along with growth, has exposed tree roots.
- (5) The landscaped rock outcroppings in the area could be better integrated in the appearance of the area.

The Project - Summary

The Scenic Outlook Project would involve:

- (1) Refresh the existing decomposed granite (“DG”) Pathway immediately adjacent to the Outlook; and going west, expand the DG to provide a level transition from the Pathway and create a more accessible and inviting Scenic Outlook “patio.”
- (2) Define the viewing patio on the western boundary by placement of random-sized boulders, creating a natural landscape barrier and perhaps offering additional seating opportunities.
- (3) If creating the DG patio does not raise the base high enough to achieve the desired seat heights on the two existing benches, consider modification of the benches by lowering the seating platform by a few inches.
- (4) Relocate irrigation valve boxes so they are outside of the defined patio.
- (5) Consult with an arborist to ensure that project goals and decisions are in keeping with protecting the health of the existing stand of Monterey Cypress trees.

Additional Reference Photos



Abrupt Transition from Scenic Pathway to Outlook Area



Uncomfortable Bench Seat Heights



Exposed Roots, Erosion Near Hardscaping



Irrigation System Access Point

(To be relocated or adapted to remain flush with ground surface)

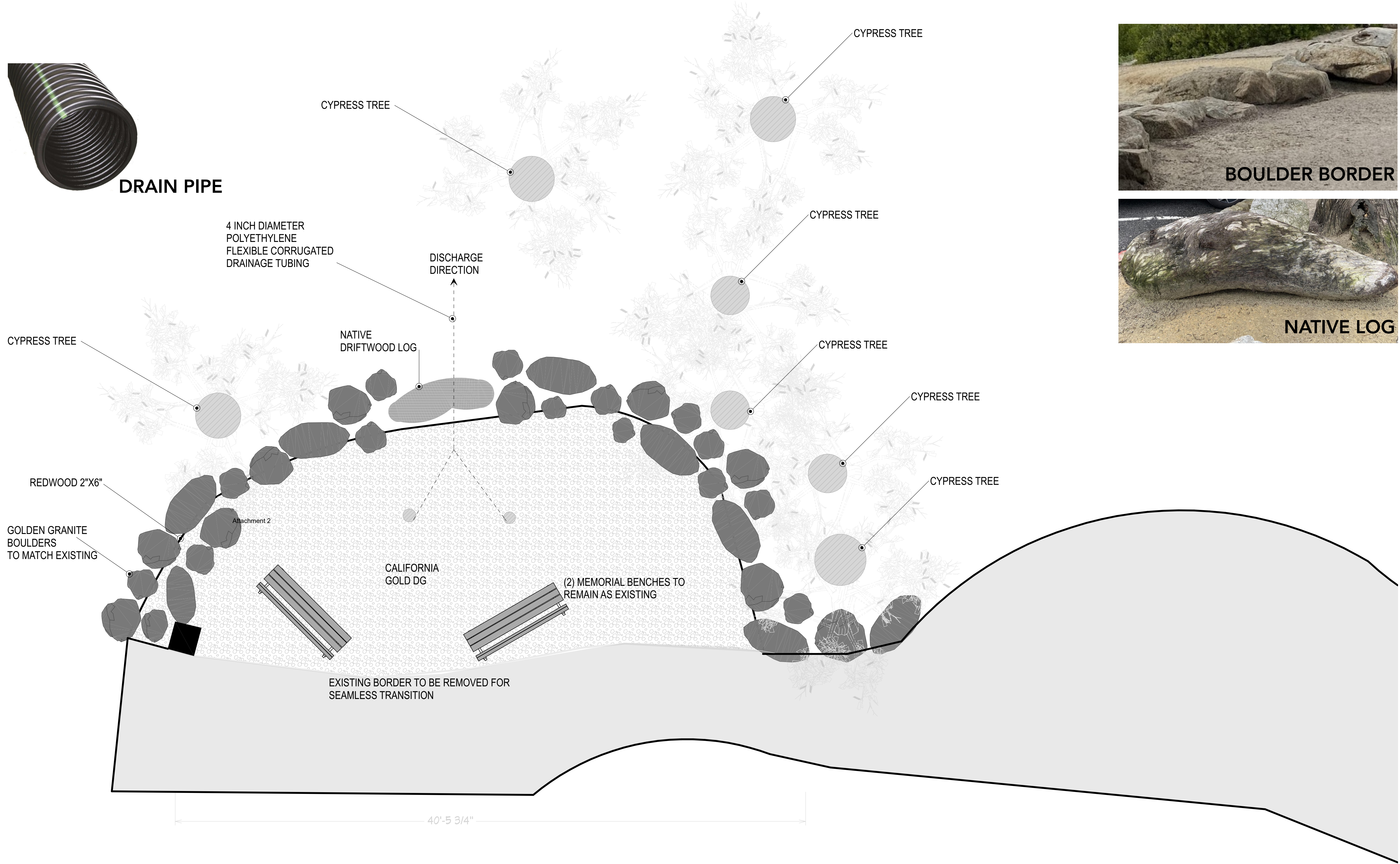


Example of Rock Outcroppings Used as a Border

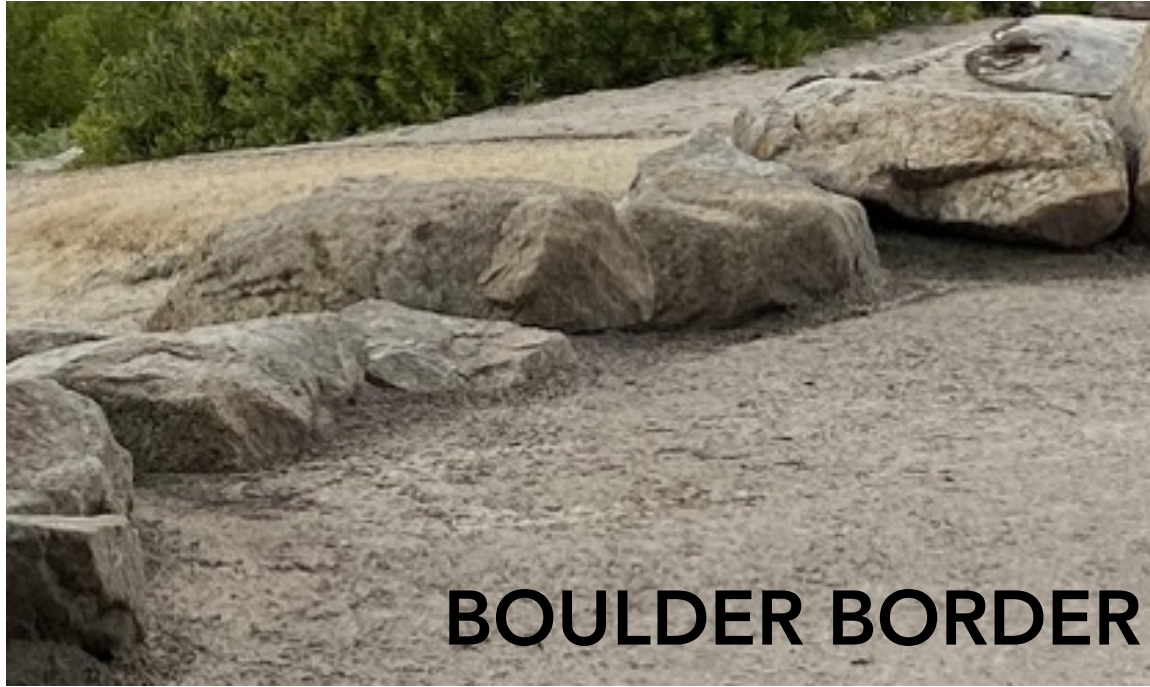
(This example is immediate north of the Outlook)



Beautiful Views to the North from the Outlook



SCALE: N/A



PROJECT:

CLIENT:

SCENIC SOUTH OF 8TH RESTORATION

LEADERSHIP CARMEL

2/1/24



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

February 8, 2024
ORDERS OF BUSINESS

TO: Forest and Beach Commissioners

SUBMITTED BY: Thomas C. Ford, Administrative Analyst

SUBJECT: Receive a presentation of two Urban Forest Master Plan (UFMP) deliverables: Tree Inventory and Species in Carmel-by-the-Sea, and the Tree Canopy and Land Cover Assessment

RECOMMENDATION:

Receive a presentation by City Forester Justin Ono on two components of the upcoming UFMP.

BACKGROUND/SUMMARY:

Attachment 1 is a summary of the Tree Inventory of 9,875 City trees broken down by tree species.

Attachment 2 is an assessment of the tree canopy and land cover within our City limits.

Both attachments were prepared by Davey Resource Group as part of the UFMP project. Additional reports will be presented to the Forest and Beach Commission over the next few months leading up to the draft UFMP which will contain these technical reports.

Environmental Evaluation

This action does not constitute a project within the meaning of the California Environmental Quality Act under Public Resources Code Section 21065. It has no potential to cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment and, therefore, does not require environmental review.

FISCAL IMPACT:

Preparation of these reports are included in UFMP project account.

ATTACHMENTS:

Attachment 1 - Tree Species

Attachment 1 - Tree Canopy and Land Cover Assessment Report

Appendix C: Tables

Table 13: Botanical and Common Names of Tree Species in Carmel-by-the-Sea's community tree resource

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Quercus agrifolia</i>	coast live oak	3,971	40.21
<i>Pinus radiata</i>	Monterey pine	1,787	18.10
<i>Cupressus macrocarpa</i>	Monterey cypress	864	8.75
<i>Acacia melanoxylon</i>	black acacia	350	3.54
<i>Sequoia sempervirens</i>	coast redwood	283	2.87
<i>Pittosporum undulatum</i>	Victorian box	278	2.82
<i>Heteromeles arbutifolia</i>	toyon	161	1.63
<i>Cedrus deodara</i>	deodar cedar	89	0.90
<i>Acacia auriculiformis</i>	northern black wattle	87	0.88
<i>Liquidambar styraciflua</i>	sweetgum	81	0.82
<i>Prunus ilicifolia</i>	hollyleaf cherry	81	0.82
<i>Prunus cerasifera</i>	cherry plum	79	0.80
<i>Arbutus unedo</i>	strawberry tree	77	0.78
<i>Ceanothus thyrsiflorus</i>	blue blossom	72	0.73
<i>Acer palmatum</i>	Japanese maple	70	0.71
<i>Olea europaea</i>	olive	69	0.70
<i>Leptospermum laevigatum</i>	coastal tea-tree	63	0.64
<i>Lyonothamnus floribundus</i>	lyontree	59	0.60
<i>Ilex aquifolium</i>	English holly	46	0.47
<i>Pittosporum eugenioides</i>	tarata	46	0.47
<i>Quercus chrysolepis</i>	canyon live oak	40	0.41
<i>Quercus ilex</i>	holly oak	39	0.39
<i>Dodonaea viscosa</i>	Florida hopbush	38	0.38
<i>Quercus wislizeni</i>	interior live oak	37	0.37
<i>Pittosporum tobira</i>	Japanese pittosporum	33	0.33
<i>Ligustrum japonicum</i>	Japanese privet	32	0.32
<i>Magnolia grandiflora</i>	southern magnolia	30	0.30
<i>Acacia confusa</i>	small Philippine acacia	27	0.27
<i>Acacia dealbata</i>	silver wattle	27	0.27
<i>Pinus canariensis</i>	Canary Island pine	26	0.26
unknown	unknown	25	0.25
<i>Syzygium paniculatum</i>	brush cherry	25	0.25
<i>Callistemon citrinus</i>	crimson bottlebrush	24	0.24
<i>Ginkgo biloba</i>	ginkgo	23	0.23
<i>Podocarpus macrophyllus</i>	yew podocarpus	23	0.23
<i>Ulmus parvifolia</i>	Chinese elm	23	0.23

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Prunus caroliniana</i>	Carolina laurelcherry	22	0.22
<i>Pittosporum viridiflorum</i>	cape cheesewood	20	0.20
<i>Prunus spp.</i>	Plum species	20	0.20
<i>Eucalyptus ficifolia</i>	redflower gum	18	0.18
<i>Maytenus boaria</i>	mayten	18	0.18
<i>Pseudotsuga menziesii</i>	douglas fir	18	0.18
<i>Pittosporum rhombifolia</i>	Queensland pittosporum	16	0.16
<i>Robinia pseudoacacia</i>	black locust	16	0.16
<i>Pittosporum crassifolium</i>	stiffleaf cheesewood	15	0.15
<i>Schinus terebinthifolia</i>	Brazilian peppertree	15	0.15
<i>Albizia julibrissin</i>	Persian silk tree	14	0.14
<i>Eriobotrya japonica</i>	loquat tree	14	0.14
<i>Platanus x hybrida</i>	London planetree	14	0.14
<i>Podocarpus gracilior</i>	fern pine	14	0.14
<i>Cotoneaster buxifolius</i>	box-leaf cotoneaster	13	0.13
<i>Juniperus chinensis</i>	Chinese juniper	13	0.13
<i>Metrosideros excelsa</i>	New Zealand Christmas tree	13	0.13
<i>Ligustrum lucidum</i>	glossy privet	12	0.12
<i>Platanus racemosa</i>	California sycamore	12	0.12
<i>Melaleuca quinquenervia</i>	punk tree	11	0.11
<i>Myoporum laetum</i>	mioporo	11	0.11
<i>Pistacia chinensis</i>	Chinese pistache	11	0.11
<i>Schinus molle</i>	California peppertree	11	0.11
<i>Camellia japonica</i>	camellia	10	0.10
<i>Cordyline australis</i>	giant dracaena	10	0.10
<i>Ficus carica</i>	common fig	10	0.10
<i>Laurus nobilis</i>	bay laurel	10	0.10
<i>Ailanthus altissima</i>	tree of heaven	9	0.09
<i>Cornus spp.</i>	dogwood species	9	0.09
<i>Malus spp.</i>	apple species	9	0.09
<i>Photinia serrulata</i>	photinia	9	0.09
<i>Pinus pinea</i>	Italian stone pine	9	0.09
<i>Pyracantha coccinea</i>	fire thorn	9	0.09
<i>Yucca spp.</i>	yucca species	9	0.09
<i>Acacia baileyana</i>	bailey acacia	8	0.08
<i>Betula pendula</i>	European white birch	8	0.08
<i>Pyrus calleryana</i>	Callery pear	8	0.08
<i>Acer macrophyllum</i>	bigleaf maple	7	0.07

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Aesculus californica</i>	California buckeye	7	0.07
<i>Cercis canadensis</i>	eastern redbud	7	0.07
<i>Citrus spp.</i>	citrus species	7	0.07
<i>Ligustrum sinense</i>	Chinese privet	7	0.07
<i>Alnus glutinosa</i>	European alder	6	0.06
<i>Cercis canadensis v. texensis</i>	western redbud	6	0.06
<i>Eucalyptus spp.</i>	gum species	6	0.06
<i>Eucalyptus robusta</i>	beakpod euclayptus	6	0.06
<i>Photinia x fraseri</i>	fraser photinia	6	0.06
<i>Quercus tomentella</i>	island live oak	6	0.06
<i>Araucaria heterophylla</i>	Norfolk Island pine	5	0.05
<i>Calocedrus decurrens</i>	incense cedar	5	0.05
<i>Sphaeropteris cooperi</i>	Cooper's cyathea	5	0.05
<i>Eucalyptus globulus</i>	blue gum eucalyptus	5	0.05
<i>Eucalyptus polyanthemus</i>	silver dollar eucalyptus	5	0.05
<i>Tristanopsis confertus</i>	vinegartree	5	0.05
<i>Magnolia x soulangeana</i>	saucer magnolia	5	0.05
<i>Pinus spp.</i>	pine species	5	0.05
<i>Pinus halepensis</i>	Aleppo pine	5	0.05
<i>Pinus ponderosa</i>	ponderosa pine	5	0.05
<i>Pinus thunbergii</i>	Japanese black pine	5	0.05
<i>Platycladus orientalis</i>	oriental arborvitae	5	0.05
<i>Ulmus americana</i>	American elm	5	0.05
<i>Umbellularia californica</i>	California laurel	5	0.05
<i>Citrus limon</i>	lemon	4	0.04
<i>Eriobotrya deflexa</i>	bronze loquat	4	0.04
<i>Eucalyptus sideroxylon</i>	mugga ironbark	4	0.04
<i>Gleditsia triacanthos</i>	honeylocust	4	0.04
<i>Juniperus californica</i>	California juniper	4	0.04
<i>Juniperus communis</i>	common juniper	4	0.04
<i>Ligustrum ovalifolium</i>	California privet	4	0.04
<i>Picea pungens</i>	blue spruce	4	0.04
<i>Rhamnus cathartica</i>	European buckthorn	4	0.04
<i>Thuja plicata</i>	western red cedar	4	0.04
<i>Washingtonia robusta</i>	Mexican fan palm	4	0.04
<i>Araucaria columnaris</i>	coral reef araucaria	3	0.03
<i>Casuarina equisetifolia</i>	Australian pine	3	0.03
<i>Eucalyptus cinerea</i>	silver dollar eucalyptus	3	0.03

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Lagerstroemia indica</i>	common crapemyrtle	3	0.03
<i>Liquidambar formosana</i>	Chinese sweet gum	3	0.03
<i>Nerium oleander</i>	oleander	3	0.03
<i>Paraserianthes lophantha</i>	plume albizia	3	0.03
<i>Platanus occidentalis</i>	American sycamore	3	0.03
<i>Rhododendron spp.</i>	rhododendron species	3	0.03
<i>Acacia spp.</i>	acacia species	2	0.02
<i>Brachychiton populneus</i>	kurrajong	2	0.02
<i>Callistemon</i>	bottlebrush species	2	0.02
<i>Callistemon viminalis</i>	weeping bottlebrush	2	0.02
<i>Cedrus spp.</i>	cedar species	2	0.02
<i>Cornus florida</i>	flowering dogwood	2	0.02
<i>Cornus kousa</i>	kousa dogwood	2	0.02
<i>Crataegus spp.</i>	hawthorn species	2	0.02
<i>Cupressus sempervirens</i>	Italian cypress	2	0.02
<i>Eucalyptus lehmannii</i>	bushy yate	2	0.02
<i>Filicium decipiens</i>	fern tree	2	0.02
<i>Hymenosporum flavum</i>	sweetshade	2	0.02
<i>Ilex vomitoria</i>	yaupon	2	0.02
<i>Liriodendron tulipifera</i>	tulip tree	2	0.02
<i>Magnolia virginiana</i>	sweetbay	2	0.02
<i>Myrtus communis</i>	myrtle	2	0.02
<i>Persea americana</i>	avocado	2	0.02
<i>Phoenix canariensis</i>	Canary Island date palm	2	0.02
<i>Pinus sylvestris</i>	Scots pine	2	0.02
<i>Pinus torreyana</i>	Torrey pine	2	0.02
<i>Populus fremontii</i>	fremont cottonwood	2	0.02
<i>Prunus persica</i>	peach	2	0.02
<i>Quercus suber</i>	cork oak	2	0.02
<i>Ravenala madagascariensis</i>	traveler's tree	2	0.02
<i>Rhamnus frangula</i>	alderleaf buckthorn	2	0.02
<i>Taxus brevifolia</i>	Pacific yew	2	0.02
<i>Tilia cordata</i>	littleleaf linden	2	0.02
<i>Tilia tomentosa</i>	silver linden	2	0.02
<i>Acer buergerianum</i>	trident maple	1	0.01
<i>Acacia farnesiana</i>	sweet acacia	1	0.01
<i>Acer grandidentatum</i>	bigtooth maple	1	0.01
<i>Acer negundo</i>	boxelder	1	0.01

