CITY OF SANTA CRUZ
City Hall
809 Center Street
Santa Cruz, California 95060

WATER COMMISSION

Regular Meeting

October 4, 2021

7:00 P.M. GENERAL BUSINESS AND MATTERS OF PUBLIC INTEREST, COUNCIL CHAMBERS/ZOOM

COVID-19 ANNOUNCEMENT: This meeting will be held via teleconference ONLY.

In order to minimize exposure to COVID-19 and to comply with the social distancing suggestion, the Council Chambers will not be open to the public. The meeting may be viewed remotely, using the following sources:

- Online:https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/Search?dropid=4&mtids=124
- Zoom Live (no time delay): https://us06web.zoom.us/j/84364492577
- Facebook: https://www.facebook.com/SantaCruzWaterDepartment/?epa=SEARCH_BOX

PUBLIC COMMENT:
If you wish to comment during on items 1-6 during the meeting, please see information below:

- Call any of the numbers below. If one number is busy, try the next one. Keep trying until connected.
  1 (346) 248-7799
  1 (720) 707-2699
  1 (253) 215-8782
  1 (312) 626-6799
  1 (646) 558-8656
  1 (301) 715-8592
- Enter the meeting ID number: 843 6449 2577
- When prompted for a Participant ID, press #.
- Press *9 on your phone to "raise your hand" when the Chair calls for public comment.
  - It will be your turn to speak when the Chair unmutes you. You will hear an announcement that you have been unmuted. The timer will then be set to three minutes.
  - You may hang up once you have commented on your item of interest.
  - If you wish to speak on another item, two things may occur:
    1) If the number of callers waiting exceeds capacity, you will be disconnected and you will need to call back closer to when the item you wish to comment on will be heard, or
    2) You will be placed back in the queue and you should press *9 to "raise your hand" when you wish to comment on a new item.

NOTE: If you wish to view or listen to the meeting and don't wish to comment on an item, you can do so at any time via the Facebook link or over the phone or online via Zoom.

The City of Santa Cruz does not discriminate against persons with disabilities. Out of consideration for people with chemical sensitivities, please attend the meeting fragrance free. Upon request, the agenda can be provided in a format to accommodate special needs. Additionally, if you wish to attend this public meeting and will require assistance such as an interpreter for American Sign Language, Spanish, or other special equipment, please call Water Administration at 831-420-5200 at least five days in advance so that arrangements can be made. The Cal-Relay system number: 1-800-735-2922.

APPEALS: Any person who believes that a final action of this advisory body has been taken in error may appeal that decision to the City Council. Appeals must be in writing, setting forth the nature of the action and the basis upon which the action is considered to be in error, and addressed to the City Council in care of the City Clerk.

Other - Appeals must be received by the City Clerk within ten (10) calendar days following the date of the action from which such appeal is being taken. An appeal must be accompanied by a fifty dollar ($50) filing fee.

Call to Order

Roll Call

Statements of Disqualification - Section 607 of the City Charter states that …All members present at any meeting must vote unless disqualified, in which case the disqualification shall be publicly declared and a record thereof made. The City of Santa Cruz has adopted a Conflict of Interest Code, and Section 8 of that Code states that no person shall make or participate in a governmental decision which he or she knows or has reason to know will have a reasonably foreseeable material financial effect distinguishable from its effect on the public generally.

Oral Communications

Announcements

Consent Agenda (Pages 1.1 – 3.15) Items on the consent agenda are considered to be routine in nature and will be acted upon in one motion. Specific items may be removed by members of the advisory body or public for separate consideration and discussion. Routine items that will be found on the consent agenda are City Council Items Affecting Water, Water Commission Minutes, Information Items, Documents for Future Meetings, and Items initiated by members for Future Agendas. If one of these categories is not listed on the Consent Agenda then those items are not available for action.

1. City Council Actions Affecting the Water Department (Pages 1.1 – 1.2)

   Accept the City Council actions affecting the Water Department.

2. Water Commission Minutes from August 23, 2021 (Pages 2.1 – 2.4)

   Approve the August 23, 2021 Water Commission Minutes.

3. Revised Water Commission Bylaws (Pages 3.1 – 3.15)

Review and approve edits to the Water Commission Bylaws that will be presented to City Council for their approval in November 2021.

Items Removed from the Consent Agenda

General Business (Pages 4.1 – 6.116) Any document related to an agenda item for the General Business of this meeting distributed to the Water Commission less than 72 hours before this meeting is available for inspection at the Water Administration Office, 212 Locust Street, Suite A, Santa Cruz, California. These documents will also be available for review at the Water Commission meeting with the display copy at the rear of the Council Chambers.

4. Request for Water Service - APN 068-17-113, Glen Canyon Road, Santa Cruz, CA 95060 (Pages 4.1 - 4.7)

Consider a request for a new water service to Assessor Parcel Number (APN) 068-171-13, Glen Canyon Road, Santa Cruz, CA 95060.

5. 2020 Urban Water Management Plan and Water Shortage Contingency Plan (Pages 5.1 - 5.15)

1. Review and comment on the draft 2020 Urban Water Management Plan, which includes the Water Shortage Contingency Plan, and
2. Recommend that City Council pass resolutions to adopt the 2020 Urban Water Management Plan and Water Shortage Contingency Plan and to authorize the Water Department to file the 2020 Urban Water Management Plan, including the Water Shortage Contingency Plan, with the California Department of Water Resources.

6. Watershed Lands Forest Management Update (Pages 6.1 - 6.116)

Receive information and take action to accept the “Opportunities and Constraints Evaluation of Forest Management Options” report.

Subcommittee/Advisory Body Oral Reports

7. Santa Cruz Mid-County Groundwater Agency

8. Santa Margarita Groundwater Agency

Director's Oral Report - No action shall be taken on this item.

Information Items

Adjournment

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WATER COMMISSION
INFORMATION REPORT

DATE: 9/29/2021

AGENDA OF: October 4, 2021

TO: Water Commission

FROM: Heidi Luckenbach, Acting Water Director

SUBJECT: City Council Actions Affecting the Water Department

RECOMMENDATION: That the Water Commission accept the City Council actions affecting the Water Department.

BACKGROUND/DISCUSSION:

August 24, 2021

Transfer within the Water Department's Capital Investment Program for FY 2021 Water Program Administration Expenses – Budget Adjustment (WT)

Resolution No. NS-29,866 was adopted transferring $2,832,635 from the Water Department's Capital Investment Program (CIP) Project c701901, Water Program Administration, to various other Water Department CIP Projects for the purpose of allocating actual program administration expenses from FY 2021 to active Water Program CIP Projects.

Consider Appointing an Interim City Manager (HR)

Motion carried to approve the appointment of Rosemary Menard as the Interim City Manager.

September 14, 2021

No items to report.

September 21, 2021 – Special Meeting

2021 Water Department Long-Range Financial Plan and Water Rate Schedule for FY 2023 to FY 2027 (WT)

Motion **carried** to:

- Adopt the 2021 Water Department Long-Range Financial Plan.
- Accept the recommended proposed schedule of water rate increases for FY 2023 through FY 2027 and the recommended proposed FY 2022 through FY 2027 Drought Cost Recovery Fee schedule for the purposes of proceeding with the required public notice and protest period requirement of water rates subject to Proposition 218.
- Authorize the Water Department to issue a Proposition 218 compliant notice of the 45-day protest period and set the required public hearing for Tuesday, November 23, 2021 after the hour of 10 a.m.

September 28, 2021

No items to report.

PROPOSED MOTION: Motion to accept the City Council actions affecting the Water Department.

ATTACHMENTS: None.

Water Commission
7:00 p.m. – August 23, 2021
Council Chambers/Zoom Teleconference
809 Center Street, Santa Cruz

Summary of a Water Commission Meeting

Call to Order: 7:00 PM

Roll Call

Present: J. Burks (via Zoom), T. Burns (Via Zoom), D. Engfer (via Zoom), S. Ryan (Chair) (via Zoom), A. Páramo (via Zoom), W. Wadlow (Vice-Chair) (via Zoom)

Absent: D. Schwarm, with notification

Staff: R. Menard, Water Director (via Zoom); D. Baum, Water Chief Financial Officer (via Zoom); C. Coburn, Deputy Director/Operations Manager (via Zoom); H. Luckenbach, Deputy Director/Engineering Manager (via Zoom); K. Fitzgerald, Administrative Assistant III (via Zoom)

Others: Two members of the public (via Zoom)

Presentation: None.

Statements of Disqualification: None.

Oral Communications: One member of the public spoke.

Announcements: None.

Consent Agenda

1. City Council Items Affecting the Water Department

2. Water Commission Minutes From August 2, 2021

No public comments were received.

Commissioner Wadlow moved the Consent Agenda as amended. Commissioner Burns seconded.

VOICE VOTE: MOTION CARRIED
AYES: All
NOES: None
ABSTAIN: None

Items Pulled from the Consent Agenda

No items were pulled.

General Business

3. 2021 Updated Long-Range Financial Plan and Proposed FY 2023 – FY 2027 Water Rates

Ms. Menard discussed the 2021 Updated Long-Range Financial Plan (LRFP).

Commissioners suggested that staff include a table that shows the revenue split by customer class in the final version of the LRFP that will be presented to the City Council. Appendices E and F summarize the charges to all customer classes.

Can staff elaborate on what attributed to the decrease in the Department's credit rating?

- Fitch was focusing on the Department's future capital needs at the time they issued the rating in November 2020; the water rates adopted in 2016 was near to the end of its five-year schedule and new rates for the next five years hadn't been developed and it was unknown whether the Council would continue to support the capital program and its spending. This uncertainty led Fitch to decrease the Department's credit rating from A+ to A-. What was not acknowledged by Fitch in their rating review was all the work that the Department has done to exceed its required debt coverage ratios as well as fund and maintain its reserves.

The LRFP mentions that Fitch used coarser metrics in their analysis of affordability, can staff speak on how accurately those metrics measured affordability in the community?

- The Department's review of affordability included 2 more detailed measures than what Fitch used in its analysis:
    - We created a performance measure to evaluate whether affordability was an issue with our customers and found that pre-pandemic, on-time payments were tracking at 97% - 98%. Since the pandemic, the payment rate has dropped slightly but in terms of collections, we expect to see only 2% to 3% of accounts that are 60 days past due when the State's emergency COVID-19 legislation to prohibit disconnecting water to non-paying customers is rescinded; and
    - The Water and Wastewater Affordability Study completed in the fall of 2020 used a "disposable income" metric created by looking at the median household income minus median housing price (includes rental costs) for each census block group and looks at water and wastewater costs as a percent of this figure. Few affordability analyses use this level of detail in looking at affordability, so our analysis is a more nuanced and accurate reflection of affordability than the one used by Fitch in its analysis

Have rate stabilization reserves been used as intended?

- Yes. We did not recommend removing this fee because it gives us the flexibility to deal with unforeseeable events, such as the wildfire last year, the pandemic and now ongoing drought, without having to impose any type of recovery fee.

Commissioners suggested the Executive Summary of the LRFP include a narrative that describes why multi-generational investment in the water system is vital to securing water supply for the community as well as protecting the environment from the uncertainties due to climate change. The Executive Summary does describe the long-term benefits of today's investments and SCWD's adaptation to climate change.

Ms. Menard introduced Mr. Sanjay Gaur (Raftelis) for the presentation and discussion of the proposed FY 2023 – FY 2027 Water Rates.

Are individual North Coast Ag customers being given the option to select their rate structure, either "Maintain Reliability" or "Decrease Reliability"?

- At this time we are retaining the option for those customers to choose, though the thinking is that the majority will favor the "Maintain Reliability" option.

Could the existing lawsuit filed by North Coast Ag customers affect the ability to pass the proposed rate structure?

- Not necessarily. If the court decides to move forward with the lawsuit and if the outcome is in favor of the North Coast Ag customers, their rates would likely have to be revised, but until that happens, should it happen, the new proposed rate structure would be in place.

Ms. Menard commented that with respect to the Drought Cost Recover Fees, for anything beyond a Stage 3 Water Shortage, they are clearly alarmingly high, which further emphasizes the importance of augmenting water supply so that the City does not have to get that point.

Would the Drought Cost Recovery Fees be lower if they were based on a uniform commodity charge?

- Yes.

Can staff clarify that if hypothetically, the City Council declared a Stage 3 Water Shortage, the Department would be allowed to charge Stage 1 drought rates instead of Stage 3 rates?

- Yes, that is correct. The muni code was revised so that if the Council declares a particular stage, we are automatically authorized to charge the Drought Cost Recovery Fee for that stage but we are not required to do so. In addition to that, the Rate Stabilization Reserve funds we have would allow us to absorb some drought-related costs.

Ms. Menard commented that there is a section of the LRFP that discusses risk mitigation and management strategies for dealing with the risks associated with a heavily volumetric-based rate structure. Detailed discussions of drought and non-drought-related risks and mitigations for those risks are included in that section.

Commissioners suggested that staff provide City Council with a comparison of water rates from other districts when the proposed rate structure is presented for their approval.

Ms. Menard responded that most other jurisdictions do not have volumetric-based rates as high as the City's so finding comparable rates to present to the Council would be a challenge.

Ms. Menard commented that the Special City Council Meeting on September 21st from 4:00 pm to 6:00 pm will be about water rates and the LRFP.

One public comment was received.

Commissioner Engfer moved that the Water Commission support the rate schedule that has been developed and ask that staff put together a complete rate schedule consistent with what has been presented covering FY 2023 – FY 2027 along with supporting materials as required in order to meet Prop 218 requirements so that those materials can be used in the Prop 218 notification process for public notification and public hearings. Commissioner Wadlow seconded.

Ms. Menard thanked the Water Commission for their efforts and contributions to the development of the LRFP and water rate structure for FY 2023 – FY 2027.

VOICE VOTE: MOTION CARRIED
AYES: All
NOES: None
ABSTAIN: None

Subcommittee/Advisory Body Oral Reports

4. Santa Cruz Mid-County Groundwater Agency (MGA)
Ms. Menard reported that the next MGA meeting will be held on September 9th.

5. Santa Margarita Groundwater Agency (SMGWA)
Commissioner Engfer reported that no activity has taken place since the last meeting and that the next meeting of the SMGWA will be held on September 23rd.

Director's Oral Report: Ms. Menard reported that effective September 1st, she will be the Interim City Manager while the City recruits a permanent City Manager and that Ms. Heidi Luckenbach will be appointed as the Interim Water Director. The October 4th Water Commission meeting agenda will include the draft 2020 Urban Water Management Plan as well as a presentation of a study looking at watershed health and fire ecology, and the November 1st meeting agenda will focus on water supply augmentation.

Adjournment Meeting adjourned at 8:19 PM.

WATER COMMISSION
INFORMATION REPORT

DATE: 09/27/2021

AGENDA OF: 10/04/2021

TO: Water Commission

FROM: Katy Fitzgerald, Administrative Assistant III

SUBJECT: Revised Water Commission Bylaws

RECOMMENDATION: That the Water Commission review and approve edits to the Water Commission Bylaws that will be presented to City Council for their approval in November 2021.

BACKGROUND/DISCUSSION: The Water Commission Bylaws (Bylaws) establish the governing rules and regulations for the procedures of the City of Santa Cruz Water Commission. The City Clerk's office took on the task to review the bylaws of each of the City's advisory bodies in part for consistency. The Water Commission updates their bylaws on a somewhat frequent basis (last updated 10/28/2014) so very few modifications/changes were made. The City Clerk's office has requested that each advisory body of the City of Santa Cruz review and take action to approve the editorial changes as seen in the redlined version of the Bylaws that is attached to this report. The City Clerk recommends the removal of the signature lines that list the names of the Water Commission members who approved that version. This is found on the first page of the document. The Bylaws are not amended frequently enough to be kept up to date and removing these signature lines will promote consistency across the City.

Upon the Commission's approval of these changes, the City Clerk will present the amended Bylaws to the City Council for its approval in November 2021.

FISCAL IMPACT: None.

PROPOSED MOTION: Approve edits to the Water Commission Bylaws that will be presented to City Council for their approval in November 2021.

ATTACHMENTS:
1. Water Commission Bylaws - Redlined

BYLAWS

of the

Water Commission

City of Santa Cruz, California

Under authority of applicable statues of the State of California and the City Charter of the City of Santa Cruz, California, for the purpose of establishing rules and regulations governing the organization and procedures of the Water Commission of the City of Santa Cruz, CA

Adopted June 27, 1977

Amended May 26, 1992

Amended May 5, 2003

Amended October 6, 2014

Approved by the City Council on October 28, 2014

~~**APPROVED:**~~

_____ _____

_____ _____

_____ _____

_____

~~**ATTEST:** _____~~

Water Commission Bylaws

Table of Contents

Water Commission Bylaws

ARTICLE I – NAME AND/OR AUTHORITY

The Name of this organization shall be the Water Commission of the City of Santa Cruz, California; hereinafter referred to as the Advisory Body.

ARTICLE II – PURPOSE

The Water Commission will act in an advisory capacity to the City Council in all matters pertaining to the Santa Cruz water system and the maintenance and management thereof.

ARTICLE III – DUTIES AND RESPONSIBILITIES

The Water Commission shall have the ability, as vested by the City Council, and be required to:

- Recommend to the City Council, after public input, the adoption, amendment or repeal of ordinances relating to Chapter 16 Water, Sewers and other Public Services of the Santa Cruz Municipal Code;
- Make recommendations concerning proposed annual Water Department budget, Capital Improvement Program, Water Rate Resolutions and Water Resale Applications;
- Undertake studies and make recommendations in the area of Water Conservation and Water Supply Planning;
- Act in an advisory capacity to the City Council in all matters pertaining to the Santa Cruz water system and the maintenance and management thereof;
- Review and make recommendations to the City Council pertaining to the improvement and extension of the water system of the City, including sources, storage, quality, transmission and distribution of water to the inhabitants, and all subjects related thereto, including estimated costs of carrying out such recommendations;
- Review, monitor, and make long-range recommendations concerning securing sources of domestic water supply for the City; including re-examination of prior reports thereon to ascertain the value thereof if any at this time;
- Receive complaints pertaining to the Santa Cruz water system;
- Perform other duties as may from time to time be prescribed by the City Council.

ARTICLE IV – MEMBERSHIP

Section 1. Membership

The Water Commission shall consist of seven Water Commissioners, hereinafter referred to as members.

Membership, term of office, and procedures for removal of members and the filling of vacancies shall be as established by City Ordinance or by the City Council.

Section 2. Qualifications

The Water Commission shall be comprised of seven members. Six members of the water commission shall be qualified electors of the city, and one member shall be a qualified elector of the county who resides outside of the city limits but within the city's water service area. (Ord. 2003-32 § 1, Ord. 2000-08 § 1, 2000: Ord. 92-26 § 1, 1992; Ord. 87-10 § 1 (part), 1987).

Section 3. Application for Membership

Prospective members shall file an application in the office of the City Clerk.

Section 4. Method of Appointment

Each City Resident member shall be appointed by motion of the City Council adopted by at least four affirmative votes. The non-resident member shall be appointed by a four-member majority of the city council and nominations for that appointment may be made by any Councilmember.

Section 5. Good Standing and Reporting of Absences

Absences will be identified as "with notification" and "without notification." An absence is considered as "with notification" if the member notifies the Staff or the Chair prior to a regular or special meeting. If there has been no prior notification, the absence is considered "without notification."

Each member is allowed three absences with notification per calendar year. Should a member exceed the allowed absences from regular and special meetings, Staff shall notify the City Clerk. Excessive absences shall result in termination of membership. A leave of absence, approved by the City Council according to Council Policy is not subject to termination.

Section 6. Termination

Each member shall be subject to removal by motion of any Councilmember, adopted by at least four affirmative votes.

ARTICLE V – TERM OF OFFICE

Section 1. Term

The term of office for each member shall be one four-year term. A member may be appointed to complete an unexpired term. A member may continue to serve until his/her successor has been appointed.

Section 2. Membership Year

A membership year shall be from February 1st to January 31st of each year.

Section 3. Length of Term

A member shall not serve more than two consecutive full four-year terms. Upon completion of a member's eighth consecutive year of service, that member will be ineligible for reappointment for a period of two years. Upon completion of a member's second full four year term, that member will be ineligible for reappointment for a period of two years.

Section 4. Dual Service

No member shall be eligible to serve on two Advisory Bodies unless one is established for less than 13 months. Members of the Commission may serve for more than 13 months, if

necessary, on advisory bodies whose charge is directly related to their service on the Water Commission when appointed to do so by the City Council.

ARTICLE VI – OFFICERS AND ELECTIONS

Section 1. Officers

Officers of the Advisory Body shall consist of a Chair and Vice Chair.

Section 2. Election of Officers

As soon as is practicable following the first day of February of every year, there shall be elected from among the membership of the Advisory Body a Chair and Vice Chair.

Section 3. Term of Office

The term of office for the Chair and Vice Chair is one calendar year. Officers may not serve in the same position for more than two consecutive years.

Section 4. Nominations

The Chair will open the floor to nominations. Any member may nominate a candidate from the membership for the position of Chair or Vice Chair; nominations need not be seconded.

A member may withdraw his/her name if placed in nomination, announcing that, if elected, s/he would not be able to serve; but s/he shall not withdraw in favor of another member.

Once the nominations are complete, the Chair will ask for a motion to close the nominations; a second of, and vote on, the motion is required.

The Chair then declares that it has been moved and seconded that the nominations be closed, and the members proceed to the election.

Section 5. Voting

Voting may be by voice vote or by roll call vote.

The candidate who receives a majority of the votes is then declared to be legally elected to fill the office of Chair, and will immediately chair the remainder of the meeting.

The same procedure is followed for the election of Vice Chair.

Section 6. Vacancy of an Officer

Should a vacancy occur, for any reason, in the office of Chair or Vice Chair prior to the next annual election, a special election shall be held to fill the vacant office from among the membership. That member shall serve until a new appointment has been made.

Section 7. Removal of Elected Officers

The Chair or Vice Chair may be removed by a majority vote of the full Advisory Body at a regularly scheduled meeting of the Advisory Body, when all appointed members are present, or at a special meeting convened for that purpose at which a quorum is present. Any officer removed ceases to hold the office once the vote has been tallied and announced. If the Chair is removed, the Vice Chair shall become the new Chair. An election for the Vice Chair shall then

be agendized for the next meeting.

Section 8. Duties of the Chair

The Chair shall preside at all regular meetings and may call special meetings. The Chair shall decide upon all points of order and procedure during the meeting; his/her decision shall be final unless overruled by a vote of the Advisory Body, in compliance with Article IX, Section 2, "General Conduct of Meetings." The Chair may not make motions, but may second motions on the floor. The Chair acts as primary contact for staff and shall represent the Advisory Body before City Council whenever the Advisory Body or Council considers it necessary unless another member(s) is (are) appointed by the Advisory Body. The Chair and staff shall jointly set the meeting agenda.

Section 9. Duties of the Vice Chair

The Vice Chair shall assume all duties of the Chair in the absence or disability of the Chair.

Section 10. Duties of the Acting Chair

In case of absence of both the Chair and the Vice Chair from any meeting, an Acting Chair shall be elected from among the members present, to serve only during the absence of the Chair and Vice Chair.

ARTICLE VII – STAFF SUPPORT

Section 1. Staff

Staff support and assistance is provided, but advisory bodies do not have supervisory authority over City employees. While they may work closely with advisory bodies, staff members remain responsible to their immediate supervisors and ultimately to the City Manager and Council.

The Director of the Water Department shall designate appropriate staff to act as staff person(s) to assist and support the Advisory Body. Staff shall attend all regular and special Advisory Body meetings. Staff shall be responsible for coordination of such reports, studies, and recommendations as are necessary to assist the Advisory Body in the conduct of its business according to City Council policy and the Brown Act. Staff may enlist the assistance of other departments as required. Staff shall be responsible for all public notification regarding all regular and special Advisory Body meetings.

Staff shall record the minutes of the meetings in accordance with these bylaws. t Staff shall supervise volunteers and interns, shall work closely with the Chair between meetings, shall make recommendations, prepare reports and proposals to the Advisory Body, may represent the Advisory Body at other meetings, presentations, and other public functions as requested, and shall perform administrative tasks.

Staff shall be responsible for the maintenance of proper records and files pertaining to Advisory Body business. Staff shall receive and record all exhibits, petitions, documents, or other materials presented to the Advisory Body in support of, or in opposition to, any question before the Advisory Body. Staff shall sign all notices prepared in connection with Advisory Body business, shall attest to all records of actions, transmittals, and referrals as may be necessary or required by law, and shall be responsible for compliance with all Brown Act postings and noticing requirements.

Section 2. Staff Relationship to the Advisory Body

Given limited staff resources, the Chair or individual members shall not make separate requests of staff without approval of the Advisory Body. If a member has a research or report request, it shall be brought to the Advisory Body for discussion, consideration, and recommendation prior to making the request of staff. If not approved by the Advisory Body, the individual member shall be responsible for his/her own research or report.

ARTICLE VIII – MEETINGS

Section 1. Time and Location of Meetings

The Advisory Body will hold its regular meeting on the first Monday of each month, which shall begin at 7:00 p.m. in the City Council Chambers and will adjourn no later than 11:00 p.m., unless the Chair, with concurrence of the Advisory Body, extends the time of adjournment.

If the scheduled date for a regular meeting falls on a holiday, such meeting shall be rescheduled in accordance with Council policy.

Section 2. Cancellation

If a majority of the membership deems it necessary or desirable, a scheduled regular meeting may be cancelled or rescheduled upon giving notice, unless a public hearing has previously been noticed.

Section 3. Special Meetings

The Chair of the Advisory Body, staff, or a majority of the membership of the Advisory Body may call a special meeting. Notice of such meeting shall state the purpose or the business to be transacted during such special meeting. No other business may be transacted at such special meeting other than as stated in the notice. Oral Communications are not required at special meetings as long as a statement appears on the agenda identifying that there will be no Oral Communications, but that members of the public will have the opportunity to address the Advisory Body on item(s) on the agenda.

ARTICLE IX – CONDUCT OF MEETINGS

Section 1. Compliance with the Brown Act and Council Policies

All regular, special, and adjourned meetings of the Advisory Body shall be open meetings to which the public and the press shall be admitted in compliance with the Brown Act. Meetings will be held at City facilities that which are accessible to persons with disabilities. The public shall have the opportunity to speak on any item on the agenda. During oral communications, the public may speak on any water related matter not on the agenda. Comments shall be limited to three minutes for any speaker unless the chair decides otherwise.

Section 2. General Conduct of Meetings

Points of order and conduct, including those not addressed by these Bylaws, shall be settled by the Chair, unless overruled by a majority vote of the Advisory Body. Points of order and conduct shall comply with the Brown Act, these Bylaws, and the City Councilmembers' Handbook. The Chair will consult with staff as necessary. Unresolved issues shall be referred to the City Attorney and continued to a future meeting.

Section 3. How Items Are Placed on the Agenda

A request to have an item placed for consideration on a future agenda may be made by staff, any Advisory Body member or a member of the public. The Chair and staff will consider the validity (within the approved scope of work) and urgency of the request and determine when and if that item should be placed on an Advisory Body agenda. Issues can be referred to an advisory body by the City Council and may have time sensitive deadlines. The items must comply with the procedures in Article XII, Section 1, "Agenda Reports to Advisory Body."

Section 4. Quorum

A quorum of the Water Commission shall consist of four (4) members, whether or not there are vacancies on the Advisory Body.

Section 5. Absence of a Quorum

In the absence of a quorum at any meeting, such meeting shall be adjourned to the next regular meeting date by the Chair, Vice Chair, or staff.

A meeting may be declared adjourned for lack of a quorum after a 15-minute period has elapsed from the scheduled time of the start of the meeting. A meeting may also be declared adjourned in advance, if absence notifications received by staff provided for lack of a quorum. Adjournment may be declared by any member or staff.

Section 6. Agenda

The Chair and staff shall jointly set the meeting agenda and its format shall generally conform to the template provided in the Handbook for City Advisory Bodies.

Section 7. Order of Business

The Chair or a majority vote of the Advisory Body may change the order of business.

ARTICLE X – MOTIONS

Section 1. Call for Motion

Upon conclusion of preliminary discussion, any member other than the Chair may place a motion on the floor. The motion shall contain the proposed action.

Section 2. Seconding a Motion

The Chair shall receive all motions and shall call for a second to each motion. The Chair may second a motion.

Section 3. Lack of a Second

If, after a reasonable time, no second has been made, the motion shall be declared dead for lack of a second, and the Chair shall state this. This shall not be considered an action of the Advisory Body and shall not be included in the minutes.

Section 4. Discussion/Debate

After a motion has been made and seconded, the Chair shall call for a discussion of the question. All discussion shall be limited to the motion on the floor. At the close of the discussion, the Chair shall put the matter to a vote.

Section 5. Time Limits on Discussion/Debate

The Chair may, at his/her discretion, limit debate of any motion; except that each member shall have the opportunity to speak.

Section 6. Amending a Motion

A motion to amend may be made by any member to revise a motion on the floor; but it cannot be a freestanding motion on its own, nor can it substitute for a main motion. The motion to amend must be voted upon, unless the maker and the second accept it as a friendly amendment, and, if it passes, it then becomes part of the main motion.

Section 7. Withdrawing a Motion

Any motion may be withdrawn by the maker and the second and shall not be included in the meeting minutes.

Section 8. Motion to Table

A motion to table may be made to suspend consideration of an item that appears on a meeting agenda for reasons of urgency or to end an unproductive discussion. A motion to table is not in order when another member has the floor. A motion to table requires a second, is not debatable, is not amendable, requires a majority vote for passage, and, if adopted, cannot be reconsidered at the meeting at which it is adopted. Members will refrain from using a motion to table as a means of capriciously limiting debate among members, to suppress a minority of the Advisory Body, or to avoid public input on an agenda item under consideration by the Advisory Body.

Section 9. Results of Voting

Except in the case of unanimous votes, the chair shall state the results of a vote by providing the names of the Commissioners voting for and those voting against.

ARTICLE XI – VOTING

Section 1. Statements of Disqualification

Section 607 of the City Charter states that "...All members present at any meeting must vote unless disqualified, in which case the disqualification shall be publicly declared and a record thereof made." No member may abstain from voting on any item, except on the approval of the minutes, when that member was absent.

The City of Santa Cruz has adopted a Conflict of Interest Code, and Section 8 of that Code states that "no person shall make or participate in a governmental decision which s/he knows or has reason to know will have a reasonably foreseeable material financial effect distinguishable from its effect on the public generally."

Any member who has a disqualifying interest on a particular matter shall do the following:

1) Publicly identify the financial interest that gives rise to the conflict of interest or potential conflict of interest in detail sufficient to be understood by the public, except that disclosure of the exact street address of a residence is not required;
2) Recuse himself or herself from discussing and voting on the matter, or otherwise acting in violation of government code Section 87100;

3) Leave the room until after the discussion, vote, and any other disposition of the matter is concluded unless the matter has been placed on the portion of the agenda reserved for uncontested matters;
4) Notwithstanding paragraph 3, a public official may speak on the issue during the time that the general public speaks on the issue.

Any question regarding conflicts of interest shall be referred to the City Attorney.

Section 2. Voice Vote

All questions shall be resolved by voice vote. Each member shall vote "Aye" or "No" and the vote shall be so entered into the minutes, noting the vote of each member. A member may state the reasons for his or her vote, which reasons shall also be entered into the minutes of the meeting. All members including the Chair shall vote on all matters, except where s/he has a disqualifying interest.

Section 3. Roll Call Vote

Any member may request a roll call vote, either before or immediately after a voice vote. A roll call vote shall be taken without further discussion. The Advisory Body staff shall call the roll and each member shall state his/her vote for the record.

Section 4. Sealed Ballot Votes

No Advisory Body shall take a sealed ballot vote in open session.

Section 5. Adoption of

Adoption of a motion shall be made by a simple majority of the members present, except as otherwise provided. The Chair shall restate the vote for the record, e.g., "The motion is approved by a vote of five to two."

Section 6. Tie Votes

Tie votes will be resolved as follows:

Full Commission Attendance (7 members): A vote resulting in a tie when the full commission is in attendance shall constitute a defeat of the motion.

Statement of Disqualification: A tie vote resulting from a Statement of Disqualification of one or more members, with no members absent and no vacancies on the Advisory Body, shall constitute a defeat of the motion.

Absence: A tie vote during the absence of one or more members, or when there is a vacancy on the Advisory Body, shall cause the item to be automatically continued to the next meeting; except that, as to matters on which action must be taken on a date prior to the next meeting, a tie vote shall constitute a denial of the requested action.

Successive Tie Vote: A tie vote at the next meeting on a matter that has been continued as a result of a tie vote shall constitute a denial of the appeal or defeat of the motion.

ARTICLE XII – REPORTS

Section 1. Agenda Reports to Advisory Body

All agenda items require a written report. Written reports serve as the analysis, detail, history, and justification for each agenda item. Reports shall include recommendation(s) and background. If a report is initiated by an Advisory Body member, a draft of that report shall be provided to staff for formatting at least five (5) business days prior to the meeting. Staff shall then format reports to be consistent with content, style, and formatting of City Council agenda reports. Items initiated by a committee shall be processed in the same manner. Draft reports not submitted in a timely manner shall be placed on a future agenda.

Section 2. Committee Reports

Committee reports may be verbal or written and may be accompanied by written documentation.

Section 3. Preparation of Advisory Body-Generated City Council Agenda Reports

All resolutions and recommendations adopted by the Advisory Body and addressed to the City Council shall be delivered to the Mayor as soon as possible. If the action requests City Council action, the item shall be placed on a future City Council agenda. Agenda reports to the City Council from the Advisory Body shall be written reports consistent with content, style, and formatting of City Council agenda reports.

Additionally, the agenda report shall include a section called analysis, which includes the pros, cons, and foreseeable consequences of the recommendation(s). In the event that staff and the Advisory Body disagree, an analysis of both recommendations shall be included.

ARTICLE XIII – RECORD KEEPING

Section 1. Maintenance of Records

All records shall be maintained according to the City of Santa Cruz Records Retention Schedule.

Section 3. Minutes

Minutes shall briefly summarize comments made by members of the public and the Commission as well as actions taken by the Commission. 'For the record" statements may be made by Commissioners when she/he desires that specific language be included in the minutes. Minutes shall be reviewed, corrected as appropriate, and or amended and approved by the Advisory Body at a subsequent meeting.

Subcommittee reports presented orally in a meeting shall be summarized in the minutes.

Section 4. Audio and Video Recording of Meetings

Proceedings for all Advisory Body meetings shall be recorded on audiotapes whenever possible. The audiotapes shall be retained for one year pursuant to the City of Santa Cruz Records Retention Schedule.

As appropriate and/or when requested by the Advisory Body or City Council, a meeting of the Advisory Body may be video recorded or televised.

Members of the public have the right to make recordings of a meeting without disrupting the proceedings under any circumstances.

ARTICLE XIV – COMMITTEES

Section 1. Ad Hoc Committees

Ad hoc committees are established by an Advisory Body to gather information or deliberate on issues deemed necessary to carrying out the functions and purpose of the Advisory Body. Ad hoc committees generally serve only a limited or single purpose, are not perpetual, and are dissolved once their specific task is completed. An ad hoc committee shall be less than six months in term and shall have fewer members than a simple majority of the membership of the appointing Advisory Body. Ad hoc committees shall bring back information to the Advisory Body in either oral or written form.

Following ad hoc committee input, the Advisory Body shall then discuss, deliberate, and make recommendations on the designated issue, thereby providing the public with the opportunity to participate in the decision-making process. This shall take place in the presence of a quorum of the Advisory Body at a properly noticed public meeting.

Ad hoc committees shall not be subject to the Brown Act. City staff shall not be required to be present at ad hoc committee meetings. All ad hoc committees shall provide a final report to the Advisory Body in lieu of minutes.

Section 2. Standing Committees

Standing committees are bodies established to gather information or deliberate on issues deemed necessary to carrying out the functions and purpose of the Advisory Body. Standing committees are ongoing in nature and are created to deal with issues and make decisions on behalf of the Advisory Body. The public has a right to participate in this process. Standing committees are subject to the Brown Act and staff will provide only such support as to ensure such compliance.

Section 3. Staff Support to Committees

City staff shall normally not be required to attend or provide support for standing or ad hoc committee meetings, unless directed by the department head. All ad hoc committees shall provide a final report to the Advisory Body in lieu of minutes. All standing committees shall provide reports, no less than quarterly, to the Advisory Body.

Section 4. Appointments

The Chair of the Advisory Body may designate or solicit participation for standing and ad hoc committees, unless overruled by a majority vote of the Advisory Body.

Section 5. Committee Meetings

All standing or ad hoc committee meetings shall be held upon call of the Committee Chair.

ARTICLE XV – AMENDMENTS

A majority of the full membership of the Advisory Body may amend these bylaws, subject to the approval of the City Council.

ARTICLE XVI – ADOPTION OF BYLAWS

Immediately upon favorable vote of not less than four 4) of the full membership of the Water Commission the City of Santa Cruz and approval of the City Council, these Bylaws shall be in full force and effect. Any and all previously adopted bylaws are hereby superseded.

These Bylaws shall not be considered or construed as superseding any ordinance or directive of the City Council of the City of Santa Cruz, nor shall they preclude the preparation and adoption of further procedural manuals and policies by which the Advisory Body may direct its activities.

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WATER COMMISSION
INFORMATION REPORT

DATE: 09/27/2021

AGENDA OF:	October 4, 2021
TO:	Water Commission
FROM:	Heidi Luckenbach, Interim Water Director
SUBJECT:	Request for Water Service - APN 068-17-113, Glen Canyon Road, Santa Cruz, CA 95060

RECOMMENDATION: That the Water Commission consider a request for a new water service to Assessor Parcel Number (APN) 068-171-13, Glen Canyon Road, Santa Cruz, CA 95060 and support staff's recommendation to deny this request due to not meeting the requirements of the existing policy.

BACKGROUND: On August 30, 2021, the Water Department received a letter from the owner of APN 068-171-13, near 500 Glen Canyon Road requesting a new water service. A copy of the letter which includes a history and need for the request is attached (Attachment 1); Attachment 2 shows the location of the parcel in relation to the Santa Cruz Water System. The subject parcel is undeveloped and landlocked, and adjacent to but outside the Water Service Area Boundary as adopted by LAFCO (Local Area Formation Commission).

Santa Cruz City Council Policy 34.05 describes the process for consideration of minor additions to the City's water service area (Attachment 3); staff's application of this policy is attached as Attachment 4. Steps for consideration include:

- Property owner request. (Attachment 2 in this instance)
- Water Commission Consideration (the October 4, Water Commission meeting in this instance)
- Reimbursement Agreement with the City for the preparation of the appropriate CEQA (California Environmental Quality Act) document(s). (Implicit in this step is the need for a certain level of design to confirm feasibility and consistency with other City and Department policies.)
- City Council Consideration: Once the CEQA process is complete, the Water Department would take the request for inclusion to City Council for certification of the environmental document and consideration of the parcel to come in to the water service area.
- Will-service Letter: If City Council approves, the Water Department would issue a will serve letter conditioned on LAFCO approval.

    - LAFCO considers the will serve letter and the certified CEQA document for possible inclusion in the City's Water Service Area.
- Final Design/Permitting/Construction: If authorized by LAFCO, the applicant to complete the service. Standard will-serve letters expire after two years, and are renewable. Design elements:
    - Water main extension and/or service line extension
    - Pump station, backflow device, tank
    - Easement acquisition

As shown in the attached policy (Attachment 3), the conditions under which a conditional will serve letter could be prepared include:

- The property is surrounded on at least two sides by parcels serviced by the City of Santa Cruz Water Department.
- No extension of infrastructure is required (the property already has principle frontage on a City [distribution] water main.
- The property has no more than one existing single family dwelling on it.
- The property has no other source of water.
- The property will be required to comply with any and all policies and regulations regarding water conservation that would be required of any new construction and would need to obtain a certificate of compliance issued by the Water Conservation Section.

