



**Lower Cascade Canal and Upper
Grass Valley Canal Long Term
Canopy Cover Study, Tree Health
Assessment Report- Monitoring
Year 6**

Banner Cascade Pipeline Project

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Prepared for:

Nevada Irrigation District
1036 Main Street
Grass Valley, CA 95945

Prepared by:

Stantec Consulting Services, Inc.
101 Providence Mine Road, Suite 202
Nevada City, CA 95959

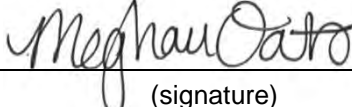


LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6


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Prepared by 
(signature)

Elan Carnahan, Biologist

Prepared and Technically Review by 
(signature)

Meghan Oats, Botanist/Biologist

Senior Review by 
(signature)

Bernadette Bezy, Principal Biologist, Project Manager



Table of Contents

ABBREVIATIONS	III
1.0 EXECUTIVE SUMMARY.....	1
2.0 INTRODUCTION.....	1
2.1 PROJECT DESCRIPTION	1
2.2 ENVIRONMENTAL SETTING	2
2.3 PROJECT PURPOSE	3
3.0 METHODS	3
4.0 RESULTS AND ANALYSIS.....	4
4.1 SITE SPECIFIC RESULTS AND ANALYSES.....	5
4.1.1 LCC Site 1 Results and Analyses.....	5
4.1.2 LCC Site 2 Results and Analysis.....	7
4.1.3 LCC Site 3 Results and Analysis.....	8
4.1.4 LCC Site 4 Results and Analysis.....	10
4.1.5 UGVC Site 5 Results and Analysis.....	11
4.1.6 DS Canal (Reference Site) Site 6 Results and Analysis	13
4.2 SITE COMPARISONS.....	14
5.0 DISCUSSION.....	16
6.0 REFERENCES.....	17

LIST OF TABLES

Table 2.1 Water Year (October - September) Totals for the Project Region	3
Table 2.2 Highest Temperatures for the Project Region.....	3
Table 4.1 LCC Site 1 Tree Health Assessment Data.....	6
Table 4.2 LCC Site 2 Tree Health Assessment Data.....	8
Table 4.3 LCC Site 3 Tree Health Assessment Data.....	9
Table 4.4 LCC Site 4 Tree Health Assessment Data.....	11
Table 4.5 UGVC Site 4 Tree Health Assessment Data.....	12
Table 4.6 Site 6 UGVC Tree Health Assessment Data.....	14
Table 6.1 Summary of Tree Health Assessment Parameters	B.3
Table 6.2 Overall Tree Health Score Descriptions.....	B.4

LIST OF FIGURES

Figure 2.1 Canal Flow in LCC and DS Canal, 2016-2019	2
Figure 4.1. LCC Site 1 Tree Health Assessment Data.....	7
Figure 4.2 LCC Site 2 Tree Health Assessment Data.....	8
Figure 4.3 LCC Site 3 Tree Health Assessment Data.....	10
Figure 4.4 LCC Site 4 Tree Health Assessment Data.....	11
Figure 4.5 UGVC Site 4 Tree Health Assessment Data	13
Figure 4.6 DS Canal Site 6 Tree Health Assessment Data.....	14



Figure 4.7. Average Overall Tree Health Scores by Study Site15

LIST OF APPENDICES

APPENDIX A PROJECT MAPS.....A.1

A.1 Project and Study Location Overview Map A.1

A.2 Tree Health Assessment Results Maps A.2

A.2.1 LCC Site- Tree Health Assessment Results Map A.2

A.2.2 LCC Site 2- Tree Health Assessment Results Map A.2

A.2.3 LCC Site 3- Tree Health Assessment Results Map A.2

A.2.4 LCC Site 4- Tree Health Assessment Results Map A.2

A.2.5 UGVC Site 5- Tree Health Assessment Results Map A.2

A.2.6 DS Canal (Reference Site) Site 6- Tree Health Assessment Results Map..... A.2

APPENDIX B TREE HEALTH ASSESSMENT CRITERIA B.3

APPENDIX C PHOTO RECORD..... C.5

APPENDIX D OBSERVED SPECIES..... D.17

APPENDIX E TREE HEALTH ASSESSMENT DATASHEETS..... E.20

APPENDIX F TEN-YEAR CANOPY COVER STUDY MONITORING PLAN..... F.21



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Abbreviations

CEQA	California Environmental Quality Act
CFS	Cubic Feet per Second
DBH	Diameter at Breast Height
DWR	California Department of Water Resources
FEIR	Final Environmental Impact Report
LCC	Lower Cascade Canal
MM	Mitigation Measure
Monitoring Plan	Nevada Irrigation District Lower Cascade Canal and Upper Grass Valley Canal Ten Year Canopy Cover Study Monitoring Plan
NID	Nevada Irrigation District
NRCS	National Resources Conservation Service
Project	Banner Cascade Pipeline Project
Report	Lower Cascade Canal and Upper Grass Valley Canal Long Term Canopy Cover Study, Tree Health Assessment Report
UGVC	Upper Grass Valley Canal