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Acer rubrum</i>	red maple	1	0.01
<i>Acer shirasawanum</i>	Shirasawa's maple	1	0.01
<i>Arecastrum spp.</i>	Arecastrum palm species	1	0.01
<i>Arctostaphylos manzanita</i>	whiteleaf manzanita	1	0.01
<i>Betula papyrifera</i>	paper birch	1	0.01
<i>Betula platyphylla</i>	Asian white birch	1	0.01
<i>Catalpa speciosa</i>	northern catalpa	1	0.01
<i>Cedrus atlantica</i>	atlas cedar	1	0.01
<i>Cinnamomum camphora</i>	camphor tree	1	0.01
<i>Cladrastis kentukea</i>	American yellowwood	1	0.01
<i>Cornus alternifolia</i>	alternatleaf dogwood	1	0.01
<i>Eucalyptus citriodora</i>	lemonscented gum	1	0.01
<i>Cotinus coggygria</i>	smoke tree	1	0.01
<i>Coprosma repens</i>	creeping mirrorplant	1	0.01
<i>Cornus sericea</i>	red osier dogwood	1	0.01
<i>Cryptomeria japonica</i>	Japanese red cedar	1	0.01
<i>Crataegus phaenopyrum</i>	Washington hawthorn	1	0.01
<i>Echium candicans</i>	Pride of Madeira	1	0.01
<i>Eucalyptus camaldulensis</i>	red gum eucalyptus	1	0.01
<i>Eucalyptus nicholii</i>	willow-leaved gimlet	1	0.01
<i>Ficus microcarpa</i>	Indian laurel	1	0.01
<i>Fremontodendron californicum</i>	California flannelbush	1	0.01
<i>Fraxinus velutina</i>	velvet ash	1	0.01
<i>Garrya elliptica</i>	wavyleaf silktassel	1	0.01
<i>Juglans nigra</i>	black walnut	1	0.01
<i>Magnolia spp.</i>	magnolia species	1	0.01
<i>Malus sylvestris</i>	European crabapple	1	0.01
<i>Ochroma pyramidale</i>	west Indian balsa	1	0.01
<i>Pinus elliottii</i>	slash pine	1	0.01
<i>Pinus monophylla</i>	singleleaf pinyon pine	1	0.01
<i>Pinus palustris</i>	longleaf pine	1	0.01
<i>Prunus angustifolia</i>	chickasaw plum	1	0.01
<i>Prunus domestica</i>	common plum	1	0.01
<i>Prunus emarginata</i>	bitter cherry	1	0.01
<i>Prunus laurocerasus</i>	cherry laurel	1	0.01
<i>Prunus serrulata</i>	Japanese flowering cherry	1	0.01
<i>Pyrus communis</i>	common pear	1	0.01
<i>Quercus spp.</i>	oak species	1	0.01

Botanical Name	Common Name	# of Trees	% of Pop.
<i>Quercus hypoleucoides</i>	silver leaf oak	1	0.01
<i>Quercus lobata</i>	California white oak	1	0.01
<i>Quercus virginiana</i>	live oak	1	0.01
<i>Rhus integrifolia</i>	lemonade berry	1	0.01
<i>Sambucus nigra</i>	European black elderberry	1	0.01
<i>Taxus baccata</i>	English yew	1	0.01
<i>Thuja occidentalis</i>	northern white cedar	1	0.01
<i>Trachycarpus fortunei</i>	windmill palm	1	0.01
<i>Ulmus spp.</i>	elm species	1	0.01
<i>Viburnum spp.</i>	viburnum species	1	0.01
<i>Washingtonia filifera</i>	California palm	1	0.01
<i>Yucca gloriosa</i>	moundlily yucca	1	0.01
Total		9,875	100.00%

Carmel-by-the-Sea, CA

Tree Canopy & Land Cover Assessment Summary Report

2023



Carmel-by-the-Sea, CA

Tree Canopy & Land Cover Assessment Summary Report

2023



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Executive Summary

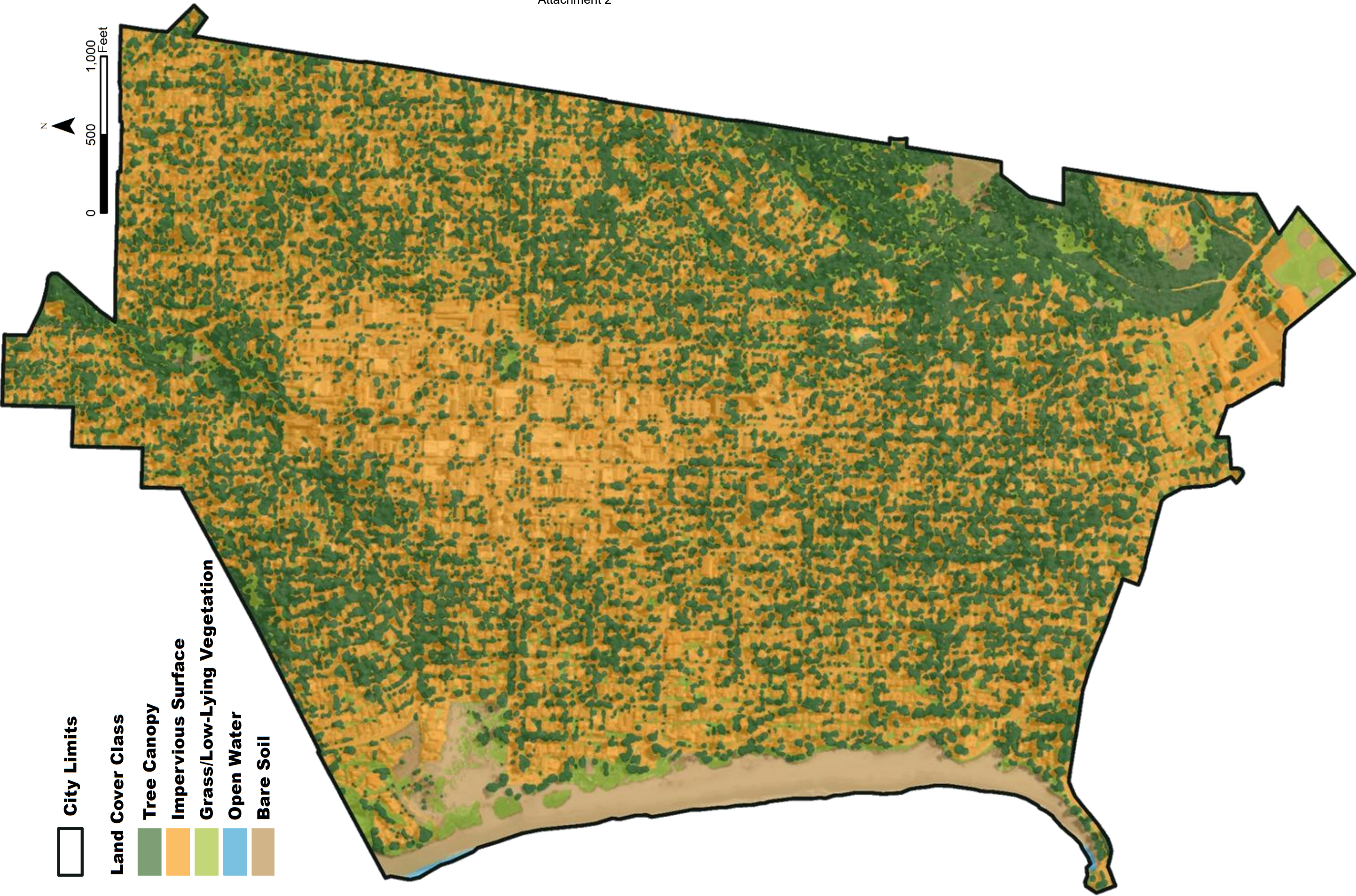
Urban forests and tree canopy cover provide vital environmental services and benefits to urban ecosystems, including reducing stormwater runoff and protecting water quality, sequestering atmospheric carbon, improving air quality, reducing energy consumption, supporting human health and welfare, and providing forage and habitat for wildlife. The benefits from the urban forest are directly related to the level of canopy cover and leaf surface area. Understanding the location and distribution of tree canopy is key to developing and implementing sound preservation and management strategies that promote the sustainability of Carmel-by-the-Sea's urban forest and the benefits it provides.

To evaluate tree canopy and its relationship with other primary land cover, the City of Carmel-by-the-Sea contracted with Davey Resource Group (DRG) in 2023 to conduct a comprehensive Land Cover Assessment. The Assessment, based on 2022 NAIP imagery, provides a birds-eye view of the entire urban forest and establishes a tree canopy baseline of known accuracy and classification methodology. This information provides important baseline values for the urban forest, including the amount and distribution of tree canopy as well as the benefits to air quality, stormwater, water quality, and carbon storage, which allows urban forest managers and planners to make informed decisions on canopy goals, maintenance, preservation, and planting plans. This report provides a summary and discussion on the key findings of this assessment.

Tree Canopy and Land Cover

Carmel-by-the-Sea encompasses 1.06 square miles (676.3 acres). The following information summarizes land cover in Carmel-by-the-Sea:

- 36% (243.3 acres) tree canopy, including trees and woody shrubs
- 45% (304.6 acres) impervious surfaces, including roads and structures
- 13.8% (93.3 acres) pervious surfaces, including bare soils and low-lying vegetation
- 0.1% (0.5 acres) open water
- Nearly 85% of canopy is in fair or better health
- 56.5% (137.6 acres) of tree canopy is on privately owned property
- 31.1 acres of tree canopy is in parks, trails, and open spaces for an average of 38.1%
- 133.0 acres of tree canopy in residential zoning (single and multi-family) for an average canopy cover of 35.6%
- Areas zoned as parkland have 31 acres of tree canopy and the highest level of canopy cover (37.9%) while areas zoned as Commercial have the lowest canopy cover (8.4%)
- 80.9 acres of possible planting sites including areas of existing bare soil and grass/low-lying vegetation, for an estimated canopy potential of 48%
- To date, Carmel-by-the-Sea's urban forest is storing 8,364 tons of carbon in woody and foliar biomass, valued at \$1.4 million



Map 1: Tree Canopy and Primary Land Cover

Environmental Benefits

i-Tree *Canopy* (v7.1) was used to quantify the ecosystem benefits from Carmel-by-the-Sea's tree canopy cover (public and private trees) to air quality, stormwater runoff, and carbon sequestration. The dollar value of these benefits was calculated based on cost-modeling valuations from i-Tree *Eco* (v6.1.36). The analysis estimates that Carmel's tree canopy is annually providing nearly \$151,719 in quantifiable benefits (Figure 1, Table 1), including:

- Removing 9 tons. of air pollutants, including carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), sulfur dioxide (SO₂), and particulate matter (PM₁₀), valued at \$48,285
- Reducing stormwater runoff by approximately 3.5 million gallons and avoiding 3,584 lb. of pollutants in stormwater runoff, valued at \$31,228
- Sequestering an additional 423 tons of CO₂, valued at \$72,206

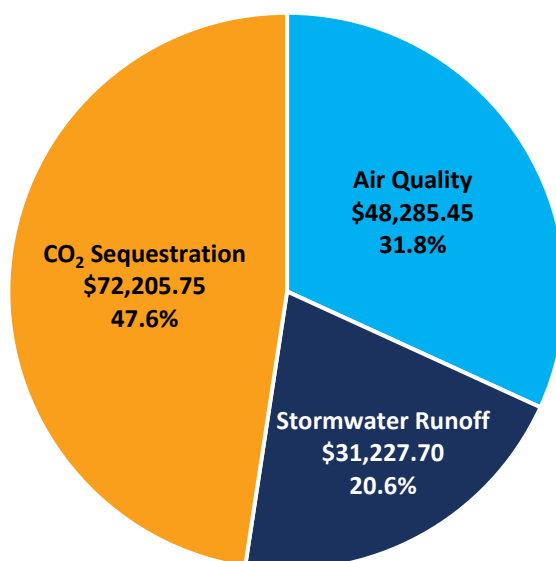


Figure 1: Annual Benefits Summary for Carmel-by-the-Sea

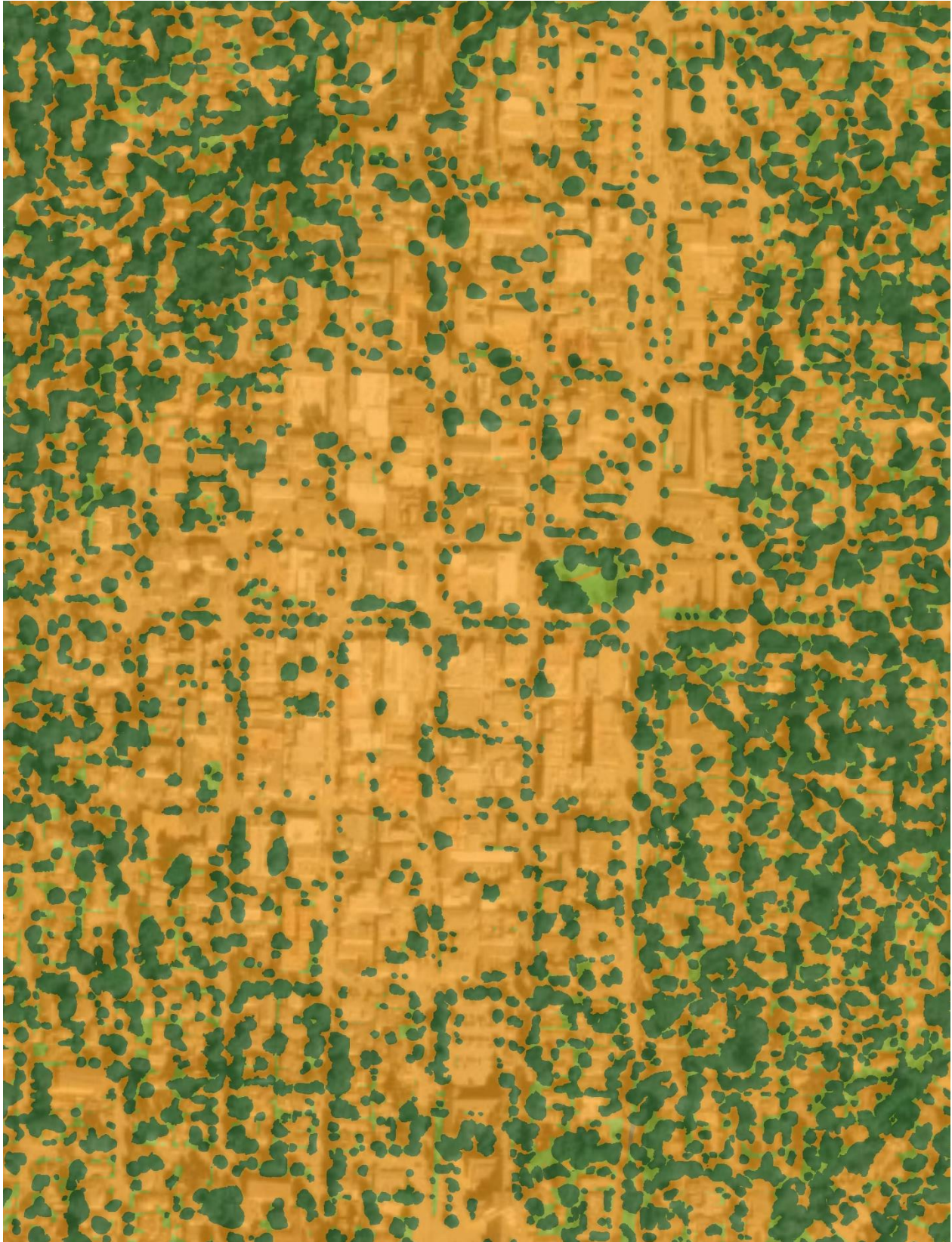
Table 1: Annual Environmental Benefits Summary

Environmental Benefit	Value	% of Total Benefit
CO ₂ Sequestration	72,205.75	47.59
O ₃	33,943.35	22.37
Stormwater Runoff	31,227.70	20.58
PM ₁₀	13,616.09	8.97
CO, NO ₂ , SO ₂	726.01	0.48
Total	\$151,718.90	100%

Management Applications

Understanding the location and distribution of tree canopy is key to developing and implementing sound preservation and management strategies that promote the sustainability of Carmel-by-the-Sea's urban forest. The data, combined with existing GIS information and emerging research, enables managers to balance urban development with tree preservation and aids in identifying and assessing urban forestry opportunities. A spatial understanding of tree canopy and other primary land cover can help urban forest managers and city leaders align urban forestry objectives with community vision, including:

- Set canopy goals for the future urban forest based on zoning, land cover distribution, and community values.
 - Carmel-by-the-Sea has an existing tree canopy cover of 36% and the potential to support up to 48% canopy.
- Expand tree canopy on public property, by focusing planting efforts in parks, trails, and open space.
- Encourage tree planting and preservation on private property by incentivizing tree planting, expanding community education, and supporting activities and programs related to urban trees.
- Use priority planting maps to develop planting plans to meet canopy goals and to support stormwater management, preserve soil, and complement the existing urban infrastructure for the greatest impact and return on investment.
 - Create a planting plan and identify and prioritize planting spaces that increase environmental benefits and complement the existing urban infrastructure.
 - Use the tree planting placement model to identify priority planting site locations.
 - Maximize available resources and planting space by planting the largest statured tree that can be accommodated in a site.
- Incorporate trees into stormwater management strategies to capture and reduce runoff and lessen the impact of flood events on existing infrastructure.
- Preserve and protect existing trees and forest stands to sustain environmental benefits.
- Conduct a periodic land cover assessment to track changes in canopy.



A spatial understanding of tree canopy and other primary land cover can help urban forest managers and city leaders align urban forestry objectives with community vision.

Introduction

Carmel-by-the-Sea is a charming town located on the central coast of California. It is situated on the Monterey Peninsula, about 120 miles south of San Francisco and 350 miles north of Los Angeles. The town is bordered by the Pacific Ocean to the west and the Carmel River to the south. Its prime location makes it an ideal spot for enjoying the stunning coastal scenery, with plenty of opportunities for hiking, biking, and other outdoor activities.

Carmel-by-the-Sea has a Mediterranean climate, characterized by mild, wet winters and cool, dry summers. The average temperature in the summer months ranges from 55°F to 68°F (13°C to 20°C), while in winter, temperatures range from 45°F to 60°F (7°C to 15°C). The town receives most of its rainfall between November and April, with an average of 20 inches of precipitation per year. Coastal fog is also a common feature in the area, particularly during the summer months, which helps to keep the temperatures mild and comfortable. Overall, the town's mild climate makes it an ideal destination for outdoor activities throughout the year.