As reported by the owner, the parcel is currently undeveloped and they are looking in to available options with respect to water service.

DISCUSSION: The parcel does not meet the requirements of the City Council Policy 34.05. While it is surrounded on two sides by parcels served by the City of Santa Cruz Water Department, it does not front a water [distribution] main and it is unclear if there is another water source such as a well. Based on these findings, denial of this request is appropriate course of action.

Staff looks forward to further discussion with the Water Commission.

FISCAL IMPACT: None at this time.

PROPOSED MOTION: Motion to reject the request for a new water service APN 068-171-13, Glen Canyon Road, Santa Cruz, CA 95060.

ATTACHMENTS:
1. Letter from Serena Russell 08-22-2021
2. Santa Cruz Service Area Map
3. Council Policy 34.05
4. Water Department Process

Serena Russell
PO Box 3409
Santa Cruz CA 95063
saggefemme@sbcglobal.net
APN 068-17-113

August 22, 2021

Water Commission of Santa Cruz County

To Whom it May Concern;

I am writing to formally request inclusion into the city of Santa Cruz Water Service Area for my property APN 06817113 located on Glen Canyon rd in Santa Cruz. The property is located directly behind and above the address 500 glen canyon rd which I was made aware does have inclusion in the water district. I was told my property is directly bordering the district. I would very much like to make my home on the property at some point but without water that is not possible. I have looked into drilling a well, but that seems unlikely as a possibility due to cost and depth requirements.

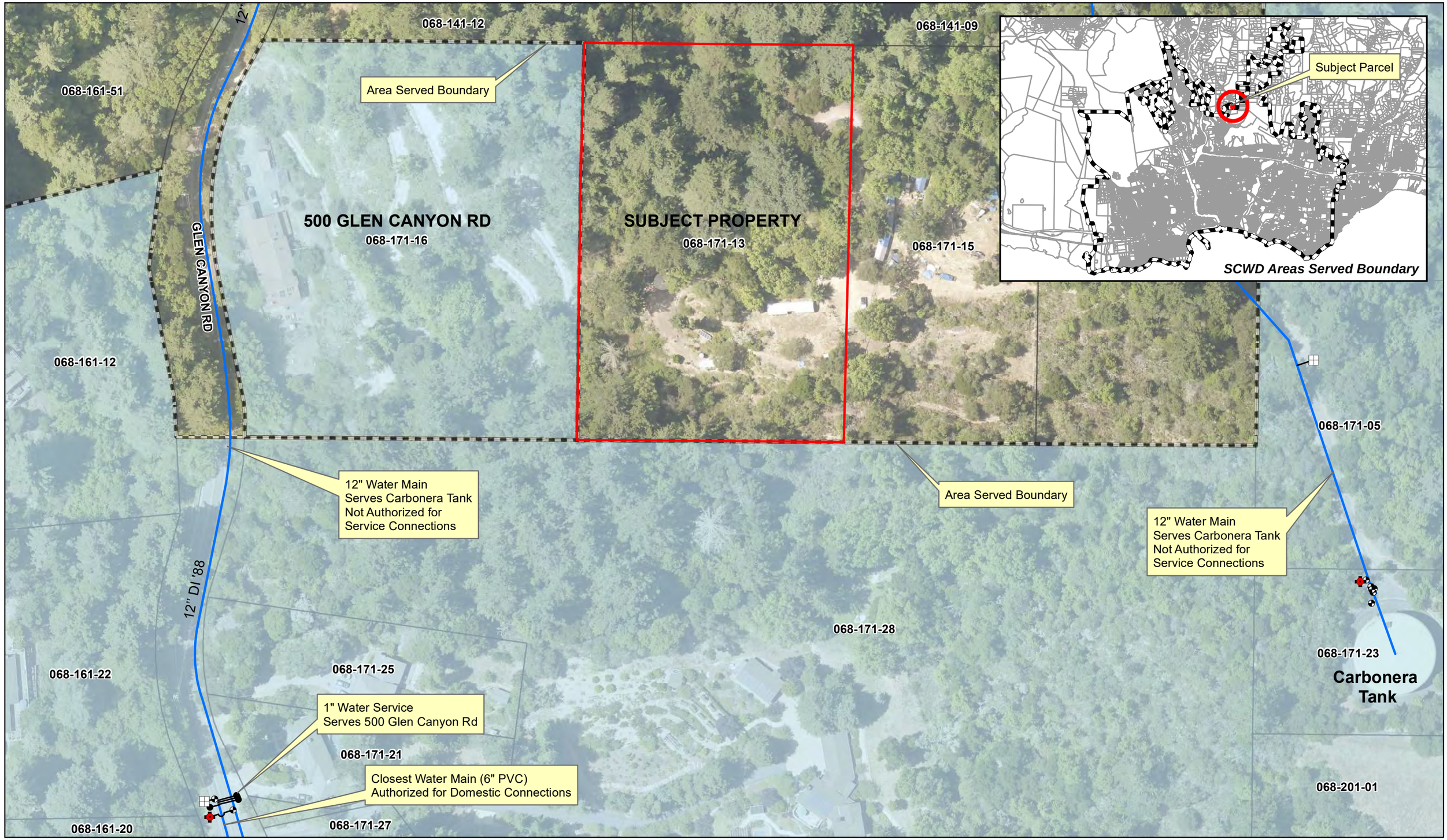
I have included a printed copy of my parcel map. Please note the 10ft utility easement as well as the marked 350ft from Glen Canyon road to the property line.

As you are surely aware, there is a lack of housing in this county. To have obtained a parcel of land is the first step, however water is the next. I am a local midwife and have lived in Santa Cruz County on and off for the last 30 years. I ask you to please consider this request for inclusion as it is the only option I am currently aware of for me to continue to move forward with my dream of owning my own home here in our beautiful county of Santa Cruz.

Sincerely yours,

Serena Russell 707-484-3403


Glen canyon Rd
104.45
64.69
(100)
(60)
139.05
172.54
(20)
(250)
400
340.37
380'
500
(340)
406.88
152.26
Please note shared easement
APN 068-171-13
336.93
200
157.71
257.29
330
183.61
172.5
302.6
122.4±



SANTA CRUZ
Water Department

- Air Relief Valve
- Water Meter
- Fire Hydrant
- Water Valve
- Water Service Lateral
- Treated Water Main
- Raw Water Main
- Area Served
- Assessors Parcels

0 20 40 80 Feet

The City of Santa Cruz Water Department (SCWD) does not guarantee the accuracy, adequacy, completeness or usefulness of any information. The SCWD does not warrant the positional or thematic accuracy of the GIS data. The GIS data and cartographic digital files are not legal representations of the depicted data. Information shown on these maps is derived from public records that are constantly undergoing change.

SCWD Water Facilities Map

COUNCIL POLICY 34.05

POLICY TITLE: SIMPLIFIED PROCESS TO CONSIDER MINOR ADDITIONS TO THE CITY WATER SERVICE AREA

POLICY STATEMENT:

Under normal conditions, the Water Director has authority to issue a willing-to-serve letter to applicants where the property is within the adopted Water Service Area Boundary.

Requests for inclusion in the Water Service Area require an applicant prepare a CEQA document prior to Council authorization of a willing-to-serve letter declaring Council's intention to conditionally annex a property into the water service area.

An owner outside the water service area meeting certain criteria could obtain a conditional willing-to-serve letter from the Water Director and proceed with environmental review. As lead agency, the City Council would certify or otherwise approve/deny the environmental document and if approved, declare its willingness to annex the property into the water service area. The owner would proceed to LAFCO for consideration of amending the water service area boundary.

The conditions under which a conditional willing-to-serve letter could be prepared by the Water Director for properties outside the water service area are as follows:

1. The property is surrounded on at least two sides by parcels served by the City of Santa Cruz Water Department.
2. No extension of infrastructure is required (the property already has principle frontage on a City water main).
3. The property has no more than one existing single family dwelling on it.
4. The property has no other possible source of water.
5. The property will be required to comply with any and all policies and regulations regarding water conservation that would be required of any new construction and would need to obtain a certificate of compliance issued by the Water Conservation Section.

AUTHORIZATION: Established by motion, July 10, 2007

(This Document is for General Guidance Purposes)

General Steps for inclusion into the City of Santa Cruz Water Service Area

For parcels that are outside of the City limits and outside of the Water Service Area Boundary, the steps involved in getting approval to come in to the water service area are:

Water Commission to consider request. If Water Commission recommends inclusion, then:

The prospective customer would enter into a reimbursement agreement for the preparation of the appropriate CEQA (California Environmental Quality Act) documents. This could range from a simple Categorical Exemption to a full Environmental Impact Report depending on the development and site specific issues. The Water Department as lead agency would then contract with an environmental consultant to prepare the document and take it through the CEQA public process as required (varies depending on level of documentation required).

Once the CEQA process is complete, we would take the request for inclusion to City Council for certification of the environmental document and consideration of the application to come in to the water service area.

If Council agrees, we would issue a will serve letter (conditioned on LAFCO approval and only good for one year after LAFCO approval) and the applicant takes that letter and the certified CEQA document to LAFCO (Local Area Formation Commission) to authorize or not authorize.

If authorized by LAFCO, applicant would have one year from the date of that action to complete the service. (in other words, LAFCO authorization is only good for one year which is why the will serve letter would be slightly different than our normal one.)

WATER COMMISSION
INFORMATION REPORT

DATE: 9/30/2021

AGENDA OF: October 4, 2021

TO: Water Commission

FROM: Sarah Perez, Principal Planner

SUBJECT: 2020 Urban Water Management Plan and Water Shortage Contingency Plan

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RECOMMENDATION: That the Water Commission:

1. Review and comment on the draft 2020 Urban Water Management Plan, which includes the Water Shortage Contingency Plan, and
2. Recommend that City Council pass resolutions to adopt the 2020 Urban Water Management Plan and Water Shortage Contingency Plan and to authorize the Water Department to file the 2020 Urban Water Management Plan, including the Water Shortage Contingency Plan, with the California Department of Water Resources.

BACKGROUND:

The Urban Water Management Planning Act, which became part of the California Water Code with the passage of Assembly Bill 797 in 1983, requires that every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually (~1 billion gallons per year) prepare and adopt an Urban Water Management Plan (UWMP), and to update it every five years. The purpose, required contents, and process for preparing and adopting Urban Water Management Plans are specified in Water Code sections 10608 and 10610 – 10657, and guidance on preparation of the 2020 plan is provided in the 2020 Urban Water Management Plan Guidebook published by the California Department of Water Resources. The overall goal is to provide water suppliers throughout the state a framework for carrying out their long-term planning responsibilities and for reporting their strategies to meet future water challenges to both the state government and the communities they serve. The plan covers a 20-year planning horizon and extends some analyses to cover an optional 25-year planning horizon.

The plan encompasses a wide range of topics, including a description of the City's water service area; current and projected population; existing and planned sources of water supply; past, current, and projected water use; an assessment of water supply reliability; a description of measures to promote efficient water use; and, a Water Shortage Contingency Plan.

The Urban Water Management Planning Act has undergone significant expansion and revision since the 2015 Urban Water Management Plan was prepared. These changes were primarily driven by prolonged droughts, groundwater overdraft, regulatory revisions, and changing climatic conditions that not only affect individual water reliability determinations, but also the broad picture of statewide water reliability. Key new requirements for the 2020 Urban Water Management Plan include the following:

- Five Consecutive Dry-Year Water Reliability. The dry-year water reliability assessment, which examines reliability over a twenty to 25-year planning horizon, is modified to consider a drought lasting five consecutive water years rather than a drought lasting three consecutive water years as previously required.
- Drought Risk Assessment. This new assessment requires examination of water supply reliability over a five-year period from 2021 to 2025 under a reasonable prediction for five consecutive dry years.
- Water Shortage Contingency Plan. Specific elements, including planning for six pre-defined shortage levels, are now required in the more prescriptive Water Shortage Contingency Plan. The Water Shortage Contingency Plan is now also required to be adopted independently of the Urban Water Management Plan. This change was made to facilitate modifications, if needed, to the Water Shortage Contingency Plan between the five-year Urban Water Management Plan cycles.
- Lay Description. There is a new statutory requirement for an easy-to-understand description of the fundamental determinations of the Urban Water Management Plan, specifically regarding water service reliability, challenges ahead, and strategies for managing reliability risks.

The Water Shortage Contingency Plan is a required element of an Urban Water Management Plan that presents information about how to manage the water system during a water shortage emergency that arises as a result of drought. It also describes water supply and demand assessment procedures, compliance and enforcement strategies, and actions that would be undertaken in response to a catastrophic interruption of water supplies, including a regional power outage, earthquake, or other emergency situation, legal authority, and other topics.

On February 23, 2021, the City Council adopted the Interim Updated Water Shortage Contingency Plan, prepared by the Water Department, replacing the City's outdated 2009 Water Shortage Contingency Plan. The interim plan was prepared to address significant changes in local water use since 2009 and better address current realities. In light of the dry conditions in early 2021, staff recommended adoption of the interim plan prior to the Urban Water Management Plan to accommodate potential water use restrictions if needed for the 2021 peak use season, and due to drought conditions, the City has been operating at Stage 1 of the Interim Updated Water Shortage Contingency Plan since May 2021.

As described above, the 2020 Urban Water Management Plan now must include more prescriptive requirements for the Water Shortage Contingency Plan. The Interim Updated Water Shortage Contingency Plan addressed most but not all of the new state requirements. The required elements not included at that time, such as procedures for conducting an annual water supply and demand assessment, were planned to be developed as part of preparing the 2020 Urban Water Management Plan.

The primary elements of the Interim Updated Water Shortage Contingency Plan include six standard water shortage levels and actions to be taken to reduce demand at each level. Shortages are based on peak season demand and correspond to the six standard shortage levels defined in Water Code of up to ten, twenty, thirty, forty, fifty and greater than fifty percent shortage, as summarized in Table 1.

Table 1: Water Shortage Contingency Plan Levels

Water Shortage Contingency Plan Levels		
Shortage Level	**Percent Shortage Range**	**Shortage Response Actions**
1	Up to 10%	Stage 1 applies to relatively minor water shortage that requires up to a 10% level of demand reduction. The allocation system applies to all stages. At Stage 1, allocations are provided to customers but excess use penalties are not yet implemented.
2	Up to 20%	Stage 2 applies to moderate water shortages with a demand reduction requirement of up to 20%. This condition requires more vigorous public information and outreach. The primary demand reduction measure that will be implemented at this stage and all stages going forward is the use of excess use penalties for water use above customer allocations.
3	Up to 30%	Stage 3 applies to a serious water shortage with a demand reduction requirement of up to 30%. This condition is a serious situation that will require significant reductions by each customer class. Allocations will be reduced to Stage 3 levels.
4	Up to 40%	Stage 4 applies to a serious water shortage with a demand reduction requirement of up to 40%. This condition is a serious situation that will require significant reductions by each customer class. Allocations will be reduced to Stage 4 levels. The water supply conditions that would trigger Stage 4 parallel the difficult situation the City experienced in the drought of late 1970s. Under this scenario, virtually all available water must be reserved either for health and safety purposes or to sustain local business.
5	Up to 50%	Stage 5 represents an imminent and extraordinary crisis threatening health, safety, and security of the entire community. Under this dire situation, extreme measures are necessary to cut back water use by up to half the normal amount. Not enough water would exist even to meet the community's full health and safety needs, the top priority. All water should be reserved for human consumption, sanitation, and fire protection purposes and any remaining amount allocated to minimize economic harm. A shortage of this severity could be expected to generate stress and confusion, much the same as any major emergency and at some point could transform into a full blown natural disaster that can no longer be governed by local ordinance and may need to be managed by the basic principles and command structures of the state Standardized Emergency Management System. The City has experienced water shortages in the past but never one of such large proportion.
6	>50%	For Stage 6 Catastrophic Water Shortage, Santa Cruz takes the position that this level of shortage would most likely only occur due to a major disaster that caused significant damage to our water treatment and/or distribution infrastructure. In such a disaster, such as a large earthquake, the Santa Cruz response would not come from this Water Shortage Contingency Plan, but rather from the main Santa Cruz Water Department Emergency Response Plan.

Previous Water Commission meetings addressing topics covered in the 2020 Urban Water Management Plan included the following:

- February 3, 2020: Water Shortage Contingency Plan Update: Data Analysis and Plan Development Process
- July 6, 2020: Analysis of the Probability and Size of Potential Future Water shortages
- September 14, 2020: Working Draft of the Water Shortage Contingency Plan
- December 7, 2020: Draft Water-Sewer Affordability Analysis
- January 4, 2021: Updated Water Shortage Contingency Plan
- February 1, 2021: Preliminary Long-Term Water Demand Forecast Update
- March 1, 2021: Urban Water Management Plan – Approach to Water Service Reliability and Drought Risk Assessment
- April 5, 2021: Urban Water Management Plan: Results of Drought Risk Assessment and Water Supply Reliability Assessment

DISCUSSION:

The draft 2020 Urban Water Management Plan, Attachment 1, follows the same basic format as the 2015 Urban Water Management Plan, adopted in August 2016 but incorporates new requirements for this planning cycle. The key findings of the 2020 Urban Water Management are summarized below.

Key Finding - System Water Use and Water Demand:

In 2020, water demand was about 2.6 billion gallons. While demand did rebound following droughts in the 1970s and 1980s, demand has not rebounded to pre-drought conditions following 2014, contrary to previous projections. Current projections forecast that water use over the next 25 years, including projected population growth, will increase at a very slow rate to reach approximately 2.8 billion gallons per year by 2045.

Key Finding - Conservation Target Compliance:

The City of Santa Cruz's target gross per capita water use[1] under Senate Bill SB X7-7 for 2020 was 110 gallons per capita per day (GPCD). In 2020, the City's gross per capita water use was 74 GPCD. This 2020 gross per capita water use is far below the 2020 target, and the City is in compliance with all requirements of Senate Bill X7-7.

Key Finding - Existing System Water Supply:

The Santa Cruz water system relies predominantly on local surface water supplies, which include the North Coast sources (Liddell Spring and Laguna, Majors, and Reggiardo Creeks), the San Lorenzo River, and Loch Lomond Reservoir. Together, these surface water sources represent the majority of the City's total annual water production used to meet system demand. The balance of the City's supply comes from groundwater, all of which is extracted from the Beltz Well system. During the past decade, the North Coast sources represented 23 percent of the total water supply, the San Lorenzo River represented 56 percent, Loch Lomond Reservoir (Newell Creek) represented 15 percent, and the Beltz Well system contributed the remaining 5 percent.

[1] Gross per capita water use is the total volume of water, whether treated or untreated, entering the distribution system of an urban retail water supplier divided by the total population served.

The City does not currently operate a recycled water system in its service area; however, the Pasatiempo Golf Course, located within the City's service area, now receives disinfected secondary effluent from the City of Scotts Valley that it treats to tertiary standards at the Pasatiempo Golf Course Tertiary Plant for use as recycled water golf course irrigation. This reduces the demand for potable water from the Santa Cruz water system that would otherwise be used for irrigation.

Key Finding - Future Water Projects:
As described below, the City of Santa Cruz is vulnerable to water shortages during multiple dry year periods and as such faces potential obstacles in meeting its future water supply needs. This is primarily due to the limitation in when and how much water is available to meet system demand, exacerbated by a lack of storage within the system. To address these limitations, the City is actively planning and implementing a number of projects and major investments in the water system designed to secure future water supply reliability. Major projects are described below.

Water Supply Augmentation Strategy
Since 2015, the City of Santa Cruz has been pursuing a Water Supply Augmentation Strategy (WSAS) developed by the Water Supply Advisory Committee. The WSAS portfolio elements, which are being pursued on a concurrent timeline, and current progress is summarized below:

- **Element 0: Demand Management**. Demand Management, or conservation, is not considered a water supply for the purposes of the Urban Water Management Plan.
- **Element 1: Transfers and Exchanges**. The City has been piloting water transfers to the Soquel Creek Water District since 2018, as water supplies are available, under a cooperative piloting agreement that extends through 2025. The Santa Cruz Water Rights Project Draft Environmental Impact Report, described below, examines implementation of water transfers and exchanges with local water districts, the Soquel Creek Water District, Central Water District, Scotts Valley Water District, and San Lorenzo Valley Water District, that would be facilitated by the proposed water rights modifications to place of use.
- **Element 2: Aquifer Storage and Recovery**. The City has been evaluating the feasibility of ASR in both the Santa Cruz Mid-County and the Santa Margarita Groundwater Basins, with current work primarily focused on the portion of Santa Cruz Mid-County Basin within the City of Santa Cruz service area. Pilot testing has been conducted at the existing Beltz 8 and Beltz 12 well facilities to better understand potential water quality and operational constraints. The Santa Cruz Water Rights Project Draft Environmental Impact Report, described below, examines implementation of ASR that would be facilitated by the proposed water rights modifications. Next steps include consideration of longer-term demonstration of ASR at existing Beltz Well system facilities.
- **Element 3: Recycled Water or Desalination**. Further study of recycled water has been prioritized over the study of seawater desalination. The City is continuing to examine the use of recycled water through commissioned engineering studies, specifically through an ongoing Phase 2 Regional Recycled Water Facilities Planning Study.

Santa Cruz Water Rights Project

The Santa Cruz Water Rights Project supports the implementation of the WSAS and involves the modification of the City's existing water rights to increase the flexibility of the water system by improving the City's ability to utilize surface water within existing allocations. This project also incorporates into the City's water rights bypass flow requirements for all of the City's surface water sources which are protective of local anadromous fisheries (Agreed Flows). The success of this project is necessary for fisheries protection and to facilitate future water supply projects. The primary components of the Santa Cruz Water Rights Project include:

- **Water rights modifications** related to place of use, method of diversion, points of diversion and rediversion, underground storage and purpose of use, extension of time, and stream bypass requirements for fish habitats;
- **Water supply augmentation components**, including new aquifer storage and recovery (ASR) facilities at unidentified locations, ASR facilities at the existing Beltz Well facilities, water transfers and exchanges and intertie improvements; and
- **Surface water diversion improvements**, including the Felton Diversion fish passage improvements and the Tait Diversion and Coast Pump Station improvements.

Santa Cruz Water Program (Capital Investment Program)

City of Santa Cruz has embarked on an ambitious capital investment program, the Santa Cruz Water Program, to secure its future water supply portfolio, to improve reliability and resiliency in the face of climate change, and to address aged infrastructure. Major investments are planned in the coming years to advance toward a twenty-first century water system. Elements of the Santa Cruz Water Program that will help contribute to support implementation of the WSAS and support water supply reliability include the following.

- **Graham Hill Water Treatment Plant Projects**. Upgrades to the City's Graham Hill Water Treatment Plant are critical to the implementation of the WSAS to allow treatment of higher turbidity source water that otherwise would need to be bypassed during high flow periods such as during and after storm events. The Facilities Improvement Project is a comprehensive evaluation of the facility that identifies the most cost-effective improvements to meet water treatment objectives and improve the overall reliability and resiliency of the plant. These investments are designed to address aging infrastructure, prevent noncompliance with drinking water standards under anticipated future conditions, and support mission-critical values of supplying adequate, safe, and reliable water for the City's customers.
- **Raw Water Transmission Pipeline Projects**. The City is planning improvements to raw water conveyance by upgrades to both the Newell Creek Pipeline and segments of the North Coast system. These projects will improve reliability and reduce hydraulic constraints to improve delivery of raw water to the Graham Hill Water Treatment Plant.
- **Tait Diversion Improvements**. The City is also investigating improvements to the Tait Diversion facility that would improve reliability and fish screening. As described in the Santa Cruz Water Rights Project Draft Environmental Impact Report, if the Tait Diversion is added as a new point of diversion to existing Felton water rights, Tait Diversion capacity would be increased to accommodate the combined diversion of water under both the Tait and the Felton water rights at this facility.

Key Finding - Water Service Reliability Assessments:

Drought Risk Assessment
The Drought Risk Assessment (DRA) is a new requirement in the 2020 Urban Water Management Plan. The assessment includes a supply and use comparison looking ahead assuming drought conditions over the next five years, 2021 - 2025. In this Urban Water Management Plan, the period 1973 – 1977 is used because it is the period in the historic record that would pose the greatest challenge to the City's water supply system. (Note it is also used in the five consecutive year supply and demand reliability assessment described below for the same reason.) In addition to using the 1973-1977 hydrology for the DRA, a second analysis was conducted to consider this same time frame under projected climate change hydrology.

Based on anticipated timing of certification of the Santa Cruz Water Rights Project Environmental Impact Report and action by the State Water Resources Control Board on proposed water rights modifications, the City's proposed water rights modifications, including implementation of the Agreed Flows which are protective of local anadromous fisheries, are assumed for 2022 through 2025 of the DRA, but are not assumed in the first year of the analysis.

Figure 1 presents the results of the DRA and anticipated supply from each source. This analysis shows that projected supply would meet projected demand for the first four years of the extended five-year drought, but that in the fifth year, a substantial, 27 percent, a shortage is projected. This projected shortage would require aggressive reduction savings according to the City's Water Shortage Contingency Plan. During an extended drought period, however, the City would likely utilize the Water Shortage Contingency Plan and implement demand reduction requirements in earlier years before an actual shortage is experienced, to ensure adequate supplies remain in Loch Lomond Reservoir, in an attempt to reduce the depth of shortage experienced in the fifth year.

The City also conducted Drought Risk Assessment utilizing a selected climate change projection. Figure 1-C illustrates the City's water supply by source that is projected to be utilized under this climate change projection. The vulnerability of flowing sources, the North Coast Streams and San Lorenzo River, to drought can be seen in the rapid drop of availability of these sources between years two and three in this scenario. Subsequently, the inability to refill Loch Lomond Reservoir during ensuing dry years leads to two successive years of projected substantial supply shortages.

Figure 1: Drought Risk Assessment Supply by Source (in million gallons)

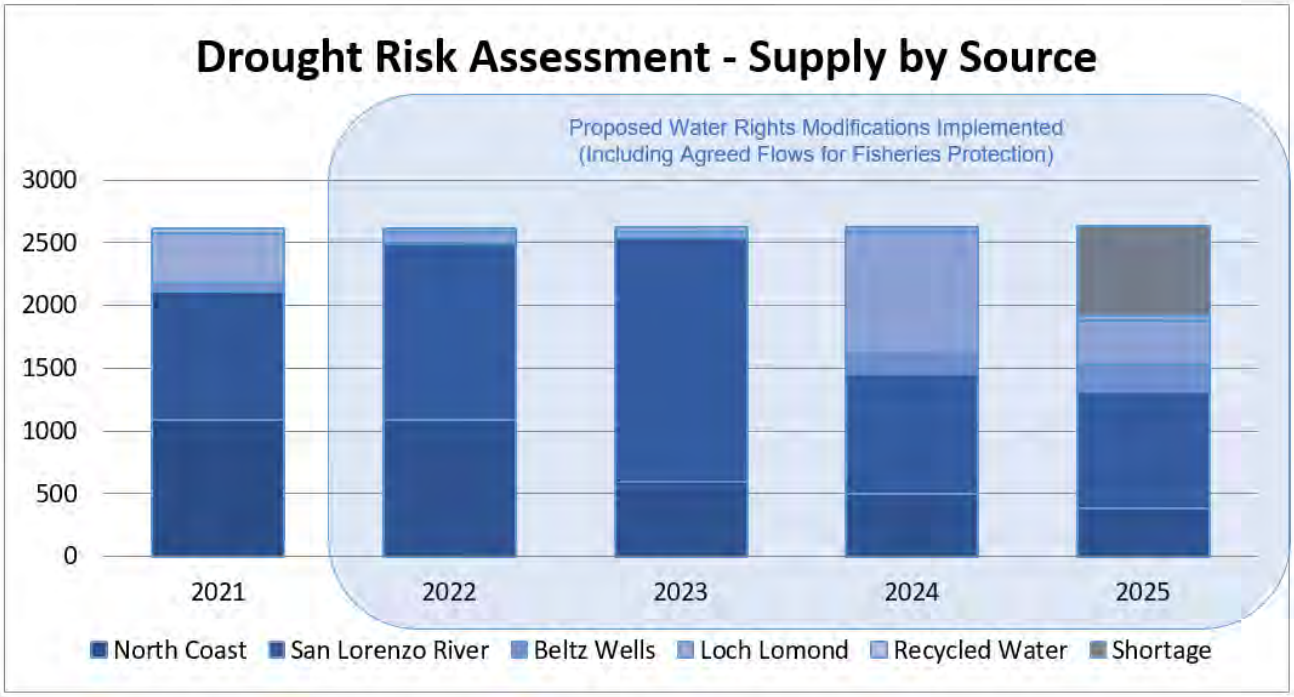
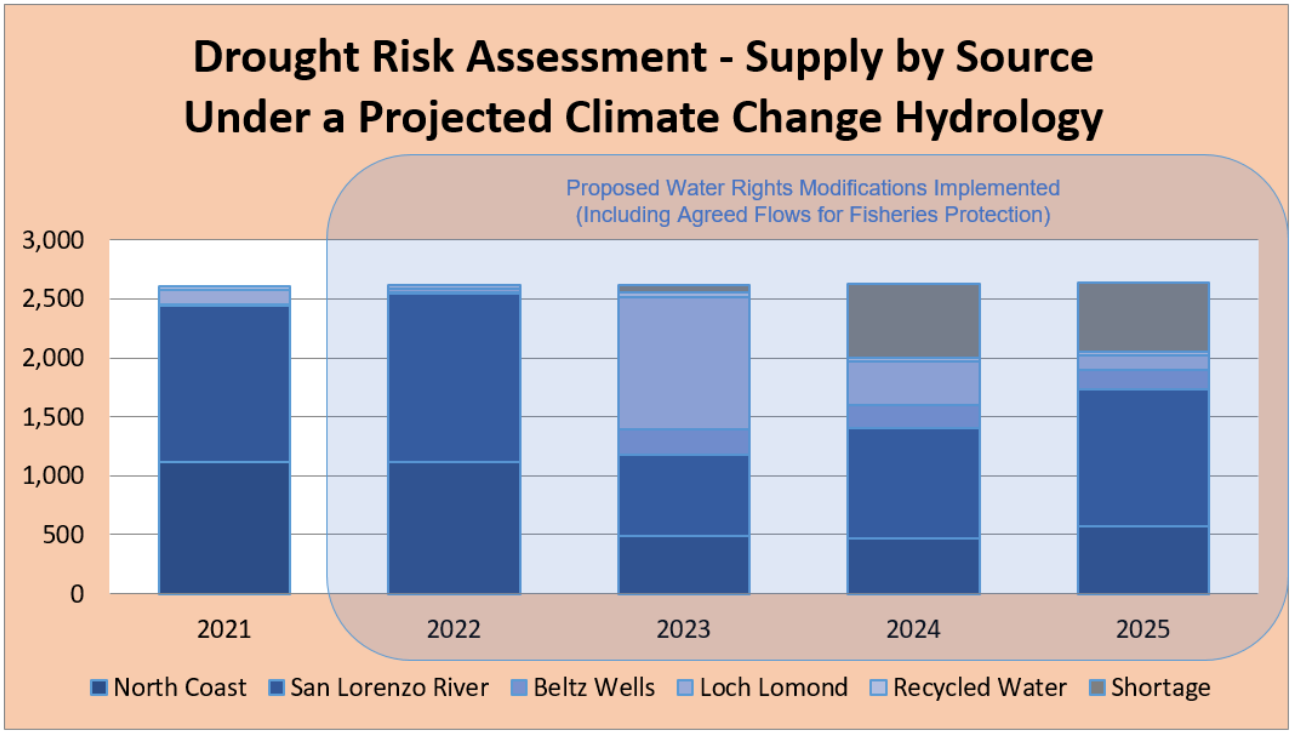


Figure 1-C: Drought Risk Assessment Supply by Source under a Projected Climate Change Hydrology (in million gallons)



Supply and Demand Reliability Assessment

To demonstrate supply reliability over time under different conditions, Figure 2 illustrates projected supply available relative to demand over the 25-year planning horizon of this assessment. While the DRA looked at supply reliability over the next five years (2021-2025), this analysis looks at supply reliability over the planning horizon (2025 – 2045) for three water supply scenarios: a normal year, a single dry year and a five-year drought period. The five-year drought period corresponds to 1973 – 1977 hydrology, and similar to the DRA, a projected climate change scenario was also considered.

The City is safeguarding against future water shortages by actively implementing future water projects as described above. Implementation of these projects is therefore assumed in the City's water supply planning process and as can be seen is a necessary component of supply reliability. Consistent with the WSAS, the following assumptions about future water projects have been used in developing projected water supplies over the 25-year planning horizon of this analysis.

- In 2025, the City will have implemented proposed water rights modifications, including implementation of the Agreed Flows which are protective of local anadromous fisheries, as described in the Santa Cruz Water Rights Project Draft Environmental Impact and
- In 2030, the City will have implemented the following components of the WSAS and planned infrastructure projects:
    - Aquifer Storage and Recovery in the Santa Cruz Mid-County Groundwater Basin and/or the Santa Margarita Groundwater Basin, as described in the Santa Cruz Water Rights Project Draft Environmental Impact Report,
    - Improvements to the Tait Diversion on the San Lorenzo River, as described in the Santa Cruz Water Rights Project Draft Environmental Impact Report and as included in the Santa Cruz Water Program,
    - Facility improvements at the Graham Hill Water Treatment Plan that will allow treatment of more turbid water as included in the Santa Cruz Water Program, and
    - Replacement of major transmission pipelines on the North Coast and the Newell Creek Pipeline as included in the Santa Cruz Water Program.

Under this supply and demand reliability assessment, the City anticipates having sufficient water supply available in normal years and single dry years to serve anticipated demand throughout the 2025 – 2045 planning period.

Under multi-year drought conditions in the near term (2025), with proposed water rights modifications but before implementation of the aquifer storage and recovery and planned infrastructure projects, available supplies would meet projected demand in years one through four of the multi-year drought scenario, but would fall short of demand by 27 percent in year five. While the analysis characterizes this vulnerability for year five of the drought period, depending on sequencing of rain years, in reality it is possible that such a shortage could occur sooner and persist longer through a multiple dry year period.

Under multi-year drought conditions after 2030, with implementation of the ASR and planned infrastructure projects, available supplies would meet projected demand in years one through four of the mutli-year drought scenario, and the year-five shortage is anticipated to be substantially reduced with projected shortages no larger than a negligible two percent.

Figure 2: Projected Supply Availability as Demand Served

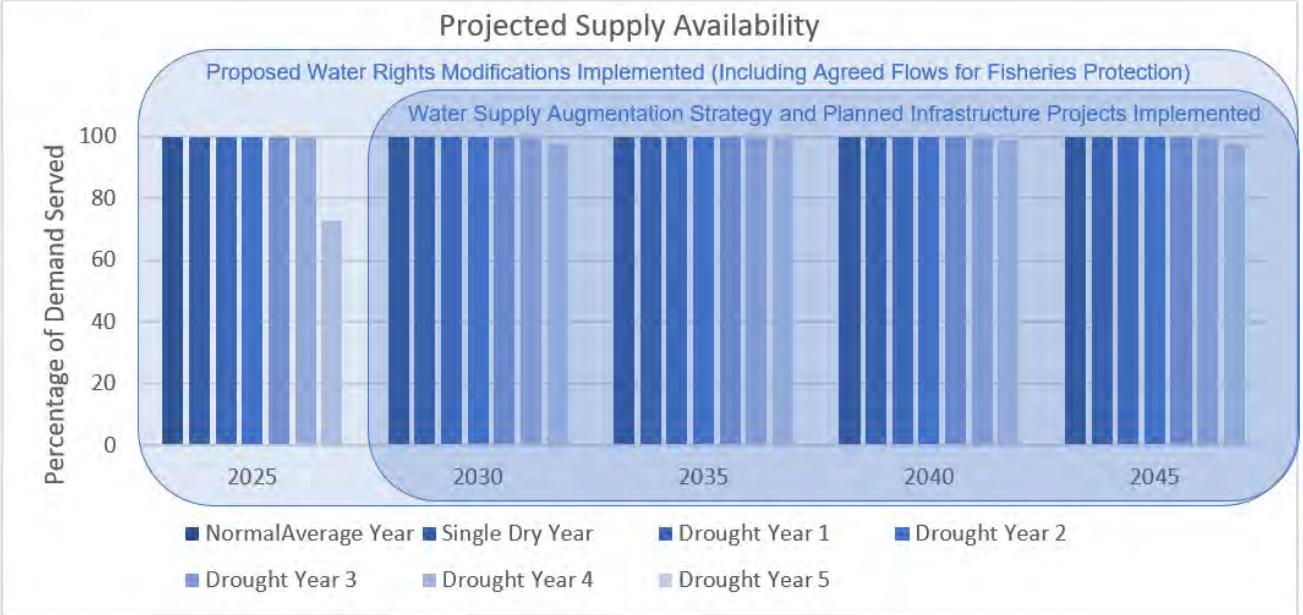


Figure 2-C: Projected Supply Availability as Demand Served under a Projected Climate Change Hydrology

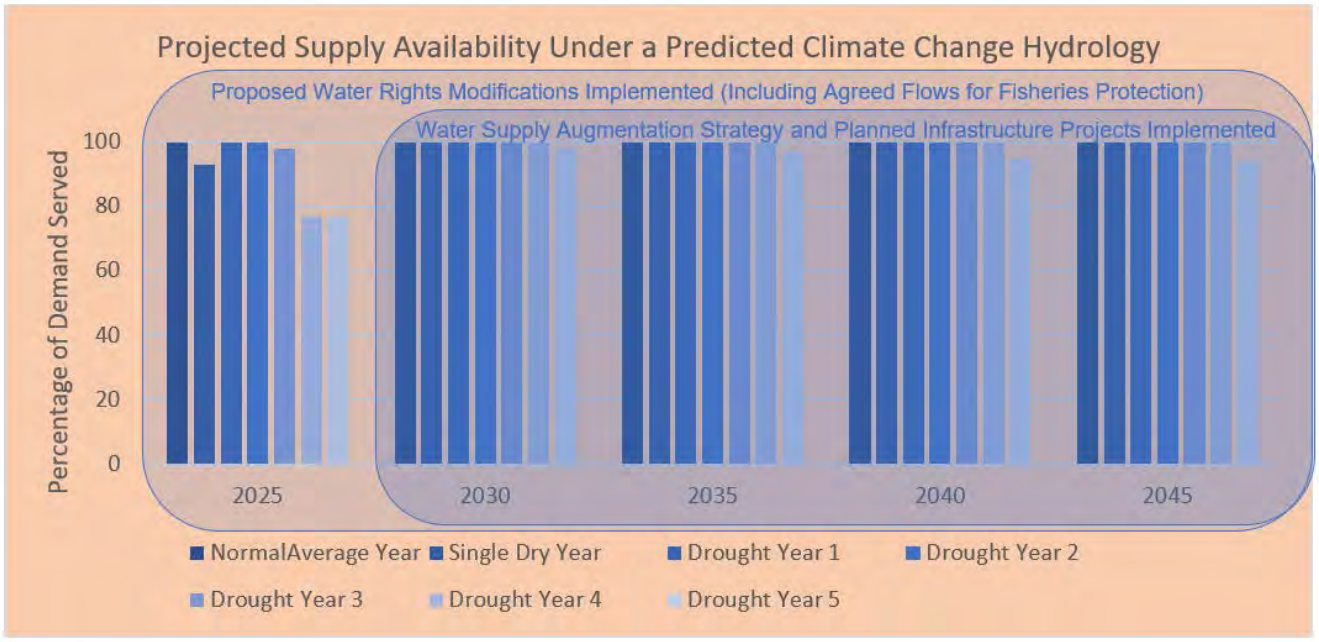


Figure 2-C shows the projected supply available relative to demand under the modeled climate change hydrology. Compared to historic hydrology, there is potential for decreased reliability under a single dry year and under multi-year drought conditions under the climate change scenario. The City projects having sufficient water supply available in normal years under the climate change hydrology.