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Executive Summary

1.0 EXECUTIVE SUMMARY

Nevada Irrigation District (NID) committed to develop a plan and implement three types of long-term ecological monitoring between 2013 and 2023 along the Lower Cascade Canal (LCC) and Upper Grass Valley Canal (UGVC) in compliance with the Banner Cascade Pipeline Project (Project) California Environmental Quality Act (CEQA) Final Environmental Impact Report (FEIR) Mitigation Monitoring and Reporting Program Mitigation Measure (MM) 3.8-1: Monitor for Evidence of Dewatering Impacts to Riparian Habitats (NID 2006).

In 2019, NID implemented the Year 6 Tree Health Assessment monitoring along the the LCC and UGVC. The 2013 (Year 0) to 2019 (Year 6) results are variable with a slight decrease in tree health at the LCC sites while still remaining within the “good health” category¹. Therefore, the overall analysis concludes that after six years of flow reduction there is a slight decline in tree health along the LCC relative to the DS Canal reference site (which did not receive flow reduction). The UGVC has not exhibited such a change. However, the study will continue for another four years and final conclusions will be made at that time. If it is necessary, as a part of MM 3.8-1, replacement standards will be developed based on canopy cover that is lost as a result of disease, parasitism, and/or water stress caused directly from the reduced flow in the canal (NID 2006). The next required monitoring events are the Canopy Assessment (which includes the Canopy Cover Assessment and Tree Health Assessment) and the Pond Study, currently scheduled for Year 8 (2021) of the CEQA required long-term monitoring period.

This Tree Health Assessment Report (Report) provides data and analysis for the Monitoring Year 6 (2019) surveys.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

NID constructed the Project to ensure reliable water deliveries to the areas of Grass Valley and Nevada City, as well as the Loma Rica and Elizabeth George Wastewater Treatment Plants, in Nevada County, California. The Project replaced both LCC and UGVC, which had reached capacity and no longer met the needs of the area. NID keeps both LCC and UGVC in service as historical, cultural, scenic, and recreational amenities, but with reduced flows (NID 2019a). DS Canal is also located in Nevada City and maintained by NID but is not experiencing flow reductions as a result of the Project and thus acts as a reference to LCC and UGVC.

¹ The category of “good health” is a score that an evaluated tree receives, and generally has the following parameters: partial to medium canopy cover, new growth present, minimal bark and leaf discoloration, no significant disease, normal surface growth, and little to some insect infestations/damage.