Individual trees and canopy play an essential role in the community of Carmel-by-the-Sea by providing many benefits, tangible and intangible, to residents, visitors, and neighboring communities. Research demonstrates that healthy urban trees can improve the local environment and lessen the impact resulting from urbanization and industry (Center for Urban Forest Research, 2017). Trees improve air quality, reduce energy consumption, help manage stormwater, reduce erosion, provide critical habitat for wildlife, and promote a connection with nature.

Tree Canopy Cover and Geographic Information Systems

Tree canopy cover is measured by the area of leaves, branches, and stems that cover the ground when viewed from above. Since trees provide benefits to the community that extend beyond property lines, this assessment includes all tree canopy within the borders of the community and does not distinguish between publicly-owned and privately-owned trees. To place tree canopy in context and better understand its relationship within the community, the assessment included other primary landcover classifications, including impervious surfaces (e.g., buildings, roads, parking lots), pervious surfaces (e.g., low-lying vegetation and bare soils), and water.

As communities focus more attention on environmental sustainability, community forest management has become increasingly dependent on geographic information systems (GIS). GIS is a powerful tool for urban forest mapping and analysis. Understanding the extent and location of the existing canopy is key to identifying various types of community forest management opportunities, including:

- Future planting plans
- Stormwater management
- Water resource and quality management
- Impacts and management of invasive species
- Preservation of environmental benefits
- Outreach and education

Using high-resolution aerial imagery (2022) and infrared technology, DRG remotely mapped tree canopy and other primary land cover (Map 1 and 2, Figure 2). The results of the study provide a clear picture of the extent and distribution of tree canopy within Carmel-by-the-Sea. The data developed during the assessment becomes an important part of the City's GIS database and provides a foundation for developing community goals and urban forest policies. With this data, managers can determine:

- Carmel-by-the-Sea's progress towards local and regional canopy goals
- Changes in tree canopy over time and in relation to growth and development
- The location and extent of canopy at virtually any level, including by land use, zoning, parks, and public or private parcels
- Potential planting space

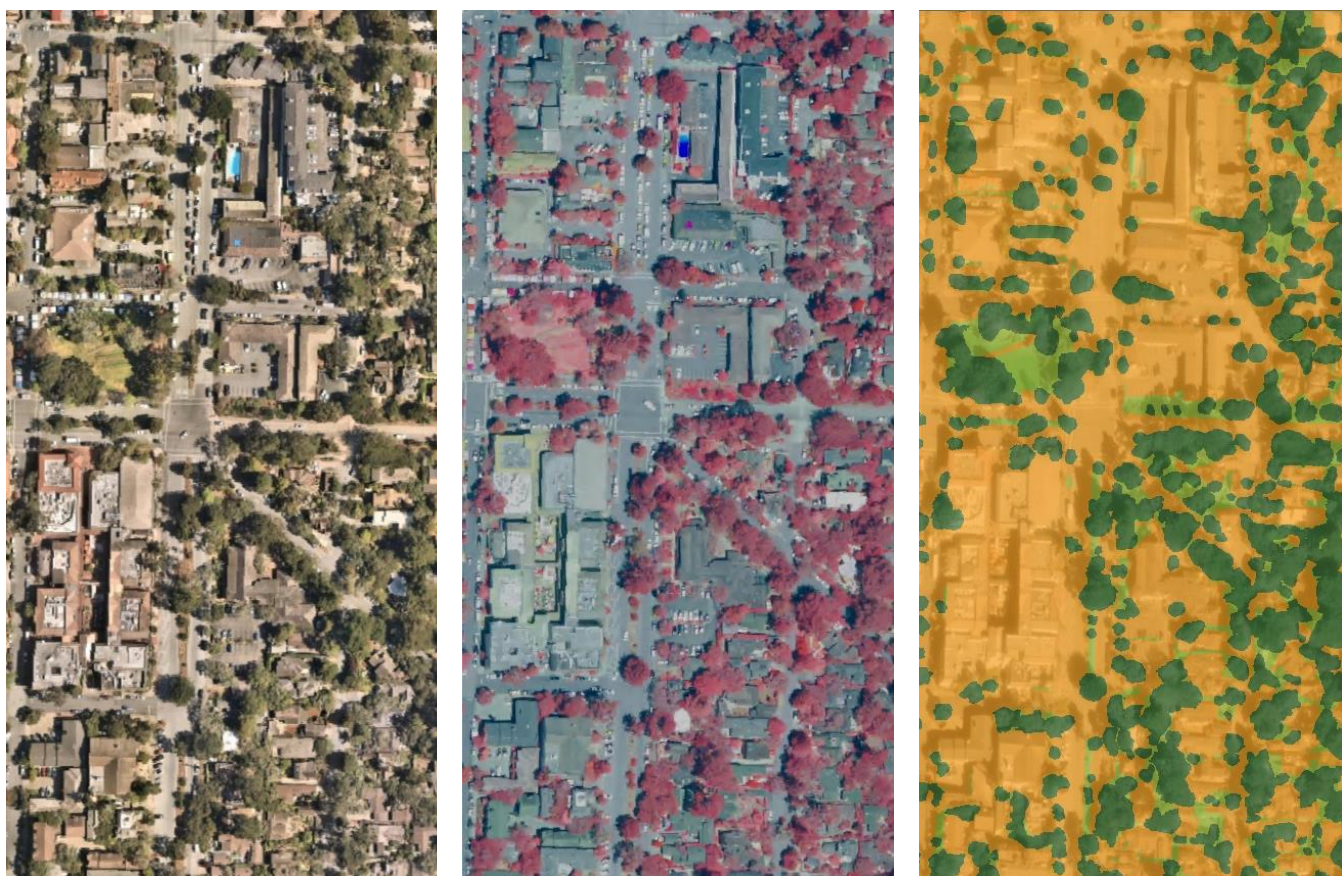


Figure 2: Land Cover Mapping

High-resolution aerial imagery (left) is used to remotely identify existing land cover. Infrared technology delineates living vegetation including tree canopy (middle). Remote sensing software identifies and maps tree canopy and other land cover (right).

Benefits of Tree Canopy

Urban forests continuously mitigate the effects of urbanization and development and protect and enhance the quality of life within the community. The amount and distribution of leaf surface area is the driving force behind the ability of the urban forest to produce benefits for the community (Clark et al, 1997). Healthy trees are vigorous, often producing more leaf surface area each year. Trees and urban forests provide quantifiable benefits to the community in the following ways:

Air Quality

Trees and canopy improve air quality in five fundamental ways:

- Reducing particulate matter (dust)
- Absorbing gaseous pollutants
- Providing shade and transpiration
- Reducing power plant emissions
- Increasing oxygen levels

Urban trees protect and improve air quality by intercepting particulate matter (PM₁₀), including dust, ash, pollen, and smoke. Particulates are filtered and held in the tree canopy. Trees and forests also absorb harmful gaseous pollutants like ozone (O₃), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂). Shade and transpiration reduce the formation of O₃, which is created during higher temperatures. In fact, scientists are now finding that some trees may absorb more volatile organic compounds (VOC's) than previously thought (Karl et al, 2010). VOC's are a class of carbon-based particles emitted from automobile exhaust, lawnmowers, and other human activities. By reducing energy needs, trees also reduce emissions from the generation of power. Through photosynthesis, trees and forests increase oxygen levels.

Annually, trees in Carmel-by-the-Sea remove 18,029 lb. of air pollutants for a total value of \$48,285, including: carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), sulfur dioxide (SO₂), and particulate matter (PM₁₀) (Figure 3).

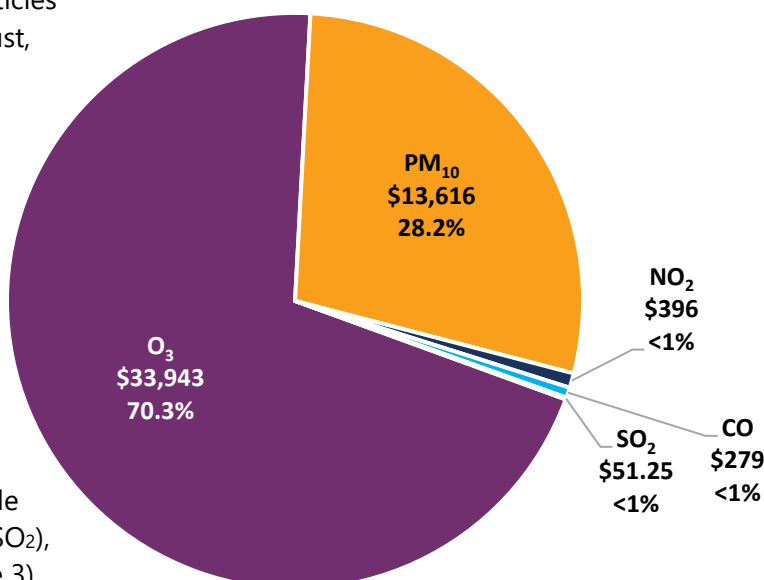


Figure 3: Annual Benefits to Air Quality

Carbon Reduction

Trees and canopy directly reduce CO₂ in the atmosphere through growth and sequestration of carbon as woody and foliar biomass. When trees die and decay, they release much of the stored carbon back to the atmosphere. In urban environments, most trees that die are removed and chipped or disposed of as firewood, releasing stored carbon. Thus, carbon storage is an indication of the amount of carbon that can be gained and lost over the course of a tree's lifecycle through growth and decomposition. Indirectly, trees and forests reduce CO₂ by lowering the demand for energy and reducing the CO₂ emissions from the consumption of natural gas and the generation of electric power.

Purchasing emission allowances (offsets) has led to the acceptance of carbon credits as a commodity that can be exchanged for financial gain. Some communities are exploring the concept of planting trees to develop a carbon offset (or credit) or to track progress toward climate action goals. i-Tree tools can be used to estimate the GHG and carbon sequestration benefits of tree planting projects (Urban and Community Forestry Program Quantification Methodology, 2020).

To date, the urban forest in Carmel-by-the-Sea is storing 8,364 tons of carbon (CO₂) in woody and foliar biomass, valued at nearly \$1.4 million. Annually, Carmel-by-the-Sea's trees sequester an additional 423 tons of carbon valued at \$72,206.

Stormwater Reduction

Trees and canopy improve and protect the quality of surface waters, such as creeks, rivers, lakes and bays, by reducing the impacts of stormwater runoff through:

- Interception
- Increasing soil capacity and rate of infiltration
- Reducing soil erosion

Trees intercept precipitation in their canopy, which acts as a mini reservoir (Xiao et al, 1998). During storm events, this interception reduces and slows runoff (Figure 4). In addition to catching stormwater, canopy interception lessens the erosive impact of raindrops on bare soil. Root growth and root decomposition increase the capacity and rate of soil infiltration by rainfall and snowmelt (McPherson et al, 2002). Each of these processes greatly reduces the flow and volume of stormwater runoff, avoiding erosion and preventing sediments and other pollutants from entering local creeks and waterways.

Surface runoff is a cause for concern in many urban areas as it contributes to the pollution and flooding of streams, wetlands, rivers, lakes, and oceans. Figure 4 illustrates the benefits of trees to reducing stormwater

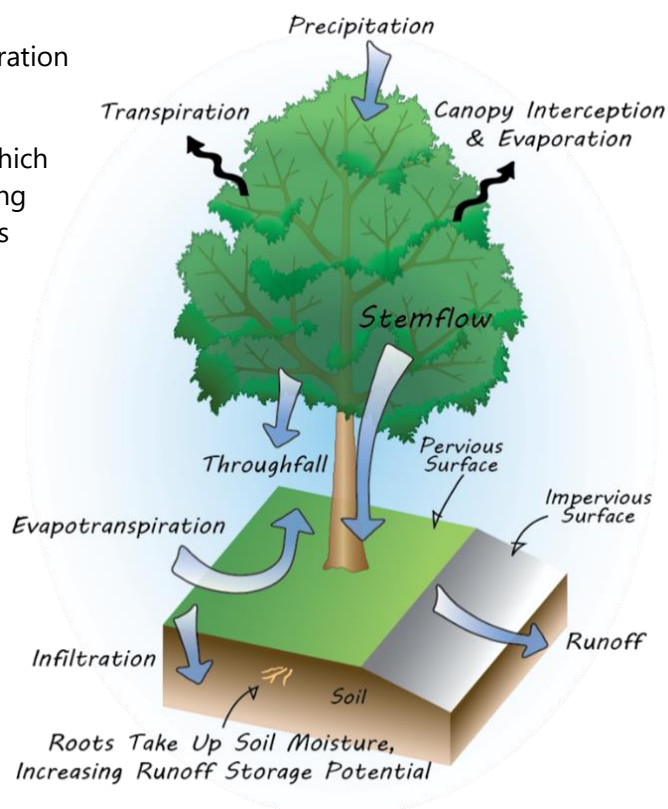


Figure 4: How Trees Reduce Stormwater Runoff

runoff. When rain falls on impervious surfaces it cannot permeate into the soil. Instead, it collects into flows and runoff. The runoff picks up sediment, trash, oil, bacteria, and other contaminants from paved surfaces and carries this non-point source pollution to bodies of water. Along with pollutants, stormwater runoff can produce flows with large volumes of water in a short period of time, causing flooding and erosion.

During precipitation events, some portion of the precipitation is intercepted by vegetation (trees, shrubs, grass, other vegetation). Some of the water is temporarily held by leaves and bark and later evaporates or gradually infiltrates into the soil, which slows and reduces the movement of water off site. The portion of the precipitation that reaches the ground and does not infiltrate into the soil or falls on impervious surfaces, becomes surface runoff (Hirabayashi, 2012). In urban areas, higher levels of impervious surfaces increase the amount of surface runoff and the cost of infrastructure a community must invest in to manage stormwater for the safety of residents and property.

Annually, the urban forest in Carmel-by-the-Sea is reducing stormwater runoff by 3.5 million gallons, valued at \$31,228 (Appendix B).

Energy Savings

Urban trees and forests modify climate and conserve energy in three principal ways:

- Shading dwellings and hardscape
- Transpiration
- Wind reduction

Shade from trees reduces the amount of radiant energy absorbed and stored by hardscapes and other impervious surfaces, thereby reducing the heat island effect, a term that describes the increase in urban temperatures in relation to surrounding locations. Transpiration releases water vapor from tree canopies, which cools the surrounding area. Through shade and transpiration, trees and other vegetation within an urban setting modify the environment and reduce heat island effects. Temperature differences of more than 9°F (5°C) have been observed between city centers without adequate canopy cover and more vegetated suburban areas (Akbari et al, 1997).

Trees reduce wind speeds relative to their canopy size and height by up to 50%. Trees also influence the movement of warm air and pollutants along streets and out of urban canyons. By reducing air movement into buildings and against conductive surfaces (e.g., glass and metal siding), trees reduce conductive heat loss from buildings, translating into potential annual heating savings of 25% (Heisler, 1986). Reducing energy needs has the bonus of reducing carbon dioxide (CO₂) emissions from fossil fuel power plants.

Aesthetics and Socioeconomics

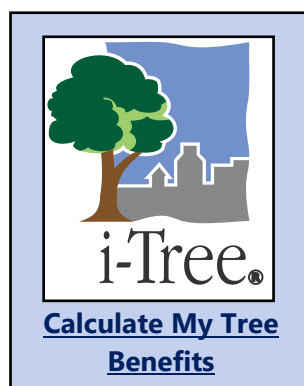
While perhaps the most difficult to quantify, the aesthetic and socioeconomic benefits from trees may be among their greatest contributions, including:

- Beautification, comfort, and aesthetics
- Shade and privacy
- Wildlife habitat and ecosystem health
- Opportunities for recreation
- Creation of a sense of place and history
- Human health

Many of these benefits are captured as a percentage of property values, through higher sales prices where individual trees and forests are located.

Calculating Tree Benefits

While all these tree benefits are provided by the urban forest, it can be useful to understand the contribution of just one tree. Individuals can calculate the quantifiable benefits of individual trees to their property by using the National Tree Benefit Calculator or with i-Tree *Design*. (design.itreetools.org).



Land Cover

Overall Canopy

Carmel-by-the-Sea encompasses an area of approximately 1.06 square miles (676.3 acres). More than 243 acres are covered by tree canopy, for an average canopy cover of 36% (Figure 5). In addition to tree canopy, Carmel-by-the-Sea's land cover includes 45% impervious surface, 13.8% grass and low-lying vegetation, 5.1% bare soil, and 0.1% open water (Figure 5, Table 2).