In single dry year conditions under a projected climate change hydrology in the near term (2025), with proposed water rights modifications but before implementation of the ASR and planned infrastructure projects, supply would fall short of projected demand by seven percent. Under multi-year drought conditions in the near term, available supplies would meet projected demand in years one and two of the multi-year drought scenario, but would fall short of system demands by two percent in year three and by 23 percent in years four and five. However, under multi-year drought conditions after 2030, with implementation of the ASR and planned infrastructure projects, available supplies would meet projected demand in years one through four of the scenario, and the year-five shortage is anticipated to be substantially reduced with projected shortages no larger than five percent.

Key Finding - Water Shortage Contingency Plan:
As required by California Water Code and to manage risks due to water supply shortages that can be expected in the future, the 2020 Urban Water Management Plan includes a Water Shortage Contingency Plan. The Water Shortage Contingency Plan, including all required content such as procedures for conducting an annual water supply and demand assessment, is comprised of both Chapter 8, Water Shortage Contingency Planning, of the 2020 Urban Water Management Plan and Appendix O, Water Shortage Contingency Analysis and Implementation, of the 2020 Urban Water Management Plan.

The key elements, overall strategy, and approach to water shortages remain unchanged from the approach included in the adopted Updated Interim Water Shortage Contingency Plan. Based on implementation of the plan in 2021, minor updates have been made to the interim plan, which is now titled Water Shortage Contingency Analysis and Implementation, and included as Appendix O to the Urban Water Management Plan. These changes are fully summarized in Attachment 2 and include the following modifications:

- Added two items to the list of Core Principles used to develop the plan:
    - Flexibility
    - Even-handedness
- Updated for new drought cost recovery fee/rate information
- Provided clarifying language about what would and would not qualify for an allocation exception
- Included the following new actions at specified shortage stages:
    - Stage 2, moratorium on bulk water permits
    - Stage 3, shut down all bulk water stations, increase monitoring of unauthorized use from hydrants and other sources, and stop issuing construction hydrant meters
    - Stage 4, institute a service connection moratorium

Under implementation of the Water Shortage Contingency Plan, the City of Santa Cruz will rely primarily on-demand reduction through the implementation of allocations to address shortages at each stage. The plan also includes outreach, operational changes, mandatory restrictions, and other actions to be implemented at each stage. The water system now has very low system-wide water use, which is beneficial from the perspective of meeting demands and preserving water resources, but it also represents a "hardened demand" that presents limited opportunity for further per capita demand reductions. These new demand characteristics mean that reductions at higher stages will be difficult to achieve. In the view of the Santa Cruz Water Department staff, curtailments beyond Stage 2 of this plan are not really feasible to implement without significant impacts to public health and safety and the Santa Cruz economy. The City is actively implementing its WSAS as the solution to dealing with larger shortages rather than demand curtailment.

Summary and Next Steps:
The draft 2020 Urban Water Management Plan was made available for public review on September 30, 2021 on the City's website, at the Water Department office, and at the City's Downtown Branch Library.

The Santa Cruz City Council will hold a public hearing at its regular meeting on Tuesday, November 9, 2021 after the hour of 10 a.m. to receive public comment and consider the adoption of the Urban Water Management Plan and Water Shortage Contingency Plan. The City Council will have the opportunity to adopt both plans at the meeting.

The draft plans were circulated, along with notice of the time and place of the public hearing, to all jurisdictions receiving water service from the City of Santa Cruz: the County of Santa Cruz and the City of Capitola. Notification letters included the location where the draft 2020 Urban Water Management Plan, including the Water Shortage Contingency Plan, could be viewed, the hearing schedule, and contact information of the preparer for the City.

In addition to these jurisdictions, the City provided notice of availability of the plan and of the public hearing to the Association of Monterey Bay Area Governments, local elected officials, the Santa Cruz Local Agency Formation Commission, and to all major public water utilities in Santa Cruz County, including Soquel Creek Water District, San Lorenzo Valley Water District, Scotts Valley Water District, Central Water District, and the City of Watsonville.

The public hearing will also be noticed to the public in the Santa Cruz Sentinel as prescribed in Government Code 6066. The notice will include the time and place of the hearing, as well as the various locations where the plans are available for public review.

Upon completion, the final adopted Urban Water Management Plan, including the adopted Water Shortage Contingency Plan, will be submitted electronically to the California Department of Water Resources and the California State Library and transmitted to all jurisdictions receiving water service from the City of Santa Cruz.

As required by the Water Code, the Urban Water Management Plan will continue to be updated, following the latest guidance, and adopted every 5 years, and the Water Shortage Contingency Plan will be included in and adopted in parallel with the Urban Water Management Plan. Additionally, the Water Shortage Contingency Plan may be updated and adopted between the Urban Water Management Plan five-year cycle as needed.

FISCAL IMPACT:
There is no fiscal impact associated with the proposed action; however, in order for an urban water supplier to be eligible for funds from any state water grants or loans administered by DWR, the agency must have a current Urban Water Management Plan on file that has been determined by DWR to address the requirements of the Water Code and must also comply with the requirements of the Water Conservation Act of 2009. The water department must both meet its water use target and report compliance in its 2020 Urban Water Management Plan in order to receive funding from DWR programs. Current Water Department funding that falls under these requirements includes nearly $150 million in Drinking Water State Revolving Fund loans for the Newell Creek Dam Inlet/Outlet Replacement Project and Graham Hill Water Treatment Plant Concrete Tanks Project.

PROPOSED MOTION:
Motion to recommend that City Council pass resolutions to adopt the 2020 Urban Water Management Plan and Water Shortage Contingency Plan, and to authorize the Water Department to file the 2020 Urban Water Management Plan, including the Water Shortage Contingency Plan, with the California Department of Water Resources.

ATTACHMENTS:
1. 2020 Urban Water Management Plan which includes the Water Shortage Contingency Plan https://www.cityofsantacruz.com/government/city-departments/water/urban-water-management-plan-2020
2. Water Shortage Contingency Plan Summary of Changes since adoption of the Interim Updated Water Shortage Contingency Plan.

Documentation of changes in latest version of WSCP. The new plan is dated September 9th 2021.

- Changed the Executive Summary to add a key point about why implementing the plan at higher stages would be difficult. There had been two key points, now there are three. The third point is stating that the city will gauge the necessity of any particular action at any stage and make a determination as to whether it can be implemented at that time.

- Changed the title to read **2021 Water Shortage Contingency Analysis and Planning**

- Add clarifying language in the Executive Summary p.3 to explain why there was an interim plan approved in February 2021 and the difference between the interim plan and the final plan.

- Introduction, p.5 added language clarifying that the document goes together with CH. 8 of the UWMP to form the full WSCP.

- Small edit to first sentence in section "Relationship to other plans".

- Added two items to the list of "Core Principles"
    - Flexibility
    - Even-handedness

- P.10 minor clarification language about the definition of the peak season

- P.14 added some definitions around types of irrigation customers, giving more examples about the differences between irrigation and golf and north coast agriculture.

- P.21 provided more information about how we arrived at the average number of residents per household, and used the word "residency" instead of "occupancy". Referenced David Mitchell's Final Technical Memorandum Update of the City of Santa Cruz's Long-Range Water Demand Forecast

- P.22 cleaned up language around why stage 1 is not considered a "warm up stage"

- P.23 added language about how MFR properties with dedicated irrigation meters can opt to shut off that meter and opt for the additional water allotment

- P.25 added language about business customers and their baseline period

- P.26 added language about business accounts that are new at the time the plan is implemented

- P.30 clarified an item in Table 22

- P.31 clarified the language around the allocation approach for North Coast Ag customers and inserted a new example as Table 23 in place of the prior one.

- P.33 added language about the Parks Department being able to opt to aggregate sites together for the purposes of managing water use during the drought

- P.34 added language about when a shortage declaration recommendation may be made by staff
- P.35 Will update table 31 with new drought cost recovery fee/rate information
- P.37 Added information about WaterSmart Software
- P.38 added language clarifying that the account holder is the party responsible for paying excess use penalties
- P.39 Added language about administrative enforcement measures and the muni code
- P.40 Added language about administrative enforcement measures and the muni code
- P.40 Added language about how much water is given to households with more than three people
- P.40-41 Added language about what would and would not qualify for an exception
- P.42 Added language about customer resources, how to file an exception
- P.43 Added language about applying policies in an even-handed way
- P.44 Added language about definitions of pools, spas and water features
- P. 46 in list of actions at Stage 2, added moratorium on bulk water permits
- P.47 in list of actions at Stage 3, added shut down all bulk water stations, Increase monitoring of unauthorized use from hydrants and other sources, stop issuing construction hydrant meters
- P.48 in list of actions at Stage 4, added institute a service connection moratorium

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WATER COMMISSION
INFORMATION REPORT

DATE: 9/29/2021

AGENDA OF: October 4, 2021

TO: Water Commission

FROM: Chris Berry, Watershed Compliance Manager

SUBJECT: Watershed Lands Forest Management Update

RECOMMENDATION: Receive information and take action to accept the "Opportunities and Constraints Evaluation of Forest Management Options" report.

BACKGROUND: The City of Santa Cruz owns 3,880 acres of land in the Newell Creek, Zayante Creek and Laguna Creek watersheds, which are managed for drinking water source protection purposes by the Water Department (Attachment 1). Particularly in the Newell Creek watershed, forest management is of the utmost importance in the City's efforts to protect its drinking water supply – both in terms of water quality and quantity. The City had commercially logged the second growth, densely-stocked forest on most of these lands from 1968 until approximately 2002, when a study conducted by Swanson Hydrologics found that forestry practices on City lands, while being generally superior to those of many other forest landowners, had likely led to increased fire danger and the potential for increased erosion and sedimentation-related impacts to water resources, specifically in Newell Creek Reservoir (aka Loch Lomond). At that time, a public advisory body appointed by the City Council including relevant technical experts advised the City Council to:

> "Continue to refrain from timber harvesting for commercial purposes, as it is inconsistent with the primary goal of maintenance of water quality. This is not intended to preclude the cutting of trees for the purposes of restoration, wildlife enhancement or ecosystem management opportunities. Further work is needed by the WMTATF (Watershed Management Technical Advisory Task Force) to adequately describe conditions where tree cutting might be used as a tool to enhance the ecosystem."

The City Council unanimously supported this recommendation in its vote on November 12, 2002 and commercial timber harvest activities ended shortly thereafter upon completion of the (then) active harvest activities on the Zayante watershed lands.

Since that time, the Water Department has been focused on custodial management of the watershed lands, including:

- Road maintenance (including maintaining water bars, cleaning out culverts, inspecting and upgrading stream crossings);
- Cutting back ladder fuels and creating shaded fuel breaks along roads;
- Maintaining the ridge road system as fire breaks;
- Abandoning problematic road segments;
- Controlling invasive plants along roads;
- Maintaining trespassing controls; and
- Performing routine patrols.

The Department also conducted minor dead and dying tree salvage and brush field treatments to reduce fire hazards on the Newell and Zayante properties and increasingly engaged in community-wide fire preparedness planning with other agencies and neighboring land owners, including being founding members of the Fire Safe Council of Santa Cruz County.

DISCUSSION: The Water Department continues to manage the properties with a custodial focus, but have increased fuel and fire break and access improvement work over the past year in response to elevated fire concerns. Most recently, the Department has been engaged in:

- Staff emergency response training;
- Planning with Santa Cruz County to reopen a ridge top firebreak on the southeast side of Loch Lomond and emergency egress from the Lompico area;
- Planning with Cal Fire and Sempervirens Fund on reopening a firebreak on the northeast side of Loch Lomond;
- Working with Cal Fire to reopen firebreaks on the ridge between MacFarlane and Newell Creeks;
- Working with Bonny Doon neighbors and Cal Fire on fuel management along Sunlit Lane and Ice Cream Grade;
- Widening existing shaded fuel breaks and lifting the canopy along access roads;
- Evaluating overall opportunities and constraints for more proactive fire preparedness across all of its watershed lands including grant proposal development with the Resource Conservation District of Santa Cruz County.

Recently, the City re-evaluated the custodial management strategy in light of the drought conditions and advancement in the understanding of local fire ecology and redwood forest fire dynamics following the CZU August Lightning Complex fire. The Department contracted with Sicular Environmental Consulting and Natural Lands Management to evaluate future opportunities and constraints for forest management that would be more protective of water resources and other natural resource values found on the City's watershed lands.

The report, "Opportunities and Constraints Evaluation of Forest Management Options" (Sicular Environmental Consulting and Natural Lands Management, 2021) provides a high level analysis of four management options ranging from the current custodial approach to a High Yield Timber Harvest option that is more revenue-focused and involves more active forest management than

the City has engaged in historically. A Fire Hazard Mitigation option was also considered. While this option improves fire prevention and preparedness, it does not include substantive forest stand thinning and will not generate any revenue through timber sales that could be used to offset management costs. The option that ranked highest relative to City goals for water quality and quantity and overall natural resource protection (and that closely resembles the City's historical management) is Integrated Production & Restoration. This option includes management of certain priority forest stands toward more fire resistant late-seral conditions, creation of forest reserve areas, enhanced fire-prevention and preparedness activity (including opportunities for use of prescribed fire) and resumption of single tree selection timber harvest activities. This option can also include the potential sale of conservation easements and development of a carbon credit program. See Attachment 2 for a full discussion of each of the aforementioned management options.

Little can be done to mitigate the potential for a catastrophic crown fire such as the CZU August Lighting Complex Fire. At its peak, this fire jumped very substantial fire breaks, burned through areas previously considered to be immune to such fire behavior and conditions were so severe that they precluded aggressive firefighting. However, more proactive forest stand management, overall fuel reduction and access improvements, as described in the Integrated Production & Restoration option, can provide additional protection against low severity fires, which also provides additional protection against the development of catastrophic crown fires. This effort will increase drinking water source protection by reducing the potential for post-fire runoff that would contaminate City water sources and contribute to overall protection of natural resources in City drinking water source watersheds. It may also generate some revenue that can be reinvested into future watershed management and restoration. Therefore, the Department will be exploring implementation of this option, as well as conservation easements and carbon credit programs, during the next fiscal year.

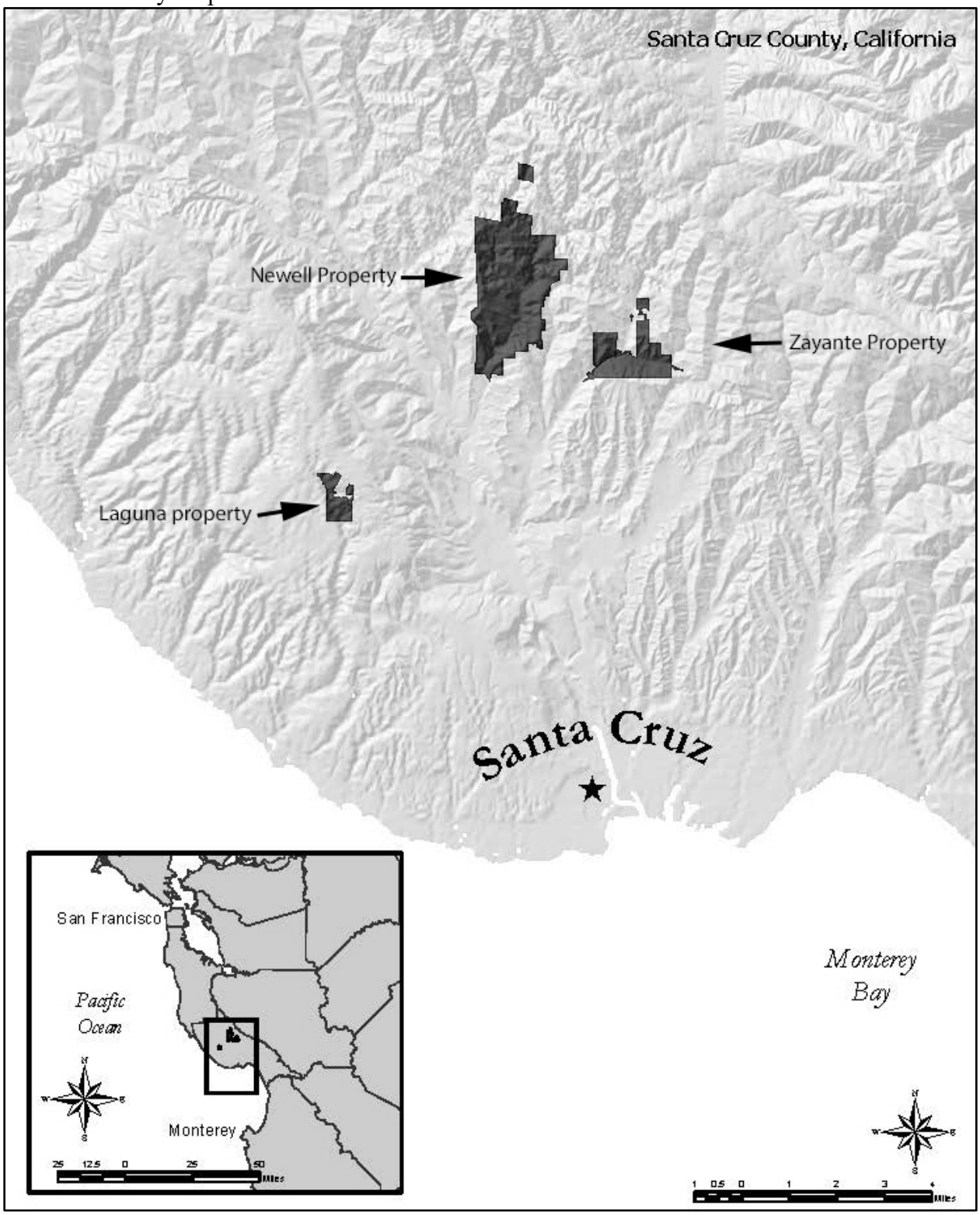
FISCAL IMPACT: Adequate funds are available in the Water Department project #o700304 to support initiation of implementation of the Integrated Production and Restoration option. Additionally, as previously referenced, grant funding may be available to support some of this work.

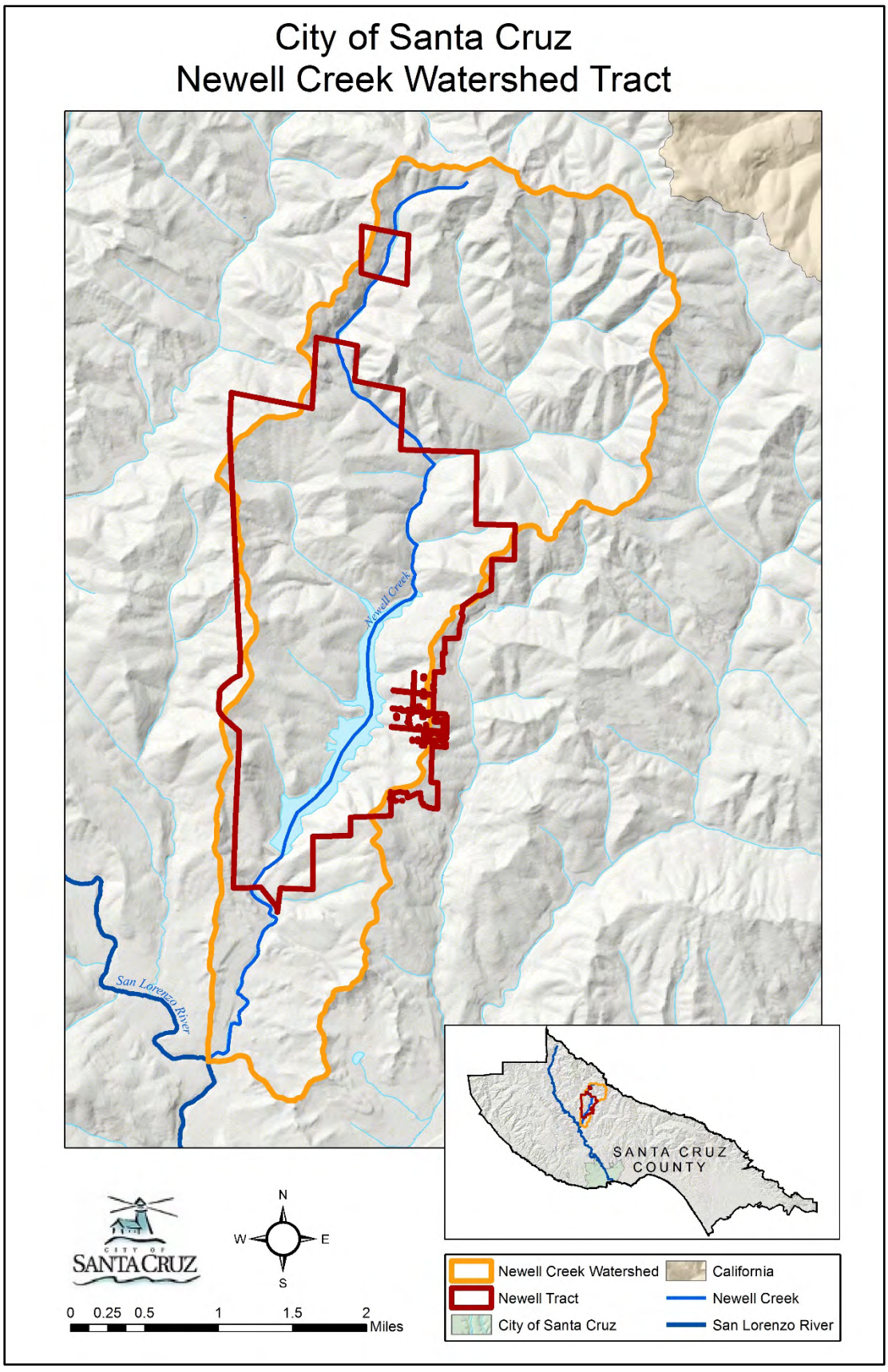
PROPOSED MOTION: None. This is an information item.

ATTACHMENTS:

1. Watershed Lands Maps
2. "Opportunities and Constraints Evaluation of Forest Management Options" (Sicular Environmental Consulting and Natural Lands Management, 2021)

General Vicinity Map

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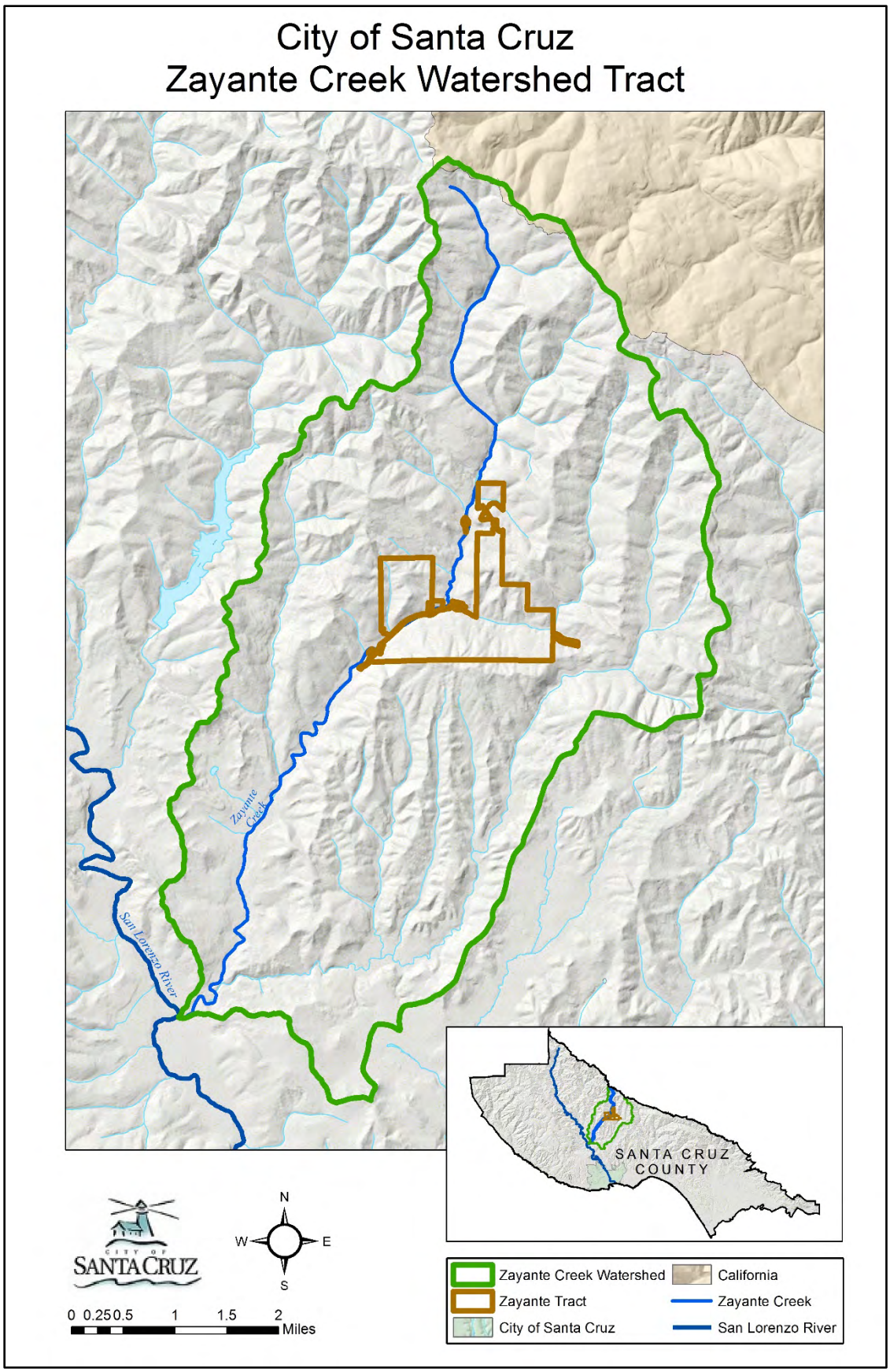
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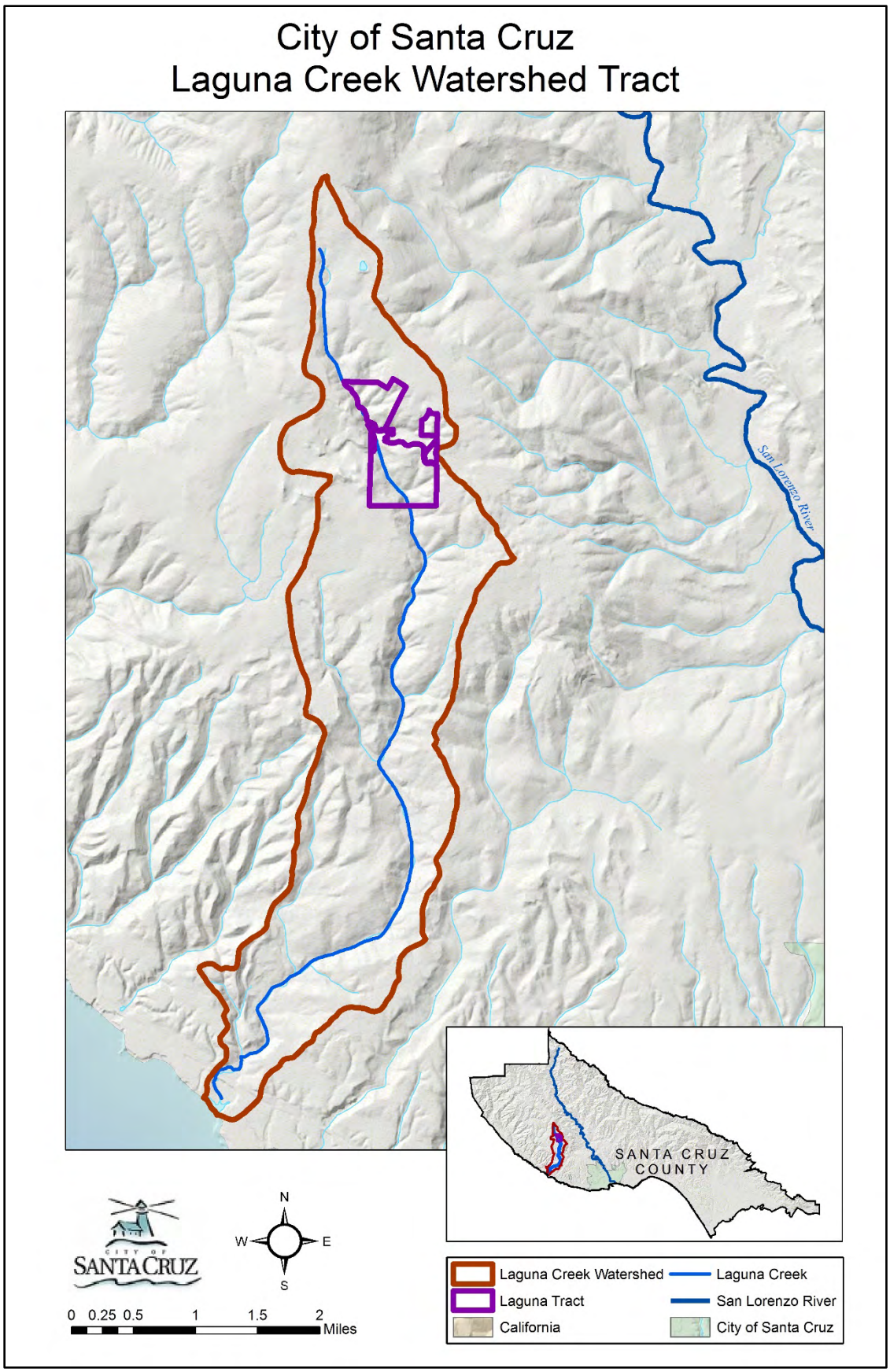
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City of Santa Cruz Watershed Lands

OPPORTUNITIES AND CONSTRAINTS EVALUATION OF FOREST MANAGEMENT OPTIONS

Prepared for: **City of Santa Cruz Water Department**

By**: Sicular Environmental Consulting and Natural Lands Management**

Dan Sicular, Ph.D.

Christopher Keyes, Ph.D.

March 2021

City of Santa Cruz Watershed Lands

OPPORTUNITIES AND CONSTRAINTS EVALUATION OF FOREST MANAGEMENT OPTIONS

Report Preparers:

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CITY OF SANTA CRUZ WATERSHED LANDS

Opportunities and Constraints Evaluation of Forest Management Options

Introduction

This report describes and evaluates a range of management options for the forests of the Santa Cruz watershed lands, and concludes with a recommendation for the option that we determine best meets the City's management goals and objectives. The report fulfills the requirements of Task 5 of our contract, Opportunities and Constraints Analysis. The report is based on our work to date on this project. This has included review of background information, including the Watershed Resources Management Plan, Existing Conditions Report (Swanson Hydrology and Geomorphology, 2001) and Planning Analysis and Recommendations Report (Swanson Hydrology and Geomorphology, 2002) and the Water Department's Watershed Lands Management Plan draft Final Implementation Report (City of Santa Cruz Water Department, 2013); interviews with forestry experts, water quality specialists, and policy makers with relevant knowledge and experience (Sicular Environmental Consulting, 2020a – included as Appendix A); site reconnaissance and discussions with City of Santa Cruz Water Department (Water Department) staff and the Water Department's Consulting Forester; and our update of the forest inventory contained in the 1994 Forest Management Report (Sicular Environmental Consulting, 2020b – included as Appendix B; City of Santa Cruz Water Department, 1994). This Opportunities and Constraints report should be read in conjunction with our previous reports on the interviews and forest inventory.

Management Goals and Objectives

The City's overall goal for management of the watershed lands is protection of the quality and quantity of the City's water supply. Within this goal, more specific and overlapping objectives include reducing the potential for catastrophic wildfire, which is recognized as the greatest threat to water quality enhancing the quality of habitat, both aquatic and terrestrial, for special status species; increasing resilience to climate change; contributing to the City's actions to address the climate crisis; providing limited recreational opportunities; and realizing some monetary return from the land.

Basis for Management Options

Below, we present three options for management of the forests of the watershed lands, developed with the intent of providing a range of approaches to meeting the City's goals and objectives. The organizing principal for establishing the range of options is management intensity: each successive option would involve a greater level of effort and more active management, in order to better meet objectives, or to emphasize one objective over the others. All three options, however, are crafted with the overarching goal

of protecting water quality and quantity. The current management regime is included in the analysis to represent the status quo option.

In developing the options, we have drawn upon our preliminary work on this project, on our experience with forest management elsewhere in the Santa Cruz mountains and the redwood range, and from the literature of forest management and forest science. The options are based on the following premises:

- The watershed lands currently produce clean water suitable for the City's water supply from Loch Lomond Reservoir, Zayante Creek, and Laguna Creek.
- The greatest threat to water quality is from catastrophic wildfire. The CZU August Complex fires of 2020 made clear that fire behavior is becoming more extreme. The potential for stand-replacing wildfire in the redwood forest, previously thought to be a rare and unlikely event, must now be considered real. A large, high-intensity wildfire in the watershed lands, especially in the Newell Creek tract, could degrade the quality of a substantial portion of the City's water supply for several years, perhaps rendering it unsuitable for drinking water for some time.
- Climate change also poses a great threat to water quality, as well as water quantity, not least because it increases the risk of catastrophic wildfire. There is also the possibility that a drying and warming climate will not support redwood, a moisture-loving species, throughout its current range, and that there may be a shift, over time, to drier forest types. If not carefully and foresightfully managed, this shift may itself increase fire hazard and impinge upon the objective of managing for special status species habitat.
- Water Department staff have made it clear that expansion of the current recreational opportunities within the watershed lands is not being considered.
- In our interviews with forestry experts and policy makers, we explored in some depth the feasibility of three potential sources of revenue from the watershed lands: sale of a conservation easement; sale of carbon credits; and sale of timber. Each of the management options includes some combination of these revenue sources.
- Based on our interviews of representatives of land trusts, there is likely limited monetary value in the sale of a conservation easement. A conservation easement is valued based on extinguishing certain property rights, or the imposition of requirements for property management, that will protect and enhance the conservation value of the property. It may be considered that the watershed lands are already protected from the greatest threat to the conservation value of forested lands, development. Some value may still be realized from restrictions on timber harvest and recreation, and by committing to restoration goals and practices.
- The property is likely too small to support a viable carbon project, due to the high fixed cost of project development and ongoing verification, and the low price of carbon credits. There is a possibility of joining a regional effort to establish a multi-ownership, aggregated carbon project, but this would be unlikely to produce more than a small revenue stream. If the carbon market strengthens, this calculus could change.
- Prior to 2000, large portions of the watershed lands, including the west side of Loch Lomond reservoir and much of the Zayante Creek tract, were managed for timber production, using the typical Santa Cruz Mountains silvicultural method of single-tree selection on a short reentry cycle. This management approach was developed by former City Forester Ed Tunheim and others

in the second growth forests of the Santa Cruz Mountains for sustainable production of high-quality redwood. Its hallmarks are creation, through selective cutting, of uneven aged redwood stands, where the clump of trees that grew up from the stump of an old growth tree taken in the clearcut of the early 20th century is the basic unit of production; rapid growth, due to selection for retention of well-spaced, well-formed trees representing 3-4 age/size classes in each clump; the removal in each 12-15 year harvest cycle of trees of merchantable size that are well suited for milling into lumber, as well as damaged, defective, and crowded stems; harvesting less than growth, so that the volume of standing timber, and the average size of trees, both increase over time; and the retention of residual old growth and open-grown trees as big tree elements of the forest.

- Our experience working in forests throughout the redwood range that are managed for the twin goals of timber production and increasing conservation value, including in the Santa Cruz Mountains, has demonstrated the viability of the single tree selection, uneven-aged system. Our interviews with forestry and water quality specialists as part of this project lend credence to the position that it is possible to manage redwood forests for timber harvest on a sustainable basis, while avoiding and minimizing adverse impacts to water quality, and protecting and enhancing the conservation value of the forest.
- Threats to water quality from timber harvest include increased sedimentation, mostly from roads, skid trails, and landings, and increased water temperature from removal of riparian trees. Sedimentation can be avoided and minimized through application of best management practices for road design, construction, maintenance, and use (Weaver, Weppner, and Hagans, 2014), or by use of yarding techniques that minimize the need for roads (Cafferata and Spittler, 1998). The current Forest Practice Rules have greatly reduced erosion and sedimentation from logging roads, compared to typical practices before passage of the Forest Practices Act (ibid; Lewis, 1998 Stream temperature warming can be avoided by maintaining a high canopy cover through the riparian corridor, as has been done within the watershed lands, as required by the Forest Practice Rules standards for retention of canopy cover within the Watercourse and Lake Protection Zone (WLPZ).
- The Swanson Existing Conditions Report (Swanson Hydrology and Geomorphology, 2001) reported few links between the timber harvest program, which had just been halted, and water quality issues. The report found that the Newell Creek tract road system, including culverts, was generally in good condition: “although there is a well-developed road system in the Newell Creek drainage, the roads were well maintained and we observed relatively few instances of severe erosion or landsliding associated with roads” (p. 3-17). The Zayante Creek tract road system was found to have more erosion issues, but the report concluded that “no specific data has been collected to determine the fine sediment loads coming solely from within the Zayante Tract, nor which fraction is natural geologic erosion, legacy land use or recent human activities” (p. 3-51). The report also found that the sedimentation rate for Loch Lomond Reservoir was comparable to that of selected reservoirs with similar characteristics (p. 3-43).
- The forests of the watershed lands are starkly different from their pre-disturbance condition, as described in the Forest Inventory Update report. Much of the forest, however, is well-suited for restoration treatments to accelerate the recovery of old growth structure, character, and ecological function. Our approach to forest restoration is to classify current stand types and describe how these differ from historic or target reference conditions, then to develop silvicultural and other

treatments to redirect their growth trajectory toward the desired condition. While in some cases altered forest stands may eventually achieve desired conditions without intervention, active silviculture can realign stand development trends with restoration objectives more quickly. In some cases, the forest has been altered to the extent that it is unlikely to grow back to its pre-disturbance condition without intervention, and passive management cannot be considered restoration, but only perpetuation of the altered condition. Anticipating the effects of climate change may lead to a conclusion that the future climate will no longer support the pre-disturbance condition. In this case, postulating an appropriate forest type, and managing toward its realization, may be an approach to achieving climate resilience, and "restoring" the forest, albeit to a different type.

Climate change stresses may be most felt at the margins of redwood-dominated stands, in the transition to drier forest types. With increased summer heat, decreased summer fog, a shortened rainy season, and deeper and more frequent droughts, redwood may decline and eventually fail in some of these marginal areas, while it persists in the moister canyon bottoms, swales, and north-facing slopes. The drier marginal areas may, however, become more suitable for Douglas-fir and hardwoods. Silvicultural treatments, including favoring retention of existing Douglas-fir and a mix of hardwoods, and, where absent, planting Douglas-fir seedlings, may facilitate transition of marginal areas to a different forest type, while avoiding a lengthy period of lowered productivity.

- Our approach to restoration is to identify and develop treatments for specific pairings of commonly occurring forest types (combinations of tree species and stand structures) with historic forest types or reference conditions. We term these pairings *Impaired Forest Condition Classes* (IFCCs; Keyes, 2005). IFCCs describe conditions that are considered outside the range of natural variability for the area's forest types, and are expressed as structural, compositional, and developmental differences between pre-disturbance historical conditions and current conditions. The definition and descriptive analysis of IFCCs forms the basis for the development of silvicultural restoration prescriptions. The restoration prescriptions are strategies for intervention into current stand development patterns designed to remediate detrimental effects of past disturbance on current trajectories of stand development. The prescriptions are strategies for indirectly recreating historic structures, by placing stands on trajectories of development that are most likely to produce those structures. The goal is to alter structural and/or compositional attributes in a fashion that will realign stand development patterns so that they more closely mimic natural patterns of stand development.

  Based on our reconnaissance of the watershed lands, we have identified the following IFCCs:

  IFCC-1: Dense second growth conifer and conifer-hardwood, fire damaged, lacking differentiation, high fuel loading and high vertical and horizontal continuity of fuels. Locations: east side of Loch Lomond reservoir and left bank of Newell Creek canyon above the reservoir, in areas not managed for timber harvest since the clearcut of the early 20th century.

  In those areas that were not brought under the previous timber harvest program in the decades of the 1960s through the 1990s, there persist suppressed, dense redwood clumps with trees still showing damage and slow growth from the fire that occurred during the construction of the reservoir, a brushy understory, and, in-between the redwood clumps, hardwood-dominated areas with a high density of poorly formed trees and dense brush. These areas deviate substantially from the pre-disturbance condition, which was likely a mixture of moderate-sized old growth redwood in moister locations, and mixed evergreen, including redwood, Douglas-fir, and hardwoods, in drier locations. These areas are unlikely to regain old growth character without intervention, and they are at risk of high intensity wildfire. Restoration of these areas would

require preliminary entries to reduce competition among redwoods and promote the growth of a cohort of larger, vigorously growing trees, reduce fire hazard through thinning of hardwood-dominated and brushy areas, and in areas where hardwoods have displaced conifers, planting-in Douglas-fir and redwood. Second and possibly third entries would be required to reduce competition for the retained large trees and to promote radial crown growth. With these treatments applied over several decades, these stands would be on a trajectory to regain the character and ecological function of the pre-disturbance forest. This condition previously occurred on the west side of Loch Lomond reservoir, but was altered through selective timber harvest, thinning, and planting under the pre-2000 management regime.

IFCC-2: Dense, planted young conifer undergrown with brush and hardwood, at high risk of stand replacement in event of fire. Locations: areas of previous firewood harvest and subsequent conifer planting in the Zayante Creek and Newell Creek tracts.

IFCC-2 occurs in portions of the Newell Creek and Zayante Creek tracts where harvest of hardwoods for firewood or other clearing was followed by planting of redwood and Douglas-fir. From the 1960s through 1993, over 500 acres of the watershed lands were cleared and planted (City of Santa Cruz Water Department, 1994). It is likely that pre-disturbance, the number of redwood trees was fewer, but they were much larger, and likely formed a continuous canopy in the moister locations along streams and in side canyons and swales. Drier locations in-between the redwood canopy supported a mixture of Douglas-fir, mixed hardwoods, and occasional redwoods, all of which would have reached large size. The clearcut and subsequent fires likely destroyed these stands, leaving them to regrow with dense accumulations of hardwood and brush. Under the previous management regime, prior to 2000, the Water Department selected areas of the watershed lands with evidence of past occupation by Douglas-fir (especially presence of stumps) for firewood harvest operations. Firewood harvests retained 40%-50% canopy, selecting larger, better formed hardwoods and all conifers for retention, and clearing out brush and small trees. Both Douglas-fir and redwood seedlings were planted into cleared areas. Where these established, the firewood harvest program was successful in increasing presence of Douglas-fir in areas that it had been displaced from (as well as increasing redwood above its likely pre-disturbance density), and in re-establishing the species mix typical of the pre-disturbance mixed conifer-hardwood forest. In the decades since the firewood harvest program ceased, many of the planted conifers have thrived, but they now face competition from brush and small hardwoods that have grown-in around them. This presents a high fire hazard. If a fire were to ignite, it would likely incinerate these planted stands, and reset successional processes, thereby perpetuating the fire hazard. To restore these stands and make them less fire prone and more resilient to climate change, mastication, hand crews, or goats could be used to reduce fuel loading and eliminate ladder fuels. This would be followed by thinning of the conifers, and retention of the larger, better-formed hardwoods to recreate low-density, closed canopy, mixed evergreen stands. With climate change, these stands may serve as seedbanks for a shift of drier forest types into adjacent areas currently occupied by redwood.

IFCC-3: Conifer stands previously managed under single tree selection, uneven-aged silviculture, dominant trees facing competition from smaller stems. Locations: west side of Loch Lomond Reservoir, Zayante Creek tract railroad grade and Cobble Creek areas. Note that these stands may be considered impaired in terms of their potential to return to pre-disturbance, old-growth condition; they are not impaired in terms of their suitability for reestablishment of sustainable timber harvest.

Currently, these stands, which were managed for timber harvest prior to 2000, differ greatly from the pre-disturbance forest, which was likely similar to that described for the IFCC-1 areas. Compared to the pre-disturbance condition, the number of redwood trees is much higher, and the trees are much smaller. Instead of growing as single, large stems in small groves and fairy rings, redwoods now grow in clumps which formed from sprouts on old growth stumps. In portions of the Newell Creek and Zayante Creek tracts, the previous management regime reduced tree density, improved spacing, promoted multi-aged structure, increased redwood occupancy of the canopy, and reduced hardwoods and brush. These areas have a cohort of larger, well-formed trees with dominant canopy position. With no further cutting, these trees can be expected to continue to grow and to increase their dominant position. However, the co-dominant and sub-dominant trees within the clumps can be expected to compete for canopy position and for soil nutrients and water, thereby reducing the potential growth of the dominant trees, and slowing the return of these stands to old growth structure. Eventually, the larger trees will outcompete the smaller ones; passive restoration is an option. Intentionally thinning out smaller stems to promote the growth of the dominants would, however, facilitate the return to pre-disturbance conditions.[1] This could be accomplished through 2-3 entry cycles to thin the smaller trees, many of which would be merchantable. It is likely that in 30-50 years, these stands could be considered restored to a sort of pre-old growth condition, and left to develop on their own without further silvicultural intervention. If combined with a prescribed fire program, which would periodically reinvigorate ground cover, reduce duff accumulation and ladder fuels, and add complexity to the forest, it is likely that these stands could begin to approach pre-disturbance conditions in 100 years or so.

Description of Management Options

Based on the premises discussed above, we present the following options for management of the forests of the watershed lands; the components of each option are summarized in Table 1, Management Option Components.

Custodial Management Option: Continue current management regime: maintain roads, including maintaining water bars, cleaning out culverts, inspecting and upgrading stream crossings, cutting back brush and creating shaded fuel breaks along roads; maintaining the ridge road system as fire breaks, controlling invasive plants along roads; maintaining trespassing controls and patrols.

Fire Hazard Mitigation Option: The main objective of the Fire Hazard Mitigation Option is protection of water quality through reducing the risk of catastrophic wildfire. The focus, therefore, is on actions to reduce fuel loading, break-up horizontal and vertical continuity of fuels, and extend infrastructure to facilitate fire suppression efforts. Treatments would include additional and wider shaded fuel breaks along roads; adding to the existing ridge road system, which is key to fire suppression efforts and halting the spread of wildfire; and stand-wide fuel reduction treatments. Fuel reduction treatments could include some combination of prescribed burning, mechanical treatment (masticator), hand work (cutting brush and small trees, lop and scatter or pile and burn of slash), and managed deployment of goat herds. Silvicultural treatments would be limited to low thinning to reduce understory and density of small stems,

[1] An example of this potential is found in "Ed's Avenue of the Giants," an extraordinary second growth stand on the west side of Loch Lomond Reservoir. As described by City Forester Slim! Butler, former City Forester Ed Tunheim used this area to demonstrate silvicultural techniques for growing very large individual trees, in a location that he recognized as having this potential because of its deep soils, favorable aspect, and abundant moisture.

retaining larger trees. This option leaves open the possibility of a conservation easement, potentially covering the entire property, and also the possibility of a carbon project. This option does not include any timber sales.

Integrated Production & Restoration Option: The Integrated Production & Restoration Option focuses on protection of water quality through reducing the risk of catastrophic wildfire, improving forest health and resilience, fostering a return to old growth conditions in a substantial part of the watershed lands, and producing a sustainable revenue stream to cover the cost of intensified land management. This option would re-initiate sustainable timber harvest in areas previously managed for timber production, including the west side of Loch Lomond reservoir and the Railroad Grade, Apple Orchard, and Cobble Creek areas of the Zayante Creek tract. These areas still have infrastructure in place to support timber harvest operations, including maintained haul roads and reusable skid trails and landings. The forest stands in these areas are very well-stocked with merchantable timber, mostly redwood. These are uneven-aged stands, with good spacing and well-formed trees that have the capability of producing high-value lumber on a sustainable basis. Timber harvest of the same type as previously practiced – single tree selection on a 12–15-year reentry cycle – has the potential to produce an estimated average of 1.5 million board feet per year (double the previous target), representing about half of estimated growth within the areas where timber harvest would be applied. In addition, areas of previous firewood harvest and subsequent planting of conifers (IFCC-2) would receive fuel reduction and thinning treatments, and would eventually be brought into the harvest cycle. If harvested at this rate and in this manner, the forest can be expected to continue to accrue volume of standing timber and stored carbon, as the average stem size increases.

In addition, this option would establish a large conservation reserve on the east side of Loch Lomond Reservoir (about 800 acres) where no timber harvest would occur, and smaller conservation reserves on the west side of the reservoir and within the Laguna and Zayante tracts. The east side Loch Lomond conservation reserve, much of which meets the description of IFCC-1, would be managed to attain old growth character and stability through application of silvicultural restoration treatments, as described above. Within areas slated for timber harvest on the west side of the reservoir and in the Zayante Creek tract, this option would establish enclaves along streams and waterways where stable, fire resistant, late seral riparian, peri-riparian and lacustrine forest stands would protect water quality, even if the surrounding forest is disturbed by fire or timber harvest. These areas, which meet the description of IFCC-3, and that encompass the WLPZ stream buffers required by the Forest Practice Rules, would be managed to create resilient stream buffers, areas of low fire hazard and high resilience to climate change and other disturbance. In all of these conservation reserve areas, restoration thinning treatments to favor the growth of already-established larger trees, of all native species but focusing on redwoods, would be applied over two or three entry cycles until desired stand dynamics are achieved, placing the forest on a trajectory to attain old growth character. Thereafter, the conservation reserves would be passively managed, with the likely exception of periodic fuel reduction treatments. The trees thinned in the application of silvicultural treatments in the resilient stream buffer reserves could, in some instances, be included in a timber sale. A third group of conservation reserves would include special, fire-dependent vegetation types, including the sand hills area of the Laguna tract, knob cone pine stands, and areas of coastal scrub and maritime chaparral. In these areas, a prescribed burn program would be established, if feasible.

This option also includes the same fire hazard reduction measures described under the Fire Hazard Mitigation Option. Here, the stand-wide fuel reduction program would be combined with timber harvest operations and restoration treatments. This option would increase the value of a conservation easement as

it would add to the conservation value of the watershed lands within the reserve areas. It would also increase the revenue potential of a carbon project, as it would result in increased carbon sequestration in both conservation reserve areas and timber harvest areas.

High-Yield Timber Option: The areas of focus of the High-Yield Timber Option are protection of water quality through reducing the risk of catastrophic wildfire, improving forest health and resilience, and producing a sustainable revenue stream, both to cover the cost of intensified land management and to produce surplus revenue that can be used to fund other Water Department programs. The principal feature that distinguishes this option from the Integrated Production & Restoration Option is the extension of a sustainable timber harvest program to areas of the watershed lands that were not included in the previous timber harvest program, most notably on the east side of Loch Lomond Reservoir. New timber harvest infrastructure, including logging roads, skid trails, and landings, as well as a new haul route, all located, designed, and constructed to be consistent with the overarching water quality objective, would be developed on the east side of Loch Lomond reservoir, extending to the left bank of Newell Creek above the reservoir. Suitable portions of the Laguna Creek tract and Zayante Creek tract, where second growth timber has not been harvested, could also be developed for sustainable timber harvest. As with the Integrated Production & Restoration Option, short-cycle, single-tree selection timber harvest would be re-started in the previously harvested areas of the Newell Creek and Zayante Creek tracts, where logging infrastructure already exists.

In the first several years of management under this option, most timber production would be from previously managed areas, since the previously unmanaged areas are for the most part relatively poorly stocked, and the redwood is typically in dense, undifferentiated clumps with a high incidence of fire damage from the wildfire that occurred during construction of the reservoir. The first entry cycle would be used to develop timber harvest infrastructure, improve stand vigor through removal of overcrowded and damaged trees, and reduce fuel loading. This may include firewood harvest to reduce the incidence of hardwoods in the interstices between redwood clumps, preserving well-formed, large, fire resistant trees. It may also include planting of conifers in understocked areas. This would be, at best, a break-even financial proposition for the first entry. By the second entry, these areas can be expected to become productive and to generate a positive revenue stream. Eventually, these areas can be expected to become as productive as the previously managed areas, adding an estimated 25-40% to the sustainably harvestable average annual volume.

This option also includes the establishment of resilient stream buffer conservation reserves in high-value water quality protection areas, as well as special management zones in fire-dependent, biologically diverse or biologically distinct areas, particularly in the Laguna Creek tract, but also in small areas of knobcone pine and maritime chaparral in the Zayante and Newell Creek tracts. As with the Fire Hazard Mitigation and Integrated Production & Restoration Options, the High-Yield Timber Option also includes additional efforts to reduce fire hazard and improve fire suppression capability, potentially including extended shaded fuel breaks and ridge roads. Stand-wide fuel reduction would be undertaken in conjunction with timber harvest operations. This option may also include a prescribed burning program, to the extent this is compatible with management for sustainable timber production. As with the other options, the High-Yield Timber Option retains the potential for a conservation easement. With this option, a conservation easement could be used to ensure protection of the conservation reserve areas, and to guarantee retention and stocking rates above the requirements of the Forest Practice Rules in areas managed for timber production. As stocking rates would continue to increase over time, this also leaves open the potential for a carbon project.

Evaluation of Management Options

Consistent with the Water Department's goals and objectives for the watershed lands, we use the following criteria for evaluation of the management options:

- Water: maintaining and improving the quality and quantity of the City's water supply;
- Wildfire and Forest Fuels: reducing the threat of catastrophic wildfire, considered the greatest threat to water quality;
- Carbon and Climate Adaptation: increasing carbon sequestration, decreasing carbon emissions, and increasing resilience to climate change;
- Ecological Quality: conservation and restoration of habitat for special status species, including late seral habitat, habitat structural elements, diversity, and reintroduction of fire to the landscape;
- Economic and Social Viability: potential for revenue generation, social acceptability, and management complexity.

In Tables 2.1 through 2.5, each of the options is evaluated against these criteria, as well as several specific attributes within each. For each attribute, each option is given a score between 0 and 3, with 3 indicating the most benefit. Following each table, a radar chart (Figures 1-5) shows the scoring in graphic format: the farther toward the outside of the chart, the greater the benefit. Table 2.6 and Figure 6 are summaries: the scores for the attributes within each criterion are averaged to produce the aggregate scores in this table and figure. Table 2-6 includes an average of the aggregated scores, which may be interpreted as an overall score for each option, though we caution against using a single number as a basis for any decision-making.

Table 1: Management Option Components

Management Practice	Custodial Management Option	Fire Hazard Mitigation Option	Integrated Production & Restoration Option	High-Yield Timber Option
Maintain existing shaded fuel breaks	X	X	X	X
Maintain existing roads and stream crossings	X	X	X	X
Trespassing control and patrol	X	X	X	X
Control invasive species infestations, especially along roads	X	X	X	X
Additional ridge roads and other strategic fire roads and shaded fuel breaks		X	X	X
Fuel reduction treatments (prescribed burn, brush reduction, low thinning)		X	X	X
Conservation reserve on east side of Loch Lomond reservoir			X	
Resilient stream buffers in high value water quality protection areas in timber harvest areas			X	X
Conservation reserves in special habitat areas			X	X
Incidental timber sales from restoration treatments			X	X
Timber harvest in areas previously managed for timber			X	X
Timber harvest in areas not previously managed for timber				X
Conservation easement	Optional	Optional	Optional	Optional
Carbon credits	Optional	Optional	Optional	Optional

Table 2.1: Water

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Attribute	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Water Quality Vulnerability. Watershed susceptibility to sedimentation from runoff and mass wasting associated with catastrophic fire.	1	2	3	3
Stream Temperatures. Associated with riparian forest structure & composition; determined by effectiveness of streamside buffers and their active/inactive stewardship	1	2	3	3
Roads & Stream Crossings. Effect on the number and quality of effectively maintained roads, stream crossings, and roadbed diversions.	2	2	3	2
Water Yield. Inversely related to standing live vegetation biomass[2]	1	1	2	3
Water Supply System Subsidy. Directly associated with revenues and rates of return.	0	0	2	3

[2] See, for example, Stednick, 1996; Bosch and Hewlett, 1982; and Keppeler, 1998. Paired watershed studies have shown that reducing forest canopy results in increased water yield, at least for several years following timber harvest or thinning, with conifer forests showing the greatest response. Measurable changes begin to be detected at removal of about 20 percent of the basal area in a forested watershed. On the other hand, this effect is temporary, and extensive removal of the forest cover can have deleterious effects, including changes to surface hydrology, the potential for increased erosion and sedimentation, loss of habitat, and, through reduction in transpiration, reduced precipitation.

Figure 1: Water Attributes

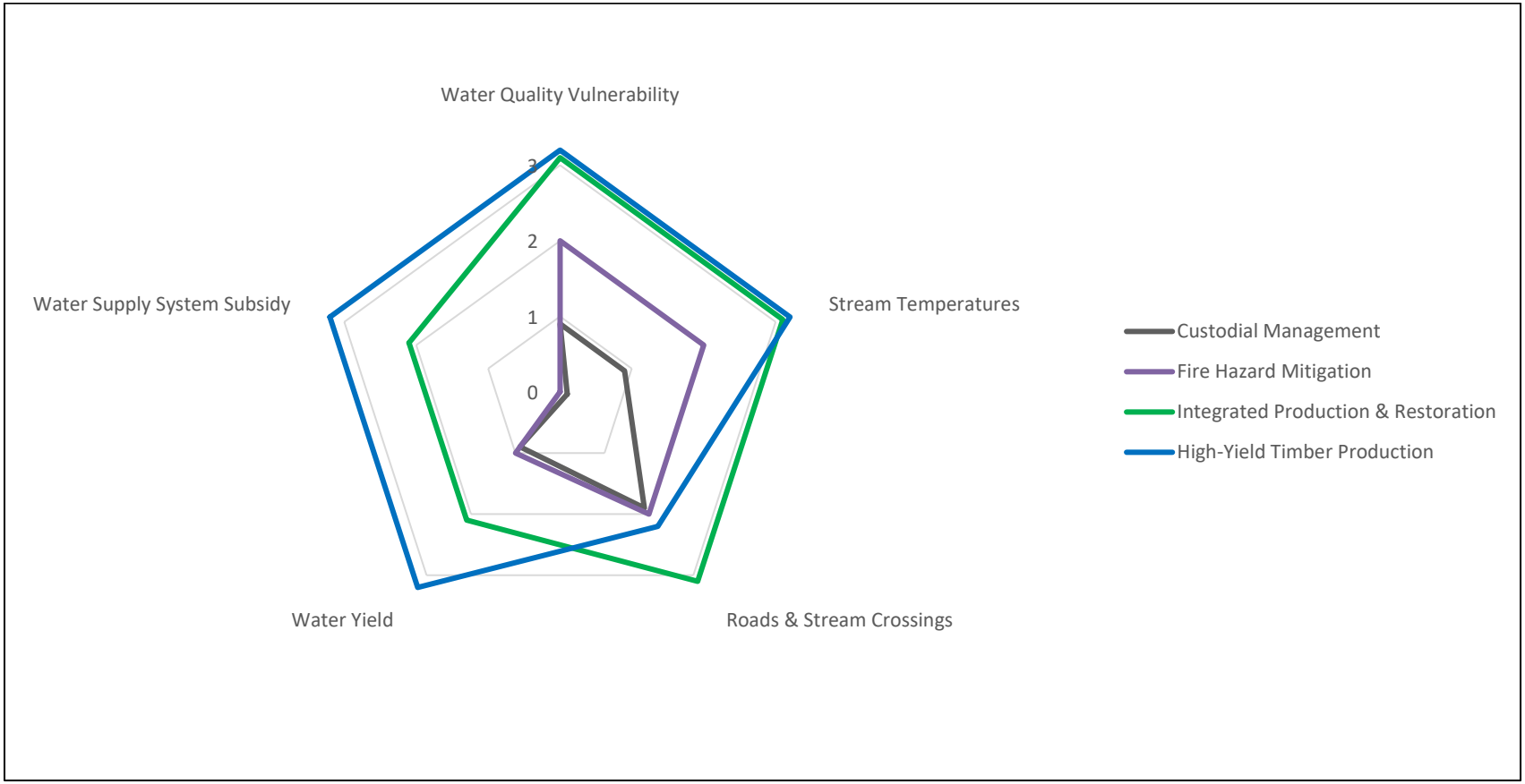


Table 2.2: Wildfire & Forest Fuels

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Attribute	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Crown Fuels – crowning potential. Effect on crown fuel loads & canopy bulk density.	1	2	3	3
Surface Fuels – surface fire behavior. Effect on surface fuel loads and fuelbed depths, and associated flame lengths and spread rates.	1	2	3	3
Ladder Fuels – torching potential. Effect on mid-story aerial fuels and crown fire initiation potential.	2	2	3	2
Survivability – cambial scorch. Effect on 1000-hr surface fuels, residence times, bark thickness.	1	1	3	2
Ignition Risk. Effect on human access and undetected remote ignitions.	3	3	2	1
Wildfire Egress. Effects on the extent & maintainable quality of forest roads.	1	2	3	3
Wildfire Control – tactical suppression. Provision of equipment access & staging, backfiring opportunity.	1	2	2	3
Firefighter Safety. Provision of shaded fuelbreaks, modified fuel zones.	1	2	3	3

Figure 2: Wildfire and Forest Fuel Attributes

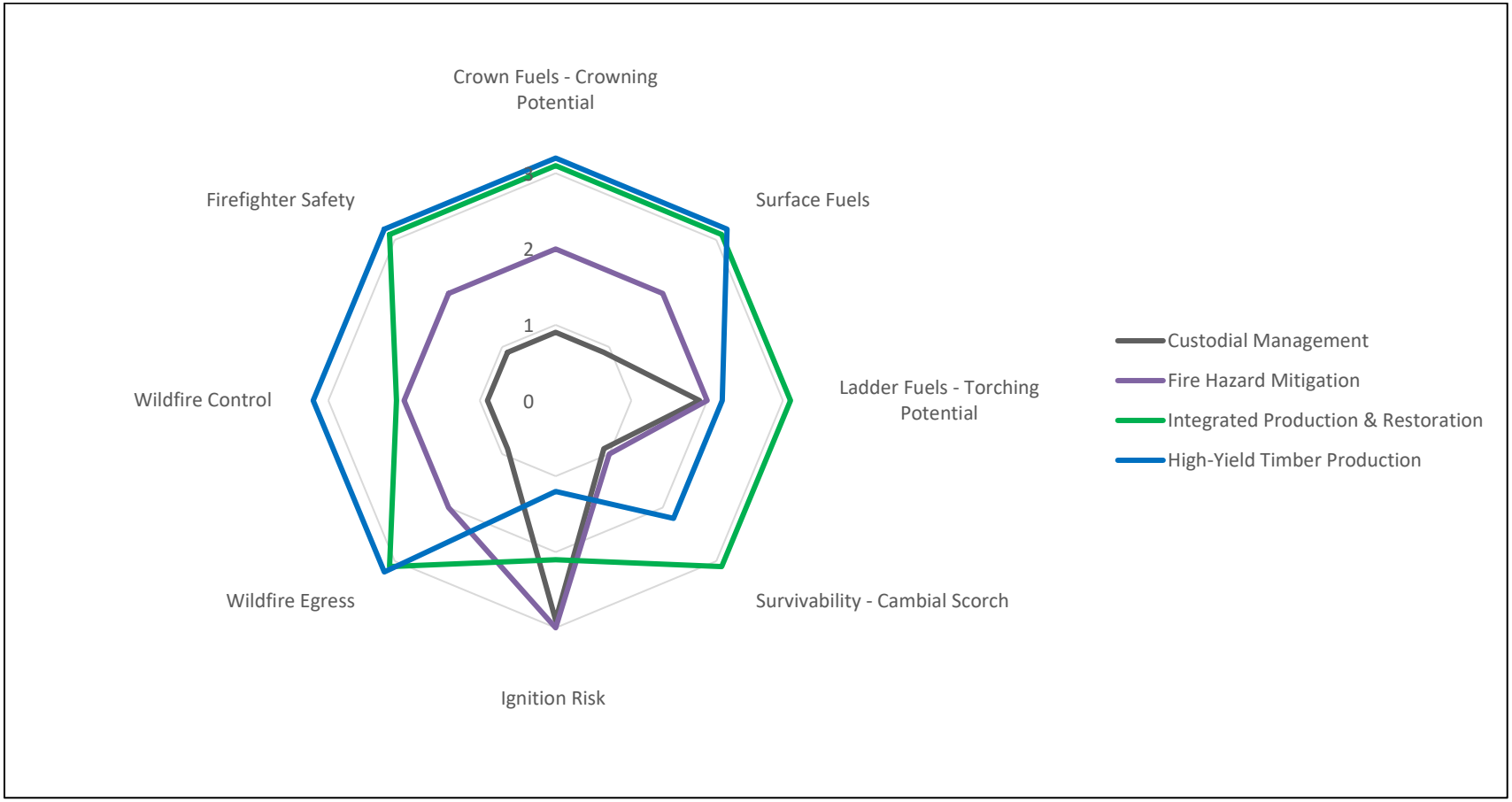


Table 2.3: Carbon & Climate Adaptation

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Attribute	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Climate Resilience. Effects on forest complexity (vertical structure, spatial heterogeneity, species composition), with implications for ecosystem resilience to uncertain changes in climate.	1	2	3	2
Drought Resistance. Forest density and biomass volume, with associated competition for available soil moisture.	1	2	3	3
Carbon Aggradation Rate. Maintenance of high rates of durable biomass accumulation via control of stand densities and high rates of tree volume growth.	2	2	3	2
On-Site Carbon Storage. Banked carbon stored on watershed lands within live trees, snags, CWD, and soils.	2	2	3	2
Off-Site Carbon Storage. Carbon stored remotely in the form of durable forest products.	0	0	2	3
Anthropogenic Carbon Emissions. Acute carbon emissions directly associated with management practices – internal combustion engines, pile burning, broadcast burning.	3	2	1	1

Figure 3: Carbon and Climate Adaptation Attributes

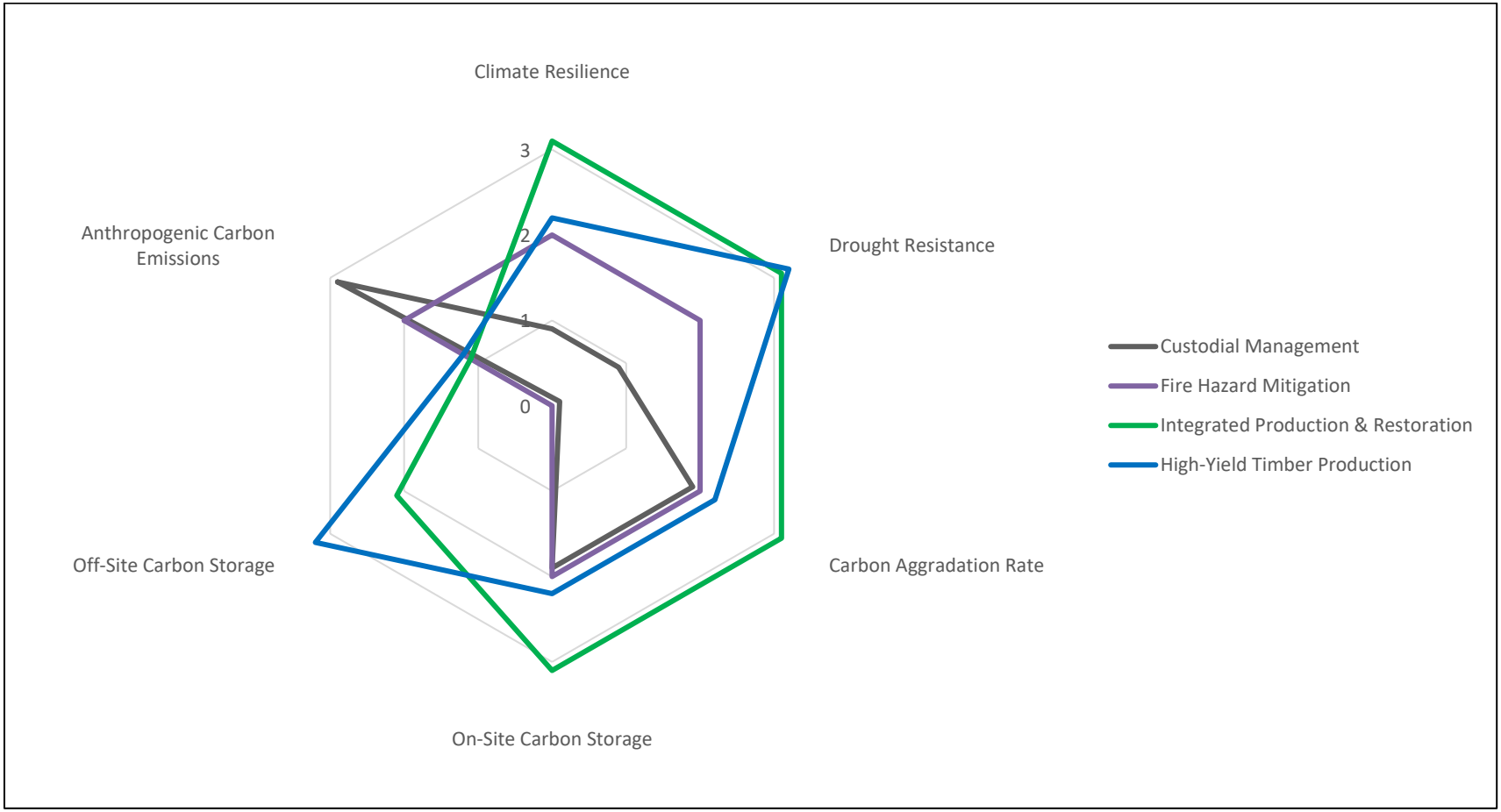


Table 2.4: Ecological Quality

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Attribute	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Structural Complexity. Effects on elements of forest complexity, including vertical structure, spatial heterogeneity, species richness and diversity.	1	2	3	2
Understory Plant Diversity. Attributable to the penetration of subcanopy sunlight via canopy cover regulation, and by the scarification of mineral soil that promotes recruitment.	1	2	3	3
Old-Growth Facilitation. Acceleration of stand dynamics; promotion of development through stem exclusion and understory re-initiation stages via silvicultural treatment.	0	0	3	2
Dominant Tree Size. Potential tree growth unlocked by density management and silvicultural forest restoration treatments, but adjusted by commercial utilization level.	1	1	3	2
Durable Snag/CWD Recruitment. A derivative of Dominant Tree Size; durability (persistence) is positively associated with stem size.	1	1	3	2
Habitat Niche Diversity. Potential utilization of diverse niches generated by the collective of ecosystem structural elements listed above.	1	1	3	2
Forest Health. Integration of tree vigor as influenced by stand densities.	1	1	3	3
Riparian Forest. Integrity and resilience of special riparian forest communities via active management of growth and recruitment.	1	1	3	3
Fire-Dependent Communities. Activation of prescribed burning opportunities for the restoration and promotion of fire-dependent plants and associated fauna.	1	2	2	2

Figure 4: Ecological Quality Attributes

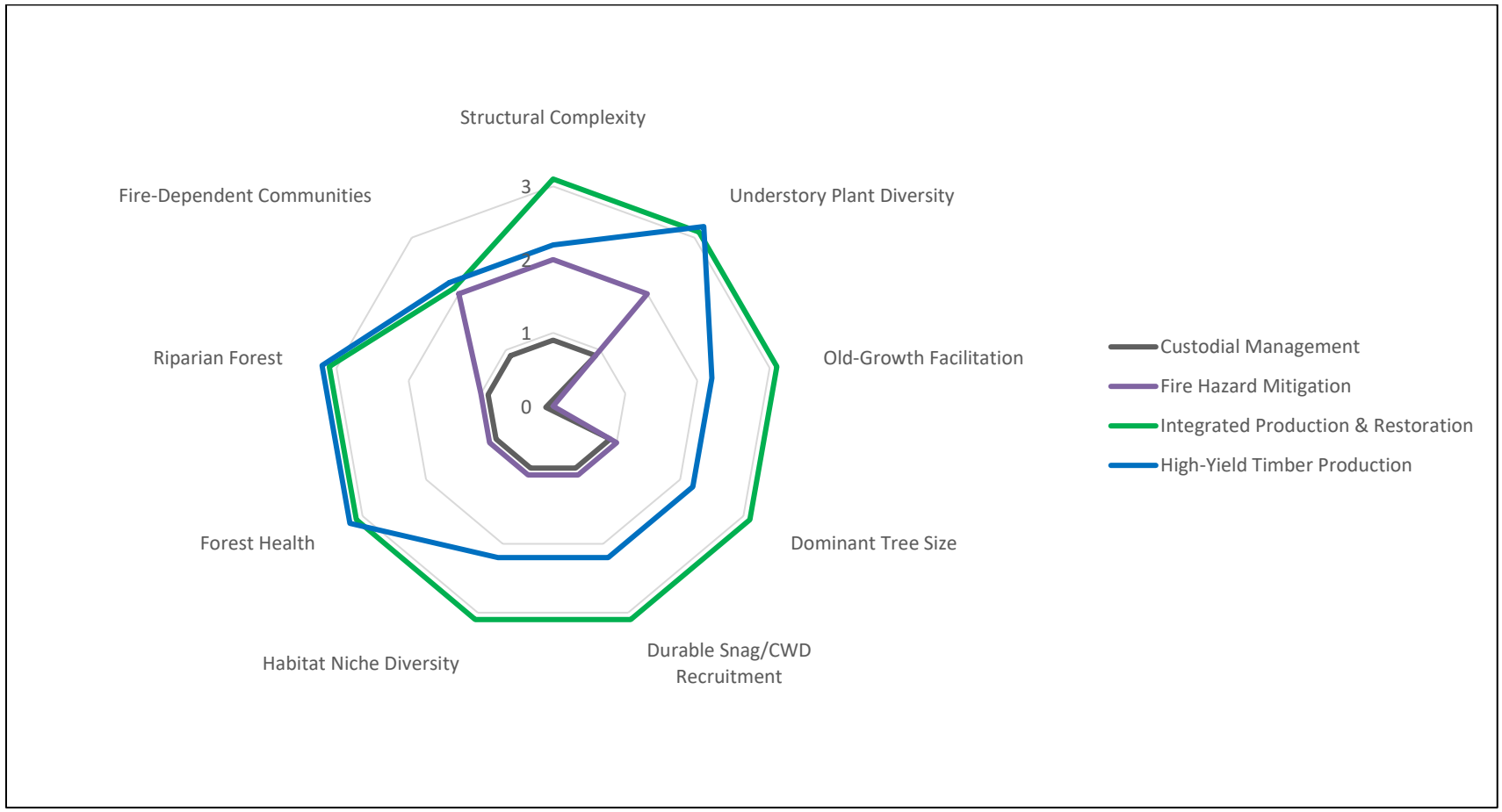


Table 2.5: Economic and Social Viability

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Attribute	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Inputs – Investment Costs. Up-front investment in the development of access roads, haul roads, log landings, and other infrastructure elements necessary for timber management regimes.	3	2	2	1
Revenues – Returns on Investment. Sustainable revenue stream associated with sustainable commercial timber management, with harvesting magnitude determined by the weighting of utilitarian objectives relative to other objectives. Scores assume continued strong demand for Santa Cruz Mountains redwood lumber, and the climate to support it.	0	0	3	3
Conservation Easement Potential. Possible easement held by land trust on conservation merits, role as working forest, or other.	2	2	3	2
Carbon Offsets Project Potential. Viability for partnering in a collective multiparty carbon offsets project.	2	2	2	2
Societal Constraints. Public perceptions and possible conflict; effort required for positive public engagement.	3	3	2	1
Management Complexity. Breadth of activity and infrastructure requiring planning and maintenance.	3	2	2	1
Staffing Requirements. Sustained demand for qualified employees or contractors with expertise in forest planning, timber sale administration, regulatory requirements, etc.	3	2	2	1

Figure 5: Economic and Social Viability Attributes

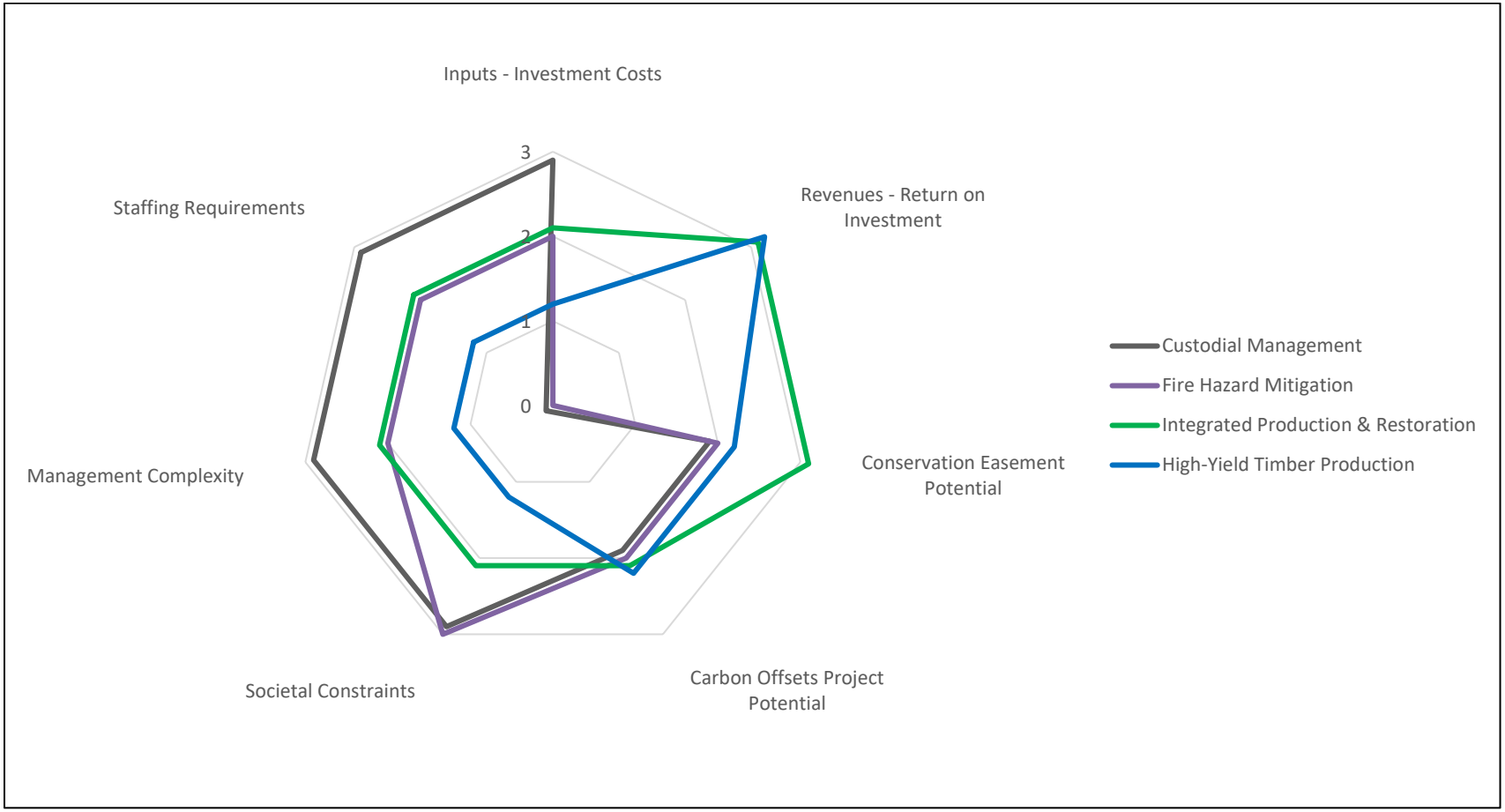
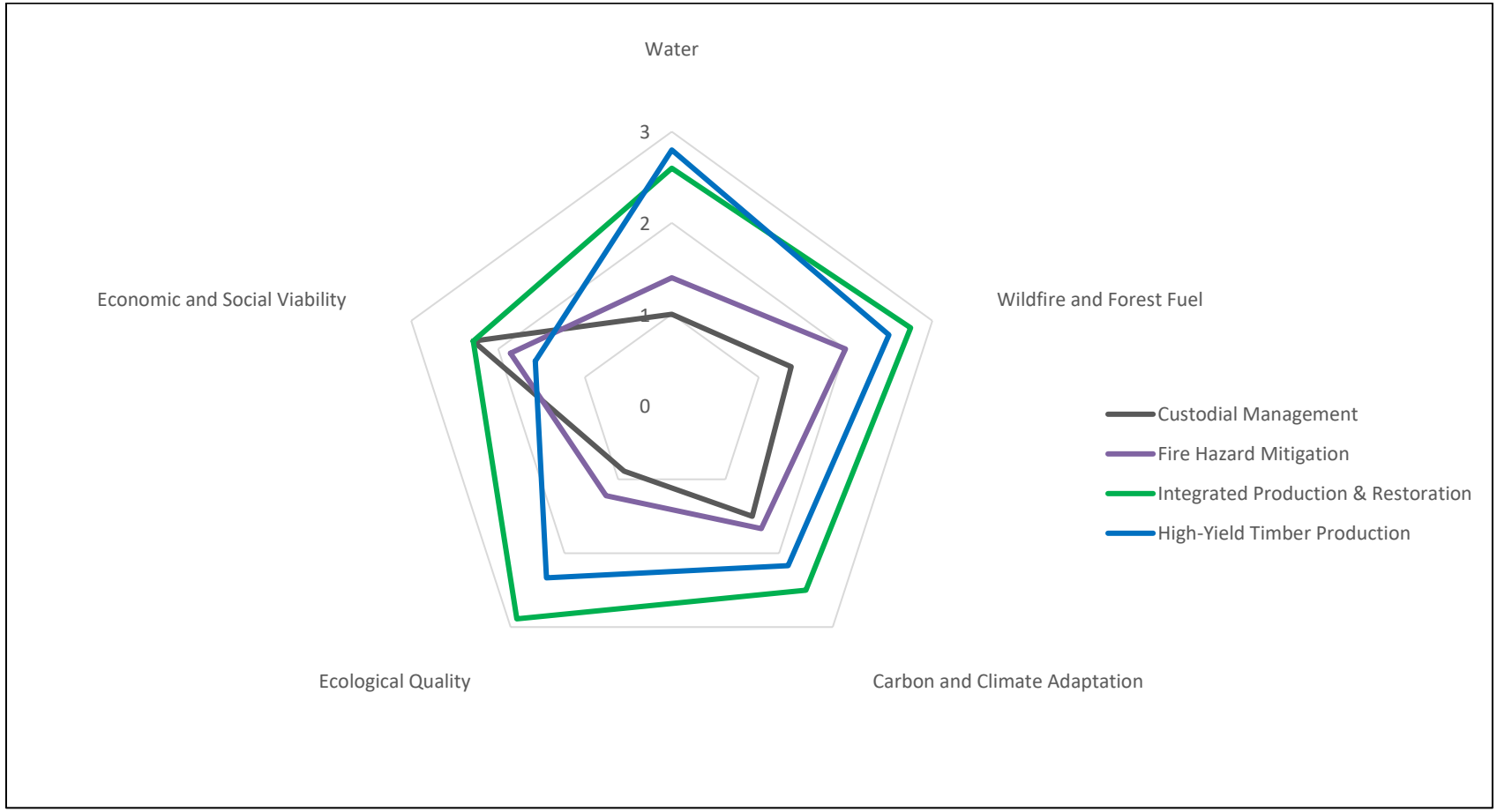


Table 2.6: Aggregate Scores

Score: 0 = No Benefit / Not Applicable; 1 = Low Benefit; 2 = Moderate Benefit; 3 = High Benefit

Evaluation Criteria	Custodial Management	Fire Hazard Mitigation	Integrated Forest Production & Restoration	High-Yield Timber Production
Water	1.0	1.4	2.6	2.8
Wildfire and Forest Fuel	1.4	2.0	2.8	2.5
Carbon and Climate Adaptation	1.5	1.7	2.5	2.2
Ecological Quality	0.9	1.2	2.9	2.3
Economic and Social Viability	2.3	1.9	2.3	1.6
Average of Aggregate Scores	**1.4**	**1.6**	**2.6**	**2.3**

Figure 6: Aggregate Scores



Recommendations

Recommended Management Option: Integrated Production & Restoration

Each of the Options that we evaluated represents an improvement over a passive land management strategy, and each is realistic. However, they are unequal in meeting the City's objectives for the watershed lands. Previous sections described and evaluated the options and their attributes. With this section we synthesize those in a presentation of the four management options, in ranked order from most to least recommended.