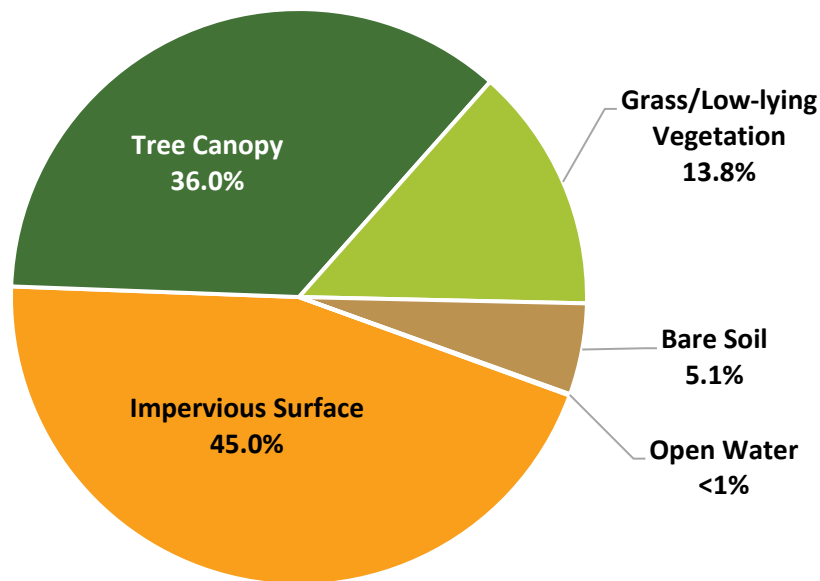
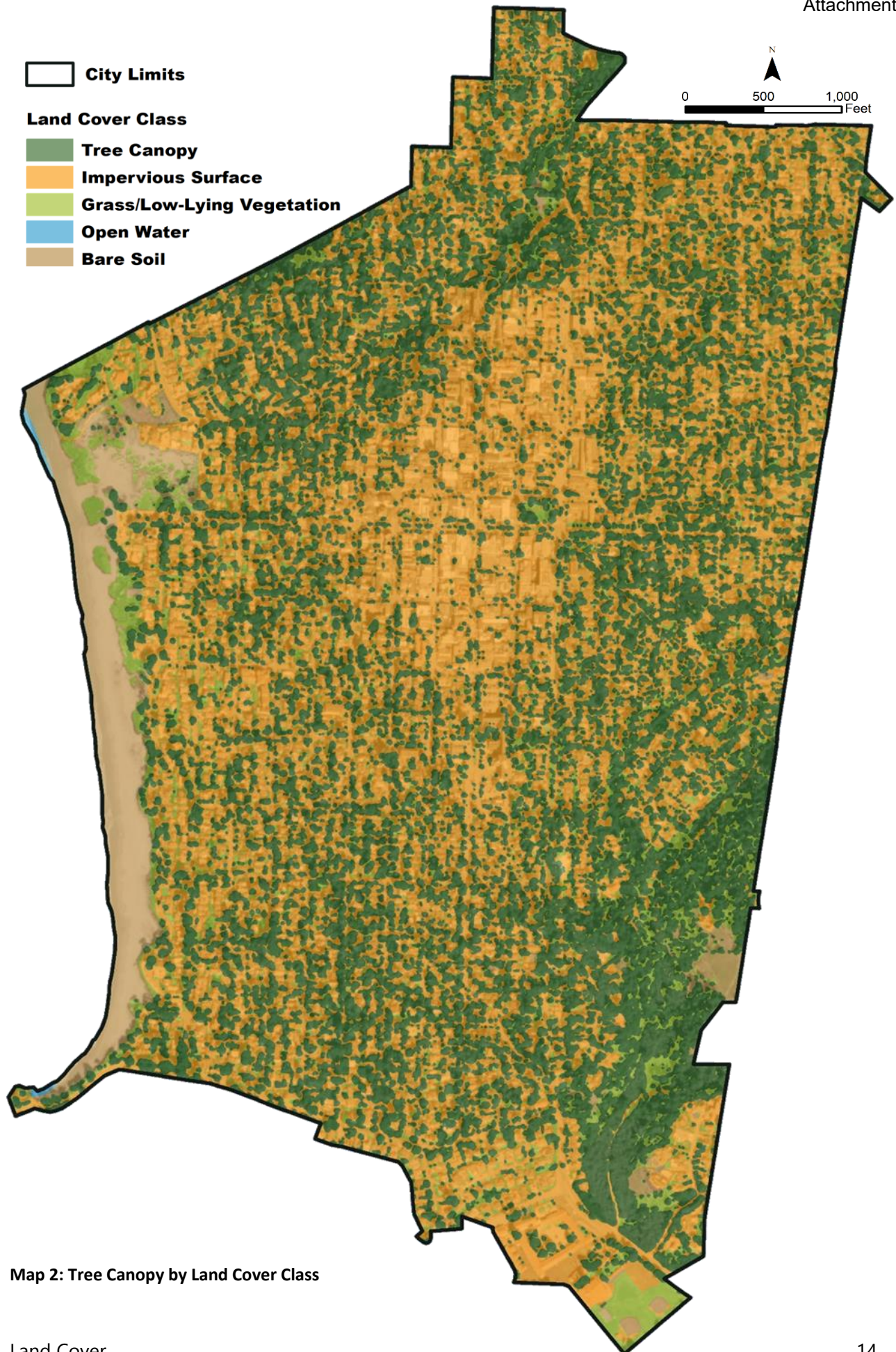


Figure 5: Carmel-by-the-Sea Land Cover

Table 2: Carmel-by-the-Sea Land Cover Classification Summary

Land Cover Class	Acres	% of Land Cover
Impervious Surface	304.56	45.03
Tree Canopy	243.26	35.97
Grass/Low-lying Vegetation	93.29	13.79
Bare Soil	34.70	5.13
Open Water	0.50	0.07
Total Acres	676.31	100%



Tree Canopy by Parks

Carmel-by-the-Sea has 9 areas designated as parks, trails, and open space that cover a total of 81.7 acres (Table 3). Together, parks, trails, and open space include 31.1 acres of tree canopy for an average canopy cover of 38.1%. Unnamed Open Space 1 has the highest level of canopy cover at 71.1% followed by Mission Trail Park at 69.3% and Picadilly Park, which is quite small at 0.1 acres, and a canopy cover of 65.8%. Not surprisingly, Carmel Beach has the lowest level of canopy cover at just under 7% and very little opportunity for additional tree planting.

As the second largest park, Mission Trail Park (34.4 acres) has the most canopy acres (23.8 acres). Mission Trail Park also has 0.9 acres of impervious surfaces and 7.0 acres of grass/low-lying vegetation. Mission Trail Park is part of the 34-acre Mission Trail Nature Preserve that features three miles of hiking trails and a native plant garden. The preserve includes a Monterey pine forest, coast live oak woodland, wetlands, a willow riparian corridor, and a coastal prairie. Tree canopy in the park provides much needed habitat for birds and wildlife.

Table 3: Canopy Cover in Carmel-by-the-Sea's Parks, Trails, and Open Space

Parks	Acres	Canopy Acres	Canopy %	Impervious Acres	Grass/Low-lying Veg. Acres	Bare Soil Acres	Open Water Acres	Potential Canopy %
Carmel Beach	39.63	2.75	6.95	0.59	7.10	28.70	0.48	17.95
Mission Trail Park	34.38	23.83	69.31	0.93	6.96	2.67	0.00	69.46
Forest Hill Park	3.90	2.55	65.28	0.36	0.76	0.23	0.00	72.30
PacRep at the Forest Theater	1.57	0.63	40.40	0.67	0.23	0.04	0.00	56.84
Unnamed Open Space 1	1.12	0.80	71.09	0.04	0.28	0.00	0.00	96.21
Devendorf Park	0.63	0.34	52.92	0.04	0.26	0.00	0.00	53.00
First Murphy Park First Murphy House	0.28	0.11	39.14	0.11	0.06	0.00	0.00	61.31
Picadilly Park	0.10	0.06	65.81	0.02	0.01	0.00	0.00	74.55
Unnamed Open Space 2	0.08	0.02	29.09	0.03	0.02	0.00	0.00	59.70
Total	81.68	31.09	38.06%	2.80	15.68	31.63	0.48	44.57%



Tree Canopy by Zoning Class

Zoning reflects the community's land classification plan and parameters for growth in specific areas (Map 4). Zoned areas encompass nearly 500 acres in Carmel-by-the-Sea and tree canopy cover varies widely across zoning designations. Examining tree canopy cover by zoning can provide additional perspective on canopy and establishing canopy goals and determining where to target new tree plantings.

Single-Family Residential zoning covers the greatest area (367 acres) and has an average canopy cover of 36%. Areas zoned for Parkland have the highest tree canopy cover (37.9%) and the potential to support up to 44.9% canopy cover (Table 4, Figure 6). Commercial zoning has the lowest canopy cover at 8.4%. Commercial areas also have a high percentage of hardscape (90.6%) and the lowest potential for canopy cover at 10.3%.

Table 4: Tree Canopy by Zoning

Zoning Class	Acres	Canopy Acres	Canopy %	Impervious Acres	Grass/Low-lying Veg. Acres	Bare Soil Acres	Open Water Acres	Potential Canopy %
Parkland	81.61	30.96	37.94	2.90	15.68	31.69	0.46	44.85
Single Family Residential	366.95	132.00	35.97	170.50	61.66	2.75	0.04	52.40
Cultural and Theatrical	4.91	1.10	22.46	3.58	0.23	0.00	0.04	27.12
Multi-Family Residential	7.06	0.95	13.42	5.54	0.49	0.00	0.00	20.09
Residential Limited Commercial	17.84	2.32	12.99	14.59	0.93	0.00	0.00	18.18
Commercial	21.47	1.80	8.39	19.46	0.43	0.00	0.00	10.30
Total	499.84	169.13	33.84%	216.84	80.09	34.36	0.49	47.43%

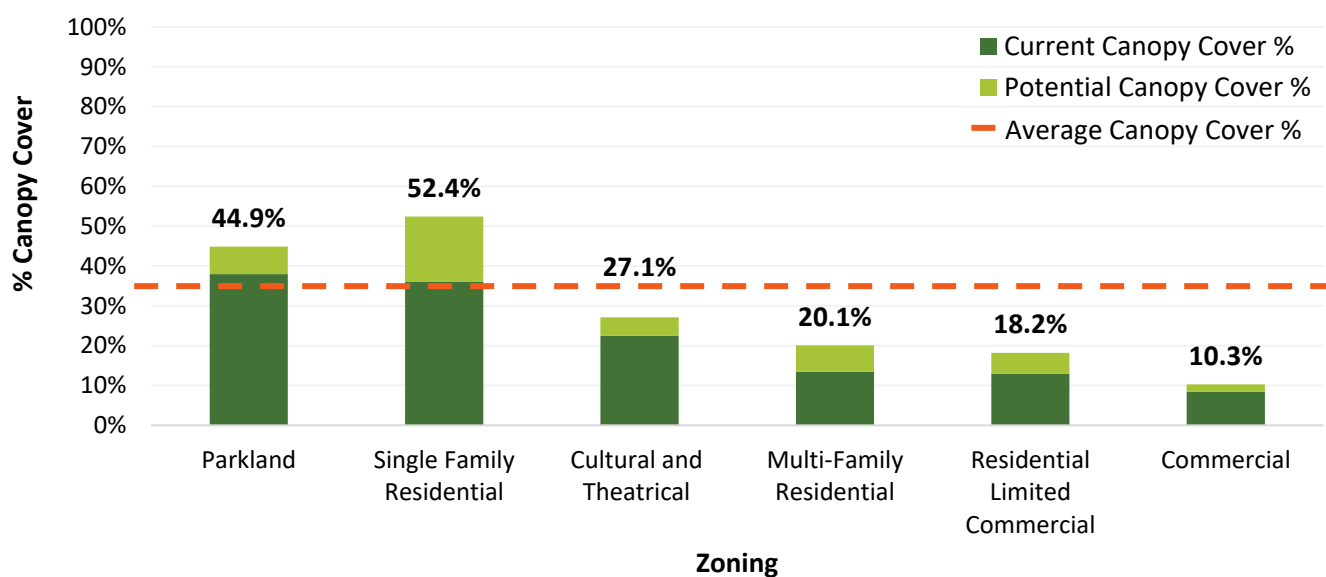


Figure 6: Current and Potential Canopy Cover by Zone



Tree Canopy by Public Versus Private Land

The urban forest is comprised of all trees in the city, including trees on publicly and privately owned properties. Mapping tree canopy by land ownership can help managers better understand the distribution of the urban forest and serve as a baseline to monitor where canopy change is occurring. Nearly 57% (137.6 acres) of Carmel-by-the-Sea's tree canopy is on privately owned property (Table 5, Figure 7). Private lands also have the greatest potential for canopy at 48.6%. Overall, the average canopy cover on privately owned lands is 33.4%. On publicly owned lands the average canopy cover is 40%.

Table 5: Canopy Cover in Public and Private Land

Land Ownership	Acres	Canopy Acres	Canopy %	Impervious Acres	Grass/Low-lying Veg. Acres	Bare Soil Acres	Open Water Acres	Potential Canopy %
Private Land	412.09	137.55	33.38	50.45	15.53	0.64	0.00	48.64
Public Land	264.22	105.71	40.01	36.58	11.09	12.14	0.18	47.22
Total	676.31	243.26	35.97%	87.03	26.62	12.78	0.19	48.08%

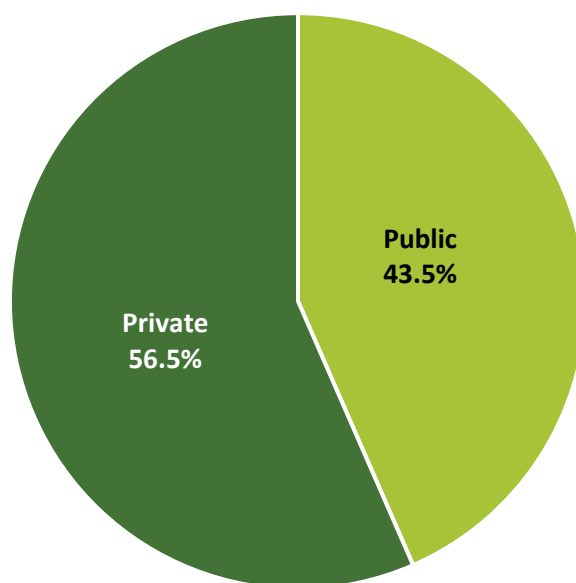


Figure 7: Canopy Cover Distribution Between Public and Private Land

Tree Canopy in Comparison with Other Communities

Communities vary in acreage, land use, and population, but comparison can be beneficial for providing context to the percentage and distribution of canopy cover in Carmel-by-the-Sea. Carmel-by-the-Sea's canopy cover falls in the top range among communities in Northern California with known canopy cover (Figure 8).

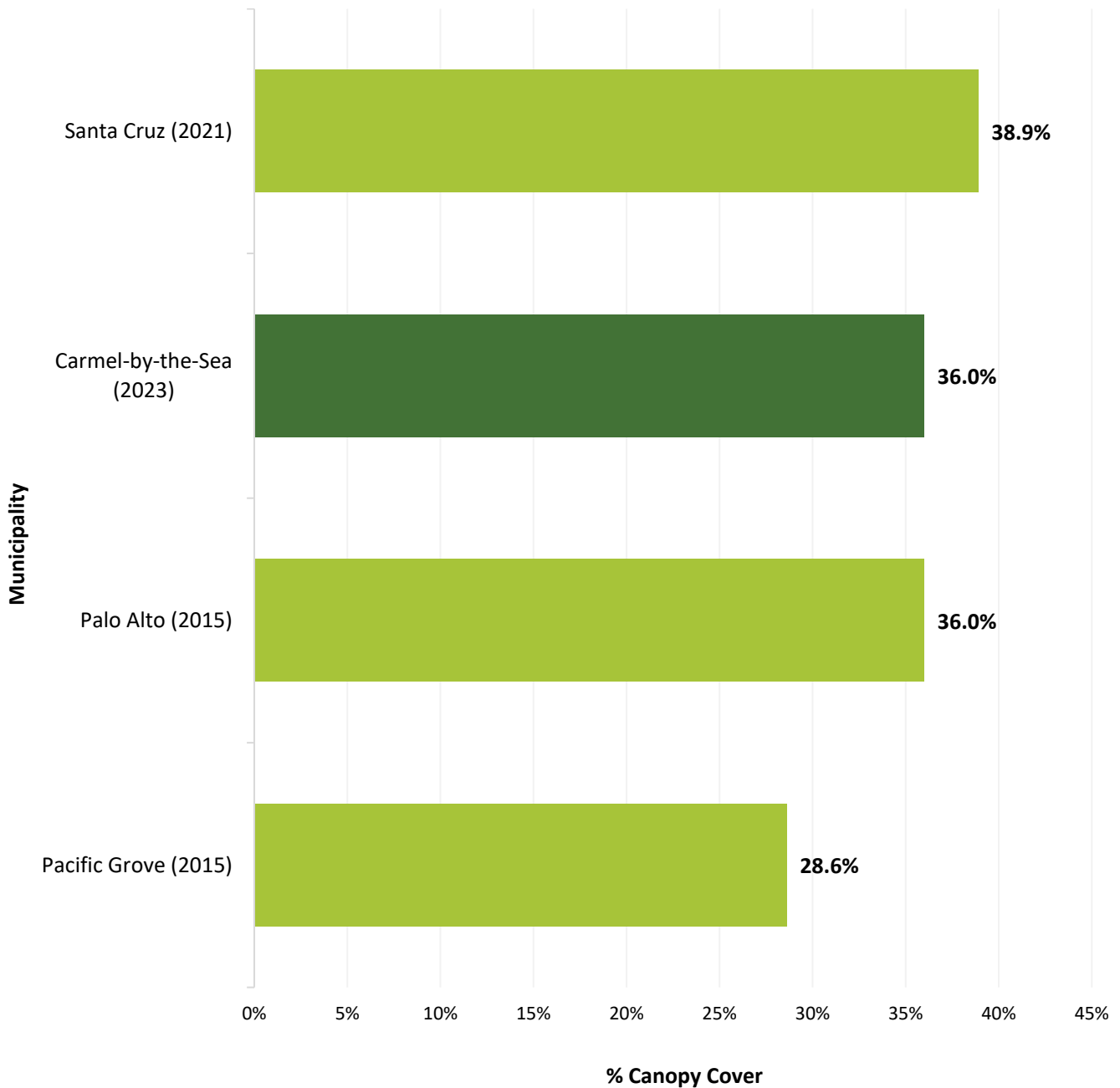


Figure 8: Canopy in comparison with other communities

Tree Canopy Health

Canopy health can be determined using near-infrared imagery and Normalized Difference Vegetation Index (NDVI) transformation. NDVI values are averaged over time to establish normal growing conditions in a region. Further analysis can characterize the health of vegetation relative to the established normal condition and classify plant condition from very good to declining. This important baseline data can help managers to better understand and evaluate forest health over time. The data can also be used as a comparison if emerging pests or disease become an issue. There are many biotic and abiotic factors that can impact the health of tree canopy, including drought, soil disturbances, pests, and disease. Where patterns of decline are apparent, a follow up field visit can help determine next steps.

In Carmel-by-the-Sea, more than 84% of tree canopy is in fair or better condition (Figure 9, Table 6). Healthy trees are vigorous, often producing more leaf surface area each year. In areas where the canopy appears to be in poor health (11.6%), field assessments and sampling (e.g., soil, foliar, pest/disease) can help to identify health factors and treatment protocols. Approximately 0.4% of canopy could not be classified due to shadows in the imagery.