The Integrated Production & Restoration Option scored the overall highest among the options (Figure 6) and is the one we recommend most highly. This option consists of a level and range of active management practices that have the highest potential to fulfill the City's objectives, including water quality protection, wildfire threat reduction, and habitat restoration, while producing revenue that would likely be sufficient to underwrite those activities. This option assigns management practices to different areas of the watershed lands, based on their past management history, current condition, and future potential.

Resumption of a timber harvesting program via the application of previously employed silvicultural strategies, limited to the areas where these were applied, ensures the high likelihood of successful forest production, regeneration, and stand development. On the west side of Loch Lomond Reservoir and in much of the Zayante Creek tract, previous management has produced well-balanced, uneven-aged stands that are predisposed to the sustainable implementation of single-tree selection silvicultural systems. Proposed harvesting levels are well below annual growth increment, ensuring sustainability of the regime as well as the accumulation of carbon stocks and the advancement of desirable late-seral forest condition attributes. Harvesting would be limited to areas already subjected to past harvesting that are well suited to the cost-effective resumption of harvesting, with well-developed infrastructure (roads, log landings, and skid trails) that requires minimal improvement prior to its utilization.

Within the areas managed for timber harvest, wildfire hazard would be addressed on several fronts. Active management would serve to continuously limit aerial fuel loads, reduce and/or flatten surface fuel loads, and boost individual-scale thermal resistance to bole scorch. A greater extent of more-effective shaded fuel breaks and ridge roads would assist fire suppression capacity, increasing the breadth of fire suppression options as well as increasing firefighter safety and improving forest egress during wildfire events. Areas of planted conifers would receive fuel reduction and thinning treatments and would be brought into the timber production cycle.

Periodic entry for timber harvest would ensure the ongoing maintenance and improvement of roads and stream crossings, in turn controlling sources of sediment. Active management of riparian forests as resilient stream buffers would ensure their structural development and sustainability over time, retaining protective attributes while controlling stand densities and preventing conditions that predispose riparian forests to low vigor or high fuel loading. Reducing wildfire hazard, boosting fire suppression capacity, maintaining high-quality roads and stream crossings, and increasing the sustainability of riparian forests all together serve to protect water quality against its most severe threats. Any near-term concerns over water quality associated with periodic timber harvesting entries can be abated with proper road, skid trail, and forest harvesting practices. This option avoids the additional construction of roads into currently-roadless areas.

Within the east side Loch Lomond Reservoir conservation reserve, non-commercial silvicultural treatments would assist structural development, promote tree vigor and longevity, foster late-seral forest conditions, and reduce wildfire hazard. This restoration program would create, over time, a large area of restored forest that would gradually regain old growth character, with attendant benefits for resilience, carbon sequestration, improved aesthetics (including in and around the recreation area), and rare species habitat.

This option would potentially provide multiple sources of revenue. There is a large volume of highly valuable, readily accessible redwood timber within the areas designated for timber harvest that would provide a steady revenue stream. The commitment to place a large part of the forest in conservation reserves would add value to a conservation easement, and make acquisition of an easement attractive to land trusts. Compared to the other options, the Integrated Production & Restoration Option would sequester more carbon, both in the conservation reserves and in the timber management areas, increasing the financial feasibility of a carbon project.

By integrating a variety of advantages while minimizing deficiencies, this option stands apart from the others and is the most highly recommended.

The High-Yield Timber Option represents the highest level of active management that is practical for these lands, focusing on the management strategy that has the highest potential for producing a steady net revenue stream, while remaining focused on the objectives of water quality and wildfire threat reduction. Overall, this option scored highly in the evaluation, but the aggregate scores were for the most part below the Integrated Production & Restoration Option. To extend timber production into areas not previously managed for this purpose, especially the east side of Loch Lomond Reservoir, this option requires the development of new infrastructure, including roads, which could degrade water quality, particularly in the short-term. Because the forest stands that would be accessed with the new infrastructure have not been treated in the past, it will take multiple entries before they are in a condition that yields timber quality and volume that is comparable to previously managed areas (those that are emphasized by the Integrated Production & Restoration Option). Moreover, the capital costs of building new infrastructure suppresses the net financial return in the short term, and the extended road system would require fixed annual costs for maintenance and patrol. The high level of activity would bring a requirement for elevated staffing, as well. Overall, the eventual financial gains of this option are not merited by the management burdens, and this option is recommended secondarily to the Integrated Production & Restoration Option.

The Fire Hazard Mitigation Option represents an upgrade to the status quo, with an expansion and intensification of fuel reduction treatments and fire suppression facilitation practices. By focusing on reducing the threat to water quality from catastrophic wildfire, without introducing practices such as road building and timber harvest that could impact water quality, this option scores highly in its ability to meet the primary goal for management of the watershed lands. Fuel reduction treatments would be focused on surface and ladder fuels, and extension of shaded fuel breaks and ridge roads would inhibit the spread of wildfire and aid in suppression efforts. This option does not, however, include active management of structural forest stand attributes such as spacing, canopy structure, age diversification, and species composition that dictate stand development patterns, stand densities, and tree growth and vigor. Consequently, there would be limited progress toward the objectives of climate resilience, carbon sequestration, and development of late seral habitat. Active management would be limited to non-commercial treatments that incur costs but generate no revenues. While there would be the potential for a conservation easement and a carbon project, the lack of emphasis on restoration of late seral and rare

habitat, and the limited potential for carbon accumulation, would inhibit the monetary value of either. Presumably, this strategy would rely on the episodic availability of federal, State, and other grants, and grant writing, management, and reporting may require additional staffing for the Water Department. The episodic nature of grant availabilities and applications implies an inconsistent and variable, piece-meal implementation of practices, while presenting challenges related to retaining necessary expertise on staff. This option suffers in comparison to the Integrated Production & Restoration and High-Yield Timber Options, yet it represents an upgrade over the Custodial Management Option, as indicated in the evaluation tables and graphs.

The Custodial-Management Option (retaining status quo) is a stopgap strategy that does no harm, and helps retain the integrity of roadways, roadside stands, and water crossings, but overall has a minimal impact on meeting the Water Department's objectives. This option provides little mitigation of wildfire hazards, mainly limited to aiding fire suppression capacity along existing roads. That modest and selectively located passive management strategy enables no active management of stand structures for alteration of either surface or aerial fuel loads, and no stewardship of stream buffers or fostering of the development of late seral conditions. Over time, fuel loads can be expected to continue to grow, increasing the susceptibility to high-severity fires. Combined with landscape homogeneity, the risk of catastrophic wildfire exposes the water supply to unacceptable potential for watershed-scale sedimentation through runoff and/or mass wasting, as well as thermal contamination. Poorly developed forest stands in roadless areas will continue to increase in density and decline in quality. We do not consider this option a viable strategy for meeting the City's goals for management of the watershed lands, and it is least recommended.

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APPENDIX A

Forest Management Issues Discussed in Interviews

CITY OF SANTA CRUZ WATERSHED LANDS

Forest Management Issues Discussed in Interviews

Prepared for: **City of Santa Cruz Water Department**
By**: Sicular Environmental Consulting and Natural Lands Management**

September 2020

Forest Management Issues Discussed in Interviews

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CITY OF SANTA CRUZ WATERSHED LANDS

Forest Management Issues Discussed in Interviews

Introduction

In May and June 2020, Christopher Keyes and Dan Sicular of Sicular Environmental Consulting and Natural Lands Management conducted telephone and videoconference interviews with fourteen people involved in various aspects of forest management, with experience pertinent to our exploration of opportunities and constraints for the future management of the City of Santa Cruz watershed lands. Chris Berry of the City of Santa Cruz Water Department joined us for several of the interviews. The interviews are included in our Scope of Work, Task 2, Data Gathering and Consultations. The purpose of these conversations was to assist us in developing a better sense of the goals for future management of the watershed lands, the range of feasible management strategies, and the perceived major opportunities and obstacles to various management strategies or methods. This document summarizes major points and issues discussed in the interviews.

Interviewees, and their affiliations, included the following:

Steve "Slim!" Butler, City of Santa Cruz Consulting Forester
Hon. Donna Meyers, City of Santa Cruz City Council
Janet Webb, Big Creek Lumber
Max Moritz, University of California, Santa Barbara
Andrew Stubblefield, Humboldt State University
Scott Stephens, University of California, Berkeley
Mark Andre, City of Arcata
Jason Teraoka, National Park Service, Forester, Redwood State and National Park
Lathrop Leonard, California State Parks, North Coast Redwoods District
Tim Hyland, California State Parks, Santa Cruz District
Tim Reilly, California State Parks, Santa Cruz District
Rich Sampson, Cal Fire
Laura McLendon, Sempervirens Fund
Richard Campbell, Save the Redwoods League

Issues discussed in the interviews are arranged below by topic and subtopic.

1. Water Supply, Water Quality

City of Santa Cruz Water Supply

- Loch Lomond reservoir is an essential part of the City's water supply, but many residents do not realize this.

- The City is very fortunate to have a good, reliable, local source of water.

- Any consideration of a change in management regime for the watershed lands must consider protection of the quality of the water supply, reducing wildfire hazard, and protecting and enhancing the environment, particularly in the context of new threats from climate change.

Forest Management and Water Quality

- One key to maintaining water quality is avoiding catastrophic wildfire. To the extent that the forest management regime reduces fire hazard, it may be compatible with the goal of maintaining water quality.

- If timber harvest targets larger, more fire-resistant trees, leaving smaller trees and substantially opening the canopy (resulting in a spate of brushy growth) this will work against the goal of reducing fire hazard.

- Local production of timber products is beneficial, from a climate change mitigation perspective: local products consumed locally have a lower carbon footprint; fewer emissions = less warming, lower fire risk. Also, California Forest Practice Rules are more protective of the environment than just about anywhere else, so the impact of logging is likely to be lower here than elsewhere.

- While roads used for forest management can negatively impact water quality, properly located, built, and maintained roads minimize the impact. If there is a demonstrated history of the roads not degrading impacting water quality, this points to good geomorphic stability. It is very important to have properly built and maintained crossings, with properly sized culverts, rocked roadway, critical dips, etc. It is also important to do remedial work after an entry, including revegetating landings, installing water bars or dips, etc. Roads should be inspected during storms when problems are beginning to become evident, and can be addressed on the spot with minor work, before they turn into major problems.

- State Parks has not monitored water quality response to their prescribed burning. They figure that low intensity fire prevents high intensity fire, and is therefore beneficial for water quality. They suggest using macroinvertebrate monitoring, but they have not been able to initiate a monitoring program.

- Several studies point to short-term impacts of timber harvest activities on water quality (especially the first winter after a harvest), but with rapidly diminishing effects after the first year.

- In Humboldt County, the RWQCB limits harvest to a maximum of 2% of the watershed area per year, to avoid changes to the evapotranspiration regime.

- In Redwood National and State Parks, the road removal program is focused on roads with higher sediment threat, particularly riparian roads. Ridge roads tend to be maintained. Monitoring shows that road removal typically results in a 1 to 2-year spike in sedimentation, then it levels out.

- Restoration thinning projects in Redwood National and State Parks are designed to reduce impacts on water quality. They maintain riparian buffers and have specific thinning prescriptions

for swales, class 1,2, and 3 streams. They have a huge monitoring record, and have not detected a negative water quality response to thinning.

- Thinning reduces competition, but is assumed not to affect water yield – it probably reduces water stress, but available water is probably taken up by the residual stand (which may itself reduce the stand's flammability, so there may be a fire hazard reduction benefit, and an indirect water quality protection benefit). But the degree to which this happens is not known.

- If the main goal is to protect water quality, the most important management actions may be those that protect the integrity of the riparian buffer. If the riparian is intact, thinning treatments, timber harvest, fire, other disturbances (except large debris flows) may not much affect water quality.

2. Watershed Lands

Condition of the Watershed Lands

- Ridgetop fire trails throughout the watershed lands are open or operable. Primary and many secondary roads have shaded fuel breaks (SFBs). For the most part the SFBs are narrow – mostly 20' wide or so – and are intended to reduce the densest brushy growth along roads. These are maintained, with additional clean-up of new brush growth 4-6 years after the original installation.

- Trespass: all entries are gated, have security cameras, and are patrolled. There are frequent gates along roads, so even if someone gets in, they cannot just drive around.

- There is quite a bit of Sudden Oak Death (SOD) on the property. There are areas where Douglas-fir has evidently been displaced by tanoak (fir stumps are present, but no trees).

Conservation Value of Watershed Lands

- The watershed lands represent some of the largest unfragmented parcels in the Santa Cruz mountains, and they are located close to or adjacent to other protected lands.

History of Management of Watershed Lands (Operational)

- Prior to 1999, there was a timber harvest on the watershed lands every year. The 1999 THP was laid out, and went to Council for approval (all THPs went to Council for approval), but was never approved.

- The management approach was to treat each redwood clump as a little forest, and the aim was to achieve a desirable age/size class distribution (3-4 age/size classes) and good spacing within each clump. The general guideline for marking trees for cutting was to count the number of trees in the 20+" diameter class, and divide by 2 (rounding down), and that was the maximum number they would take. They would then select trees for cutting so that the remaining trees moved the clump toward the goals of good spacing, size class distribution, and "thrifty" form. Entry was on a 14-year cycle. Almost all the conifer-dominated stands in the Newell Creek (west side of the reservoir) and Zayante Creek tracts were cut twice.

Politics and Public Relations of Management of the Watershed Lands

- In the current politics of Santa Cruz, social equity concerns are at least as salient as environmental concerns.

- There is more consciousness of the potential benefits of active forest management than there was 20 years ago.

- If commercial logging is considered as a part of a management strategy, there is a danger of it looking like the City is rushing to sell logs. Any sale of timber should be seen in the context of the City's goals of protecting and improving water quality, and protecting and enhancing the environment. If money can be made while attaining these goals, okay – but more as a consequence, than a goal in itself.

- Current City policy requires any revenue from timber harvest to be put back into management of the watershed lands.

- Cutting trees can have legitimate ecological purposes – restructuring the forest to mimic or put it on a track to achieving late seral structure; increasing diversity of habitat. Cutting trees to achieve explicit ecological objectives is perhaps more of an acceptable goal, than cutting trees for money.

- In considering any management strategy that involves cutting of trees, there is the need for outreach and compromise. It is necessary and desirable to give people an opportunity to be heard.

- The Arcata Community Forest, owned and managed by the City of Arcata, provides several lessons that may be applicable to the watershed lands. Management of the ACF includes regular timber harvest. Timber harvest operations get few complaints from the public. The City has worked hard to achieve that. Residents have come to understand that harvest operations are short-term, and that the City does a good job of clean-up afterwards. People see the City expanding the boundaries of the ACF via acquisitions, also improved recreational access, and understand that forest growth exceeds what is harvested. The City does not close trails and roads during timber harvest, but instead has workers posted at each end to hold up traffic; this provides an opportunity to discuss the project and policies with the public. There is knowledge among the public of benefits of timber harvest revenues, including purchasing parkland. Media relations are key, especially newspapers. City staff have cultivated relationships with long-time reporters. (TV more difficult, as reporters tend not to stick around, so difficult to build relationships). The City provides game cam footage of wildlife in the ACF to the media, which they use for popular features. It is critical to get the environmental community involved, seek their input and eventually their buy-in. The City's forest policy is based on a 3-legged stool: ecological, economic, social. The City just updated their Forest Management Plan and CEQA document. They are always striving to improve management.

Possible Sources of Funding for Watershed Lands Management

- California Forest Improvement Program (CFIP) offers cost shares for forest management planning and implementation.

- California Climate Initiative (CCI) Forest Health/CCI Forest Improvement grants are available.
- Federal money is being routed through the State Firesafe Council.
- The US Forest Service has a grant program funding creation of small community forests with multiple benefits: Community Forest Program – https://www.fs.usda.gov/managing-land/private-land/community-forest/program. The program requires fee title, does not fund conservation easements; requires public access; funds up to 50% of project cost, including land acquisition.

3. Fire and Climate Change

Fire History/Risk of Watershed Lands

- The Newell Creek tract is on a north-south trending ridge between the northern summit area above Boulder Creek, and any fire coming out of the Los Gatos area. There are a lot of illegal grows (regarded as enhanced fire risk) in this area. If a fire gets started, such as the 2017 Bear Fire, it could blow south toward Ben Lomond. Given existing fuel loading in much of the area, a fire would be very damaging.
- The 2008 Martin Fire in Bonny Doon got into the Laguna Tract, and went all the way to the creek, though it burned at low intensity, and had beneficial effects, particularly in the sandhills. The Water Department's post-fire monitoring showed no deleterious effect on water quality.

Fire History of the Santa Cruz Mountains

- The 2009 Lockheed fire burned through redwood forests, including burning crowns. This fire was perhaps more severe than one would expect in a redwood forest. It occurred during a high wind event and burned through mixed vegetation – oak, chaparral.
- The 1948 Pine Mountain fire was a "mixed intensity" fire, with higher intensity burn associated with Monterey Pine stands.
- Cal Fire has fire history maps and good information going back to 1960, including GIS layers. Some historical information is contained in master's theses. Cal Fire also has incident reports back to 2005, but not much before that.

Fire in the Redwoods Generally

- The southern redwoods are drier than the northern redwood forest. They have the potential to carry fire; often high litter loads; and higher Douglas-fir and tanoak components, which can make fire more volatile. Douglas-fir in particular has different fire behavior than redwood – it has the ability to torch. Smoldering duff fires can be damaging – certainly kills understory easily, and can damage redwood. There are no insect pests of redwood, so there is not secondary damage after a fire. SOD has a big impact in redwood country, with potential to increase the flammability of the forest, but there is conflicting information on that. SOD might extend the seasonal burn window. Tanoak litter is flammable; carries fire "nicely." In shrub form, tanoak can form a continuous understory that torches like crazy.

- Interface of forest and open areas (balds) appear to be a particular concern for fire hazard. These ecotones are probably the most hazardous, with ladder fuels, high flammability, high levels of fuel accumulation.

- In the past, there was a misconception that redwood forests don't burn. It is even possible to have stand-replacing fires, in patches, like 50 acres. The conditions must be right (wrong) for this: seasonal window, north wind event. Otherwise, most fires in the redwoods are pretty benign surface fires. If fires spread beyond about 30 acres, you may see some areas of intense burning.

Climate Change in the Redwood Forest

- Climate change – the context for forest management is changing. Does this point to the need for more active management? The rainy season is shorter. There is increased threat from wildfire. Climate change becomes the story line as to why things are different from 20 years ago.

- The answer is not yet in on effects of climate change on the redwood forest. Will it become drier, leading to poorer site, making the forest more prone to catastrophic fire? Is there a carbon fertilization effect with increased atmospheric CO_2?

- Some redwood stands are probably on the fringe of where redwood can grow. Those areas are likely to become more vulnerable, less manageable as redwood lands as the climate changes.

- Are we managing the forests to allow transition to the next type, or trying to hang on to the climate and forest of the past? Timescales of resilience: in the short term, whether talking about sea level rise, fire, whatever, the typical response is to try to buffer effects of change. Longer term, it may be more productive to think of adaptation and accommodating change. What is the most likely future condition? How can this be accommodated? Is this consistent with the desirable future condition?

- Already, fog and precipitation are less steady. This has likely increased fire hazard. Yet, foliage of redwood does not burn readily. It takes a pretty dry day to get the understory to burn at all – just a little fog, even in young second growth, prevents duff from burning. So the big question is, how will the precipitation regime, and the fog regime, change?

Effects of Management Activities on Fire Hazard

- There is a desire for a win-win-win strategy to reduce fire hazard, increase carbon storage, increase water yield, protect water quality. But there are not a lot of extant examples, and little conclusive research on how to achieve this. If you optimize forest management for reducing fire, this does not automatically achieve these other goals.

- Activity fuels (slash and other vegetative matter from logging operations) tend to decompose pretty quickly in the redwood forest, absent drought. Small amounts of activity fuel on the ground probably do not substantially increase hazard. Elevated hazard tends to last for 1-2 years.

- Management of the understory is the key to reducing fire hazard. If management addresses understory conditions (fuel loading, ladder fuels), one may argue that you are reducing the intensity of any subsequent wildfire. Single tree selection, with lop and scatter or pile and burn

slash treatment, typically does not much affect the understory, so it is difficult to make that argument. It would require an explicit prescription to address the condition of the understory.

- Active management tends to benefit fire suppression operations. The watershed lands have valuable timber, but also some areas that are very vulnerable to fire, especially ridge tops and chamise/knobcone areas. Keeping roads open enhances fire suppression capacity. Specific fuel reduction projects also help. A lack of income from the watershed lands makes this difficult to keep up. Income from, e.g., timber harvest, could be used to reduce fire hazard (currently, City policy requires use of any income from the watershed lands to be used to manage the properties).

Prescribed burn

- There is a new prescribed fire council organization in Santa Cruz - Monterey-Santa Cruz UC Cooperative Extension Range advisor – Avey Row – they just got a grant to start-up a prescribed fire "node" in a broader network (http://www.norcalrxfirecouncil.org/). This effort is being spear-headed by UC advisors. They use a private "burn boss" instead of Cal Fire. Agencies won't usually get involved unless there is a distinct fire hazard reduction angle.

- In areas that are dominated by redwood, prescribed fire is possible. These are smoky fires – due to high moisture of duff and litter – poor combustion, so tremendously smoky. In terms of effects on water quality, burning limited areas – 20% or less of a watershed – should minimize WQ impacts. But it would be smoky. The concept of "reclamation fire" – reclaiming it for burning. It is possible to burn off the shrub layer, maintaining the duff, if you burn in late spring or early summer, when the duff is still wet, but when 1- and 10-hour fuels are relatively dry. May be a benefit for water quality, as maintenance of some of the duff reduces post-fire erosion.

- Broadcast burning: Cal Fire has been tasked to do it, but has not been able to do much beyond Big Basin, and it's been 4 years since they had a good burn there. They are changing to winter and spring burns in drier years, pre-treated with crushing or other treatment to reduce fire hazard. Air Quality regulations enable it in Santa Cruz, but not in San Mateo. There is a question of the feasibility of broadcast burning in the Zayante Creek and Newell Creek tracts, because of the proximity to other properties. Target areas for prescribed burning are along ridges, or in tanoak, to break-up the continuity of fuels.

- Lake Tahoe study of effects of fuel reduction treatment on water quality: (https://www.fs.fed.us/psw/publications/knapp/psw_2016_knapp003_harrison.pdf). Prescribed burning in the spring resulted in a patchy, uneven burn. It succeeded in breaking-up the continuity of fuels; there were still islands of duff to slow erosion, which reduces sediment delivery to the lake. In treated areas (including masticated areas) fire behavior calmed down, then popped up on other side, in untreated areas. Patchiness is key. Erosion will occur in areas of bare soil; the question is, will something intercept it before it reaches the waterway? Masticated areas serve as barriers to erosion. In areas where mastication resulted in a thick layer of material, it could still burn, and could still cook the cambium of leave trees. So it might be beneficial to use mastication in a patchy way, to break up the continuity of a subsequent burn. It is hard to say how much of a masticated duff layer is enough, but generally it does not take much to slow erosion.

State Parks – Santa Cruz District Prescribed Burn Program

- The prescribed fire program started in Big Basin with the goal to reduce fuels to protect old growth redwood, as well as to reintroduce fire as an ecological process, to initiate the complexity you get from fire on the landscape. This is an attempt to mimic pre-settlement fire regimes. While prescribed burn does result in reduced fuel loads, the main goal is ecological. The program has now been going for 30+ years. State Parks was burning in Big Basin about every other year, but not so much lately; it has become increasingly challenging to burn there. They have expanded the program to include grasslands at Año Nuevo and Wilder Ranch SP, and into sandhill chapparal at Henry Cowell and Wilder. They have been able to do burns in these vegetation types just about every year. Some burns have also been done in the understory of mixed forest. Now they are looking at black oak woodlands on the ridge at Castle Rock to control Douglas-fir invasion. Parks is using fire substitutes where impractical to burn, including masticator and hand crews.

- Work windows for prescribed burning: State Parks has burned in the fall, after a little rain, in the old growth stands in Big Basin. Though Cal Fire has been willing to consider burning pre-rain (a lot less risky to burn going into the cool wet winter, rather into warm dry summer). Chaparral and grass burns occur in the spring.

- Partnering with Cal Fire, there are overlapping goals – Cal Fire's goal is primarily fuels reduction, State Parks' goal is ecological. Partnering with Cal Fire allows for bigger projects, with more labor and equipment (State Parks has its own small fire department, so they can manage smaller burns themselves). Typically, State Parks and Cal Fire each write their own burn plan for the same joint project.

- Burn unit size: in old growth redwood, they were laying out 300-acre plots for a while, then went to 100; now they may be heading back to larger plots again. In grasslands, it really depends on the size of the grassy area. These burns extend to the edge of the forest. They burn grasslands about every 3 years. Chaparral plots are typically around 15 acres, but they are looking at larger plots up to 30+ acres. As they move to wildland-urban interface (WUI) areas, plots need to get smaller. In new areas, it is a 10+ year effort to prepare for larger fires, by burning-in strategic breaks along ridges. They may start small, and use those first burned areas as anchor points for bigger blocks later. It is very labor intensive, especially when there is the need to pre-treat fuels, as in chapparal stands. The willingness of Cal Fire to take on larger projects is largely at the discretion of individual battalion chiefs.

- Burns are not always within a single vegetation type – e.g. at Big Basin, chaparral and redwood. Especially if partnered with Cal Fire, more labor and equipment are available, so this is possible. But it is easier to burn within a single vegetation type, due to different moisture conditions, which enables them to limit fire spread.

- Edge effects: these are "prescription" burns, based on conditions within and around the targeted plot. They do not burn when it is judged too risky or hot; they burn when fuels outside the plot are unlikely to ignite, those within the plot are likely to burn. Edges of grasslands: in the first few years, the fire goes out at the forest edge, where it encounters wet fuels. After repeated burnings, they get more carry of fire into the forest, as more light has been let in, and so there more flammable dead material from previous scorching.

- Ecological response: the most striking thing is in sandhill chaparral: the trickiest veg type to manage for simultaneous fuel reduction and biodiversity, given that it is adapted to infrequent, high intensity, stand-replacing fire, exactly what fire suppression attempts to avoid. The issue is in chaparral that is overtopped by mixed forest types: you need a pretty hot fire to maintain it. They have been able to accomplish this in Big Basin, with fall burns. (Recent masters thesis in Big Basin looking at fuels response to fire). Their goals are to reduce tanoak and reduce fuel loads. Fire is important in redwood for initiating cavities, etc. Grasslands burns have been successful: at Wilder, they have not turned these areas back to wildflower fields, as they had hoped (due to competition from annual grasses), but they have restored structural components of coastal prairie. They have succeeded in maintaining a very diverse coastal prairie at Año Nuevo (the burns there are to control gorse). Relatively recently, they have been burning in oak woodlands, to attempt to control Douglas-fir invasion.

- Fires in old growth stands result in mortality of some old growth trees. They have no data on initiation of cavities, but they are definitely seeing more complexity and diversity in burned areas. There was a suggestion that they could do pile burning in the middle of fairy rings to try to initiate cavities, and kill some of the smaller stems. Fairy rings tend to accumulate fuels anyway, so there is the potential that these would be high severity fires. They proposed a project in Nisene Marks years ago that would have involved thinning out 12" DBH and smaller trees, placing them in the center of a fairy ring, and lighting them on fire. The project did not get funded.

- Pile burning – the poor stepchild to broadcast burn, but with proper pile size/structure, pile burning offers some ecological value in forested areas. In grassland, piles tend to cook seed bank of forbs and native grasses, so they are avoided there.

- Grasslands are shrinking; the goal of burning in grasslands is to kill the encroaching shrubs. They follow-up in the fall with herbicide to suppress re-sprouting shrubs (coyote bush). It is very difficult to control re-sprouting without herbicides.

- Parks infrastructure was not created for broadcast burning operations. Roads are mostly a legacy of past ownership/management; Parks staff work with what is there. There are a lot of ridge roads, however, and that's a good place to start a fire. More roads give you more opportunities to burn. Areas with timber harvest infrastructure tend to have a lot of mid-slope roads that are not very useful for controlling fires.

- Prep work prior to burning: in redwood, prep work is focused on the control line. They remove snags along the line which would be likely to torch. If they have dedicated resources along the control line, they can generally exclude fire from the trees along the line. They tried in the past to rake duff away from old growth trees in the plot, but it does not work unless there is someone standing there to manage it – the trees burn anyway. This practice was not found to be productive, so they no longer do it. They could potentially reduce fire severity by pre-treating jackpots, but that would be costly.

- Pre-treatment in chaparral – inmate crews cut vegetation to knee height to keep down flame height. They have used dozers, but they uproot plants, which is a different effect, as it prevents sprouting. They have also tried masticating before burning, but the machine compacts the duff and they don't get a very good fire. They want a stand-replacing fire. Also, they are targeting the

duff layer – which can be 6-8 inches thick– and they need a hot fire to get into the duff. You can't get that in the spring. Duff accumulation can lead to succession to oaks and other evergreens that will overtop and kill the shrub layer.

- Public reaction: most complaints from neighbors are from people who are afraid the fire will burn their houses down, or they don't like the smoke. Parks staff have never fielded a call from anyone worried about the ecological implications. There has been an overwhelmingly favorable reaction to burning of grasslands. No one complains about burning brush. Some people's affinity for trees means they don't like to see them burned. Burning in spring – nesting bird season concerns– they do nesting surveys, and try to burn after fledging. Carefully crafted prescriptions help avoid biological damage. Still, many parties with particular interests need to be considered.

- Whether prescribed burn is practical is very site-specific. You can also use non-fire techniques, such as mastication, in some places where it is not practical. The best strategy is to concentrate on doing what can be done. They would like to burn all 65,000 acres of State Parks land in Santa Cruz, but this is not feasible logistically. They prioritize viciously. Grasslands: greatest diversity. Sandhill chaparral – rarest habitat. Old growth forest – value of this forest type. They figure the program has burned less than 1% of total State Park lands in the Santa Cruz District. With succession management and mechanical treatment (often with pile burning component), the area treated is somewhat more.

4. Potential for Sustainable Timber Harvesting

Condition of Timber on Watershed Lands

- The last THP – (1999) is pretty much ready to implement (Newell Creek tract, "The Saddle" area, west side of reservoir, upstream). The stand is all marked and flagged. They would need to update the THP to reflect changes in the Forest Practice Rules, and refine the marking to avoid wildlife trees and streamside trees that were marked previously.

- The infrastructure for timber harvest is in good condition. Some roads have narrowed due to in-growth. Stream crossings are good. Main haul roads are lightly rocked.

- The Laguna tract is not really set-up for logging at this point. It has not been logged since the original clearcut.

Politics of Logging

- Since logging ceased, a lot of new neighbors have moved in, who are not accustomed to logging operations. A lot of forest lands in the Santa Cruz Mts. are out of production, so there is not as much familiarity with logging operations as there was during the period of active management of the watershed lands.

- Political viability of timber harvest at this point is unknown. There is a long history of environmental protection and activism in Santa Cruz. The most viable way forward is to look at future forest management of the watershed lands in terms of land management, water quality, and

wildfire management; not timber harvest per se. Timber harvest may have the added benefit of offsetting upcoming water rate increases.

- There are a small number of individuals in the Santa Cruz area who are adamantly opposed to logging or any kind of active forest management.

- Local production of timber is important – California uses a large amount of lumber – from a climate perspective, it is better to produce it locally.

Santa Cruz Timber Market and Infrastructure

- Big Creek, a family-owned business (now into their fourth generation), is the sole remaining lumber mill in the southern Redwood region. They produce about 15 million bf of lumber, mostly redwood, per year. Only about 10% of the logs they mill come from their own land, so they rely on a (shrinking) resource base of timberlands owned by others. Previously, San Vincente Redwoods constituted a large portion of their timber base. They sometimes struggle to find enough logs to maintain the mill, but are hanging on, are committed to being there, and think they can do it. A steady supply of timber from the City's watershed lands would be a welcome addition to their resource base and would bolster the company's economic resilience. The rest of the Santa Cruz Mountains logging infrastructure – Licensed Timber Operators (LTOs), truckers, fallers, foresters, is small but committed; they are aging but hanging on. Given the special Forest Practice Rules of the Southern District, Big Creek's own land management practices, and generally high conservation consciousness of other landowners, it takes highly specialized, careful crews to pull off logging jobs successfully; it is difficult to simply recruit crews from outside the area. LTOs are struggling to comply with ever-increasing State rules, such as California air pollution standards for trucks and equipment.

- Logs from the Santa Cruz Mountains also go to the Redwood Empire mill in Cloverdale (a 4-hour haul) and occasionally to the Sierra Pacific mill in Lincoln. For now, the market appears to be stable.

- In the Santa Cruz Mountains, as elsewhere, there is an alternative between maintenance of larger parcels as working lands, or their sale for development. This does not apply directly to the watershed lands, but if the watershed lands were brought back into production, this would increase the resource base, making the local timber industry as a whole more viable, and thus contributing to maintenance of other ownerships as working lands.

- In general, redwood lumber is losing market share (to plastic lumber and tropical species) at the rate of ½-1% per year. The mills, however, are still selling all the boards they produce. The reputation of the product has taken a beating, due to poor quality timber produced from some second-growth forests, but Big Creek has a reputation for producing high quality redwood lumber.

5. Restoration Forestry/Sustainable Forestry

Working conservation forest model

- The opportunity is there to have a working forest while maintaining and even enhancing conservation values. Working forest conservation easements often include water quality standards. e.g., the Maillard Ranch in Mendocino, which requires water quality protection measures equivalent to the landowner requirements in the Garcia River TMDL, even for the portion of the ranch in another watershed.

- In working forests, if revenue generation is one of the goals of forest management, along with maintaining or enhancing conservation value (including water quality), which is the more important goal? There is the need to be extra careful in maintaining the hierarchy. Fire protection – as a benefit or co-benefit – also raises the question of whether it is consistent with a clear hierarchy of goals.

- Save the Redwoods League includes requirements in their conservation easements that ensure that growth exceeds cut, that there is a mix of size/age classes of trees, and that specific ecological features and functions are protected or created. The CE allows for the League to review and approve a management plan.

Examples of Other Working Forests and Forest Restoration Projects

- There are a lot of conserved lands in the Santa Cruz Mountains, but not much protected working forest, other than San Vicente Redwoods. Other examples include Big Creek Lumber, which has an easement on part of their land; Cal Fire's Soquel State Demonstration forest, and Land Trust of Santa Cruz's Byrne Forest.