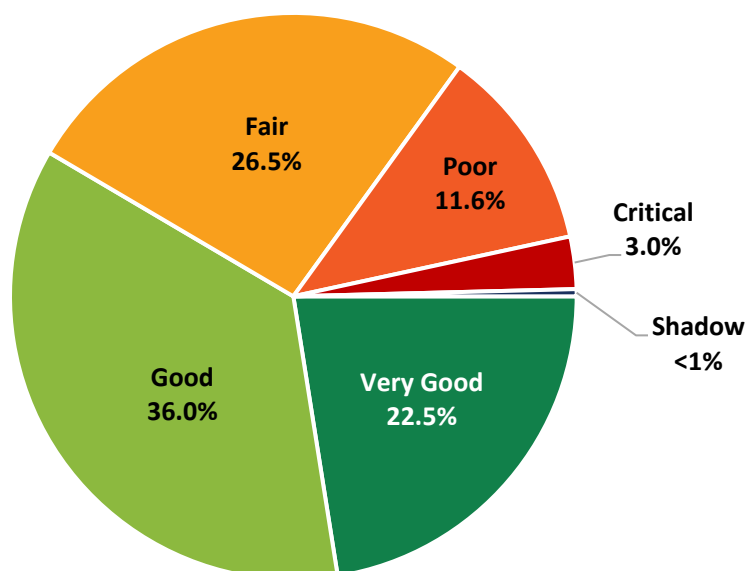
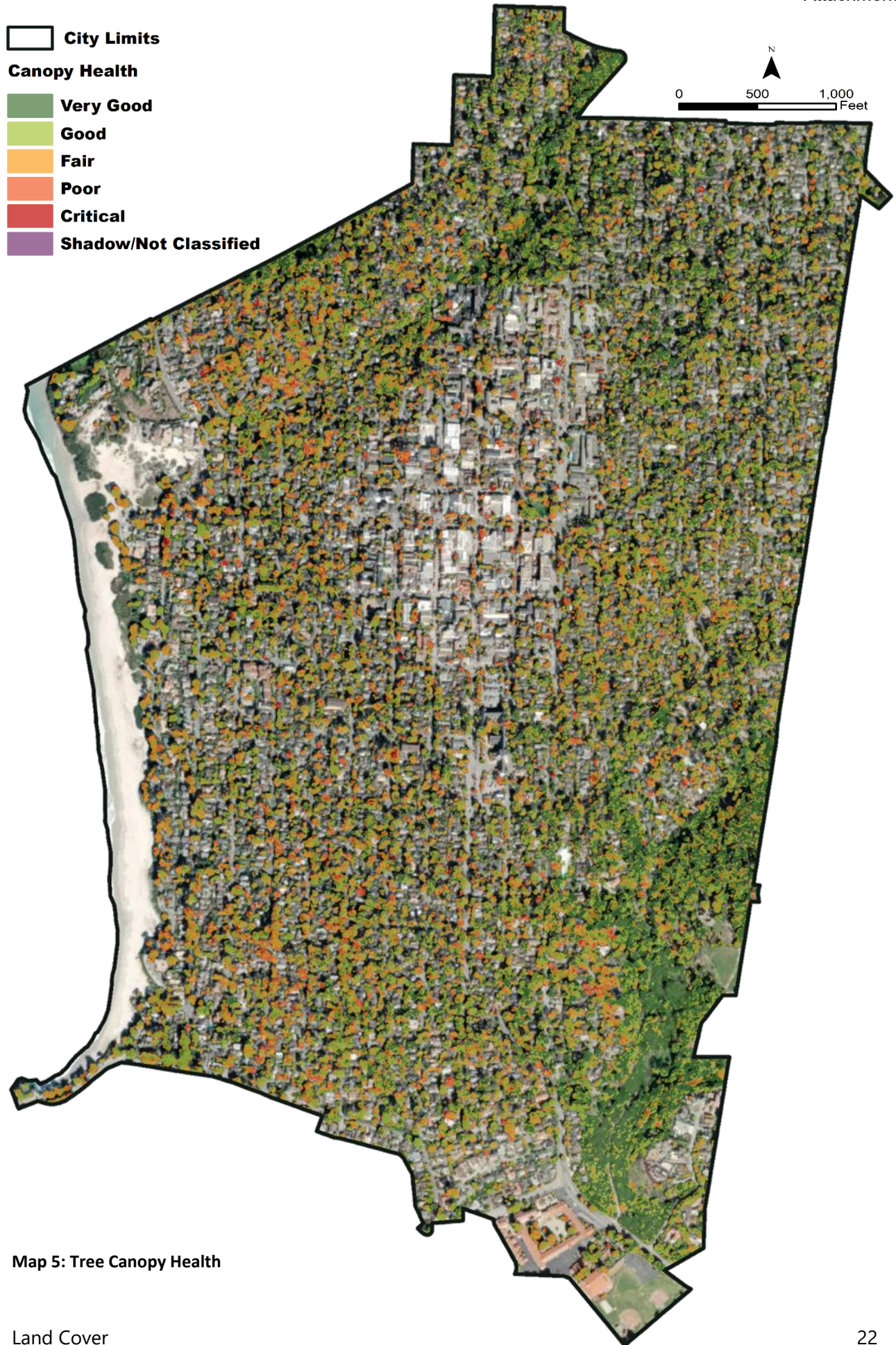


Figure 9: Summary of Canopy Health

Table 6: Summary of Canopy Health

Health Rating	Acres	% Canopy
Very Good	54.69	22.49%
Good	87.48	35.98%
Fair	64.43	26.50%
Poor	28.28	11.63%
Critical	7.26	2.99%
Shadow	0.99	0.41%
Total	243.14	100%



Map 5: Tree Canopy Health

Tree Planting Opportunities

To identify tree planting opportunities in Carmel-by-the-Sea, canopy data was used to conduct three different analyses: possible planting, priority planting, and tree placement modeling (Appendix B).

Possible Planting

Areas of the city where additional tree canopy is possible were identified, including grass, low-lying vegetation, and bare soil. Some locations were excluded because they are not suitable or realistic planting locations due to soil quality and/or conflicts with the intended use of the site. Examples of this include areas designated and intended to be open and free from trees and canopy cover such as Carmel Beach and sports fields. The analysis identified 80.9 acres where additional trees could be planted, including 2.1 acres in commercial areas and 78.8 acres in residential areas (Map 6).

Including existing canopy (243.3 acres) there are a total of 324.2 acres with the potential to support tree canopy. If all possible sites are planted and existing trees are preserved, canopy cover could be increased to 48%. This analysis did not consider additional factors that might further inform the potential for canopy cover, including:

- Expansion of tree canopy over existing impervious surfaces, from the growth of newly planted and/or existing young trees
- Planned removal of trees and tree canopy for other land use
- Reclamation of existing impervious surfaces for new planting space

Priority Planting

Planting trees in some sites can be more beneficial for reducing stormwater runoff and preventing soil loss. To prioritize these locations, DRG assessed environmental factors, including proximity to hardscape, canopy fragmentation, soil permeability, slope, and potential for soil erosion factor (K-factor) (Table 7). Residential areas were prioritized to optimize stormwater capture and reduce canopy fragmentation. Commercial areas were prioritized to optimize stormwater capture and where soil conditions are conducive to planting trees.

Many trees in the community are mature and over time, as they reach the end of their useful life, they will need to be removed. As a result, losses in tree canopy should be anticipated over the next decade or so. The priority planting analysis can help identify areas where new tree planting will provide the greatest benefits for reducing stormwater runoff and soil erosion along with mitigating canopy loss. The analysis identified 21.6 acres of possible planting areas as high or very high priority (Table 8 and Map 6).



Priority Planting Close-Up

Priority Planting

- Very Low**
- Low**
- Moderate**
- High**
- Very High**
- Commercial Area**

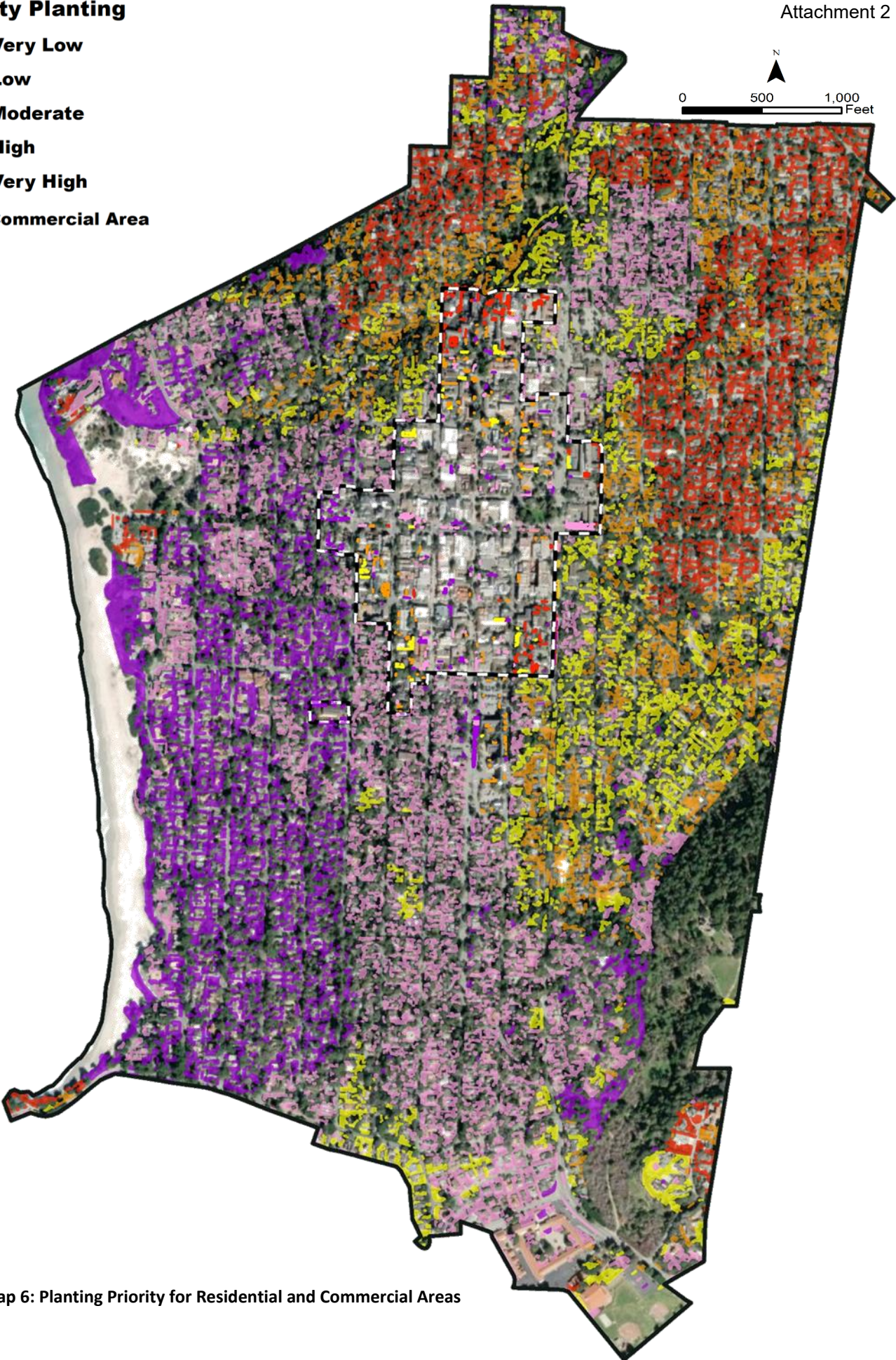


Table 7: Factors Used to Prioritize Planting Sites in Residential and Commercial Areas

Dataset	Source	Weight
Residential		
Proximity to Hardscape	Land Cover Assessment	0.4
Distance to Canopy	Land Cover Assessment	0.3
Soil Permeability	Natural Resource Conservation Service	0.1
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.1
Slope	National Elevation Dataset	0.1
Commercial		
Proximity to Hardscape	Land Cover Assessment	0.5
Soil Permeability	Natural Resource Conservation Service	0.17
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.17
Slope	National Elevation Dataset	0.16

Table 8: Priority for Possible Planting Areas by Residential and Commercial

	Residential (acres)	Commercial (acres)
Very High	11.11	0.53
High	9.54	0.45
Moderate	13.55	0.30
Low	21.24	0.45
Very Low	23.35	0.41
Total	78.79	2.14

Tree Placement

A tree placement model was used to estimate the number of large, medium, and small stature trees¹ that can be planted based on possible planting space. Where a possible planting site in the public rights-of-way includes an existing stump, this information is noted in the database. Possible planting sites on private property may also have stumps; however, the city does not track this data. The model identified 888 planting sites on public rights-of-way in residential and commercial areas, including 46 sites with existing stumps (Table 9 and 11, Figure 10 and 11). A total of 2,832 possible planting sites are located on private property.

Within residential areas, 10% of possible planting sites could accommodate a large stature tree, whereas within commercial areas only 4% of possible sites were appropriate for a large tree. Nearly 27% of possible planting sites in residential areas and more than 47% of possible sites in commercial areas are in planting areas classified as high or very high priority. Forty-six possible planting sites have an existing stump, 44 of which were in residential areas.

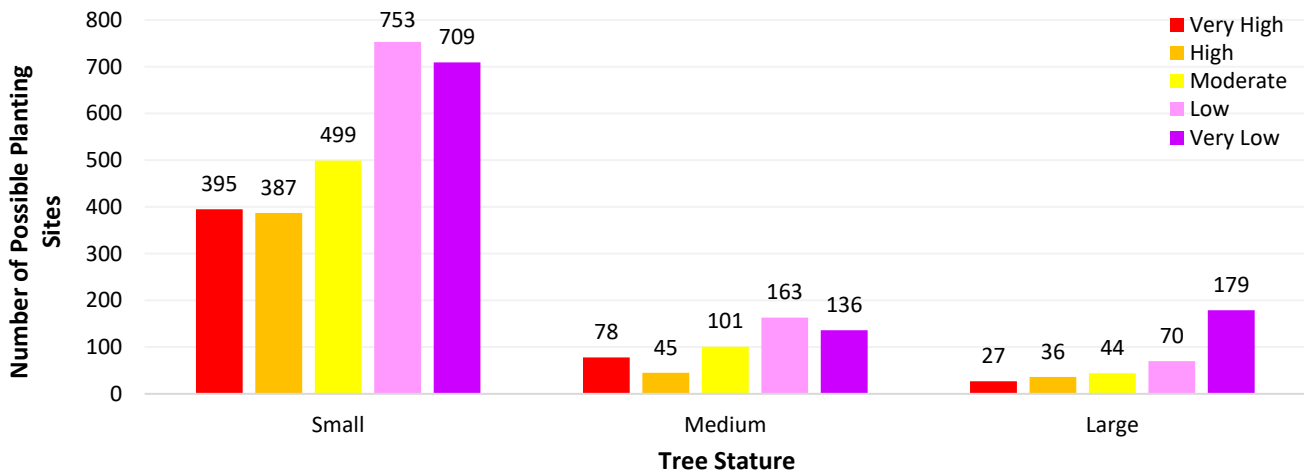
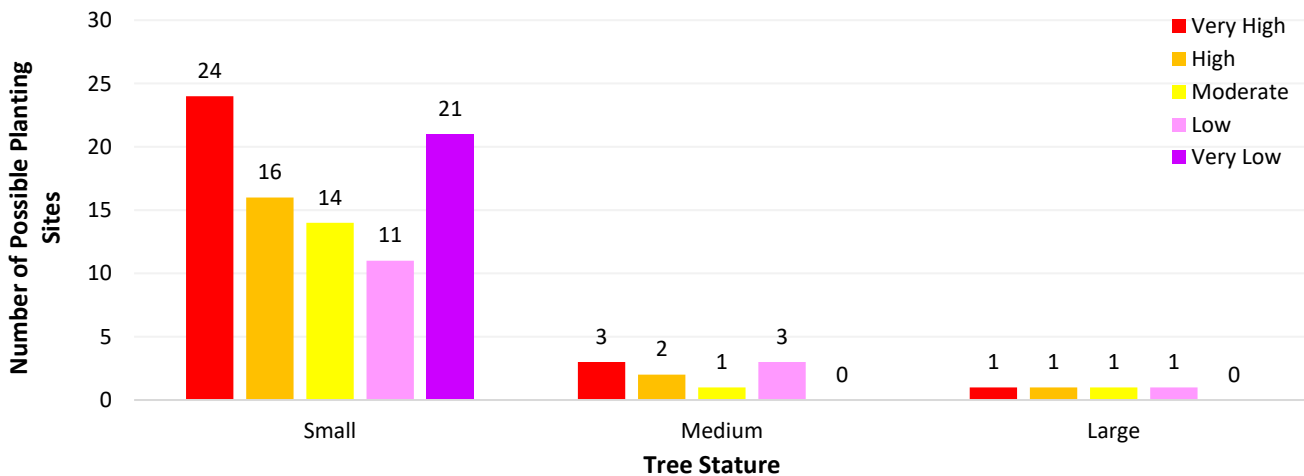
¹ Tree stature is based on the diameter of estimated canopy spread at maturity: small (15 feet), medium (30 feet), and large (50 feet)

Table 9: Possible Planting Sites in Residential Areas

Priority	Total Sites	Private Sites	Public Sites	Public Sites with Stumps	Total Tree Polygon Acres
Very High	500	392	108	11	4.31
High	468	350	118	11	4.14
Moderate	643	510	133	11	5.92
Low	986	794	192	6	9.28
Very Low	1,024	728	296	5	13.55
Total	3,621	2,774	847	44	37.20

Table 10: Possible Planting Sites in Commercial Areas

Priority	Total Sites	Private Sites	Public Sites	Public Sites with Stumps	Total Tree Polygon Acres
Very High	28	22	6	0	0.21
High	19	10	9	1	0.15
Moderate	16	11	5	0	0.13
Low	15	7	8	1	0.15
Very Low	21	8	13	0	0.10
Total	99	58	41	2	0.74

**Figure 10: Priority for Possible Planting Sites in Residential Areas****Figure 11: Priority for Possible Planting Sites Commercial Areas**

Conclusion

Carmel-by-the-Sea's Tree Canopy and Land Cover Assessment establishes a new baseline for monitoring tree canopy cover throughout the community and augments the City's GIS database with a landcover layer that identifies the location and extent of existing canopy and possible planting sites. This data can be used in conjunction with other geographic layers to further prioritize planting plans and strategically manage canopy cover by zoning class, census tracts, parks, schools, parcels or other boundaries. The data provides a foundation for developing urban forest management strategies and measuring the success of those strategies over time.

Currently, Carmel-by-the-Sea has an overall average canopy cover of 36%. Considering there are nearly 81 acres of possible planting sites, there is the potential to increase canopy cover up to 48%, if all possible sites are planted.

Based on this assessment, urban forest managers have the following opportunities:

- Identify canopy goal(s) based on zoning, land cover distribution, and community values.
- Replace and expand canopy by planting trees in parks, trails, and open spaces, as these areas have 5 acres of possible planting sites.
- Encourage tree planting and preservation on private property by incentivizing trees and through community education and support for activities and programs related to the urban forest.
 - Incentivize tree preservation and planting on private property through tree planting campaigns and other activities and programs aimed at increasing awareness of the value and benefits of trees and canopy cover.
 - Support volunteer activities and initiatives that help the community realize tree planting and canopy goals.
 - Support and augment policies that protect private trees and mitigate replacement of trees that require removal.
- Use priority planting maps to develop planting plans that support canopy goals, stormwater management, soil preservation, and complement existing infrastructure for the greatest impact and return on investment.
 - Use tree placement modeling to optimize the potential for possible planting sites. Where possible, planting large stature trees will result in the greatest benefits.
 - Prioritize planting sites that do not have an existing stump.
 - Remove existing stumps to increase possible planting space.
 - Incentivize tree planting on private property, particularly in areas of high and very high priority.
- Periodically reassess canopy cover (e.g., every 10 years) to track changes and trends.
- Preserve and protect existing trees to maximize and sustain environmental benefits.



In Carmel-by-the-Sea there are 375 acres zoned as residential that include 134 acres of tree canopy for an average canopy cover of 35.6%

Appendix A: References

- Akbari, H., D. Kurn, et al. 1997. Peak power and cooling energy savings of shade trees. *Energy and Buildings* 25:139–148.
- Chandler T.J. 1965. *The Climate of London*. London UK. Hutchinson.
- City of Pacific Grove Urban Tree Canopy Assessment. 2015. City of Pacific Grove. Retrieved from: https://www.cityofpacificgrove.org/Document_Center/Departments/Public%20Works/Programs%20&%20Initiatives/Environmental%20Programs/Landscaping%20Guidelines/pacific-groveutc-assessment2015-09-04.pdf
- Clark JR, Matheny NP, Cross G, Wake V. 1997. A model of urban forest sustainability. *Journal of Arboriculture* 23 (1): 17-30.
- Heisler GM. 1986. Energy Savings with Trees. *J Arbor* 12 (5): 113–125.
- Hirabayashi, S. 2014. i-Tree Canopy Air Pollutant Removal and Monetary Value Model Descriptions. http://www.itreetools.org/canopy/resources/iTree_Canopy_Methodology.pdf
- Hirabayashi, S. (2013). i-Tree Eco precipitation interception model descriptions. US Department of Agriculture Forest Service: Washington, DC, USA, 1, 0-21.
- i-Tree Canopy v7.1. i-Tree Software Suite. [Accessed 29 March 2023] <http://www.itreetools.org/canopy>
- i-Tree Hydro v6.1. i-Tree Software Suite. [Accessed 29 March 2023] <http://www.itreetools.org/hydro/index.php>
- Karl, Tom, P. Harley, L. Emmons, B. Thornton, A. Guenther, C. Basu, A. Turnipseed, K. Jardine. Efficient Atmospheric Cleansing of Oxidized Organic Trace Gases by Vegetation. October 2010. <http://www.sciencemag.org/cgi/content/abstract/330/6005/816>
- McPherson, E. 1994. "Cooling urban heat islands with sustainable landscapes." In R. Platt, R. Rowntree, & P. Muick (Eds.), *The Ecological City* (pp. 151–171). Amherst; University of Massachusetts Press.
- McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q. 1999. *Tree Guidelines for San Joaquin Valley Communities*. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research.
- McPherson, EG., Xiao, XI, Maco, S.E., Van Der Zanden, A., Simpson, J.R., Bell, N., Peper, P.J. 2002 *Western Washington and Oregon Community Tree Guide: Benefits, Costs and Strategic Planting*. Center for Urban Forest Research Pacific Southwest Research Station. Fs.fed.us/psw
- Santa Cruz, California Street Tree Master Plan. 2021. City of Santa Cruz.
- Sustaining the Legacy: Palo Alto Urban Forest Master Plan. 2019. City of Palo Alto. Retrieved from: <https://www.cityofpaloalto.org/files/assets/public/public-works/tree-section/ufmp/urban-forest-mp-after-adoption-reduced-2-25-19-complete.pdf>
- University of Birmingham. (2016, March 10). Flooding alleviated by targeted tree planting and river restoration, scientists discover. *ScienceDaily*. Retrieved June 17, 2019 from www.sciencedaily.com/releases/2016/03/160310214139.htm

U.S. Forest Service. 2012. STRATUM Climate Zones. [Accessed 29 March 2023]
<http://www.fs.fed.us/psw/programs/uesd/uep/stratum.shtml>

U.S. Environmental Protection Agency (US EPA). 2012. Environmental Benefits Mapping and Analysis Program (BenMAP). <http://www.epa.gov/air/benmap> [Accessed 10 October 2018]

Xiao, Q., McPherson, E.G., Simpson, J.R., Ustin, S.L. 1998. Rainfall Interception by Sacramento's Urban Forest. *Journal of Arboriculture*. 24(4): 235-244.



There are 81.7 acres in Carmel-by-the-Sea dedicated to parks, trails, and open space with an average canopy cover of 38.1%.

Appendix B: Methodology

Calculating Benefits

Air Quality

The i-Tree *Canopy* v7.1 Model was used to quantify the value of ecosystem services for air quality. i-Tree *Canopy* was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports air pollutant removal rates and monetary values for carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), sulfur dioxide (SO₂), and particulate matter (PM) (Hirabayashi 2014).

Within the i-Tree *Canopy* application, the U.S. EPA's BenMAP Model estimates the incidence of adverse health effects and monetary values resulting from changes in air pollutants (Hirabayashi 2014; US EPA 2012). Different pollutant removal values were used for urban and rural areas. In i-Tree *Canopy*, the air pollutant amount annually removed by trees and the associated monetary value can be calculated with tree cover in areas of interest using BenMAP multipliers for each county in the United States.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree *Canopy*. Those canopy percentages were matched by placing random points within the i-Tree *Canopy* application. Benefit values were reported for each of the five listed air pollutants.

Carbon Storage and Sequestration

The i-Tree *Canopy* v7.1 Model was used to quantify the value of ecosystem services for carbon storage and sequestration. i-Tree *Canopy* was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports carbon storage and sequestration rates and monetary values. Methods on deriving storage and sequestration can be found in Nowak et al. 2013.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree *Canopy*. Those canopy percentages were matched by placing random points within the i-Tree *Canopy* application. Benefit values were reported for carbon storage and sequestration.

Stormwater

The i-Tree *Hydro* v6.1 Model was used to quantify the value of ecosystem services for stormwater runoff. i-Tree *Hydro* was designed for users interested in analysis of vegetation and impervious cover effects on urban hydrology. This most recent version (v6.1) allows users to report hydrologic data on the city level rather than just a watershed scale giving users more flexibility. For more information about the model, please consult the i-Tree *Hydro* v6.1 manual (<http://www.itreetools.org>).

To calculate ecosystem services for the study area, land cover percentages derived for the project area and all municipalities that were included in the project area were used as inputs into the model. Precipitation data from 2005-2012 was modeled within the i-Tree *Hydro* to best represent the average conditions over an eight-year time period. Model simulations were run under a Base Case as well as an Alternate Case. The Alternate Case set tree canopy equal to 0% and assumed that impervious and vegetation cover would increase based on the removal of tree canopy. Impervious surface was

increased 4% based on a percentage of the amount of impervious surface under tree canopy and the rest was added to the vegetation cover class. This process was completed to assess the runoff reduction volume associated with tree canopy since i-Tree Hydro does not directly report the volume of runoff reduced by tree canopy. The volume (in cubic meters) was converted to gallons to retrieve the overall volume of runoff avoided by having the current tree canopy.

Through model simulation, it was determined that tree canopy decreases the runoff volume in the project area by 3,469,744 gallons per year using precipitation data from 2005-2012. This equates to approximately 14,265 gallons per acre of tree canopy (3,469,744 gals/243.23 acres).

To place a monetary value on storm water reduction, the cost to treat a gallon of storm/waste water was taken from McPherson et al 1999. This value was \$0.01 per gallon. Tree canopy was estimated to contribute roughly \$1,579,828 to avoided runoff annually to the project area.

Land Cover Extraction and Accuracy Assessment

Davey Resource Group, Inc. utilized an object-based image analysis (OBIA) semi-automated feature extraction method to process and analyze current high-resolution color infrared (CIR) aerial imagery and remotely-sensed data to identify tree canopy cover and land cover classifications. The use of imagery analysis is cost-effective and provides a highly accurate approach to assessing your community's existing tree canopy coverage. This supports responsible tree management, facilitates community forestry goal-setting, and improves urban resource planning for healthier and more sustainable urban environments.

Advanced image analysis methods were used to classify, or separate, the land cover layers from the overall imagery. The semi-automated extraction process was completed using Feature Analyst, an extension of ArcGIS®. Feature Analyst uses an object-oriented approach to cluster together objects with similar spectral (i.e., color) and spatial/contextual (e.g., texture, size, shape, pattern, and spatial association) characteristics. The land cover results of the extraction process was post-processed and clipped to each project boundary prior to the manual editing process in order to create smaller, manageable, and more efficient file sizes. Secondary source data, high-resolution aerial imagery provided by each UTC city, and custom ArcGIS® tools were used to aid in the final manual editing, quality checking, and quality assurance processes (QA/QC). The manual QA/QC process was implemented to identify, define, and correct any misclassifications or omission errors in the final land cover layer.

Classification Workflow

1. Prepare imagery for feature extraction (resampling, rectification, etc.), if needed.
2. Gather training set data for all desired land cover classes (canopy, impervious, grass, bare soil, shadows). Water samples are not always needed since hydrologic data are available for most areas. Training data for impervious features were not collected because the City maintained a completed impervious layer.
3. Extract canopy layer only; this decreases the amount of shadow removal from large tree canopy shadows. Fill small holes and smooth to remove rigid edges.
4. Edit and finalize canopy layer at 1:2000 scale. A point file is created to digitize-in small individual trees that will be missed during the extraction. These points are buffered to

represent the tree canopy. This process is done to speed up editing time and improve accuracy by including smaller individual trees.

5. Extract remaining land cover classes using the canopy layer as a mask; this keeps canopy shadows that occur within groups of canopy while decreasing the amount of shadow along edges.
6. Edit the impervious layer to reflect actual impervious features, such as roads, buildings, parking lots, etc. to update features.
7. Using canopy and actual impervious surfaces as a mask; input the bare soils training data and extract them from the imagery. Quickly edit the layer to remove or add any features. Davey Resource Group tries to delete dry vegetation areas that are associated with lawns, grass/meadows, and agricultural fields.
8. Assemble any hydrological datasets, if provided. Add or remove any water features to create the hydrology class. Perform a feature extraction if no water feature datasets exist.
9. Use geoprocessing tools to clean, repair, and clip all edited land cover layers to remove any self-intersections or topology errors that sometimes occur during editing.
10. Input canopy, impervious, bare soil, and hydrology layers into Davey Resource Group's Five-Class Land Cover Model to complete the classification. This model generates the pervious (grass/low-lying vegetation) class by taking all other areas not previously classified and combining them.
11. Thoroughly inspect final land cover dataset for any classification errors and correct as needed.
12. Perform accuracy assessment. Repeat Step 11, if needed.

Automated Feature Extraction Files

The automated feature extraction (AFE) files allow other users to run the extraction process by replicating the methodology. Since Feature Analyst does not contain all geoprocessing operations that Davey Resource Group utilizes, the AFE only accounts for part of the extraction process. Using Feature Analyst, Davey Resource Group created the training set data, ran the extraction, and then smoothed the features to alleviate the blocky appearance. To complete the actual extraction process, Davey Resource Group uses additional geoprocessing tools within ArcGIS®. From the AFE file results, the following steps are taken to prepare the extracted data for manual editing.

1. Davey Resource Group fills all holes in the canopy that are less than 30 square meters. This eliminates small gaps that were created during the extraction process while still allowing for natural canopy gaps.
2. Davey Resource Group deletes all features that are less than 9 square meters for canopy (50 square meters for impervious surfaces). This process reduces the number of small features that could result in incorrect classifications and also helps computer performance.
3. The Repair Geometry, Dissolve, and Multipart to Singlepart (in that order) geoprocessing tools are run to complete the extraction process.
4. The Multipart to Singlepart shapefile is given to GIS personnel for manual editing to add, remove, or reshape features.

Accuracy Assessment Protocol

Determining the accuracy of spatial data is of high importance to Davey Resource Group and our clients. To achieve the best possible result, Davey Resource Group manually edits and conducts thorough QA/QC checks on all urban tree canopy and land cover layers. A QA/QC process will be completed using ArcGIS® to identify, clean, and correct any misclassification or topology errors in the final land cover dataset. The initial land cover layer extractions will be edited at a 1:2000 quality control scale in the urban areas and at a 1:2500 scale for rural areas utilizing the most current high-resolution aerial imagery to aid in the quality control process.

To test for accuracy, random plot locations are generated throughout the city area of interest and verified to ensure that the data meet the client standards. Each point will be compared with the most current NAIP high-resolution imagery (reference image) to determine the accuracy of the final land cover layer. Points will be classified as either correct or incorrect and recorded in a classification matrix. Accuracy will be assessed using four metrics: overall accuracy, kappa, quantity disagreement, and allocation disagreement. These metrics are calculated using a custom Excel® spreadsheet.

Land Cover Accuracy

The following describes Davey Resource Group's accuracy assessment techniques and outlines procedural steps used to conduct the assessment.

1. **Random Point Generation**—Using ArcGIS, 1,000 random assessment points are generated.
2. **Point Determination**—Each point is carefully assessed by the GIS analyst for likeness with the aerial photography. To record findings, two new fields, CODE and TRUTH, are added to the accuracy assessment point shapefile. CODE is a numeric value (1–5) assigned to each land cover class (Table 12) and TRUTH is the actual land cover class as identified according to the reference image. If CODE and TRUTH are the same, then the point is counted as a correct classification. Likewise, if the CODE and TRUTH are not the same, then the point is classified as incorrect. In most cases, distinguishing if a point is correct or incorrect is straightforward. Points will rarely be misclassified by an egregious classification or editing error. Often incorrect points occur where one feature stops and the other begins.
3. **Classification Matrix**—During the accuracy assessment, if a point is considered incorrect, it is given the correct classification in the TRUTH column. Points are first assessed on the NAIP imagery for their correctness using a “blind” assessment—meaning that the analyst does not know the actual classification (the GIS analyst is strictly going off the NAIP imagery to determine cover class). Any incorrect classifications found during the “blind” assessment are scrutinized further using sub-meter imagery provided by the client to determine if the point was incorrectly classified due to the fuzziness of the NAIP imagery or an actual misclassification. After all random points are assessed and recorded; a classification (or confusion) matrix is created. The classification matrix for this project is



presented in Table 11. The table allows for assessment of user's/producer's accuracy, overall accuracy, omission/commission errors, kappa statistics, allocation/quantity disagreement, and confidence intervals (Table 11).

Table 11: Classification Matrix

Reference Data	Classification Data							Producer's Accuracy	Errors of Omission
	Classes	Tree Canopy	Impervious	Grass/Veg	Bare Soils	Water	Row Total		
	Tree Canopy	370	11	8	0	0	389	95.12%	4.88%
	Impervious	4	418	2	0	0	424	98.58%	1.42%
	Grass/Veg	6	13	116	2	0	137	84.67%	15.33%
	Bare Soils	0	0	0	46	0	46	100.00%	0.00%
	Water	0	0	0	0	4	4	100.00%	0.00%
	Column Total	380	442	126	48	4	1,000		
	User's Accuracy	97.37%	94.57%	92.06%	95.83%	100.00%		Overall Accuracy	95.40%
	Errors of Commission	2.63%	5.43%	7.94%	4.17%	0.00%		Kappa Coefficient	0.9287

4. Following are descriptions of each statistic as well as the results from some of the accuracy assessment tests.

Overall Accuracy – Percentage of correctly classified pixels; for example, the sum of the diagonals divided by the total points $((370+418+116+46+4)/1,000 = 95.40\%)$.

User's Accuracy – Probability that a pixel classified on the map actually represents that category on the ground (correct land cover classifications divided by the column total $[370/380 = 97.37\%]$).

Producer's Accuracy – Probability of a reference pixel being correctly classified (correct land cover classifications divided by the row total $[370/389 = 95.12\%]$).

Kappa Coefficient – A statistical metric used to assess the accuracy of classification data. It has been generally accepted as a better determinant of accuracy partly because it accounts for random chance agreement. A value of 0.80 or greater is regarded as "very good" agreement between the land cover classification and reference image.

Errors of Commission – A pixel reports the presence of a feature (such as trees) that, in reality, is absent (no trees are actually present). This is termed as a false positive. In the matrix below, we can determine that 2.63% of the area classified as canopy is most likely not canopy.

Errors of Omission – A pixel reports the absence of a feature (such as trees) when, in reality, they are actually there. In the matrix below, we can conclude that 4.88% of all canopy classified is actually classified as another land cover class.

Allocation Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less-than-optimal match in the spatial allocation (or position) of the classes.

Quantity Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less than perfect match in the proportions (or area) of the classes.

Confidence Intervals – A confidence interval is a type of interval estimate of a population parameter and is used to indicate the reliability of an estimate. Confidence intervals consist of a range of values (interval) that act as good estimates of the unknown population parameter based on the observed probability of successes and failures. Since all assessments have innate error, defining a lower and upper bound estimate is essential.

Table 12: Confidence Intervals

95% Confidence Intervals				
Landcover Assessment				
Class	Acres	%	Lower Bound	Upper Bound
Tree Canopy	243.23	36.0%	34.1%	37.8%
Impervious	304.65	45.0%	43.1%	47.0%
Grass/Veg	93.22	13.8%	12.5%	15.1%
Bare Soils	34.71	5.1%	4.3%	6.0%
Water	0.50	0.1%	0.0%	0.2%
Total	676.31	100.0%		

Statistical Metrics Summary:

Overall Accuracy =95.4%

Kappa Coefficient = 0.9287

Allocation Disagreement = 3%

Quantity Disagreement = 2%

Accuracy Assessment						
Class	User's Accuracy	Lower Bound	Upper Bound	Producer's Accuracy	Lower Bound	Upper Bound
Tree Canopy	97.4%	96.5%	98.2%	95.1%	94.0%	96.2%
Impervious	94.6%	93.5%	95.6%	98.6%	98.0%	99.2%
Grass/Veg	92.1%	89.7%	94.5%	84.7%	81.6%	87.7%
Bare Soils	95.8%	92.9%	98.7%	100.0%	100.0%	100.0%
Water	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Priority Planting

Summary

This project was conducted to assess priority planting locations for Carmel-by-the Sea, CA. Data sources were sought across the board to analyze a variety of factors that can contribute to accessing tree canopy needs. Analysis included data sets from the city of Carmel-by-the-Sea, US Department of Agriculture, and United States Geological Survey. The resulting analysis found plantable areas in both public and private properties across the town.

Description

To help the census tract in the city of Carmel-by-the-Sea increase its canopy coverage, an urban tree canopy assessment was conducted by the town to assess land cover using 2022 aerial imagery. The study was completed in 2023. An analysis to identify the most suitable locations was conducted by analyzing each planting location to assign a priority ranking for stormwater.

Each data source utilized the most current version available and described in the subsequent sections. Stormwater uses the most recent NAIP imagery, soil data, hydrography data, and elevation data.

Methodology

In order to create a priority planting plan, the locations for planting must first be determined. Planting location polygons were created by taking all grass/open space and bare ground areas and combining them into a single dataset. Non-feasible planting areas such as agricultural fields, recreational fields, major utility corridors, airports, etc. were restricted and noted as a query-able attribute in the final GIS dataset. This layer was reviewed and approved by the city of Carmel-by-the-Sea before the analysis proceeded. The remaining planting space was consolidated into a single feature and then, exploded to multipart features creating separate, distinct polygons for each location. The final step broke polygons up again to note planting restrictions as their own feature.

Stormwater:

To identify and prioritize planting potential based on the stormwater analysis, locations were assessed with several environmental features, including proximity to hardscape, proximity to canopy, soil permeability, slope, and soil erosion factor. These factors are based on numerous historic projects completed by DRG for stormwater analysis. Each factor was assessed using data from various sources and analyzed using separate grid maps. Values between zero and four (with zero having the lowest priority) were assigned to each grid assessed. A value of zero indicates that this classified piece of information yielded little or no overall value within the dataset. The grids were overlain with the values averaged to determine the priority levels at an area on the map. A priority ranging from Very Low to Very High was assigned to areas on the map based on the calculated average of all grid maps using quantile classification breaks within ArcGIS. This step of the process was completed to statistically subset data evenly into five classes of increasing importance. Areas of higher potential for runoff and erosion were considered higher priority due to their ability to diminish water quality within urban areas.

Once the process of identifying priority was completed, the development of planting strategies will be the next step in the process. While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next few years, should be planned for areas in most need, and where they will provide the most benefits and return on investment given a particular set of circumstances and desires to fulfill certain obligations to the community. The city of Carmel-by-the-Sea can choose to target individual factors like heat islands for certain projects or select from the composite ranking to get the most return on investment across the board.