- San Vicente Redwoods under previous ownerships was under a single management regime, very similar to the watershed lands. Now, as a working conservation forest, SVR is divided or zoned into "working forest" and "restoration/conservation reserve" areas. Currently, some of the working lands look better (i.e., closer to a late seral condition) than the Deadman Gulch Restoration Reserve, where restoration has begun. We can eventually expect a convergence of structure of working forest area and restoration reserves before, eventually, restoration reserves will exceed working forest in terms of late seral quality. The riparian areas in the working forest should look good in perpetuity, due to very high standards for protection in riparian buffer areas.

- City of Arcata Community Forest – barely under 2,500 acres, so just fits under Non-Industrial Timber Management Plan rules (meaning that the City does not need to file individual THPs, but rather much simpler notifications). The City also has a carbon project, which together with the NTMP defines the allowable cut. Arcata usually harvests 300-400,000 board feet per year. Proceeds generally pay for management of the forest; in the past the City has used proceeds to purchase additional forest lands and park lands. Now, the City is considering a parcel tax to support recreational trails, etc. If this were to pass, it could take the pressure off to continue timber harvest to pay for these amenities.

- Working conservation forests tend to produce larger logs, due to restrictions on logging and explicit requirements (generally contained in CEs) for growing trees larger or maintaining higher stocking levels. In Humboldt County, most of the mills are no longer tooled for larger logs; the Arcata Community Forest has shipped logs south all the way to Willits. Bigger trees = lower operational costs: fewer logs, more volume per truck load, fewer pieces to move. However, it may be necessary to ship the logs a longer distance to the mill, which might off-set these advantages.

- Working forest model – demonstrating sustainability in your own back yard – is a powerful message for winning public support of the Arcata Community Forest. Since Arcata is a college town, there are always a lot of people coming through. Humboldt State does a very good job getting people up to speed on the Arcata Community Forest. Complaints are rare. The Forest is FSC certified, which also helps. There is a very experienced Forest Management Committee, with members with long tenure, a lot of continuity, and a high level of trust. They have a lot of volunteer workdays, with volunteers working on trail maintenance, invasive plant control, garbage clean-up. This helps build a sense of community ownership.

- With regard to Redwood Park restoration thinning, which at times includes log sales of thinned trees: it took a lot of work with the environmental community to get them to accept the idea of putting logs on log trucks and taking them out of Redwood National Park. There was intensive outreach to the environmental community, stressing ecological goals of the project. Eventually, EPIC and Save the Redwoods League were both on board. The response in thinned stands from projects conducted 15 years ago is visually stunning (in a positive way), so there are now good examples of what can be achieved with active forest management. NPS is still doing a lot of group tours and hosting symposia.

- There has been a huge shift in forest conservation focus from protection/conveyance to restoration. The working conservation forest model is a part of that. The Redwoods Rising initiative in Humboldt and Del Norte Counties is a prime example. Locally, San Vicente Redwoods is another prime example.

- In State Parks in Humboldt and Del Norte counties, restoration thinning projects have been initiated in areas where roads had already been decommissioned, and they lost the opportunity for log sales, unless skylining is an option (e.g., Lost Man Creek). In these areas, they leave logs on the ground and lop and scatter the slash. The Redwoods Rising initiative is enabling thinning treatments prior to road removal – the idea is "one and done" – a single entry for restoration thinning, then take out the roads as part of a watershed rehabilitation strategy.

- State parks partnership with National Parks Service and Save The Redwoods League, together they are managing the Redwoods Rising initiative. The aim is holistic watershed restoration, including road removal, forest thinning/restoration. The goal is to put the forest on a growth trajectory to achieve later seral conditions. Ecologically, they are basing decisions on the idea of surplus biomass: what needs to be left to meet ecological goals? That which is not needed can be thinned out. They vary thinning treatments across the landscape, with the goal of increasing heterogeneity of stand type and structure across the landscape. They are developing a template within RNSP, that can be carried over to other redwood parks, including Humboldt Redwoods SP. They have completed a NEPA-CEQA joint document for Redwood Park covering 70,000

acres. The program allows for multiple entries. They figure there will be an end point, where silviculture gives way to fire.

Unintended Negative Consequences of Restoration Thinning and Working Conservation Forests

- Every decision is bigger when there are fewer, bigger trees. Thinning older stands: benefits to water quality may be less, and there may be more of a downside than an upside.

- If the goal is to maintain a sustainable harvest program, it is important to avoid creep toward a late seral stand that cannot be managed for timber production. Selecting and monumenting permanent leave trees, or designating riparian areas as big tree zones, or establishing conservation reserves where the explicit goal is big trees and late seral conditions, allows for more flexibility in managing the rest of the stand, while still maintaining a big tree component of the forest.

- In Del Norte Coast Redwoods State Park, overthinning leads to more bear damage. One thinning project used a single entry into a young stand, using variable density thinning, with a target density of 75-150 trees per acre, with the goal to put the stand on a trajectory toward old growth conditions. However, the post-thinning stand suffered heavy bear damage, with up to 40% of the remaining trees, and virtually all the bigger redwoods, suffering damage.

- Spreading treatments out over time allows some time to make adjustments mid-course, and practice adaptive management. For example, in Prairie Creek Redwoods SP, 5,000 acres are to be treated over a decade or so. There is a similar timeframe for San Vicente Redwoods Deadman Gulch restoration project (2,700 acres).

- More aggressive treatment leads to greater growth; more natural regeneration, with the potential for other species to grow in – whether intended or not.

6. Conservation Easements

How CEs are Valued/Saleable Conservation Value of the Watershed Lands

- The value of a conservation easement for the watershed lands is questionable. Certainly, it would be possible to donate a CE; but the potential for selling a CE is less apparent. What is the conservation value that would be protected by a CE?

- Sempervirens Fund would be interested in discussing the possibility of a CE. SFV has their own appraisers. CEs are tailor-made to each property. Rights that are purchased can vary greatly. SVF usually purchases development rights (and extinguishes them), sometimes also some or all timber harvesting rights. For the watershed lands, it may be considered that there is already no development potential – that the watershed lands may already be considered protected from development. If the goal is to manage the watershed lands as a restoration forest, there is more potential value if the City were to sell the timber rights up front. The appraiser looks at 2-3 entry cycles, performs a net present value analysis. The more restrictions on timber harvest, the greater the value for a CE. Also, there is some potential value in restricting recreational use. CE's can include requirements for invasive species removal, other value-added conservation activities. A

CE could include reserve areas as well as working forest areas, as at San Vicente Redwoods. This could include, for example, stream conservation zones, where timber restrictions greater than the requirements of the Forest Practice Rules are applied. The Laguna parcel may be a good candidate for a conservation reserve.

- A CE could be used to demonstrate that the City is serious about its conservation objectives, and is not out simply to maximize revenue.

- If combined with a carbon project, a CE can be used to reduce the buffer pool requirement, thereby reducing project costs.

7. Carbon Projects

Suitability of Watershed Lands for a Carbon Project

- In Santa Cruz, it is difficult to satisfy the additionality requirement for carbon projects, since the Southern District Forest Practice Rules are already quite strong, the baseline stocking requirement for public entities is relatively high. The City's holdings may not be large enough to achieve economies of scale necessary for a successful project, since management, administration, and verification costs are very high.

- The Lompico Forest carbon project, adjacent to the Newell Creek Tract, owned by Sempervirens Fund, has a carbon project. SVF is no longer selling carbon credits, however, because revenues are less than the costs to maintain the project.

- SVF is trying to develop a forest carbon aggregation project with American Carbon. The target is 5-10,000 acres of redwood forest made up of small and medium holdings in the Santa Cruz Mountains, to achieve economies of scale for project development and administration. The analysis to date indicates this would not be a big money maker for landowners, but there would be some return. The program is currently in the planning stages.

APPENDIX B

Forest Inventory Update

CITY OF SANTA CRUZ WATERSHED LANDS

Forest Inventory Update

Prepared for: **City of Santa Cruz Water Department**

By**: Sicular Environmental Consulting and Natural Lands Management**

September 2020

Forest Inventory Update

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CITY OF SANTA CRUZ WATERSHED LANDS

Forest Inventory Update

Introduction

The City of Santa Cruz's 1994 Forest Management Report (1994 FMR; City of Santa Cruz Water Department, 1994) includes results of a timber inventory or cruise, conducted in 1992 and 1993 that characterizes the different forest types within the watershed lands in terms of timber volume, species composition, size distribution, and other forest characteristics, and projects growth and sustainable yield. We refer to this as the "1993 inventory." Sicular Environmental Consulting's scope of work (Task 4) includes updating the 1993 inventory to develop a rough estimate of current volume of standing timber, sequestered carbon, and future growth. While too much time has elapsed to have a high level of confidence in the accuracy of such projections, the results are intended to provide a rough quantitative estimate of current conditions, sufficient to inform the exploration of management options (Task 5). A future planning process may benefit from, or may require, a new inventory.

Specifically, the scope of work for Task 4 includes the following:

- Digitize the stand type maps from the 1993 inventory.
- Estimate current volume of standing timber, based on the previous inventory and reported growth rates.
- Estimate current stock of sequestered carbon.
- Provide a rough estimate of future growth and potential sustainable timber production and carbon sequestration yields.
- Based on forest stand typing and observed conditions, comment qualitatively on fuel loading, current fire hazard, and likely trajectory for these both. Evaluate existing resources and data needs for strategic assessment of site-specific wildfire hazards.
- Discuss the history of fire on the three tracts and in the forested landscapes of the Santa Cruz mountains in general, including the legacy of periodic burning by Native Americans; major wildfires of the 20th century; the effects of fire suppression and timber harvest; and the importance of fire to the ecology of the redwood forest.

- Discuss current conditions in the context of (and in comparison to) the likely condition of the pre-clearcut forest. Specifically, how do current stand structure and composition differ from the pre-disturbance condition? What do the current conditions suggest about the likely trajectory of stand development?

Methodology

Methodology for the 1993 Inventory

The 1994 FMR includes a description of the methodology used for the 1993 inventory. The inventory used generally accepted methods and a robust sample. The following is the methodology description, taken verbatim from the 1994 FMR:

> A 3% cruise[1] of the timbered areas on the three tracts owned by the City of Santa Cruz Water Department was performed. The cruising was done during June and July of 1992.
>
> The sampling procedure is described as stratified, double sampling. Approximately 250 temporary 1/5 acre plots[2] were established on a grid pattern across the tracts. Of these 250 plots every fourth plot was additionally measured as a growth plot. The plots were stratified (grouped) by timber type.
>
> Timber types[3] were initially determined from aerial photographs and modified by field observation. The air photos are black and white and were taken in 1989 at a scale of 1:24,000.
>
> Within the standard 1/5 acre plot, all conifer trees in excess of 12" in DBH were measured for diameter to the nearest 2" and a height to a 6" diameter minimum in increments of 16 foot log lengths. Conifers under 12" DBH were counted. Hardwood volumes were visually estimated. At each plot, a tree was also measured to determine site values in terms of total height in feet.[4]

[1] i.e., 3% of the area within the study was sampled.

[2] Presumably, these were circular, fixed area plots.

[3] Timber types, or stand types (the two terms are used interchangeably in this report), refer to a "community of trees possessing sufficient uniformity in composition or structure to be distinguished from adjacent forest communities" (1994 FMR, page 11).

[4] Site value provides an indication of the potential for growth, given ideal growing conditions in a particular location. The site value indicates the potential height to which a given species could grow to at age 50 or 100. For example, a SI_{100} value of 120 indicates that a tree could grow to 120 feet height at age 100. According to City Forester Slim! Butler, the "site tree" chosen from each sample plot was the dominant tree closest to the plot center, and was either a redwood or Douglas-fir, depending on which species was most prevalent at the site. The site index used was the 100 year index published by Lindquist and Palley, 1961 and 1963. To determine site index, Tunheim and Butler measured total tree height and assumed a tree age of 80 years, based on the age of the stand, which had been clearcut between 1900-1920.

> The following parameters were also measured or estimated at each plot: overstory cover, understory cover and composition, basal area, woody debris, and snag density and quality.
>
> On every fourth plot, growth data was also measured. On these plots, all conifer trees over 12" DBH were measured to the nearest 1/10th of an inch DBH. All conifer trees over 12" DBH were then cored with an increment borer and the last 10 years of radial growth was recorded to the nearest 1/20th of an inch.[5]
>
> All the raw data were synthesized into the tables, charts, graphs and narrative contained in the Management Report.
>
> (1994 FMR, page 108).

The classification scheme for timber types used in the 1993 inventory, as described in the 1994 FMR, is as follows:

Vegetation Type Symbols:

> R - Redwood
>
> DF - Douglas-fir
>
> HW - Hardwoods (oak, Madrone, bay)
>
> B – Brush
>
> KP – Knobcone pine

Age class:

> O - Old growth timber more than 200 years old, usually more than 50 inches in diameter
>
> Y – young growth timber less than 200 years old

The most widespread vegetation type/age class within the watershed lands is RY, young redwood. None of the stands are typed as old growth, though there are scattered individual old growth and "residual[6]" trees within the Watershed lands.

[5] According to Slim! Butler, the method for calculating the growth rate involved use of published volume tables relating diameter at breast height (DBH) to volume, applied to the current diameter measurement of the tree, and also to an estimated diameter of the tree ten years before, based on core sampling and measurement of the width of the previous ten year's growth rings. Previous volume was subtracted from current volume, divided by 10, and expressed as a percentage.

[6] "Trees which were alive during the initial old growth harvest, but were either a younger or suppressed tree at the time" (1994 FMR, page 11)

Two numbers following the type/age class symbols indicate percent of ground area covered by crowns of conifer trees, called crown cover or canopy cover.

1 - 80% + ground covered by conifers

2 - 50-80% ground covered by conifers

3 - 20%-50% ground covered by conifers

4 - 5%-20% ground covered by conifers

5 - Less than 5% ground covered by conifers

The first number indicates ground cover of merchantable sized conifers (defined in the 1994 as 18" or more in diameter at breast height (4.5 ft), a size threshold that reflected the market conditions at that time), while the second number indicates ground cover of all conifers.

Example:

RY32 Young growth (i.e., second growth) redwood is the dominant species; crowns of merchantable trees cover between 20-50% of the ground, and total conifer cover is 50-80%.

In addition to the tables in the 1994 FMR that provide statistical descriptions of each stand type, the report also contains narrative descriptions. While outdated in terms of the description of size and volume of trees present, these descriptions are still useful in providing a fuller characterization of each stand type. We found during a reconnaissance site visit in July, 2020, that the descriptions are still valid. Therefore, we have included the descriptions in an appendix (Appendix A) to this update report.

Inventory Update Methodology

To update the inventory to 2020, we first entered the data from the tables contained in the 1994 FMR (pp. 29-43) in an excel spreadsheet. The digitized and reformatted tables are included at the end of this report. We found several apparent typographical or mathematical errors in the summing of totals and in the extrapolation of per-acre figures to per-stand type totals (such as board feet[7] per acre for a particular stand type to total board feet for that stand type). Since we did not have access to the underlying raw data, we did our best to resolve these issues, by correcting obvious errors and using our best judgement and comparing figures to the narrative description of timber types and growth that follow the tables in the 1994 FMR (Appendix A). The major anomalies we found in the original tables were the following:

- Zayante Creek tract, Table Z-4, the total growth by timber type figures did not match the per acre figures in Table Z-3. Consequently, the total growth per year figure in the

[7] Board foot is a unit of measure of the volume of commercial timber species and timber products: one board foot (bf) = 1" x 12" x 12." MBF = 1,000 board feet; MMBF = 1,000,000 board feet. The measurement of board footage is not equivalent to the total biomass of the tree, but only a subset including the portion that can be milled into solid dimensional timber products.

original appears to be too high, by about 111,000 board feet per year. We corrected this in our version of the table;

- Laguna Creek tract, Table L-4, same issue as Zayante Table Z-4: the total growth by timber type figures did not match the per acre figures in Table L-3. The total growth per year figure in the original appears to be too high, by about 41,000 board feet per year. Again, we corrected this in our version of the table.

Together, these two anomalies result in an apparent overstating of annual growth by about 150,000 board feet per year, or about 8 percent, for all the watershed lands.

We digitized the timber type polygons from the maps that accompany the 1994 FMR, and created new GIS maps of the timber types in each tract (Maps 1-3). In so doing, we changed the timber type symbols to match those used in the 1994 FMR (e.g., Y32, used in the original maps, becomes RY32 in the new maps). We also recalculated areas of each timber type. In some instances, these differ substantially from the acreages given in the tables in the 1994 FMR. In our tables, however, we kept the acreage figure originally stated, as the original maps were small scale and low resolution; our digitized polygons cannot be expected to improve on the originals.

In producing the new maps, we found that one of the mapped timber types in the Laguna Creek tract (RY32), which we measured as encompassing about 36 acres, appears to have been omitted from the tables and the text of the 1994 FMR.

Growth projections and Estimates of current Volume

To project growth and arrive at a rough estimate of the current volume of timber present on the watershed lands, we used the growth rates for each timber type (Table S-2) and tract presented in the Forest Management Plan. These are expressed as annual percentage growth in board feet. As discussed above, growth rates were determined in the 1993 inventory using the previous 10 years of radial growth data from core samples taken at every fourth sample plot. Radial growth was extrapolated to volume growth using volume tables specific to the Santa Cruz Mountains. While the Forest Management Plan provides separate growth figures for smaller (pre-merchantable) conifers below 18" DBH[8] and for larger conifers, we applied the figure for larger trees, which in all cases was lower, to project growth rates to the present. This provides a more conservative estimate of growth overall, and accounts for the slowing of growth of smaller stems over time, as well as the apparent decline in new in-growth (observed during the reconnaissance and noted by the Water Department's consulting forester, Slim! Butler, RPF). We compounded growth by applying the annual percentage growth rate to the previous year's estimate of standing volume for each year from 1994 through 2020.

We recognize that stand growth rates are not constants; they are the net result of multiple elements of stand dynamics, including individual tree growth rates, mortality, and stand in-growth. Tree growth rates alone are a function of tree size, age, and vigor, as well as stand-level

[8] DBH = diameter at breast height. This is the diameter of a tree measured outside the bark at 4.5 feet above the ground.

growth factors (such as precipitation) during any given period of growth. However, in the absence of comparative inventory data, expressed growth during the most recent inventory period (in this case, the 10 years leading up to 1992) provide the best available proxy for growth rate. While growth rates can be expected to slow eventually given no new cutting or other disturbance, our observations during the July reconnaissance suggest that, particularly in the previously logged areas, trees are likely still growing rapidly. Given the density and spacing of trees and the availability of canopy gaps, the forest is likely to continue to grow at these rates for some time. Therefore, we can project that at least the current annual growth, estimated at about 3.2 percent or 3.8 million board feet per year, will continue for some time.

Carbon Sequestration

To estimate the amount of carbon sequestered in the forest, we used conversion factors and formulas from CalFire for coast redwood, Douglas fir, and hardwoods (CalFire, 2010). These estimates, which are based on volume estimates of biomass, include only carbon sequestered in live trees, and do not include down and dead standing trees, soil carbon, or carbon sequestered in forest products from timber removed from the property. The estimate of 1993 carbon is based on board footage of each timber species and basal area of hardwoods presented in our corrected tables from the 1993 inventory, extrapolated to total live biomass, and thenreported as metric tons of carbon dioxide equivalent ($MTCO_2e$). We applied the same conversion factors to our estimate of 2020 standing timber and to the current (2019-2020) annual growth rate.

Results

The digitized and corrected tables from the 1994 FMR and growth projections to 2020 for each tract are presented in Tables N-1 through N-10 (Newell Creek Tract), Z-1 through Z-10 (Zayante Creek Tract), and L-1 through L-10 (Laguna Creek Tract). Select data from the tables is presented in charts (Figures N-1 through N-9, Z-1 through Z-9, and L-1 through L-9). Summaries covering all three tracts, including our projections of growth, standing timber volume, and carbon sequestration, are presented in Tables S-1 through S-4 and Figures S-1 through S-7. All tables and figures follow the text of this report.

The majority of the volume of timber, and the majority of its growth, are in the Newell Creek tract, followed by the Zayante Creek tract. Within each of these two tracts, the majority of the timber is within the RY32 timber type, and nearly all of it is redwood; both tracts have a very small amount of Douglas fir (Figures N-6, Z-6). Within the Laguna Creek tract, which is by far the smallest tract (Table S-1), the majority of the timber is distributed between the RY22, RY33, and RY43 timber types; all three types have a substantial amount of Douglas fir, as well as redwood (Figure L-6).

Standing volume of timber in 1993 was about 56 million board feet for all tracts combined. We estimate that this has more than doubled, to about 126 million board feet in 2020 (Figures S-1 and S-2). Assuming, as we have, that the rate of growth has remained constant at about 3.2 percent per year for all three tracts combined, the annual increment of growth has increased from about 1.7 million board feet per year in 1993 to about 3.8 million board feet per year today (Figure S-3).

The 1994 FMR includes mention of timber volume as reported in previous cruises on the watershed lands, with records going back to 1958 for the Newell Creek tract and 1974 for the Zayante Creek and Laguna Creek tracts. This historic information is combined with data from the 1993 inventory and from our projections of growth in Table S-3 and Figure S-5. These show the dramatic increase in timber volume, with a starting point 40-50 years after the clearcut of the watershed lands. In 1958, timber volume was about 12 million board feet on the Newell Creek tract. Despite the construction of the reservoir, which removed a substantial portion of the forest (the surface area of the reservoir is about 175 acres, and the reservoir has a capacity of 8,650 acre feet), this figure had increased to about 38 million board feet in 1993. We estimate that there is currently about 80 million board feet of timber within the Newell Creek tract, an almost four-fold increase since 1958.

We estimate that the average volume per acre has also more than doubled in each tract. Volume per acre varied by timber type within each tract in 1993 (Figures N-3, Z-3, and L-3), but averaged between 13,000-18,000 board feet per acre. We estimate that this has increased to about 24,000 board feet per acre in the Laguna Creek tract, 35,000 board feet per acre in the Newell Creek tract, and 49,000 board feet per acre in the Zayante Creek tract (Figures S-4, N-8, Z-8, and L-8). In the Newell Creek and Zayante Creek tracts, we estimate that the volume per acre for timber type RY32 has increased from the reported 22,660 and 21,390 board feet per acre, respectively, in 1993, to over 50,000 board feet per acre in 2020 in both tracts. The Laguna Creek tract volumes vary widely by timber type. The small area of type RY22 was reported as having about 85,000 board feet per acre in 1993. We estimate that this area now has about 146,000 board feet per acre – an extraordinarily high volume for a second growth redwood stand, but a credible estimate given the very high quality growing conditions (the 1994 FMR gives a 100-year site index value of 220 for this timber type, as shown in Table S-2) and our observations of the girth, height, and density of trees in this stand during the reconnaissance.

Figures N-5, Z-5, and L-5, and Tables N-2, Z-2, and L-2, show the number of redwood trees per acre, by diameter class, for each timber type in 1993. The number of small trees below 12 inches diameter ("ingrowth") is reported in the narrative description of each timber type in the 1994 FMR, and included in the charts. We did not attempt to project diameter distribution, but in general, we expect that the same shape curve would persist and shift to the right, as individual trees grow into larger categories. This comports with our observations during the reconnaissance of a substantial number of trees in the 36 inch+ diameter category, especially in portions of the Newell Creek tract on the west side of the reservoir. With the cessation of logging and hardwood-conifer conversion efforts, in-growth, which includes planted and naturally generated seedlings and redwood stump sprouts, has likely declined, though we observed some in-growth, particularly redwoods, in most stands during our reconnaissance. The Laguna Creek tract diameter distributions vary widely by timber type. Note the large number of trees in the largest size category in Laguna type RY22.

Figures N-4, Z-4, and L-4, and Tables N-1, Z-1, and L-1 show the volume per acre by diameter class for each timber type. In the Newell Creek and Zayante Creek tracts, the majority of the volume was in the mid-size diameter classes in 1993. The exception to this is Zayante type RY44, which had an unusually high number of larger redwoods. Again, the Laguna Creek tract does not follow the typical pattern. Note also that the great majority of volume in Laguna type RY22 is

within the largest diameter class. We expect that now a much larger proportion of the volume in the previously managed[9] RY32 and RY43 types in the Newell Creek tract and the RY32 and RY33 types in the Zayante Creek tract is in larger trees greater than 36 inches DBH.

Basal area (the total cross-sectional area of tree stems at breast height, expressed as square feet per acre) for each timber type, by species, is shown in Tables L-10, Z-10, and L-10, and in Figures L-2, Z-2, and L-2. In 1993, basal area in the stand types managed for timber production within the Newell Creek and Zayante Creek tracts (timber types RY32, RY33, and RY43) ranged from 130-180 square feet per acre of conifer, with varying amounts of hardwood. Other timber types in these tracts were dominated by hardwood. Basal area and species composition varied widely from type to type in the Laguna Creek tract. Note the very high basal area of conifers, 350 square feet per acre, in type RY 22 in the Laguna Creek tract. We did not project the increase in basal area between 1993 and 2020, but it has undoubtedly increased substantially, commensurate with the increase in volume.

Sequestered Carbon

Our estimates of carbon sequestered in live trees in 1993 and 2020 is presented in Table S-4 and Figure S-6. Since the amount of carbon sequestered is a function of biomass, our estimate of an approximate doubling of sequestered carbon between 1993 and 2020 is not surprising. We estimate that currently, there is approximately 1 million metric tons of carbon dioxide equivalent ($MTCO_2e$) sequestered in the living trees within the watershed lands. By comparison, the City of Santa Cruz calculated total annual greenhouse gas emissions from the City to be 278,661 $MTCO_2e$ in 2008 (City of Santa Cruz, 2010). The amount of carbon sequestered in living trees growing on the watershed lands is equivalent to about three and a half years of the City's emissions at the 2008 rate. As shown in Table S-4 and Figure S-7, we estimate that the current annual rate of carbon sequestration is about 25,000 $MTCO_2e$, equivalent to about 10 percent of the City's 2008 greenhouse gas emissions.

Observations and Discussion

The following qualitative discussion is based on our observations of current conditions during the reconnaissance site visit in July 2020, our previous experience in the Santa Cruz Mountains, our interviews with forest experts for this project,[10] and on the literature cited.

Fuel Loading and Fire Hazard

During the reconnaissance, we observed moderate fuel loading in the conifer-dominated stands that we visited. Although increases in live tree volume or carbon relates directly to aerial fuel loads, an increase in fuel volume alone is not an indicator of fire hazard. The structural

[9] The term "previously managed" stands is used in this report to refer to those areas of the Watershed Lands that were brought under the previous management regime, which included short rotation, single tree selection timber harvest and firewood harvest of hardwood dominated stands followed by planting of conifers.

[10] See separate report: City of Santa Cruz Water Department, 2020. City of Santa Cruz Watershed Lands: Forest and Forest Management Issues Discussed in Interviews. Prepared by Sicular Environmental Consulting and Natural Lands Management, September 2020.

arrangement of fuels can often be more determinant of fire behavior than fuel quantity. In large trees, a great quantity of total fuel is unavailable to combustion, and plays no role in the behavior of an active flaming front; a relatively small amount of fuel in the form of accumulated small diameter material on the ground, and ladder fuels consisting of live and dead grasses, shrubs, small trees, and low branches, contribute disproportionately to fire hazard.

Fuel loading was generally lighter in previously managed stands, such as Zayante Creek tract types RY32 and RY33 and Newell RY32 (west side of the reservoir). In the stands in these two tracts with a higher hardwood component, and in unmanaged stands, fuel loading appeared to be higher. Within the previously managed stands, the more mature conifer areas (redwood clumps and groves) are generally well-spaced, lacking ladder fuels, and with a moderate accumulation of duff and dead and down material. Within the previously managed stands, there are numerous areas that had been converted from hardwood to conifer (following firewood harvest) in the areas in-between redwood clumps and groves. Most of these areas now have vigorously growing (planted) small conifers, which appear to be outcompeting surrounding brush and hardwoods. However, the non-conifer component makes these areas highly flammable; if a fire were to come through these areas, it is likely that the planted conifers would be lost.

Currently, the main tool for reducing fire hazard employed on the watershed lands is the maintenance of roads with shaded fuel breaks (SFBs). Most of the SFBs are relatively narrow, extending about 20 feet from either edge of the road, but they are likely effective in reducing ignition from sources along the roads, and in making the roads accessible to firefighting crews. In some instances, especially ridge roads, they could serve as fire lines. The network of maintained roads likely increases the chance that a wildfire could be extinguished before it spreads to catastrophic proportions. The road network also could contribute to the feasibility of a prescribed burn program.

We reconnoitered only a small part of the Laguna Creek tract, the tributary canyon with the RY22 stand. This canyon, and what we could see of the mainstem Laguna Creek canyon, had a sparse understory and good separation from the base of crowns of the very tall conifers; fuel loading and fire hazard both appeared to be low. We did not visit other areas of the Laguna Creek tract, but descriptions of those other stand types, several of which are dominated by hardwoods and young Douglas fir, are likely to present much higher fire hazard.[11]

Since the moister sites occupied by redwoods include stream channels and draws, the relatively low fire hazard of the redwood-dominated areas may be particularly beneficial in protecting water quality: even if dryer ridges and hardwood-dominated stands were to burn, the likelihood of lower intensity, spottier fires in the less flammable redwood areas may provide a buffer to reduce the potential for delivery of sediment from burned areas. Brush reduction treatments, and in some areas, thinning of planted conifers within the hardwood-to-conifer conversion areas, could help hasten the development of these areas into stands with lower fire hazard, both by removing ladder fuels, and by reducing competition for conifers.

[11] These observations were made prior to the CZU complex fire, which ignited several weeks after our site visit, and which burned through portions of the Laguna Creek tract.

A more comprehensive and quantitative assessment of fire hazard and fuel loading could assist the City in planning land management projects and activities to reduce risk to water quality and increase forest resiliency. This could be undertaken as a separate fuels study, including a field survey to quantify fuel loading, identification of high-risk ignition sources, and modeling of fire spread and behavior.

Comparison to the Pre-Disturbance Forest

Prior to the clearcut of the early 20th century, it is likely that the forests within the watershed lands had a similar range of species composition and stand types, from redwood-dominated stands in moister areas, grading to more Douglas fir, hardwoods, and chapparal upslope and in dryer locations. There are few alluvial flats (we did see one on Zayante Creek, the fish enhancement site); most of the watershed lands consist of steep slopes, with redwood occupying narrow canyon bottoms, "stringer" side canyons, and areas of shallow or emergent groundwater. Based on the stumps and the few scattered old growth trees we saw during the reconnaissance, most areas did not support very large redwoods, such as can be seen in the alluvial groves in Big Basin and Henry Cowell State Parks. Still, in the redwood dominated areas, there were numerous trees 5-8 feet DBH, with the occasional tree to 12-15 feet DBH. Even in those areas with smaller old growth redwoods, relatively few trees – on the order of 20-30 trees per acre – would account for a very high canopy cover. In some areas, notably the slope through which the Railroad Grade passes, geologic instability would likely have prevented the development of very old, very large stands, despite this area having good growing conditions; landslides likely replaced redwood groves at intervals of several hundred years, with redwoods reaching moderate girth and height before the next mass wasting event.

In-between and above redwood groves, dryer locations would have had a mixture of Douglas fir, large hardwoods and occasional large diameter, mostly short stature redwoods. Hardwood-dominated areas, especially along ridges and in proximity to settlements, were likely selectively maintained by Native Americans through fire. Mean fire return interval in the redwoods prior to European colonization and settlement has been estimated at between 8-50 years (Lorimer et al, 2009; Stephens and Fry, 2005; Jones and Russell, 2015). Native Americans used fire to maintain hardwoods, particularly tanoak and true oaks, as a food source; to maintain grasslands for ungulate habitat; for ease of movement; and to encourage growth of other plants for fiber, medicine, and food (Lorimer et al, 2009). Fires set by Native Americans would sometimes creep into redwood-dominated stands, but as low intensity fires resulting in limited mortality. While the post-European settlement fire return interval may have shortened (Jones and Russell, 2015), fire behavior likely changed substantially, from predominantly low intensity fires pre-disturbance to mixed (Stephens et al, 2004) and high intensity fires, especially following the clearcut.

In the Laguna Creek canyon, and perhaps even more so its side canyons, deep, well-drained soils and cool summer temperatures supported magnificent conifer stands, which, given the exceptional growing conditions, are rapidly recovering their former stature. The RY22 stand in the tributary canyon is well on its way to achieving typical old growth metrics, including girth and height of individual trees, as well as volume and basal area per acre. Still lacking are the large branches and unique features caused by infrequent disturbance events, such as broken tops and reiterated trunks, that provide specialized habitat for old growth-dependent species, such as marbled murrelet.

It was typical for the early clearcut loggers to burn slash following the cut. These fires likely incinerated small redwood regrowth, and favored sprouting of tanoak. Hardwoods grew-in aggressively, and for a time out-competed redwoods (until they could grow through the tanoak canopy). Some areas of the watershed lands likely experienced additional fires in the mid-20th century (CalFire records go back to 1960); the one recorded event was the 1959 or 1960 fire during the construction of the reservoir. Some of these fires in regrowth forest may have led to displacement of Douglas fir by tanoak, and further hemming in of young redwoods, which would have been damaged, but not killed, by the fire. In the years prior to reestablishment of active management on the watershed lands, the forest grew back dense, thick, and relatively undifferentiated, conditions associated with very high fire hazard

Currently, the managed stands within the watershed lands differ greatly from the pre-disturbance forest: the density of the forest is still much higher, and the trees much smaller. In portions of the Newell Creek and Zayante Creek tracts, the previous management regime reduced tree density, improved spacing, promoted multi-aged structure, increased redwood occupancy of the canopy, and reduced hardwoods and brush. The previously managed redwood areas have a cohort of larger, well-formed trees with dominant canopy position. With no further cutting, these trees can be expected to continue to grow and to increase their dominant position. The co-dominant and sub-dominant trees within the clumps can be expected to compete for canopy position and for soil nutrients and water, thereby reducing the potential growth of the dominant trees, and slowing the return of these stands to old growth structure, but they are on a trajectory to regain old growth character eventually, as the larger trees eventually outcompete and shade out the smaller ones, and as some trees are damaged or destroyed during fires, floods, and storms. Intentionally thinning out smaller stems to promote the growth of the dominants, as occurred previously in the "Ed's Avenue of the Giants" area of the Newell Creek Tract,[12] would facilitate the return of these redwood areas to pre-disturbance conditions. This could be accomplished through 2-3 entry cycles to thin the smaller trees, many of which would be merchantable. It is likely that in 30-50 years, these stands could be considered restored to a sort of pre-old growth condition, and left to develop on their own without further silvicultural intervention. If combined with a prescribed fire program, which would periodically reinvigorate ground cover, reduce duff accumulation and ladder fuels, and add complexity to the forest, it is likely that these stands could begin to approach pre-disturbance conditions in 100 years or so.

For those areas that were not brought under the previous management regime in the decades of the 60s through the 90s, there persists a brushy understory, suppressed, damaged, and dense redwood clumps, and hardwood-dominated areas with a high density of poorly-formed trees and dense brush. These areas deviate much more substantially from the pre-disturbance condition than the previously managed areas, and would require a greater level of intervention to place them on a trajectory to regain old growth character. This could include preliminary entries to reduce competition among redwoods and promote the growth of a cohort of larger, vigorously growing trees; reduce fire hazard through thinning of hardwood-dominated areas, retaining the

[12] As described by Slim! Butler, Ed Tunheim selected this area on the western side of Loch Lomond Reservoir, which appears to have exceptional growing conditions, as a demonstration of silvicultural techniques for growing very large individual trees.

bigger, better formed trees; and in some areas planting in Douglas fir and redwood. Even if actively restored, these areas are likely 50 years behind the previously managed stands, in terms of recovery of the character of the pre-disturbance forest.

The former, or a similar, management regime could also be reinitiated in the managed stands, and applied to areas that were not previously brought under management, such as the RY32 areas on the eastern side of the reservoir, and portions of the Laguna Creek tract. Short return interval (12-15 years), single tree selection could again be practiced in the managed areas, potentially with approximately double the sustainable yield calculated in the 1990s.

Preliminary Identification of Impaired Forest Condition Classes

We use the concept of *Impaired Forest Condition Classes* (IFCCs; Keyes, 2005) to conceptualize how existing forest stands have diverged from pre-disturbance conditions. IFCCs pair commonly occurring forest types (combinations of tree species and stand structures) with historic forest types or reference conditions. IFCCs describe conditions that are considered outside the range of natural variability for the area's forest types, and are expressed as structural, compositional, and developmental differences between pre-disturbance historical conditions and current conditions. IFCCs may be used as a basis for developing silvicultural prescriptions for forest restoration, as well as for understanding how past forest management practices have altered forest conditions and may affect future management. Here, we use the concept as a point of departure for our upcoming evaluation of new or modified forest management regimes to achieve the City's goals for the watershed lands.

Based on the reconnaissance site visit in July, 2020, we have identified the following IFCCs:

IFCC-1: Dense second growth conifer and conifer-hardwood, fire damaged, lacking differentiation (e.g., unmanaged RY32 stands on east side of Loch Lomond reservoir).

IFCC-2: Dense, planted young conifer facing competition from brush and hardwood, at high risk of stand replacement in event of fire (e.g., areas of previous firewood harvest and Timber Stand Improvement in the Zayante Creek and Newell Creek tracts).

IFCC-3: Previously managed conifer stands, dominant trees facing competition from smaller stems (e.g., RY32 and RY43 stands on the west side of Loch Lomond Reservoir, Zayante Creek tract apple orchard area and railroad grade). Note that these stands may be considered impaired in terms of their potential to return to pre-disturbance, old-growth condition; they are not impaired in terms of their suitability for reestablishment of sustainable timber harvest.