Table 13: Priority Weighting Scheme

Dataset	Source	Weight
Residential		
Proximity to Hardscape	Land Cover Assessment	0.4
Distance to Canopy	Land Cover Assessment	0.3
Soil Permeability	Natural Resource Conservation Service	0.1
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.1
Slope	National Elevation Dataset	0.1
Commercial		
Proximity to Hardscape	Land Cover Assessment	0.5
Soil Permeability	Natural Resource Conservation Service	0.17
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.17
Slope	National Elevation Dataset	0.16

Weighted Overlay Equation for stormwater priority:

$$(\text{"Impervious Distance"} * 0.40) + (\text{"Soil Permeability"} * 0.10) + (\text{"Soil Erosion"} * 0.10) + (\text{"Canopy Distance"} * 0.30) + (\text{"Slope Percent"} * 0.10)$$

Weighted Overlay Equation for stormwater priority:

$$(\text{"Impervious Distance"} * 0.50) + (\text{"Soil Permeability"} * 0.17) + (\text{"Soil Erosion"} * 0.17) + (\text{"Slope Percent"} * 0.16)$$

Stormwater*Distance to Hardscape*

Source: Carmel-by-the-Sea Urban Tree Canopy Assessment

Data: Distance to Impervious

Distance to hardscape is derived by selecting the impervious surfaces data from the Carmel-by-the-Sea landcover layer. This impervious raster is used as an input layer into the Euclidean Distance tool within ArcGIS to create a layer that measures straight-line distance from each impervious surface location within the town. These distances are grouped into five classes from 0 - 4 with 4 being the closest to impervious surfaces and, therefore, the highest priority. The further a location is from an impervious surface, the lower the ranking it receives. A ranking of 0 is given to locations that are currently represented as impervious surfaces in the land cover data while the value of 4 indicates that the open area next to the impervious surface is available for planting trees to reduce the amount of runoff and sedimentation.

Table 14: Distance to Hardscape Ranking

Distance to Hardscape	
Rank	Distance to Impervious (ft)
0	0
1	Over 100
2	51 - 100
3	26 – 50
4	1 – 25

Distance to Canopy

Source: Carmel-by-the-Sea Urban Tree Canopy Assessment

Data: Distance to Canopy

Distance to canopy is derived by selecting the tree canopy data from the Carmel-by-the-Sea landcover layer. This canopy raster is used as an input layer into the Euclidean Distance tool within ArcGIS to create a layer that measures straight-line distance from each canopy location within the town. These distances are grouped into five classes from 0 - 4 with 4 being the closest to Canopy and therefore the highest priority. The further a location is from the canopy, the lower the ranking it receives. A ranking of 0 is given to locations that are currently occupied by tree canopy and not plantable. Higher values in this ranking will prioritize areas that have small gaps that can be filled in order to increase tree canopy closure, which has great impact of wildlife habitat by providing larger corridors to support a variety of different species.

Table 15: Distance to Canopy Ranking

Distance to Canopy	
Rank	Distance to Canopy (ft)
0	0
1	Over 200
2	101 - 200
3	51 - 100
4	1 - 50

Soil Permeability

Source: Natural Resource Conservation Service – USDA Web Soil Survey

Link: <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Data Attribute: Hydrologic Soils Group (HSG)

Soil Permeability is found by analyzing the Hydrologic Soils Group (HSG) information from the USDA Soil Surveys. This data is classified into four classes: A, B, C and D. Group A soils have a high infiltration rate, Group B has a moderate infiltration rate, Group C has a slow infiltration rate, and Group D has a very slow infiltration rate. The remaining values are classified as W denoting water. These areas are typically larger bodies of water such as ponds, lakes or rivers. The rankings range from 0 - 4 with 4 being the highest priority. A ranking of 4 is given to the D classification due to its low infiltration rate. Planting in these locations will increase stormwater uptake and therefore, reduce the amount of runoff. Lower rankings are given to the A, B and C classes as these classes have higher infiltration rates where water is able to percolate through the soil without creating surface runoff leading to an decrease in harmful pollutants and sediment into streams and stormwater infrastructure over time. The W class is given a 0 ranking because these areas are classified as water and have no bearing of runoff.

Table 16: Soil Permeability Ranking

Soil Permeability - HSG	
Rank	Threat
0	W
1	A
2	B
3	C
4	D

Soil Erosion

Source: Natural Resource Conservation Service – USDA Web Soil Survey

Link: <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Data Attribute: K-factor

Soil Erosion is found by analyzing the K-factor information from the USDA Soil Surveys. This data is classified into decimal numbers that range from 0.02 – 0.69. The higher numbers within this range mean that the area is more susceptible to sheet and rill erosion by water. Remaining values are given a value of 0 of which can represent water, quarries, pits, and other harder surface types. Water features are typically ponds, lakes and rivers. Rankings for this data are based on the susceptibility to erosion. A 0 ranking is given to areas that have little to no risk of erosion. The ranking increases as the risk of erosion increases with the highest ranking being 4. Planting in these priority areas will help decrease erosion vulnerability.

Table 17: Soil Erosion (K-factor) Ranking

Soil Erosion – K-factor	
Rank	K-factor (expressed as whole numbers)
0	0 - 10
1	45250
2	21 - 30
3	31 - 37
4	Over 38

Slope

Source: National Elevation Dataset – USDA Geospatial Data Gateway

Link: <https://datagateway.nrcs.usda.gov/>

Data: DEM

Slope is calculated by using the Digital Elevation Model (DEM) from the USDA and finding the slope percent rise of the DEM. The Percent Rise results were grouped into five classes from 0 - 4 with 4 being the highest priority as shown below. The rankings for this data are based on the percent rise of the area. The larger the percent rise of the land, the higher the planting priority. A ranking of 0 is given to areas of no percent rise and the rankings then increase as the percent rise increase with the highest ranking being 4. Planting trees on areas of high percent rise can help decrease stormwater runoff.

Table 18: Slope Ranking

Slope – Percent Rise	
Rank	Percent Rise
0	0
1	0 - 3
2	44991
3	45089
4	Over 12

Tree Placement

Summary

The purpose of this feature class is to create a planting placement guide for Carmel-by-the-Sea, California. This layer identifies possible locations for tree placement based on the placement analysis.

Description

To help Carmel-by-the-Sea, California increase its canopy coverage by community, an urban tree canopy assessment was conducted to determine the current land cover. This landcover was used to find the most suitable locations to plant trees. These locations were narrowed down to exclude areas within 5 feet of existing trees or 5ft existing impervious surface.

Use Limitations

As determined by the Carmel-by-the-Sea, California

Data Quality

Planting sites and their tree sizes are generalized based on data derived from the Priority Planting analysis and the Tree Placement model. No field verification of planting sites was conducted. Before planting, the City will need to conduct site assessments to ensure planting locations can adequately sustain planting trees.

Lineage

This process uses the priority planting areas to create points for tree placement. Grids area created over the designated area and points are placed within these grids within the priority planting areas. The size of the trees are determined by the size that is able to fit within both the grid and the planting area. The model places large trees first and then uses the remaining area to place medium trees and then again for small trees.

Fields

ET_X - X coordinate

ET_Y - Y coordinate

BUFF_DIST - The radius of the crown

Crown Size - The size (small, medium, large) of the tree crown

UNIQUEID - unique identifying number

Zone – If the tree placement point falls into a residential or commercial area

Priority - Stormwater priority rank



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

February 8, 2024
ORDERS OF BUSINESS

TO: Forest and Beach Commissioners

SUBMITTED BY: Justin Ono, City Forester

SUBJECT: Receive a demonstration of TreeKeeper, a digital tree inventory program

RECOMMENDATION:

Receive a presentation by City Forester Justin Ono on the TreeKeeper digital platform.

BACKGROUND/SUMMARY:

Davey Resource Group has uploaded City tree inventory data into the digital TreeKeeper computer platform. At the Forest and Beach Commission Meeting, the City Forester will perform a live demonstration of the program showing mapping capabilities, tree attributes, and links to permits and other information.

Environmental Evaluation

This action does not constitute a project within the meaning of the California Environmental Quality Act under Public Resources Code Section 21065. It has no potential to cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment and, therefore, does not require environmental review.

FISCAL IMPACT:

The TreeKeeper program costs are covered in the Forestry Division's operating budget.

ATTACHMENTS:



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

**February 8, 2024
ORDERS OF BUSINESS**

TO: Forest and Beach Commissioners

SUBMITTED BY: Justin Ono, City Forester

SUBJECT: City Forester's Report for January 2024

RECOMMENDATION:

Receive the City Forester's Report for January 2024

BACKGROUND/SUMMARY:

Environmental Evaluation

This action does not constitute a project within the meaning of the California Environmental Quality Act under Public Resources Code Section 21065. It has no potential to cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment and, therefore, does not require environmental review.

FISCAL IMPACT:

ATTACHMENTS:

Attachment 1 - Foresters Report



CITY OF CARMEL-BY-THE-SEA

Monthly Report

City Forester's Report

TO:	Forest and Beach Commissioners
FROM:	Justin Ono, City Forester
SUBJECT:	January 2024 Forester's Report

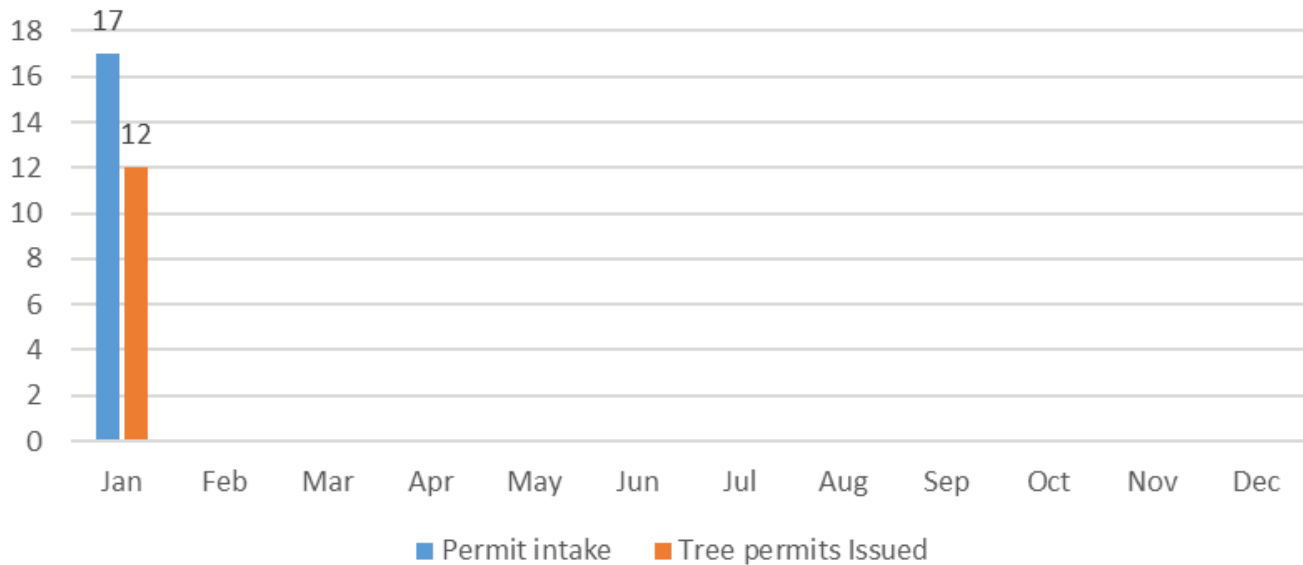
Forestry, Parks, and Beach Highlights:

- Status of Davey Resource Group (DRG) development of the Urban Forest Master Plan (UFMP):
 - The first draft of the UFMP was expected in December, but has been delayed to February due to the resignation of a key DRG project team member.
 - The UFMP technical report regarding the Tree Canopy and Land Cover Assessment will be presented to the Forest and Beach Commission and Steering Committee in February.
- Forestry crews planted 14 new trees, removed 8 dead/hazardous trees, pruned 14 trees, and removed 1 stump in January.
- Overgrown acacia was pruned around the viewing deck at the west end of the Del Mar parking lot.
- Crews also pruned overgrown trees and shrubs which were partially blocking views of Stop signs.
- Crews began to clear out a backlog of logs left over by PG&E line clearing crews.
- Crews started driving our new, 2023 Dodge Dakota 1500 trucks which have much larger bed capacity for trees and landscape equipment and materials versus the older trucks they replaced.
- Tree contractors removed several 4 large stumps and 14 dead or dying trees under contract Task Orders.
- Landscape maintenance work across the City continues to be fully engaged by Town & Country.
- Forestry staff attended a "Navigating Urban Forestry Workshop" sponsored by West Coast Arborists in Menlo Park. Key topics included tree health and using drones and new technology.
- Forestry welcomed back Administrative Analyst Tom Ford from Paternity leave after his wife Michelle gave birth to their baby boy Jason Sergio Ford in late November.

Permit Information

2024 Permitted removals, pruning, and required planting												
	Tree permits received	Tree permits Issued	Site Inspections Performed	Total Prunings	Total Removals	Removal of Upper	Removal of Lower	Required to Plant Upper	Required to Plant Lower	No room for new tree	Meets Density Rec.	Total Number of Trees Required
January	17	12	1	4	8	6	2	5	1	0	2	6
February												
March												
April												
May												
June												
July												
August												
September												
October												
November												
December												
2024 Totals	17	12	1	4	8	6	2	5	1	0	2	6

2024 Permits Intake vs. Issued

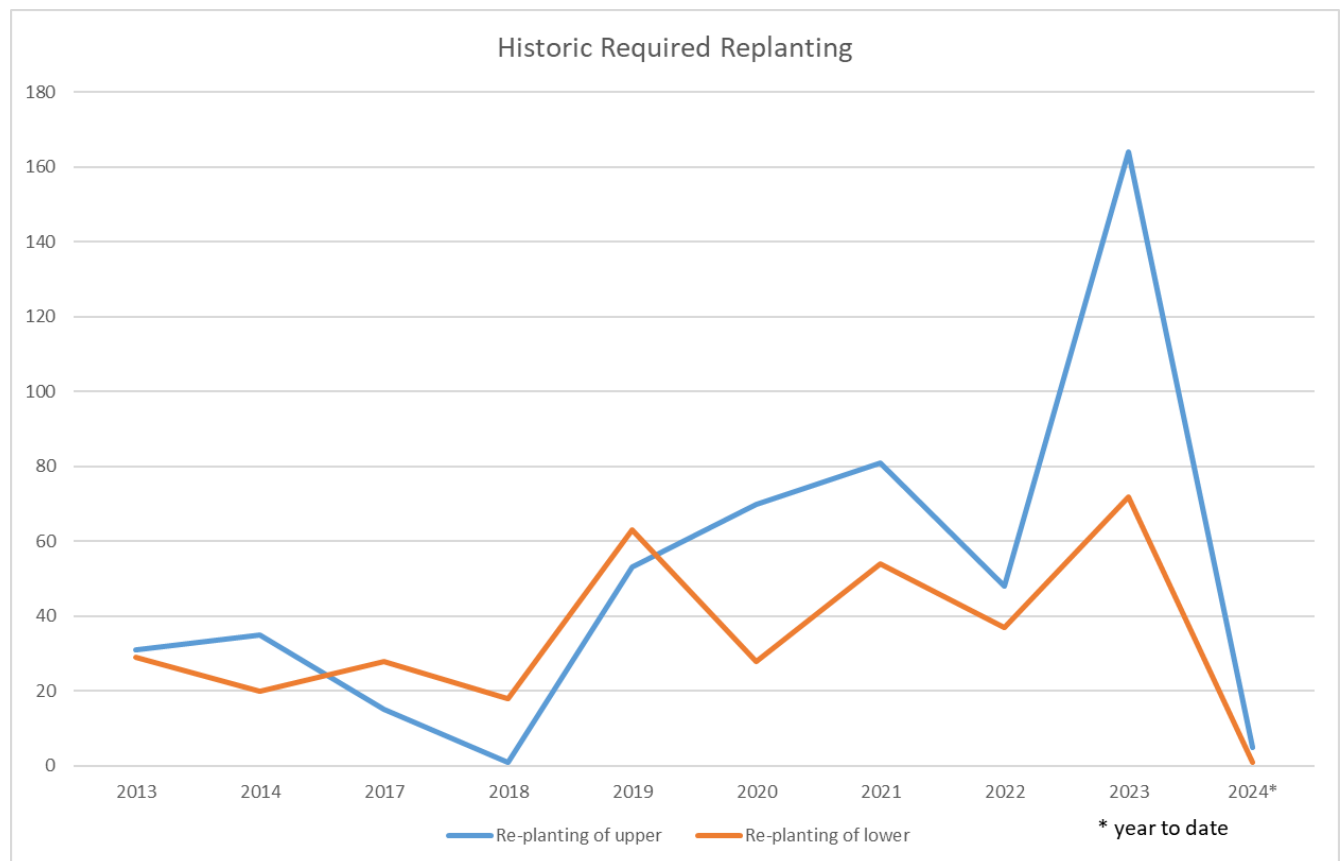


Historic permitted removals and required planting

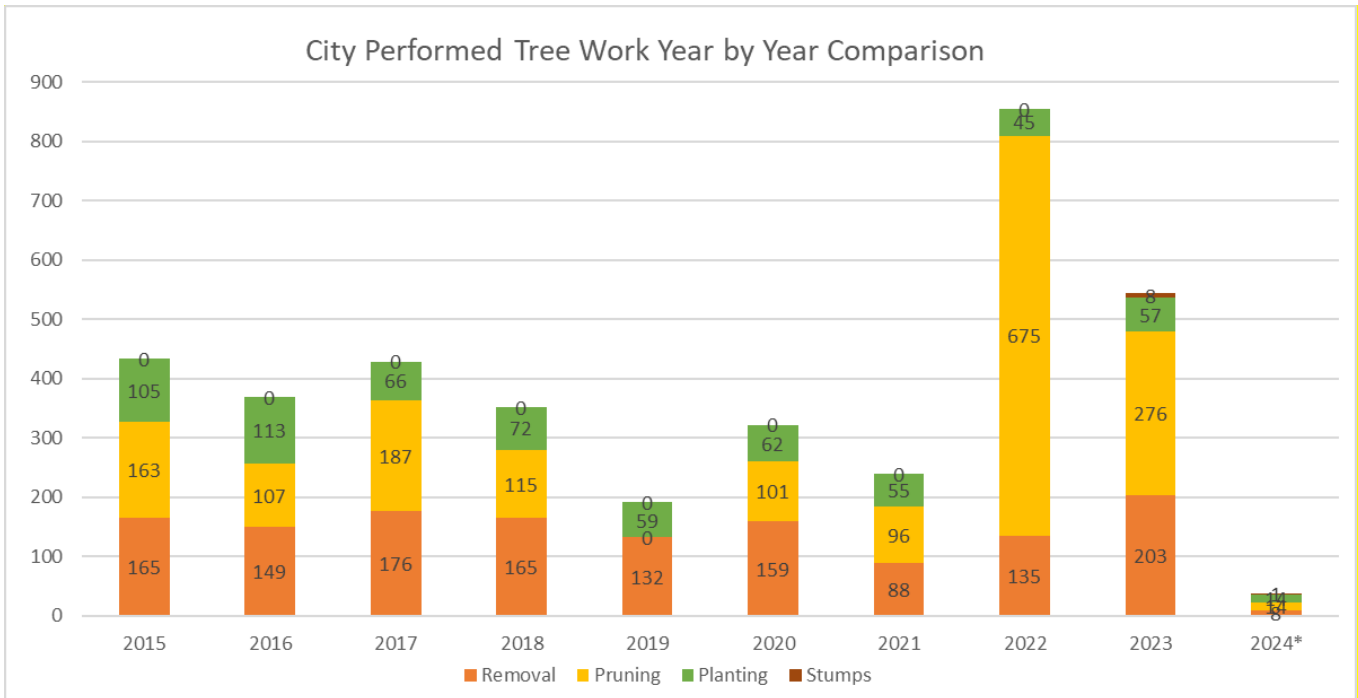
	Re-planting of upper	Re-planting of lower
2013	31	29
2014	35	20
2017	15	28
2018	1	18
2019	53	63
2020	70	28
2021	81	54
2022	48	37
2023	164	72
2024*	5	1
*year to date		