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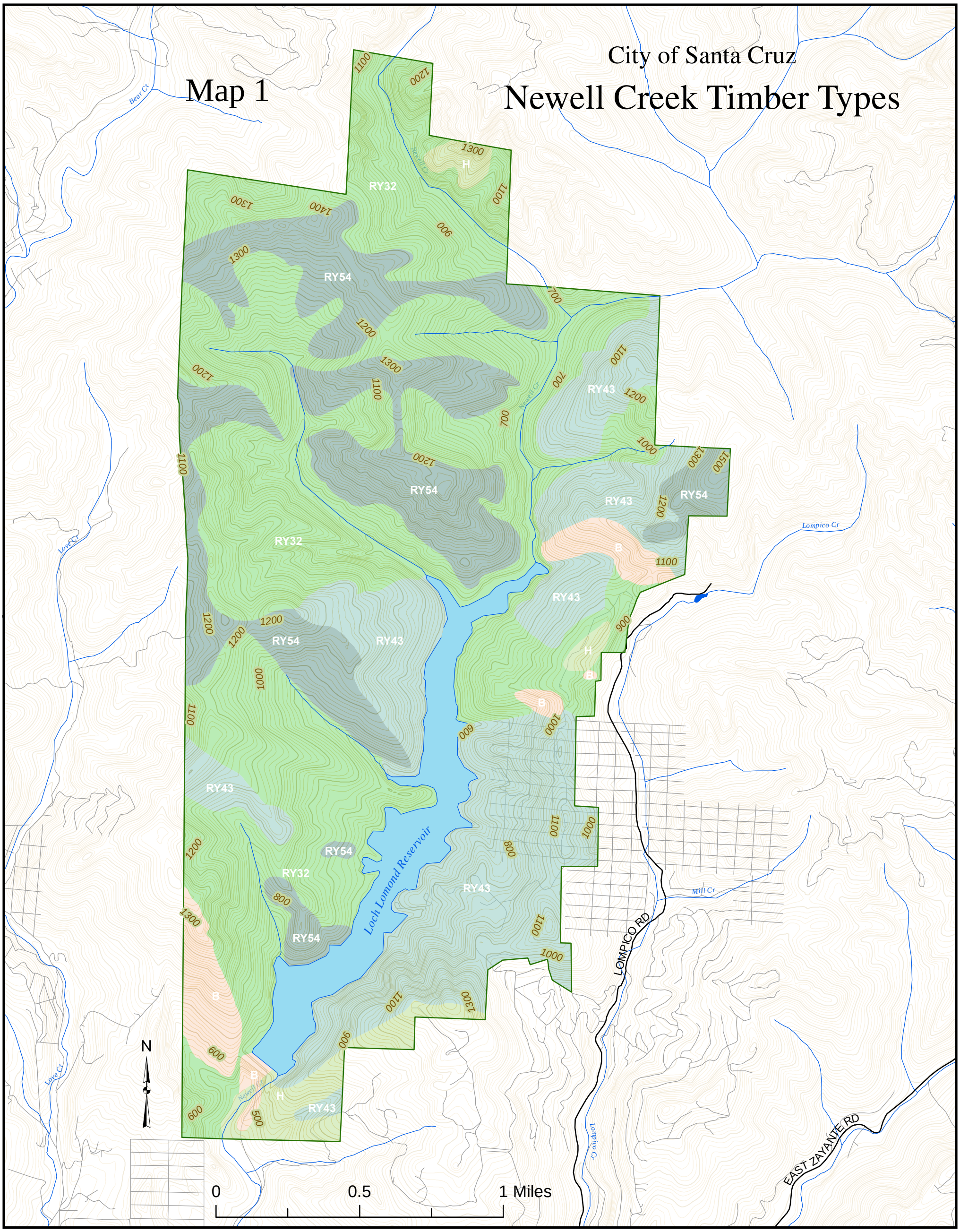
Maps, Figures, and Tables

City of Santa Cruz

Map 1

Newell Creek Timber Types



1992 Timber Types Total: 2,825.4 Acres

- B — Brush, 104.9 ac.
- H — Hardwood, 91.1 ac.
- RY32 — Young Growth Redwood Fairly Dense with a High Merchantable Ratio, 1,378.5 ac.
- RY43 — Young Growth Redwood Low Density with Some Hardwood, 686 ac.
- RY54 — Young Growth Redwood Very Low Density with a Hardwood Mixture, 564.9 ac.

Scale: 1:20,000

Contour Interval: 20 Feet

Coordinate System: NAD 1983
State Plane California III FIPS 0403 Feet

Source: Tunheim, 1992

Cartographer: Kevin McManigal

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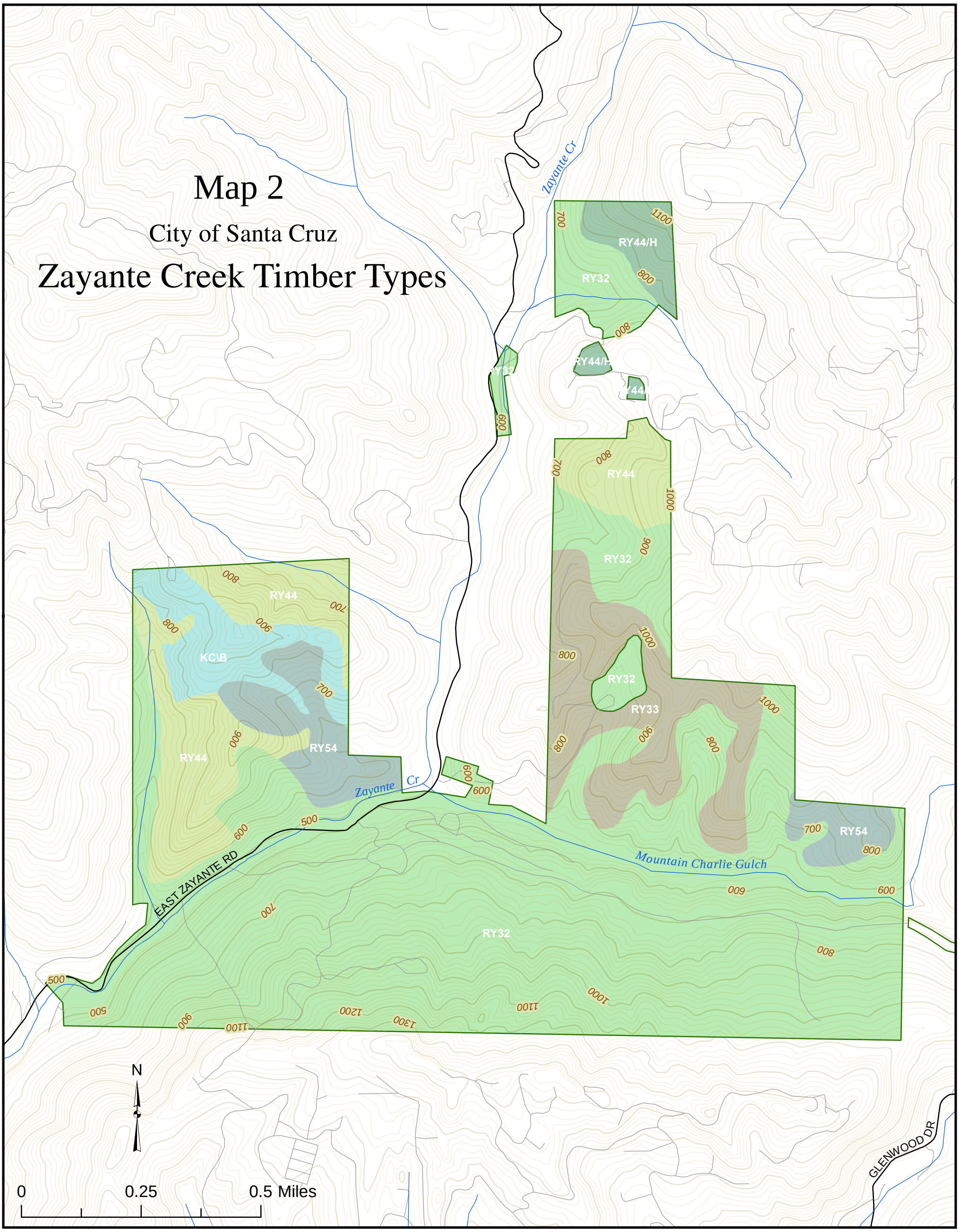
Map 2

City of Santa Cruz

Zayante Creek Timber Types



1992 Timber Types Total: 873.8 Acres

- KC\B Knob Cone Pine Forest, 37.2 ac.
- RY32 Young Growth Redwood Fairly Dense with a High Merchantable Ratio, 587.7 ac.
- RY33 Young Growth Redwood Fairly Dense but with a Lower Merchantable Ratio, 81 ac.
- RY44 Young Growth Redwood Low Density with Some Hardwood, 98.2 ac.
- RY44H Young Growth Redwood Low Density\Hardwood, 21 ac.
- RY54 Young Growth Redwood Very Low Density with a Hardwood Mixture, 48.7 ac.

Scale: 1:12,000

Contour Interval: 20 Feet

Coordinate System: NAD 1983
State Plane California III FIPS 0403 Feet

Source: Tunheim, 1992

Cartographer: Kevin McManigal

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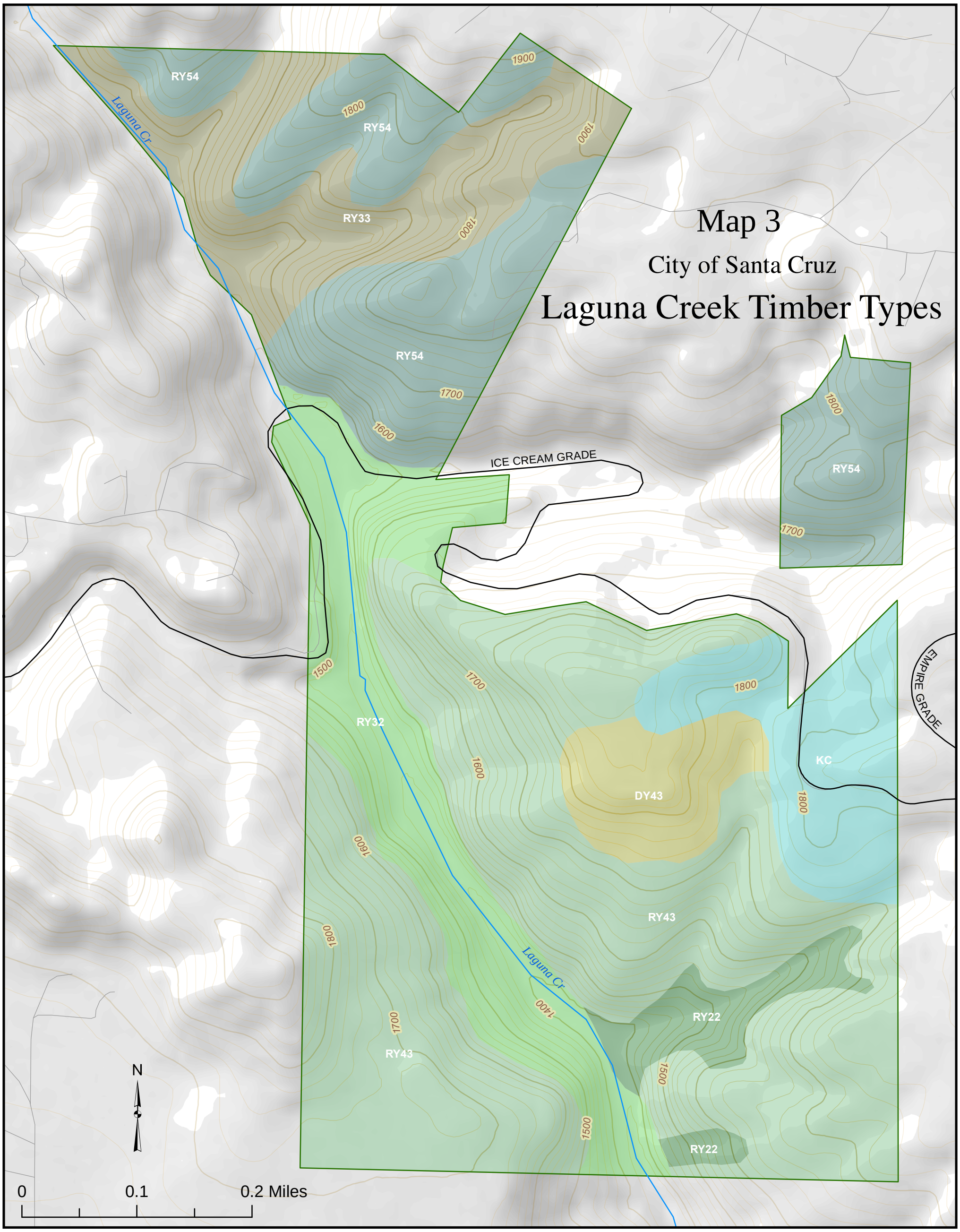
Map 3

City of Santa Cruz

Laguna Creek Timber Types



1992 Timber Types Total: 249.6 Acres

- KC — Knob Cone Pine Forest, 19.2 ac.
- RY22 — Young Growth Redwood Very Dense with a High Merchantable Ratio, 8.6 ac.
- RY32 — Young Growth Redwood Fairly Dense with a High Merchantable Ratio, 36.4 ac.
- RY33 — Young Growth Redwood Fairly Dense but with a Lower Merchantable Ratio, 28.7 ac.
- RY43 — Young Growth Redwood Low Density with Some Hardwood, 97.8 ac.
- DY43 — Young Growth Douglas Fir Low Density with Some Hardwood, 11 ac.
- RY54 — Young Growth Redwood Very Low Density with a Hardwood Mixture, 48 ac.

Scale: 1:5,000

Contour Interval: 20 Feet

Coordinate System: NAD 1983
State Plane California III FIPS 0403 Feet

Source: Tunheim, 1992

Cartographer: Kevin McManigal

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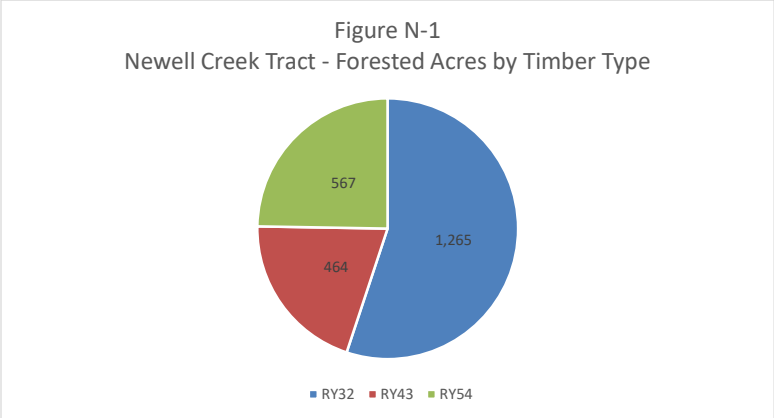
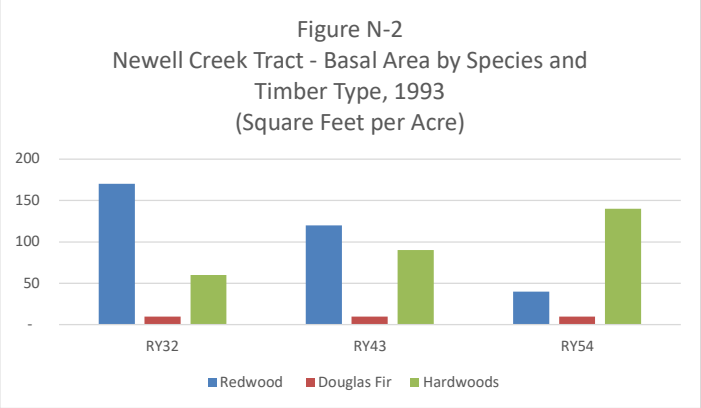
Figures - Newell Creek Tract





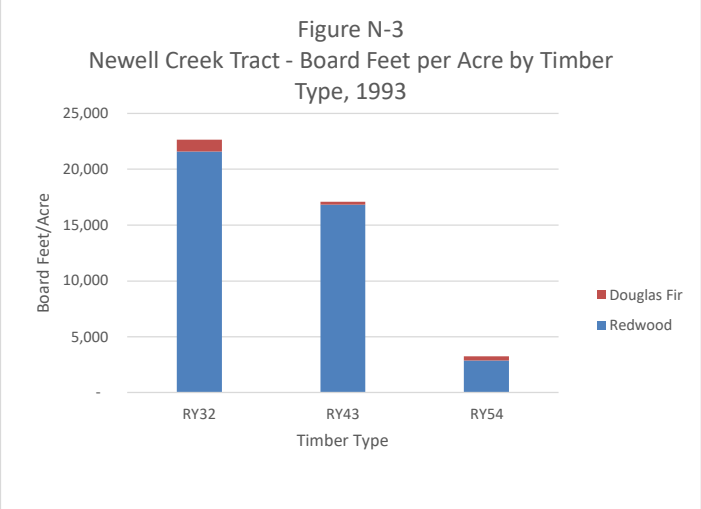


Figure N-4
Newell Creek Tract - Board Feet of Redwood per Acre by Timber Type and Diameter Class, 1993

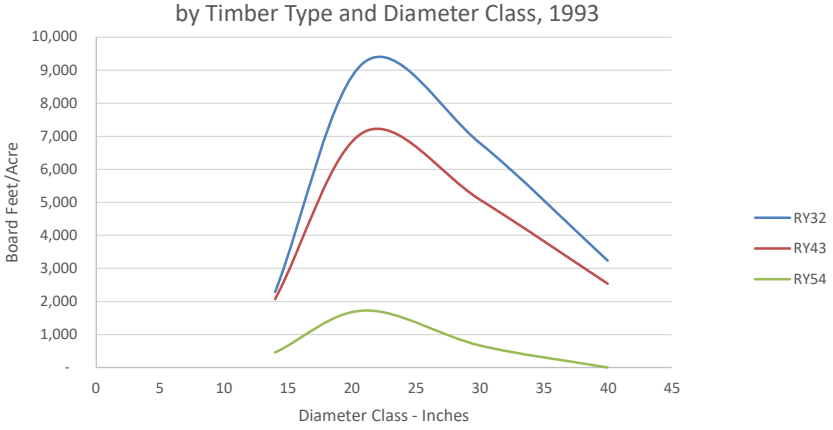


Figure N-5
Newell Creek Tract - Redwood Trees per Acre by Timber Type and Diameter Class, 1993

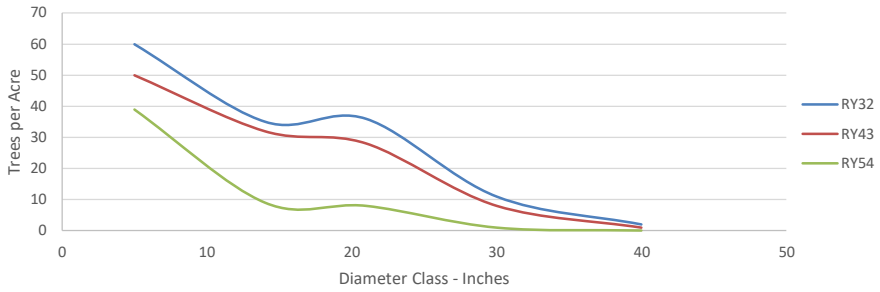


Figure N-6
Newell Creek Tract - Total Timber Volume by Timber Type, 1993

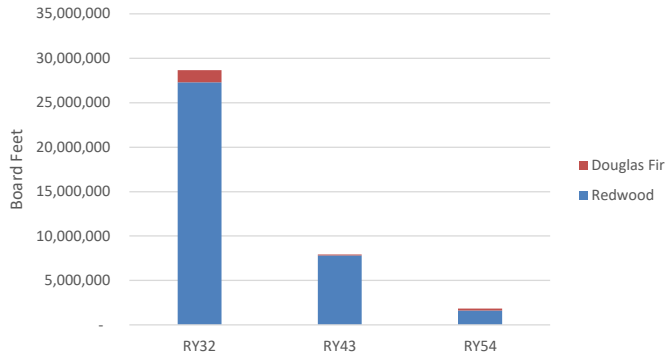


Figure N-7
Newell Creek Tract - Estimated Annual Growth of Conifers, 1993-2020 (Board Feet/Year)

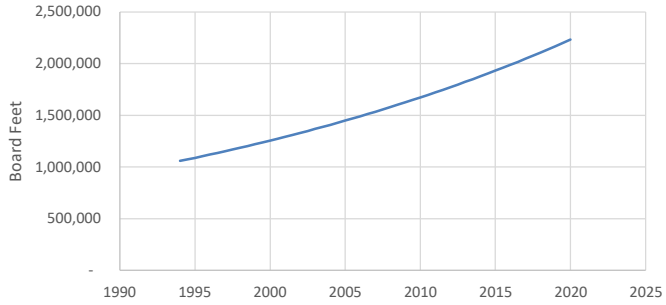


Figure N-8
Newell Creek Tract - 1993 and Estimated 2020 Timber Volume per Acre by Timber Type

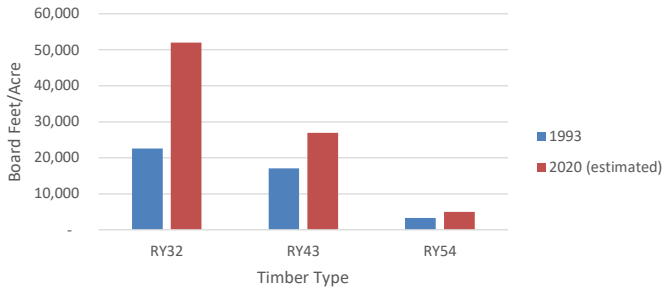
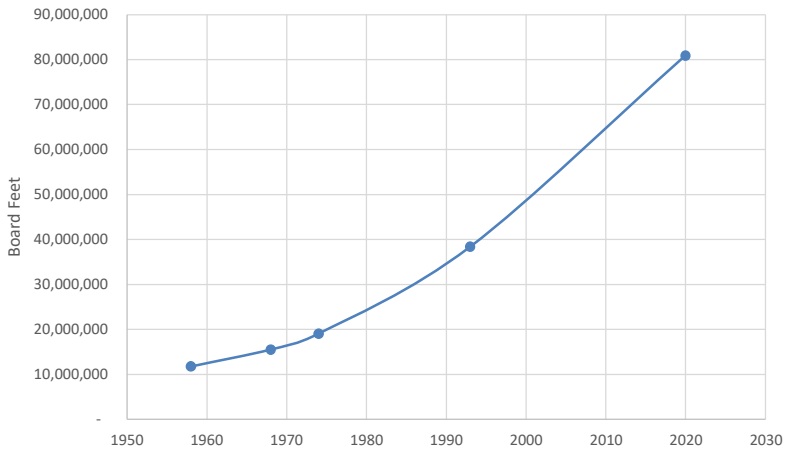
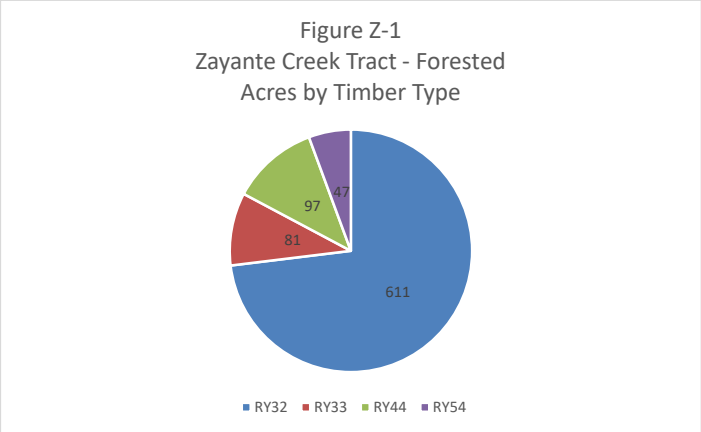
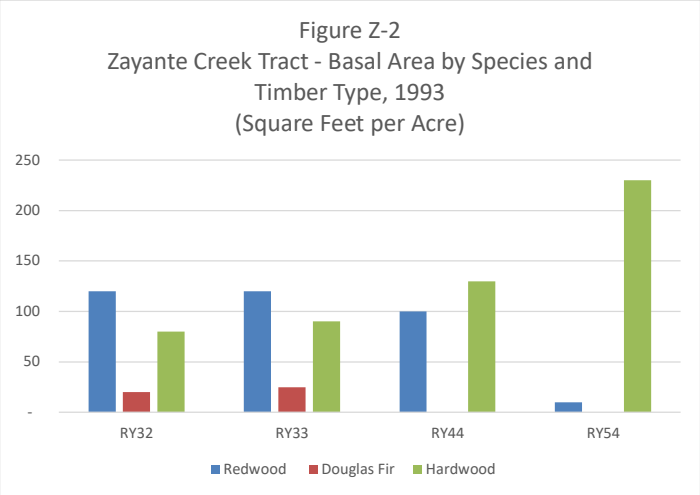


Figure N-9
Newell Creek Tract - Historic Growth of Timber Volume, 1958-2020 (1993-2020 estimated)



Figures - Zayante Creek Tract





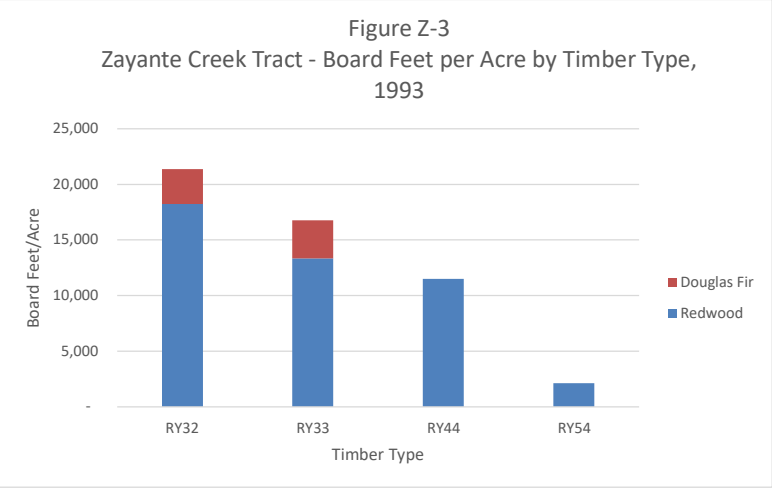


Figure Z-4
Zayante Creek Tract - Board Feet of Redwood per Acre
by Timber Type and Diameter Class, 1993

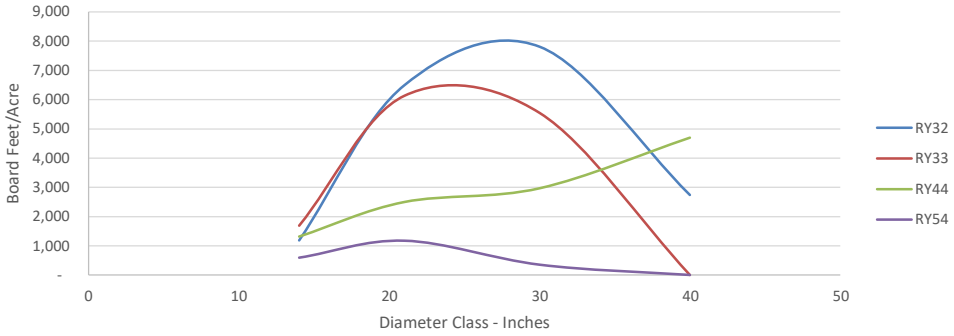


Figure Z-6
Zayante Creek Tract - Total Timber Volume by Timber Type,
1993

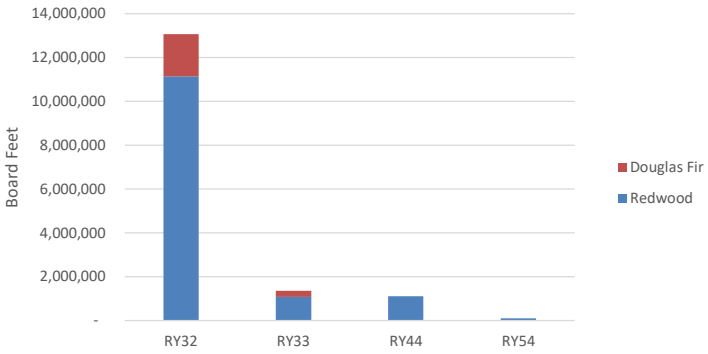


Figure Z-7
Zayante Creek Tract - Estimated Annual Growth of Conifers, 1993-2020
(Board Feet/Year)

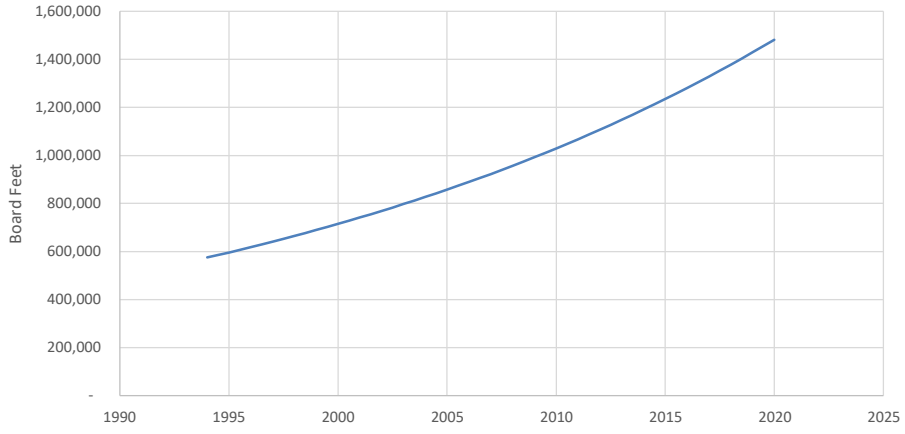
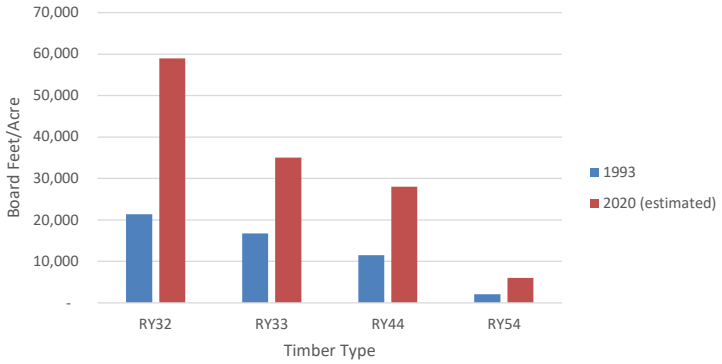
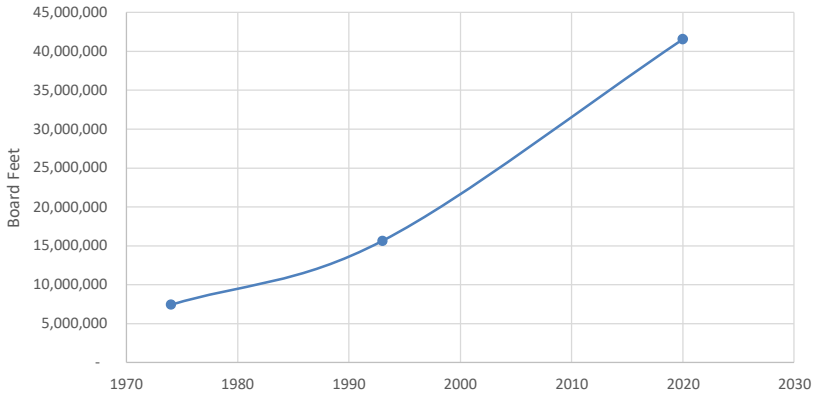


Figure Z-8
Zayante Creek Tract - 1993 and Estimated 2020 Timber Volume per Acre by Timber Type



Figiure Z-9
Zayante Creek Tract - Historic Growth of Timber Volume, 1974-2020 (1993-2020 estimated)



Figures - Laguna Creek Tract

Figure L-1
Laguna Creek Tract - Forested Acres by Timber Type

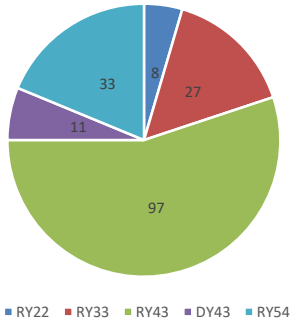


Figure L-2
Laguna Creek Tract - Basal Area by Species and Timber Type, 1993
(Square Feet per Acre)

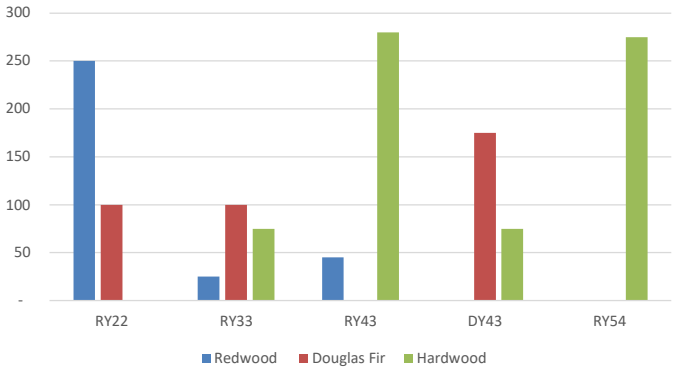


Figure L-3
Laguna Creek Tract - Board Feet per Acre by Timber Type, 1993

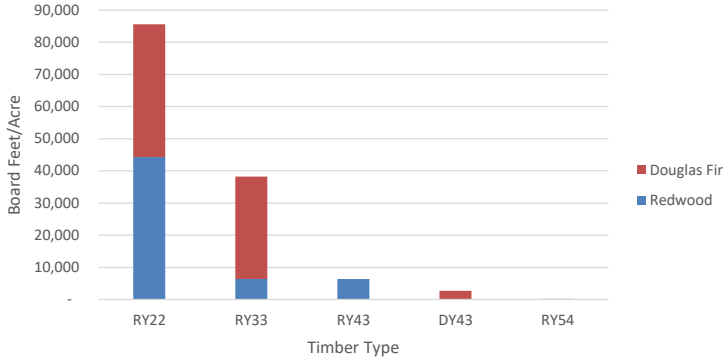


Figure L-4
Laguna Creek Tract - Board Feet of Redwood per Acre
by Timber Type and Diameter Class, 1993

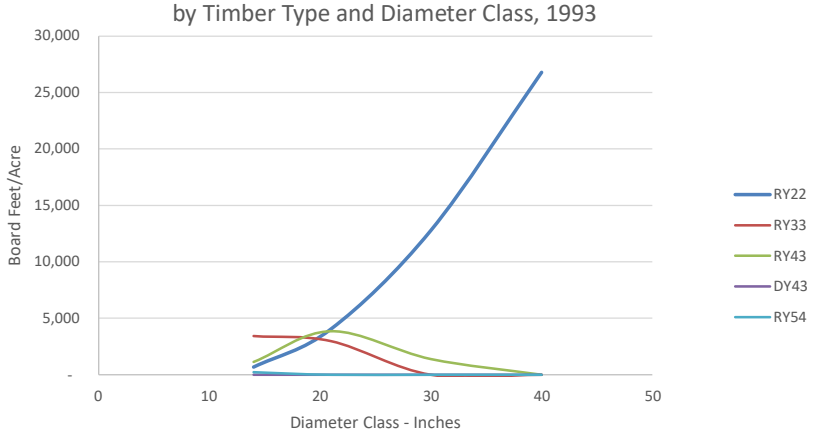


Figure L-5
Laguna Creek Tract - Redwood Trees per Acre by Timber Type
and Diameter Class, 1993)

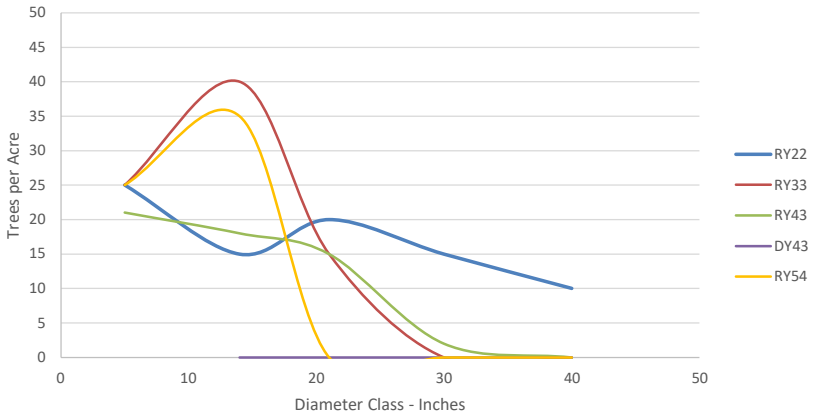


Figure L-6
Laguna Creek Tract - Total Timber Volume by Timber Type, 1993

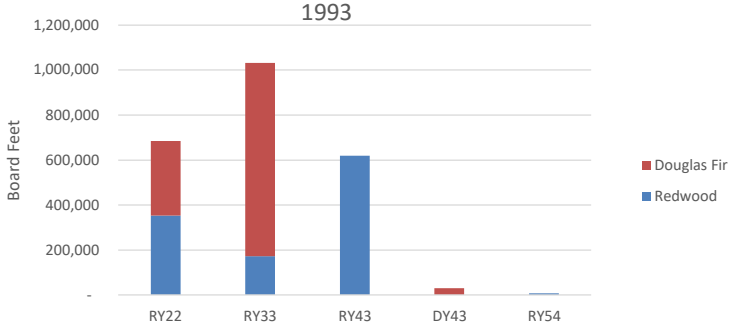


Figure L-7
Laguna Creek Tract - Estimated Annual Growth of Conifers, 1993-2020 (Board Feet/Year)

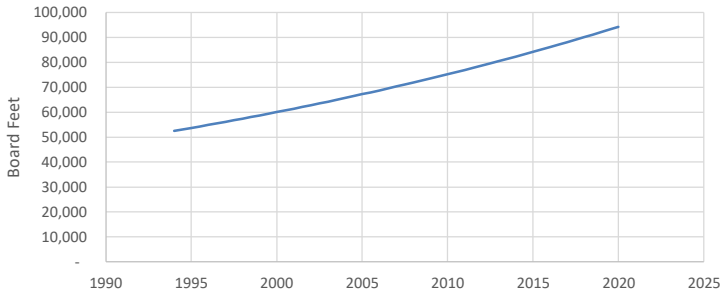


Figure L-8
Laguna Creek Tract - 1993 and Estimated 2020 Timber Volume per Acre by Timber Type

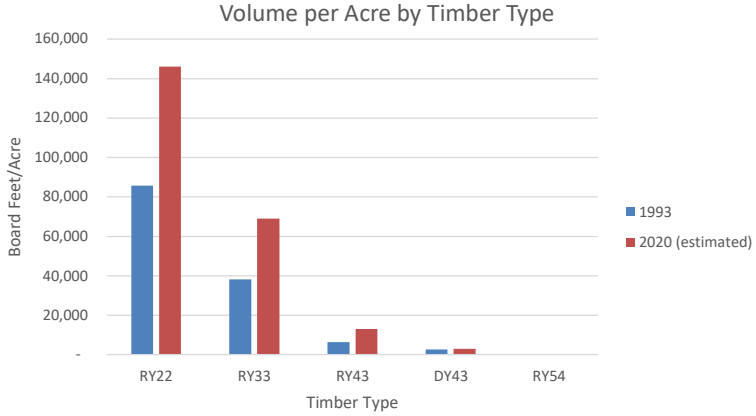
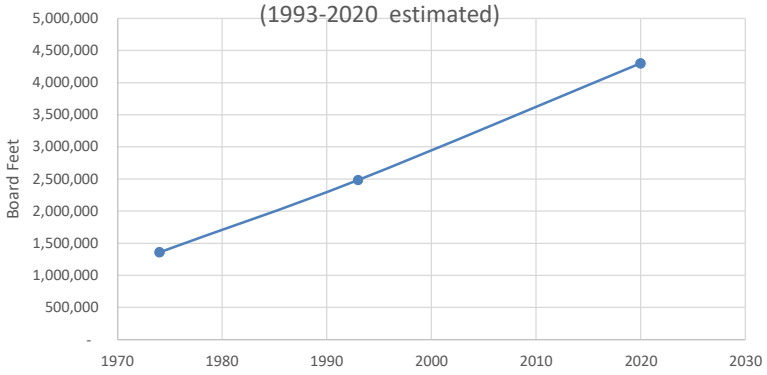
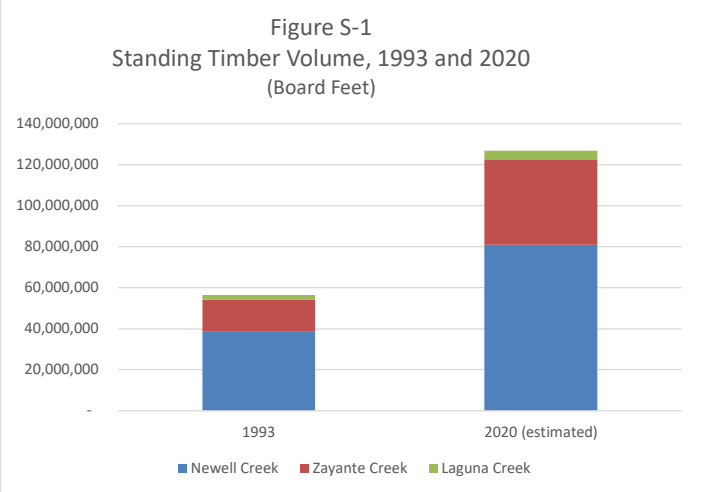


Figure L-9
Laguna Creek Tract - Historic Growth of Timber Volume, 1974-2020
(1993-2020 estimated)



Summary Figures



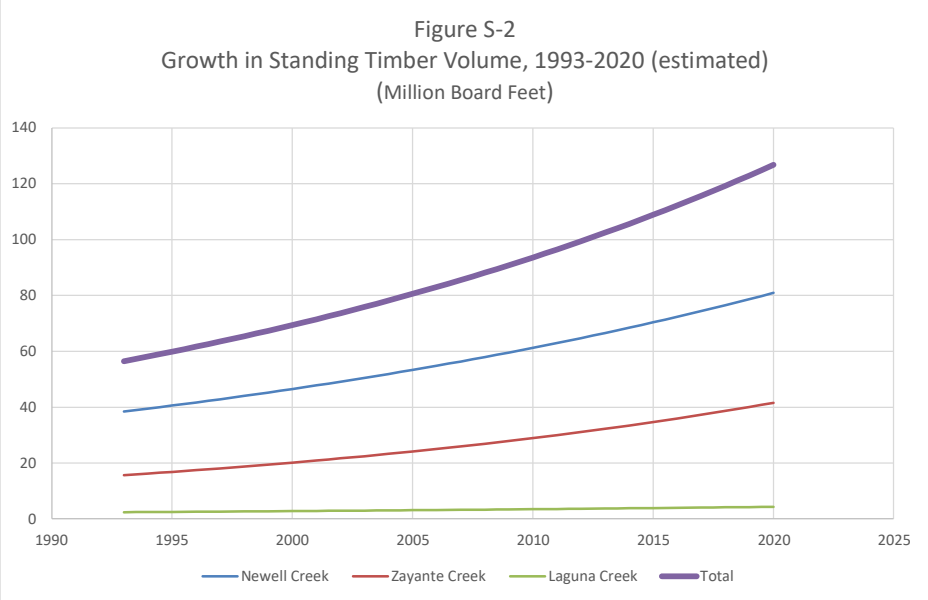


Figure S-3
Incremental Annual Growth of Standing Timber Volume, 1993-2020
(estimated)
(Board Feet per Year)

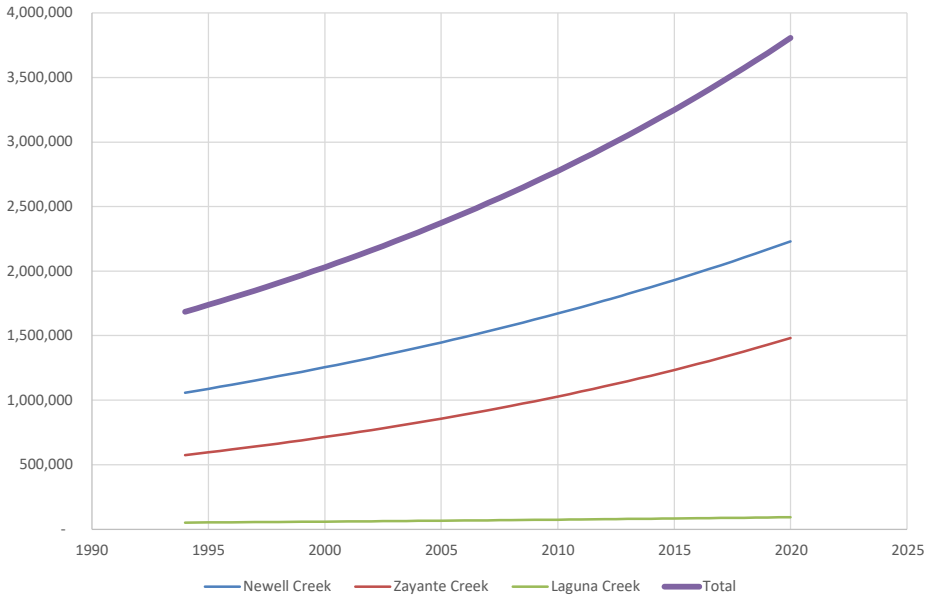


Figure S-4
Average Standing Timber Volume per Acre, 1993 and 2020
Board Feet/Acre

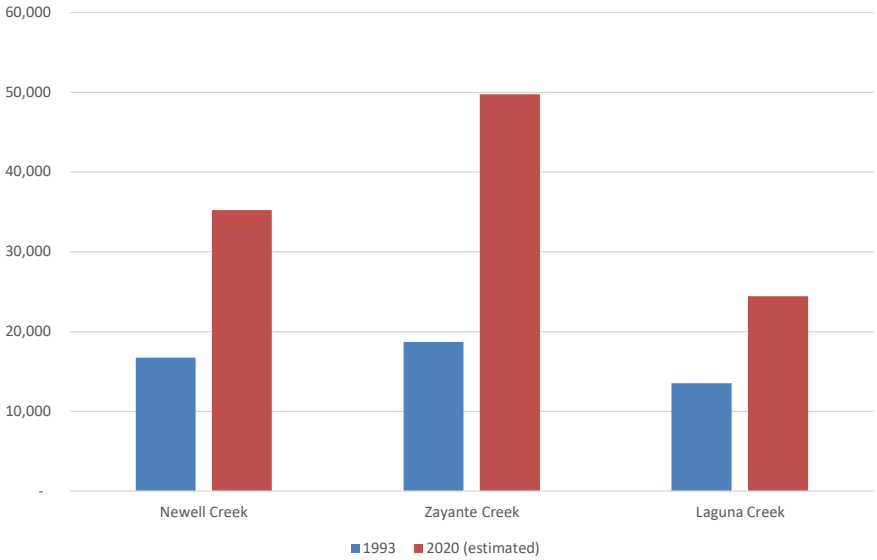


Figure S-5
Historic Growth in Standing Timber Volume, All Tracts, 1958-2020
(Board Feet; 1994-2020 estimated)

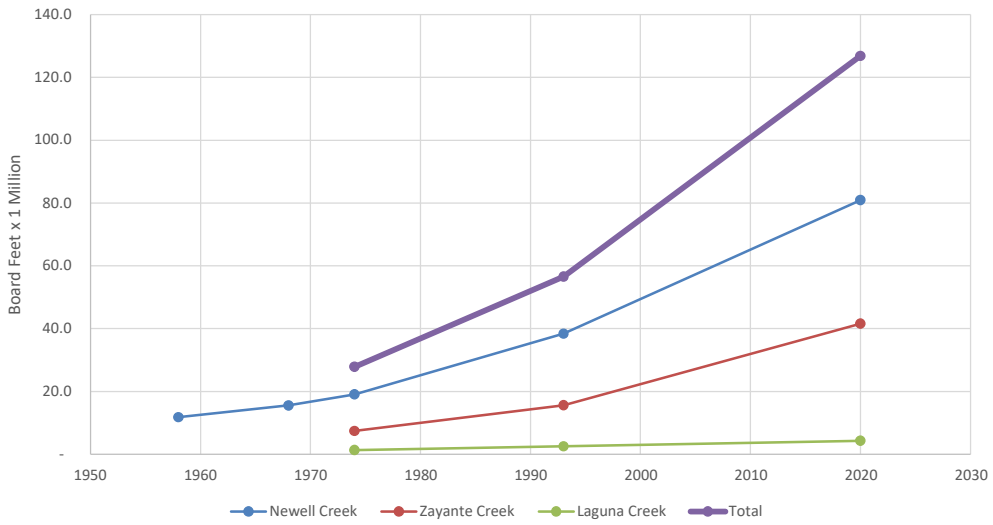


Figure S-6
Sequestered Carbon, 1993 and 2020
living trees, all species
metric tonnes carbon dioxide equivalent

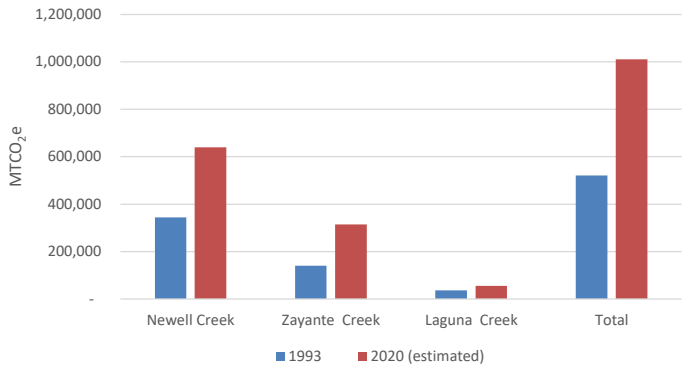
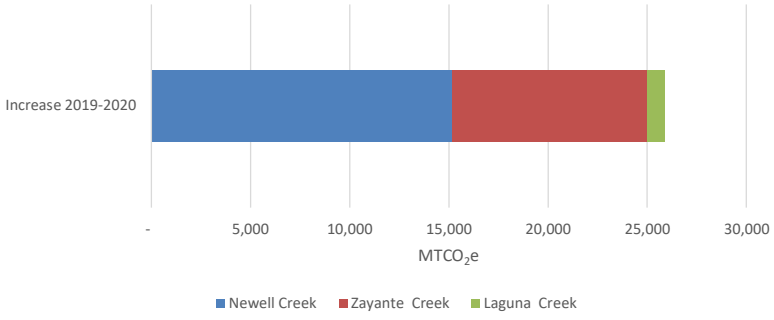


Figure S-7
Estimated Current Annual Carbon Sequestration (2019-2020)



Newell Creek Tract Tables

Acres by timber type	
Timber Type	Acres
RY32	1,265
RY43	464
RY54	567
Total	2,296

Table N-1: Newell Creek Tract, Board Feet per Acre by Diameter Class, Timber Type, and Species										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	2,290	9,250	6,800	3,240	70	130	650	230	22,660	20,300
RY43	2,070	7,140	5,090	2,540	20	50	170	-	17,080	14,990
RY54	460	1,730	670	-	10	90	-	300	3,260	2,790
TOTAL	(average weighted by acreage)								16,741	14,903

Table N-2: Newell Creek Tract, Number of Trees per Acre by Diameter Class, Timber Type, and Species										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	35	36	11	2	1	1	1	-	87	51
RY43	32	28	8	1	-	-	-	-	69	37
RY54	9	8	1	-	-	-	-	-	18	9
TOTAL	(average weighted by acreage)								66	38

Table N-3: Newell Creek Tract, Annual Growth of Conifers in Board Feet per Acre by Timber Type						
\	Acres	Sub-Merchantable		Merchantable		Total
RY32	1,265	125	5.3%	630	3.1%	755
RY43	464	135	6.4%	255	1.7%	390
RY54	567	-	0.0%	55	1.9%	55

Table N-4: Newell Creek Tract, Total Annual Growth in Board Feet by Timber Type						
Timber Type	Acres	Sub-Merchantable		Merchantable		Total
RY32	1,265	158,100	5.3%	797,000	3.1%	955,100
RY43	464	62,600	6.4%	118,300	1.7%	180,900
RY54	567	-	0.0%	31,200	1.9%	31,200
TOTAL		220,700		946,500		1,167,200

Table N-5: Newell Creek Tract, Total Board Foot Volume by Diameter Class, Timber Type, and Species (Net Volume)										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	2,896,850	11,701,250	8,602,000	4,098,600	88,550	164,450	822,250	290,950	28,664,900	25,679,500
RY43	960,480	3,312,960	2,361,760	1,178,560	9,280	23,200	78,880	-	7,925,120	6,955,360
RY54	260,820	980,910	379,890	-	5,670	51,030	-	170,100	1,848,420	1,581,930
TOTAL	4,118,150	15,995,120	11,343,650	5,277,160	103,500	238,680	901,130	461,050	38,438,440	34,216,790

Table N-6: Newell Creek Tract, Total Number of Trees per Diameter Class, Timber Type, and Species										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	44,275	45,540	13,915	2,530	749	499	1,265	126	108,899	63,875
RY43	14,848	12,992	3,712	464	110	110	110	-	32,346	17,388
RY54	5,103	4,536	675	-	135	270	-	135	10,854	5,616
TOTAL	64,226	63,068	18,302	2,994	994	879	1,375	261	152,099	86,879

Table N-7: Newell Creek Tract, Board Foot Timber Volume per Acre by Timber Type and Merchantableness					
Timber Type	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY32	2,290	19,290	70	1,010	20,300
RY43	2,070	14,770	20	220	14,990
RY54	460	2,400	10	390	2,790

Table N-8: Newell Creek Tract, Number of Trees per Acre by Timber Type, Species, and Merchantableness						
Timber Type	Acres	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY32	1,265	35	49	1	2	51
RY43	464	32	37	-	-	37
RY54	567	9	9	-	-	9
TOTAL	(average weighted by acreage)	28	37	1	1	38

Table N-9: Newell Creek Tract, Hardwood Volumes and Basal Area				
Timber Type	Acres	Avg. Basal Area per Acre in Sq. Ft.	Cords/Acre	Cords/Timber Type
RY32	1,265	60	10	12,650
RY43	464	90	10	4,640
RY54	567	140	20	11,340
TOTAL	2,296			28,630

Table N-10: Newell Creek Tract, Average Basal Area per Acre (in Square Feet)						
Timber Type	Acres	Redwood	Douglas Fir	Hardwood	Total Conifer	Total
RY32	1,265	170	10	60	180	240
RY43	464	120	10	90	130	220
RY54	567	40	10	140	50	190

Zayante Creek Tract Tables

Acres by timber type	
Timber Type	Acres
RY32	611
RY33	81
RY44	97
RY54	47
Total	836

Table Z-1: Zayante Creek Tract, Board Feet per Acre by Diameter Class, Timber Type, and Species

Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	1,190	6,490	7,810	2,740	80	570	1,200	1,310	21,390	20,120
RY33	1,690	6,130	5,540	-	660	1,040	-	1,700	16,760	14,410
RY44	1,320	2,500	2,970	4,700	-	-	-	-	11,490	10,170
RY54	590	1,180	350	-	-	-	-	-	2,120	1,530
TOTAL	(average weighted by acreage)								18,709	17,367

Table Z-2: Zayante Creek Tract, Number of Trees per Acre by Diameter Class, Timber Type, and Species

Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	19	23	11	1	1	2	1	1	59	39
RY33	21	21	8	-	10	6	-	2	68	37
RY44	22	10	4	3	-	-	-	-	39	17
RY54	9	8	1	-	-	-	-	-	18	9
TOTAL	(average weighted by acreage)								55	35

Table Z-3: Zayante Creek Tract, Growth of Conifers in Board Feet per Acre by Timber Type per Year						
Timber Type	Acres	Sub-Merchantable		Merchantable		Total
RY32	611	60	5.1%	760	3.8%	820
RY33	81	160	6.6%	400	2.8%	560
RY44	97	70	5.3%	340	3.3%	410
RY54	47	50	8.6%	60	3.6%	110

Table Z-4: Zayante Creek Tract, Total Growth in Board Feet per Year by Timber Type						
Timber Type	Acres	Sub-Merchantable		Merchantable		Total
RY32	611	36,700	5.1%	464,400	3.8%	501,100
RY33	81	13,000	6.6%	32,400	2.8%	45,400
RY44	97	6,800	5.3%	33,000	3.3%	39,800
RY54	47	2,400	8.6%	2,800	3.6%	5,200
TOTAL		58,900		532,600		591,500

Table Z-5: Zayante Creek Tract, Total Board Foot Volume by Diameter Class, Timber Type, and Species (Net Volume)										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	727,100	3,965,400	4,771,900	1,674,100	48,900	348,300	733,200	800,400	13,069,300	12,293,300
RY33	136,900	496,500	448,700	-	53,500	84,200	-	137,700	1,357,500	1,167,100
RY44	128,000	242,500	288,100	455,900	-	-	-	-	1,114,500	986,500
RY54	27,700	55,500	16,500	-	-	-	-	-	99,700	72,000
TOTAL	1,019,700	4,759,900	5,525,200	2,130,000	102,400	432,500	733,200	938,100	15,641,000	14,518,900

Table Z-6: Zayante Creek Tract, Total Number of Trees per Diameter Class, Timber Type, and Species										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY32	11,609	14,053	6,721	611	611	1,222	611	611	36,049	23,829
RY33	1,701	1,701	648	-	810	486	-	162	5,508	2,997
RY44	2,134	970	388	291	-	-	-	-	3,783	1,649
RY54	423	376	47	-	-	-	-	-	846	423
TOTAL	15,867	17,100	7,804	902	1,421	1,708	611	773	46,186	28,898

Table Z-7: Zayante Creek Tract, Board Foot Timber Volume per Acre by Timber Type and Merchantableness					
Timber Type	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY32	1,190	17,040	80	3,080	20,120
RY33	1,690	11,670	660	2,740	14,410
RY44	1,320	10,170	-	-	10,170
RY54	590	1,530	-	-	1,530

Table Z-8: Zayante Creek Tract, Number of Trees per Acre by Timber Type, Species, and Merchantableness						
Timber Type	Acres	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY32	611	19	35	1	4	39
RY33	81	21	29	10	8	37
RY44	97	22	17	-	-	17
RY54	47	9	9	-	-	9
TOTAL	(average weighted by acreage)	19	31	2	4	35

Table Z-9: Zayante Creek Tract, Hardwood Volumes and Basal Area				
Timber Type	Acres	Avg. Basal Area per Acre in Sq. Ft.	Cords/Acre	Cords/Timber Type
RY32	611	80	10	6,110
RY33	81	90	10	810
RY44	97	130	20	1,940
RY54	47	230	25	1,175
TOTAL	836			10,035

Table Z-10: Zayante Creek Tract, Average Basal Area per Acre (in Square Feet)						
Timber Type	Acres	Redwood	Douglas Fir	Hardwood	Total Conifer	Total
RY32	611	120	20	80	140	220
RY33	81	120	25	90	145	235
RY44	97	100	-	130	100	230
RY54	47	10	-	230	10	240

Laguna Creek Tract Tables

Acres by timber type	
Timber Type	Acres
RY22	8
RY33	27
RY43	97
DY43	11
RY54	33
Total	176

Table L-1: Laguna Creek Tract, Board Feet per Acre by Diameter Class, Timber Type, and Species

Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY22	680	4,050	12,780	26,780	-	1,400	-	39,950	85,640	84,960
RY33	3,420	2,970	-	-	-	-	5,990	25,840	38,220	34,800
RY43	1,130	3,860	1,400	-	-	-	-	-	6,390	5,260
DY43	-	-	-	-	2,680	-	-	-	2,680	-
RY54	220	-	-	-	-	-	-	-	220	-
TOTAL	(average weighted by acreage)								13,487	12,099

Table L-2: Laguna Creek Tract, Number of Trees per Acre by Diameter Class, Timber Type, and Species

Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY22	15	20	15	10	-	5	-	10	75	60
RY33	40	15	-	-	-	-	5	15	75	35
RY43	18	15	2	-	-	-	-	-	35	17
DY43	-	-	-	-	25	-	-	-	25	-
RY54	35	-	-	-	-	-	-	-	35	-
TOTAL	(average weighted by acreage)								42	17

Table L-3: Laguna Creek Tract, Growth of Conifers in Board Feet per Acre by Timber Type per Year						
Timber Type	Acres	Sub-Merchantable		Merchantable		Total
RY22	8	30	4.0%	1,700	2.0%	1,730
RY33	27	140	4.1%	770	2.2%	910
RY43	97	50	4.8%	140	2.6%	190
DY43	11	130	4.8%	-	N/A	130
RY54	33	10	4.1%	-	N/A	10

Table L-4: Laguna Creek Tract, Total Growth in Board Feet per Year by Timber Type						
Timber Type	Acres	Sub-Merchantable		Merchantable		Total
RY22	8	240	4.0%	13,600	2.0%	13,840
RY33	27	3,780	4.1%	20,790	2.2%	24,570
RY43	97	4,850	4.8%	13,580	2.6%	18,430
DY43	11	1,430	4.8%	-	N/A	1,430
RY54	33	330	4.1%	-	N/A	330
TOTAL		10,630		47,970		58,600

Table L-5: Laguna Creek Tract, Total Board Foot Volume by Diameter Class, Timber Type, and Species (Net Volume)										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY22	5,400	32,400	102,200	214,200	-	11,200	-	319,600	685,000	679,600
RY33	92,300	80,200	-	-	-	-	161,700	697,700	1,031,900	939,600
RY43	109,600	374,400	135,800	-	-	-	-	-	619,800	510,200
DY43	-	-	-	-	29,500	-	-	-	29,500	-
RY54	7,300	-	-	-	-	-	-	-	7,300	-
TOTAL	214,600	487,000	238,000	214,200	29,500	11,200	161,700	1,017,300	2,373,500	2,129,400

Table L-6: Laguna Creek Tract, Total Number of Trees per Diameter Class, Timber Type, and Species										
Timber Type	Redwood				Douglas Fir				Total	Total Merchantable (>16" Diameter)
	12-16"	18--24"	26-34"	36"+	12-16"	18--24"	26-34"	36"+		
RY22	120	160	120	80	-	40	-	80	600	480
RY33	1,080	405	-	-	-	-	135	405	2,025	945
RY43	1,746	1,455	194	-	-	-	-	-	3,395	1,649
DY43	-	-	-	-	275	-	-	-	275	-
RY54	1,155	-	-	-	-	-	-	-	1,155	-
TOTAL	4,101	2,020	314	80	275	40	135	485	7,450	3,074

Table L-7: Laguna Creek Tract, Board Foot Timber Volume per Acre by Timber Type and Merchantableness					
Timber Type	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY22	680	43,610	-	41,350	84,960
RY33	3,420	2,970	-	31,830	34,800
RY43	1,130	5,260	-	-	5,260
DY43	-	-	2,680	-	-
RY54	220	-	-	-	-

Table L-8: Laguna Creek Tract, Number of Trees per Acre by Timber Type, Species, and Merchantableness						
Timber Type	Acres	Redwood Sub-Merchantable	Redwood Merchantable	Douglas Fir Sub-Merchantable	Douglas Fir Merchantable	Total Merchantable
RY22	8	15	45	-	15	60
RY33	27	40	15	-	20	35
RY43	97	18	17	-	-	17
DY43	11	-	-	25	-	-
RY54	33	35	-	-	-	-
TOTAL	(average weighted by acreage)	23	14	-	4	17

Table L-9: Laguna Creek Tract, Hardwood Volumes and Basal Area				
Timber Type	Acres	Avg. Basal Area per Acre in Sq. Ft.	Cords/Acre	Cords/Timber Type
RY22	8	0	-	-
RY33	27	75	5	135
RY43	97	280	30	2,910
DY43	11	75	15	165
RY54	33	275	30	990
TOTAL	176			4,200

Table L-10: Laguna Creek Tract, Average Basal Area per Acre (in Square Feet)						
Timber Type	Acres	Redwood	Douglas Fir	Hardwood	Total Conifer	Total
RY22	8	250	100	-	350	350
RY33	27	25	100	75	125	200
RY43	97	45	-	280	45	325
DY43	11	-	175	75	175	250
RY54	33	-	-	275	-	275

Summary Tables

Table S-1 Forested Acreage of each Tract	
Newell Creek	2,296
Zayante Creek	836
Laguna Creek	176
Total	3,308

Table S-2: Timber Type Vital Statistics

Tract	Timber Type	Acres	Site Class	Site Index	Annual Growth Rate
Newell Creek					
	RY32	1,265	High IV	126	3.1%
	RY43	464	IV	115	1.7%
	RY54	567	V	96	1.9%
Zayante Creek					
	RY32	611	III	135	3.8%
	RY33	81	IV	115	2.8%
	RY44	97	IV	105	3.3%
	RY54	47	V	90	3.6%
Laguna Creek					
	RY22	8	I	220	2.0%
	RY33	27	IV	105	2.2%
	RY43	97	IV	120	2.6%
	DY43	11	IV	95	N/A
	RY54	33	V	95	N/A

Table S-3: Historic Growth				
	Million Board Feet of Standing Timber			
Year	Newell Creek	Zayante Creek	Laguna Creek	Total
1958	11.8			
1968	15.5			
1974	19.1	7.4	1.4	27.9
1993	38.4	15.6	2.5	56.5
2020	80.9	41.6	4.3	126.8

Table S-4: Sequestered Carbon					
	$MTCO_2e$				
	Newell Creek	Zayante Creek	Laguna Creek	Total	Per Forested Acre
1993	343,864	140,275	36,167	520,306	157
2020 (estimated)	639,735	315,210	54,951	1,009,895	305
Increase 2019-2020	15,197	9,799	874	25,870	8

Appendix A: Description of Timber Types

Excerpt from the 1994 Forest Management Plan

NEWELL CREEK TIMBER TYPES

RY 32 1265 ACRES

This is the most prevalent timber type on the property. It is similar in all respects to the RY 32 type described on the Zayante parcel.

This type is classified as high Site Class IV or site index 126. There is a fair amount of variability within this type including small pockets of pure hardwood and strips of timber near the creek bottoms that approach a RY 22 type.

The type carries 22,660 total BF per acre. The area is characterized by second growth clumps of redwood intermixed with Douglas-fir and scattered hardwoods. Hardwoods fully occupy many small poor sub-sites within this type. The hardwood species are tan oak, live oak, and madrone. The live oak is typically associated with slightly poorer or dryer sites. Big leaf maple and alder are found near the larger creeks.

An analysis of the tables reveals the following additional information about the type.

The area is adequately stocked with conifers. The conifer basal area of 180 sq.ft/acre is typical of the site class.

The growth rate for the type averages 3.1%. This is a good growth rate.

The diameter distribution of trees reflects the hypothetical optimum of an all aged stand. That being a pyramid shape distribution built on a foundation of many small trees apexing with a lesser number of the largest trees at its peak.

The species composition is typical of a coastal redwood forest. It is predominantly redwood with a mixture of hardwoods and a scattering of Douglas-fir.

Most of the ground within the RY 32 type with the exception of the area on the east side of the reservoir has been harvested at least once for second growth timber. Many portions have been harvested twice for second growth timber. Additionally, many areas have had limited fuelwood operations associated with the conifer

harvest. These factors have combined to create this high growth rate and healthy forest structure.

The understory vegetation is extremely variable and is very dependent on timber cover, past treatment, and aspect.

In general, the understory is moderately thick, and consists of tan oak, madrone, sword fern, hazel nut, ocean spray (Arrowwood), poison oak, and blackberry. The understory often has numerous small (<12" DBH) conifer stems. This type has an average of 60 small conifer trees per acre in the understory.

RY 43 464 ACRES

This type typically occupies semi-exposed areas. The type is considered to be merchantable. The tree diameter distribution is similar to the RY 32 type although the stocking is definitely poorer. The scenario in this type is that the redwood clumps are normally fairly well stocked with trees, but the type is not well stocked with redwood clumps.

The areas between the clumps are filled with hardwoods. These hardwoods are live oak, madrone, and tan oak. Bay laurel is also present. This area carries 10 cords per acre of hardwoods. This component of the forest is also considered merchantable where access permits removal for fuelwood.

The growth rate of the conifers on this type is 1.7% per year. This appears to be below its potential in light of the fact that the ground is rated as Site Class IV and has a site index value of 115. The main reason for this low growth rate appears to be excessive competition. This competition exists both between trees within the clumps and between the clumps and the surrounding hardwoods.

An analysis of the tables reveals the following additional information about the type. The area appears to be inadequately stocked in terms of potential, considering its site value. The basal area also reflects this under-stocking. The total basal area value of 220 sq.ft/Acre reflects the lower Site Index Value of the type. However, the 130 sq.ft/Acre value of the conifer component

appears to be below the capacity of the site. The area could likely carry 150 sq.ft./acre of conifer.

The species composition is typical of the site. The area is primarily redwood, with hardwood and a scattering of Douglas-fir.

The understory is typically dense and consists of madrone, tan oak, poison oak, live oak, hazel nut, sword fern, huckleberry, and wild rose. There are numerous small (<12" DBH) conifers in the understory averaging 50 stems to the acre.

RY 54 567 ACRES

This type is essentially a hardwood stand with a scattering of redwood and Douglas-fir. The conifers within this area are typically smaller than in the other types. The area carries 3,260 BF/acre of conifers. This volume is not considered merchantable at this time due to its small size and very scattered nature. The hardwood component of this stand which averages 20 cords to the acre is considered merchantable where access permits removal.

The hardwood species are live oak, madrone, and some tan oak.

The understory is typically quite dense. It consists of: madrone, live oak, tan oak, manzanita, chamise, toyon, poison oak, Ceonothus, wild rose, coyote brush, blackberry, bay laurel, and bracken fern. There are also approximately 39 small (<12" DBH) conifers per acre present in the understory.

An analysis of the tables reveals the following information about the type.

The area is poorly stocked with conifers both in terms of volume per acre and number of trees per acre.

The area has a low site rating, Site Class V or Site Index 96. The growth rate of 1.9% is reasonable considering the site.

The diameter distribution of the trees is similar to the hypothetical optimum of an all age stand with the exception that there are too few trees in the larger diameter classes.

The species distribution is typical of the site rating of the area.

H This type is similar to the Y 54 type except that it has virtually no conifer stocking and a high component of brush.

B This type consists of brush and grass. The brush is typically manzanita, Ceonothus, coyote brush, or chamise.

ZAYANTE CREEK TIMBER TYPES

RY 32 611 ACRES

This type contains the best timber ground in this parcel It is classified as Site Class III growing ground with an average Site Index of 135. It encompasses the ground south of Zayante and Mt. Charlie Creeks. It is also found in patches along creeks and draws on the remaining portion of the property.

This type carries a total volume of 26,350 BF/acre of conifers. It is characterized by second growth clumps of redwood with intermixed Douglas-fir. In low areas near creeks and draws, the stand approaches an RY 22 type with only a light scattering of hardwoods breaking up the conifers. On the main and spur ridges, the conifer forest is seriously broken up by large numbers of hardwoods. Hardwoods fully occupy many small, poor sub-sites within this type. The hardwoods species are tan oak, madrone, live oak, alder, and maple. Tan oak and madrone are the predominant species on north facing slopes. A live oak and madrone mix is more typical of the south facing slopes and poorer site areas. Alder and maple are found in riparian areas and on some of the large, wet (spring fed) unstable areas on the property and within the type.

The Douglas-fir within the type occurs as both scattered trees and in small semi-pure stands. These small stands of Douglas-fir are typically associated with old land slide failures.

Much of this type has been selectively harvested once for conifer. Portions of this type which were heavy with hardwood were

selectively cut for hardwood and planted with conifers during the 1980's.

The growth rate for the type is approximately 3.8%; the growth rate in the harvested and converted areas being higher than in the non-thinned areas.

An analysis of the tables reveal the following information about the type.

The conifer stocking of the area is below its apparent potential based on the site rating of the area. The volume per acre is good, however, the conifer component of the stand based upon basal area figures appear low. More of the area currently occupied by hardwoods should be supporting conifer.

The diameter distribution is good and is representative of a healthy, managed, all age stand.

There is an apparent spike in the number of trees in the 18-24" class.

The species composition consists of a little higher volume of Douglas-fir per acre than is typical. This is due mainly to the large amounts of inherently unstable ground on the Zayante parcel. The disturbed areas from historic mud flows have seeded in with Douglas-fir. Douglas-fir is a prolific seed producer and an aggressive tree on disturbed soil.

The understory vegetation is typically moderately light. It consists of tan oak, blackberry, poison oak, madrone, live oak, Douglas-fir, and redwood. The lowest herbaceous layer consists of Redwood sorrel, wild rose, bracken fern, sword fern, and other small herbaceous plants.

Areas of fairly thick blackberry or poison oak are prevalent near road sides and around sunny disturbed areas. Areas of light ground cover consisting of Redwood sorrel, ferns and other small herbaceous plants are prevalent under areas of good timber or within large redwood clumps.

The understory is well stocked in small trees (<12" DBH). It is stocked with an average of 86 trees per acre.

RY 33 81 ACRES

This type contains a good volume per acre of conifers, but is typically not as well stocked as the RY 32 type. It is classified as Site Class VI or Site Index 115. This type encompasses the more exposed and dryer sites above the RY 32 type.

This type carries a volume of 16,760 BF per acre. It is typically characterized by second growth redwood clumps intermixed with a significant component of pre-merchantable Douglas-fir. The conifer component of the stand is broken up by a large amount of hardwoods. The hardwood species are live oak and madrone.

Portions of this type have been selectively harvested for conifer and hardwood.

An analysis of the tables reveal the following information about the type.

The conifer stocking appears adequate for the site.

The growth rate for the type is 2.8%. The growth rate in the harvested and converted areas is higher than in the un-thinned areas. This is a good growth rate based on the site rating.

The diameter distribution for the stand is typical of managed all-aged redwood stands. As with the RY 32 type, there is a spike in the number of trees in the 18-24" diameter class.

The species composition of the type has a higher than normal stocking of Douglas-fir. This is similar to the Zayante Creek RY 32 type. This is no doubt a result of the inherent instability of much of the ground on the Zayante Creek unit as described under the RY 32 unit.

The understory vegetation is typically moderately heavy. It consists of poison oak, blackberry, live oak, toyon. The toyon in the understory is an indication of poorer sites. This is represented both in the site class and the slightly lower growth rate percentage.

Poison oak and blackberry is prevalent in disturbed areas such as road-sides, and conversion areas. Scotch broom flourishes along the roads within this type and is even found within the forest, particularly in disturbed areas.

The understory typically contains 86 small (<12" DBH) conifers per acre.

RY 44 97 ACRES

This type is only partially merchantable. The area is very heavy with hardwoods. This is confirmed by both the high basal area of the stand occupied by the hardwoods and the high number of cords of hardwoods per acre.

The stand carries 11,490 BF/acre of conifer despite this low average stocking per acre, a portion of this volume is merchantable due to the clumpish nature of the scattered redwoods within the type. The hardwood component of the stand at 20 cords to the acre is definitely merchantable on the accessible ground within the type.

The growth rate of 3.3% is good considering the area is a Low Site Class IV and has a Site Index of 105.

The stand diameter distribution is very good and is similar to the hypothetical optimal distribution of an all-aged redwood stand.

The species distribution is typical of the area and the site.

The understory is composed of live oak, madrone, and some tan oak.

The understory is typically dense and comprised of hazel nut, ocean spray, live oak, poison oak, blackberry, buckeye, and toyon.

The toyon and buckeye in the understory are typical indicators of poorer sites. The understory contains an average of 41 small (<12" DBH) conifer per acre, both redwood and Douglas-fir.

RY 54 47 ACRES

This area is essentially a hardwood type, although it does have approximately 18 redwood trees per acre. The area has no real merchantable conifer value although the accessible ground could be harvested for fuelwood. The type typically carries 25 cords per acre. live oak and madrone are the predominant species although tan oak and bay laurel are present in the stand.

The type is rated as Site Class V with an average Site Index of 90. The growth rate of 3.6% is bolstered a bit because the trees are at a size when they are in transition from sub-merchantable (<18"DBH) to the merchantable (>18" DBH) size class.

The diameter distribution is good although it is compressed toward the smaller diameter classes, but this is typical considering the age and site value of the stand and the lack of harvesting done in this type.

The understory in the type is variable. It ranges from a light open understory of live oak, tan oak, madrone, poison oak, or a dense understory of the same. There are many areas where a low carpet of live oak or tan oak covers the ground. There is an average of 25 small (<12" DBH) conifer per acre in the understory.

LAGUNA CREEK TIMBER TYPES

RY 22 8 ACRES

This timber type represents the best timber ground on any of the City of Santa Cruz Water Department's holding and is highly merchantable. It is classified as Site Class I with a site value of 220. This type is in the bottom of a canyon where a draw intersects Laguna Creek in the southeast portion of the property.

The type carries almost 85,000 BF/acre. The type is characterized by a 90-100% overstory of mature conifers, both redwood and Douglas-fir. There are very few hardwoods in the stand.

The understory is typically light due to the extensive crown cover. It is composed of elks clover, giant chain fern, wild ginger, sword ferns, and some redwood and Douglas-fir seedlings and saplings. The conifer seedlings and saplings average 25 per acre.

The growth rate of 2% is low for the area considering the site class. This is due to the relative over stocking of the area. This is well documented by the basal area measurement of 350 sq.ft/acre.

The area is currently near its sustainable potential. The very high total volume and conifer basal area value of 350 sq.ft/Acre reflects both the high stocking and high productive potential (site value) of the area.

The diameter distribution is good, however, a short fall in the smaller size class (12-16"DBH) is evident. This is due to the lack of regeneration is the recent past.

The species composition has a high component of Douglas-fir. This shows up in 2 size classes. The largest size class (36"+ DBH) resulted from the initial old growth harvest. The Douglas-fir in the 18-24" diameter class probably resulted from a more recent 40+ years ago) partial site disturbance such as a fire or mud flow.

RY 33 27 ACRES

This type is found along Laguna Creek and the bottom of its tributaries. Despite the types proximity to the draws, it is only rated as Site Class IV with a site index of 105. The area does have a moderate component of hardwood which averages 5 cords per acre. As you move up-slope of this type, the hardwood component increases and the type changes to RY 43 or RY 53. The growth rate of 2.2% is below the site's apparent potential.

The high competition between redwoods within the clumps and from hardwoods is evident and is likely the main cause of the low growth rate.

The stand diameter distribution is unique in that there is a fair distribution of trees through the size classes, but the largest diameter classes are comprised completely of Douglas-fir. The stand diameter distribution is skewed toward the large diameter classes.

The species composition is as described above with almost all of the merchantable volume being Douglas-fir. Part of the reason for the high percentage of Douglas-fir in the stand may be elevation related, as all of this type is above 1500' elevation.

The understory is typically moderate and consists of tan oak, live oak, and sword fern. Elks clover and thimble berry are common

near the drainages. There is some conifer in the understory, but it only averages 25 stems per acre.

RY 43 97 ACRES

This type is essentially a hardwood type with some redwood clumps. Despite the low volume per acre of conifer (5,260 BF/Acre). Some of this area is merchantable for conifer. The more accessible areas are definitely merchantable for hardwood. The hardwood species are tan oak and madrone. The area carries 30 cords per acre of hardwoods.

The area is rated as Site Class IV or site index 120. This is not a bad conifer site and the growth rate of 2.6% reflects this, as there is currently heavy competition between the scattered redwood clumps and the surrounding hardwood stands.

The diameter distribution in the stand is good and approximates the hypothetical model of an ideal stand, however, it is skewed toward the smaller diameters. This is partially due to the age and site rating of the area and to the lack of previous harvesting in this type.

The species composition is typical of the area. There is some scattered Douglas-fir in the stand, but not enough to show up in the cruise.

The understory is typically light and open. This is due to the almost un-broken hardwood canopy. This is well documented by the basal area measurement of 280 sq.ft/acre for the hardwoods. The understory is mainly tan oak with approximately 21 small redwood seedlings or saplings per acre.

DY 43 11 ACRES

This is a Douglas-fir type which occupies the upper slopes below the ridge line near the center of the southern portion of the property. The area is not merchantable at this time, however, the stand is well on the way to being merchantable. It is well stocked in both per-merchantable trees (12-16" DBH) and in saplings and seedlings (<12" DBH). The area averages 25 pre-merchantable trees

per acre and 50 small trees per acre, all Douglas-fir. There is also approximately 15 cords per acre of hardwood. This is typically tan oak, live oak, and madrone.

The understory in this type is light consisting of Douglas-fir, poison oak, and tan oak.

The area is rated as Site Class IV with a site index of 95.

The diameter distribution in this stand is poor. It is a typical single age class Douglas-fir forest. The type probably resulted from a combination of site conditions and an event which disturbed the area 30+/- year ago.

RY 54 33 ACRES

This type is essentially a hardwood type with approximately 35 pre-merchantable redwoods and approximately 25 seedlings and saplings per acre.

The area carries 30 cords per acre of hardwood. These hardwoods are considered merchantable where access permits removal. The hardwood species are tan oak and madrone.

The understory is light to moderate in density and consists primarily of tan oak.

The area is rated as Site Class V with a site index of 95.

KC

This type is a knob cone pine and brush area. Knob cone pine has no merchantable value.

S-SCRUB

This type consists of brush and scrub oaks. The area has no merchantable value.