Historic permitted removals and required planting

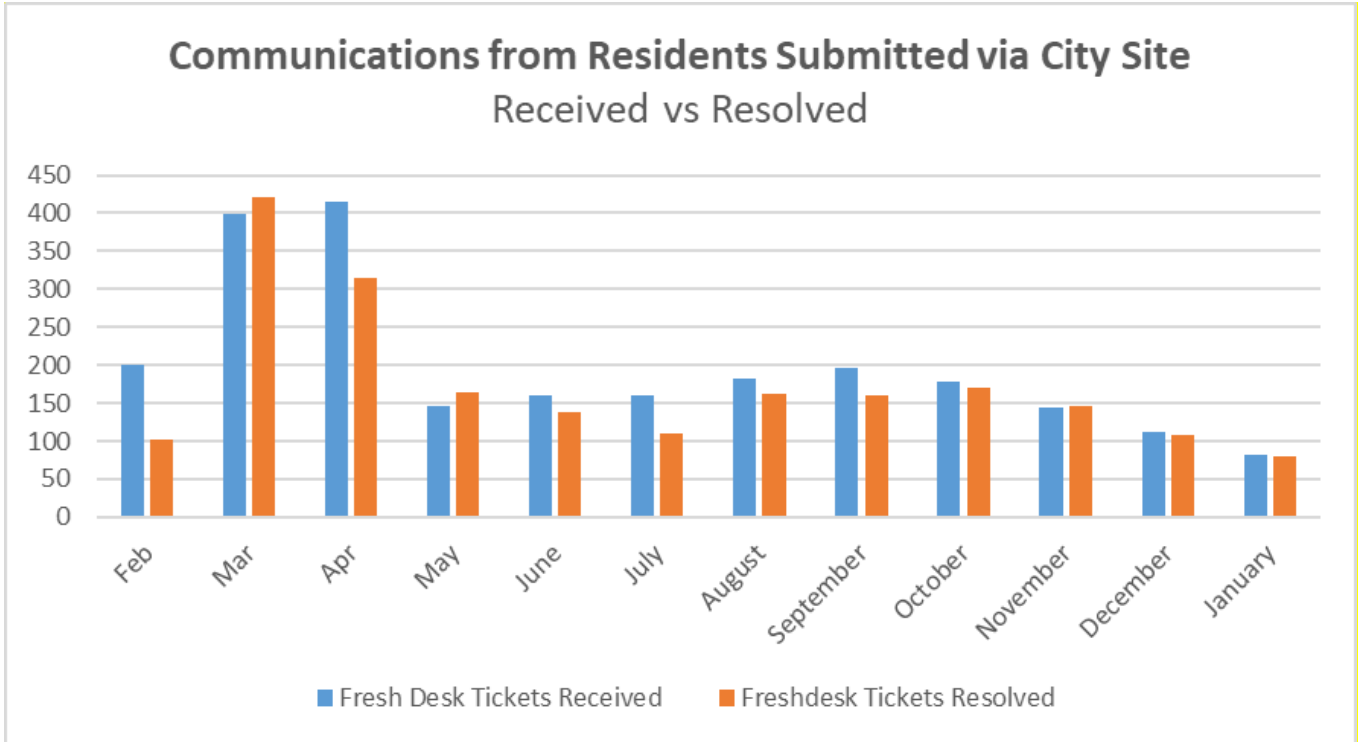
Year	Permitted removals	Removal of upper	Removal of lower	Replanting Required	Replanting of upper	Replanting of lower	Replanting %	Applications processed
2021	204	81	123	135	81	54	66.18%	213
2022	149	82	67	85	48	37	57.05%	155
2023	324	211	113	223	164	72	68.83%	336
2024	8	6	2	6	5	1	75.00%	17



City Forestry, Parks, and Beach Activities



*Year to date



*Numbers only represent correspondences received via the City's website and do not include live calls, voicemails, drop-in visitors, and emails sent directly to employees from residents, nor return calls and emails from staff.



CITY OF CARMEL-BY-THE-SEA FOREST AND BEACH COMMISSION Staff Report

February 8, 2024
ORDERS OF BUSINESS

TO: Forest and Beach Commissioners

SUBMITTED BY: Robert M. Harary, P.E., Director of Public Works

SUBJECT: Public Works Director's Report for January 2024

RECOMMENDATION:

Receive the Public Works Director's Report for January 2024.

BACKGROUND/SUMMARY:

The Public Works Director's Report for January 2024 will include:

- A. City Council actions related to Forestry, Parks, and Beach issues
- B. Forestry, Parks, and Beach-related Capital Improvement Projects
- C. Climate Committee meetings and Climate Action and Climate Adaptation Plan implementation
- D. Update on Volunteer Organizations
- E. Miscellaneous Forestry, Parks, and Beach-related Public Works items

Environmental Evaluation

This action does not constitute a project within the meaning of the California Environmental Quality Act under Public Resources Code Section 21065. It has no potential to cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment and, therefore, does not require environmental review.

FISCAL IMPACT:

None.

ATTACHMENTS:

Attachment #1 - Public Works Director's Report for January 2024



CITY OF CARMEL-BY-THE-SEA

Public Works Department

January 2024 Monthly Report

TO:	Honorable Mayor and City Council Members
SUBMITTED BY:	Robert M. Harary, P.E., Director of Public Works
SUBMITTED ON:	February 1, 2023
APPROVED BY:	Chip Rerig, City Administrator

City Council Special Meeting of January 8, 2024

- Held a Study Session regarding the Police Building condition assessment summary, Police Department programming needs, potential options for renovating the existing facility or constructing a new facility, comparison of potential sites, and recommended pursuing schematic design concepts for preferred alternatives. Based on public comments, additional Public Meetings will be held.

City Council Meeting of January 9, 2024

- Adopted Resolution 2024-005 awarding a construction contract to Color New Company, in the amount of \$392,150, for painting the exterior of the Sunset Center north wing, exterior of the Harrison Memorial Library (HML), and interior of the HML. A change order is being processed to reduce the amount of HML interior painting.
- Adopted Resolution 2024-006 approving Amendment No. 2 to the Professional Services Agreement (PSA) with Ten Over Studio, for a fee of \$29,500, to prepare design concepts for the Sunset Center Portico Project.
- Adopted Resolution 2024-008 ratifying the appointment of Gerard Montmorency to the Forest and Beach Commission to complete the term of former Commissioner Sours, expiring May 30, 2025.
- The Public Works Director gave a presentation summarizing the history of the Scout House and comparing pros and cons for the following five options: 1) Renovate the Scout House as a Capital Improvement Project, 2) Sell the property, 3) Reissue the Request for Proposal for a contractor to renovate, lease, and operate the Scout House, 4) Relocate and Renovate the building and sell the existing property, and 5) Status quo. Council directed staff to pursue relocate the facility (Option 4) to a site to be determined.

City Council Special Meeting of January 25, 2024

- Based on public comments received at the January 8th Study Session, the Police Building Ad Hoc Committee, comprised of Mayor Potter and Councilmember Baron, presented an overview of the Police Building project and solicited public comments.

Forest and Beach Commission Meeting of January 11, 2024

- Announcements included:
 - Thanked Mark Shurvington-Bradley for doing a great job as a temporary Forestry administrator since February. He accepted a permanent position as a Planner with Sonoma County.
 - Welcomed Gerald Montmorency, who was in the audience, as the new Commissioner.
- Received the final Rules of Procedure of the Forest and Beach Commission as adopted in December.
- Public Hearing held regarding pruning of two, City-owned, coast live oak trees located at the northwest corner of Lincoln Street and Santa Lucia Avenue. Commission approved pruning of one of the two trees under the supervision of the City Forester and at the Applicant's expense.
- Public Hearing held regarding two City-owned holly oak trees and a coast live oak located on Monte Verde Street, 3 northeast of Ninth Avenue, that were significantly over-pruned and damaged by a landscaping contractor without a pruning permit nor a current business license. Commission released

a Stop Work Order subject the property owner/responsible party paying fees for a Stop Work Order investigation, double the tree permit fees, cost for an independent arborist report, and depreciated value of the trees totaling \$9,140.

- The Commission approved the Environmental Programs Manager's proposal to install a three-rail, split rail cedar fence on the North Dunes Habitat Area boundary along Ocean and San Antonio Avenues. The 900-foot long fence will replace the existing post and cable rail fence, and provide openings at designated trails into the Dunes site. Fence will be installed by Public Works this Spring.
- The City Forester presented the Forester's Report for December 2023 which included a summary of metrics comparing 2022 and 2023.
- The Public Works Director presented the Public Works Department Reports for December 2023.

Administration

- Prepared staff report and resolution with budget amendments for Council to accept donations from Carmel Cares for 2023 totaling \$148,814 and 5,958 labor hours at their February 6th meeting.
- For the proposed Wave Astound Broadband fiber optic cable project, met with Wave, researched and developed responses to 14 public questions received in October 2023 when the project was introduced, and prepared the staff report and presentation for the February 6th Council meeting.
- Met with new Forest and Beach Commissioner, Gerard Montmorency, to provide an overview of the Public Works Departments services and challenges associated with improving and maintaining the City's forest, parks, beach, and sensitive habitat areas.
- For the Maintenance Worker vacancy, 52 applications were screened, and tentatively 14 candidates will move forward to a panel interview in mid-February.
- Met with the City Attorney's office to review public project cost accounting options, prevailing wages, and insurance issues associated with City support groups.
- Served on interview panel for City Engineer candidates for the City of Marina.

Carmel Cares and Other Volunteer Groups

- Carmel Cares installed a stone paver apron in front of the trash enclosure on the Scenic Pathway near Ninth Avenue.
- "Downtown Detail" volunteers cleaned and improved the downtown area, with particular emphasis on upgrading tree wells.
- "Median Minders" volunteers continued to improve medians across the Village.

Environmental Programs

- The \$500,000 Local Coastal Programs (LCP) Grant Agreement was approved by the California Coastal Commission and executed!
- For the Coastal Engineering Study, Phase 2, Amendment No. 1 to the PSA with EMC Planning/Integral/Haro Kasunich was finalized for a fee of \$450,000. A staff report and resolution were prepared for Council to approve the LCP Grant-funded Amendment at the February 6th meeting.
- As part of the above Council action, staff is requesting Council to reallocate \$100,000 that was included in the Capital Improvement Program for the Coastal Engineering Study Phase 2, to add to funding for the Shoreline Infrastructure Repair Project.
- For the Coastal Engineering Study, Phase 1, met with Integral to review preliminary findings of Tasks 3 and 4 associated with sea level rise impacts on the beach and adaptation strategies.
- Updated project status worksheets for projects included in the Climate Action and Climate Adaptation Plans. Projects worksheets will be presented at the next Climate Committee meeting.
- Prepared a staff report for the March Forest and Beach Commission meeting regarding a presentation by the Police Chief to review criteria for closing down Carmel Beach, coordinating emergencies with Monterey County, and potential funding sources for shoreline repairs, such as from FEMA.
- Consultant Applied Marine Science obtained watershed samples for water quality laboratory testing and reporting.
- Issued a Purchase Order to Native Solutions to provide oversight of volunteers during weed pulling at the North Dunes Habitat Restoration site.

- Researched funding availability from 3CE for upcoming City EV charging station projects located at the Vista Lobos and Sunset Center north parking lots.
- Continued to coordinate with vendors for the second annual Earth Day, to be held in conjunction with Arbor Day and Community Day, in April 2024.
- Friday Letter public announcements included information about reducing plastic pollution, home electrification, and king tides.
- Served on the City of Gilroy interview panel for a Public Works Administrative Analyst.

Facility Maintenance

- As a Capital Improvement Project, at Sunset Center, eight new bollards were received for the area between the west parking area and the box office. A Contractor installed four of the bollards, and four were put in storage for use when other bollards are struck by vehicles and damaged.
- At Sunset Center, a Contractor installed and tested a new, \$8,300 fire pump bypass system which will allow water pressure testing to recycle, rather than discharge, 40,000 gallons of water each year.
- At the Fire Station, a Contractor prepared the back-patio deck surface and applied waterproofing materials. The \$10,000 project cost was roughly split with Carmel Cares.
- Received a budgetary quote of \$14,400 from an electrical contractor to rebuild the electrical panel next to the Ocean/Juniper Christmas tree for safety reasons. Evaluating quote and permit requirements.
- As part of the ADA Upgrade Project Year 6, additional slanted ADA-compliant mirrors were installed in building restrooms.
- Continued making repairs and upgrades in various park restrooms by clearing clogged drains, replacing broken toilets and rusted plumbing, and installing new water filters.
- Due to a high Cal Am water bill during winter months, checked water meters, restrooms, and backflow devices for leaks. Only one leak was found and repaired. A fire hydrant that was struck by a truck driver resulting in the loss of considerable amount of water appears to have contributed to the increased bill.
- Removed holiday decorations from Devendorf Park and along the Ocean Avenue medians.

Forest Theater

- PacRep Theatre's request to temporarily place a Conex storage box in the Forest Theater parking lot was authorized.
- 2nd Quarter April 1 - June 30, 2023 Forest Theater Management Report:
 - Activities: 50 rehearsals, and 37 performances and events: "Celebrating the Beatles," "Something Rotten," SLV – Music in the Forest, FTG – Films/"Ride the Cyclone," "What the Constitution Means to Me," and MCTA – "White Knight, Shoes to Tight"
 - Total Attendance: 2,637. Total Facility Fees paid to City \$2,506.
- 3rd Quarter July 1- September 30, 2023 Forest Theater Management Report:
 - Activities: 26 rehearsals, and 44 performances and events: FTG- Films/"Ride the Cyclone," SLV- Music in the Forest, Puddles Pity Party, Monterey Symphony, PacRep Theatre – "The Addams Family," and PacRep Theatre – "Cymbeline."
 - Total Attendance: 10,917. Total Facility Fees paid to City \$8,247.

Project Management for the Capital Improvement Program

4 Leaf Projects:

- Presented the Police Building Project at the Council Study Session on January 8th. Presentation included the building condition assessment, Police space programming needs, and these preliminary alternatives for schematic designs at existing or alternative sites.

Ausonio, Inc. Projects:

- For the Sunset Center North Wing and HML Exterior/Interior Painting Project, the contract documents from Color New Company were submitted, and the construction contract was executed. A kickoff meeting and technical submittals are planned for February.

- Executed Amendment No. 1 to the PSA with M3 Environmental to provide hazardous materials monitoring and testing during painting of Sunset Center and HML, for a fee of \$26,147.
- Two bids were received for the Park Branch Library Dumbwaiter Decommissioning. The low bid of \$8,838, submitted by Elevator Service Company, was responsive. Contract documents were received, and the contract was executed. A separate contractor permanently sealed off a fire sprinkler head in the dumbwaiter shaft as required by the Building Official. Decommissioning is scheduled in February
- Submitted 90% complete contract documents for re-bidding the City Hall Roof Replacement Project. This project was extracted from a larger facility renovation project, and will be re-bid to allow roofing contractors to directly bid on the project.
- For the Sunset Center Portico Design Project, Amendment No. 2 to the PSA with Ten Over Studio was executed to develop two portico concept designs, including structural connections, lighting concepts, and a demolition plan. A kickoff meeting was held, and a site visit is planned for early February.
- For the Sunset Center Retaining Walls Repair Project and San Antonio Walkway Repair Project, Second to Fourth Avenues, a PSA with ZFA Structural Engineers for \$55,000 was finalized and routed for signatures. Kickoff meeting scheduled for February 7th.

Wallace Group Projects:

- For the FY 2022/23 Concrete Streets Repair Project, BKF Engineers are incorporating 95% review comments, generated by Wallace Group and staff, on their construction plans, specifications, and cost estimates.
- For the FY 2023/24 City-wide Paving Project, Wallace Group is finishing up the 30% design package which is scheduled to be submitted to the City for review in mid-February.
- For the Shoreline Infrastructure Repair Project, reviewed a draft Request for Proposal to hire an engineering firm with shoreline expertise. Resolving issues including environmental services scope and availability of prior plans and reports when the RFP is issued.

Additional Capital Projects:

- For the \$1.14M, FY 2021/22 City-wide Paving Project, Monterey Peninsula Engineering dug out and patched failed sections of asphalt, performed conform paving along edges, and constructed an asphalt overlay on Junipero Street, Third to Fourth Avenues, along Santa Fe Street, Fourth to Fifth Avenue, and at the Junipero/Camino del Monte Intersection. Sidewalk repairs are scheduled in February.
- For the Mission Trail Nature Preserve (MTNP) 3 Drainage Project, the design plans, specifications, and bidding contract documents were approved, and advertising for construction bids will begin in early February. A proposal received from Dudek for environmental monitoring during construction was rejected.
- For the 4 City-wide Drainage Improvement Projects, 90% plans and cost estimates were submitted by Neill Engineers and are being checked by staff. Denise Duffy & Associates were authorized to prepare Notices of Exemption under CEQA for two of the drainage project sites, and one easement will be required at the south end of Santa Fe Street, south of Eighth Avenue.
- For the Sunset Center Electrical Panel Replacement Project, Advanced Design Consultants and staff met with PG&E to evaluate the option of having two electrical services in the north parking lot: one for the existing commercial service for parking lot lighting, and a new service for additional EV charging stations which would be provided at reduced energy rates, but at a higher capital investment cost.

Street Maintenance

- During and following several storm events throughout January, cleared out storm drains, picked up fallen branches, and placed sandbags to reduce erosion. No flooding problems were reported.
- All beach access stairs continue to be temporarily closed. Signs and barricades were replaced as needed.
- Heavily-damaged beach access stairs at Fourth Avenue, Tenth Avenue, Twelfth Avenue, and Martin Way and the equipment access ramp near Eighth Avenue will be closed until further notice.
- Filled a number of potholes that resulted from rain events.

- Filled in puddle spots along the Scenic Pathway using decomposed granite.
- Priority sidewalk repairs are underway based on the Annual Sidewalk Survey Update completed in December.
- Reconstructed the MTNP entry gate at Rio Road using salvaged parts from the old Eleventh Avenue gate, and painted the new gate.
- Repaired the new split rail fence along Mission Street at the border of Forest Hill Park that was damaged by a fallen tree.
- Installed several more ribbon-style trash and recycling containers.
- Updated the 5-year Capital Plan for City vehicles and heavy equipment.
- The vehicle maintenance lift was inspected and repairs were made.
- Prepared two old forestry trucks for public auction.

Forestry, Parks, and Beach (Forester's Report)

- [See separate Forester's Report](#)