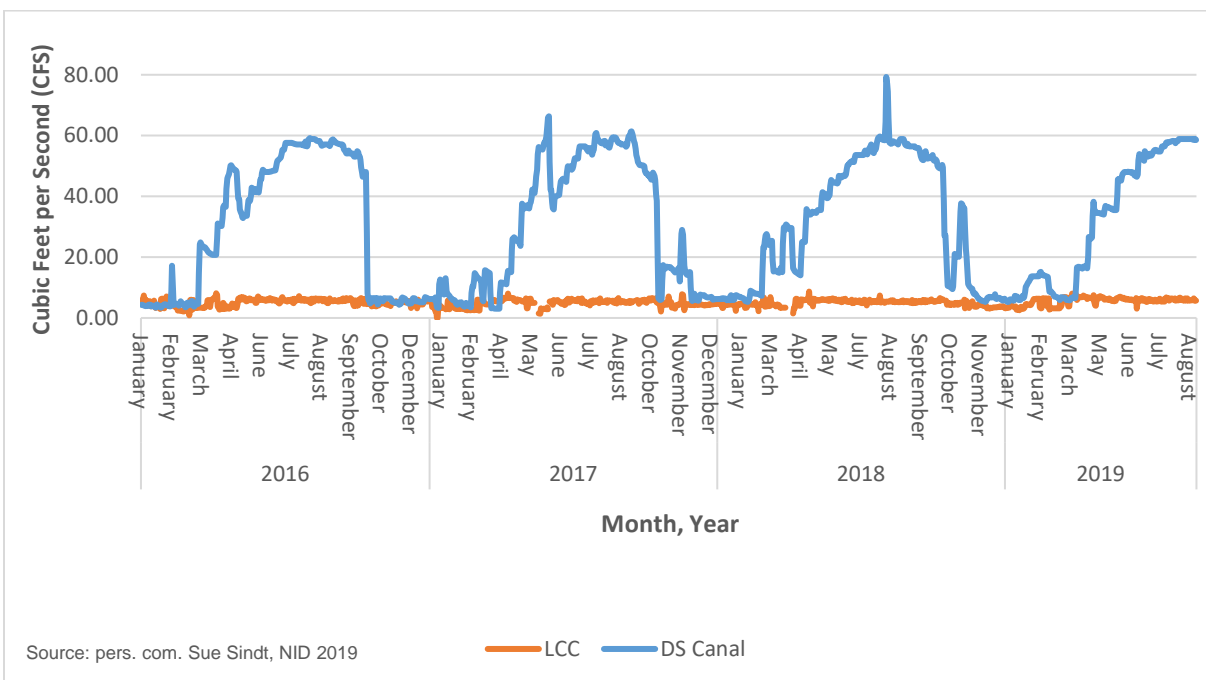


LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Introduction

Flows in LCC were reduced from approximately 45 to 5 cubic feet per second (CFS) as part of the Project. Branching from LCC, flows in the UGVC were reduced from 12 to 1 CFS as part of the Project. Flows in DS Canal have continued per normal operating conditions at rates averaging approximately 50 CFS during the summer (May-September) and 15 CFS during winter months (October-April) (pers. com. Sue Sindt, NID 2019b) (Figure 2.1).

Figure 2.1 Canal Flow in LCC and DS Canal, 2016-2019



2.2 ENVIRONMENTAL SETTING

LCC, UGVC, and DS Canal are located on Banner Mountain in Nevada County, California, in the western foothills of the Sierra Nevada mountain range at approximately 3,000 to 3,325 feet (920 to 1,010 meters) above mean sea level. These canals contain water diverted from Deer Creek above (LCC/UGVC) and below (DS Canal) Scotts Flat Reservoir. The primary vegetation community present along all three canals is Sierran Mixed Conifer-Hardwood Forest, comprised of both upland and riparian, or wet-adapted (i.e., emergent, hydrophytic, mesic) plant species (Sawyer et al. 2009).

Over the course of the implementation of the Ten Year Monitoring Plan (Monitoring Plan) (Appendix F), the climate has fluctuated in the region as noted by the temperature and overall precipitation in each water year. Water years (October-September) are designated by the calendar year in which it ends (i.e., Year 2013 represents the overall water during October 2012 – September 2013). While the water years of 2014, 2015, and 2018 were considered drought conditions (i.e., there was an overall decrease in annual precipitation as well as a spike in overall seasonal temperatures), 2013, 2016, 2017, and 2019 experienced average to above average rainfall (California Department of Water Resources [DWR] 2019, National Resources Conservation Service [NRCS] 2019) (Table 2.1 and Table 2.2).



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Methods

Table 2.1 Water Year (October - September) Totals for the Project Region

Location/Water Year		2013	2014	2015	2016	2017	2018	2019
Nevada City, California	Precipitation (inches)	56.8	37.6	37.1	62.8	103.8	49.9	76.6
	Percent of average	106%	70%	70%	118%	194%	93%	144%
Grass Valley, California	Precipitation (inches)	47.2	33.9	32.1	55.7	95.9	48.0	68.2
	Percent of average	88%	63%	60%	104%	179%	89%	127%

Source: DWR 2019

Table 2.2 Highest Temperatures for the Project Region

Location/Calendar Year		2013	2014	2015	2016	2017	2018	2019
Nevada City, CA	Highest Temperature (degrees Fahrenheit)	98	99	98	99	101	99	94
	Percent of average	110%	112%	110%	112%	114%	112%	106%
	Month of Occurrence	Jun	Jul	Jun/Jul	Jul	Sept	Jul	Jul/Aug
Grass Valley, CA	Highest Temperature (degrees Fahrenheit)	100	98	99	99	102	98	104
	Percent of average	114%	112%	113%	113%	116%	112%	118%
	Month of Occurrence	Jun	Aug	Jul	Jul	Sept	Jul	Jul

Source: NRCS 2019

2.3 PROJECT PURPOSE

Reducing flows in LCC and UGVC reduces the wetted perimeter in each canal and the head on the remaining wetted perimeter. As identified in the Project’s Draft Environmental Impact Report, this change in hydraulic conditions may reduce the amount of leakage and seepage from the canals and has the potential to impact the environment created and maintained by canal leakage over the years (NID 2004). Possible stress from the flow reductions could lead to increased susceptibility of riparian trees to disease and parasitism and, in turn, result in loss of trees, associated shade canopy, and habitat for common and special-status wildlife species. As such, the FEIR deemed it necessary to study the effects of the reduced flows on riparian vegetation adjacent to the affected canals (NID 2006). The purpose of NID’s long term monitoring is to evaluate and make interpretations based on potential observed changes in spatial and compositional land cover as canal flows decreased/were shifted to the Lower Cascade Pipeline.

3.0 METHODS

A total of six representative Tree Health Assessment study sites were selected (Appendix A). The six Tree Health Assessment sites are comprised of four study sites along LCC (Sites 1-4), one study site



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

along UGVC² (Site 5), and one reference site along DS Canal (Site 6). Representative sites were specifically selected based on vegetation type, areas suspected of maximum leakage (i.e., unlined stretches of the canal), and other associated riparian plant species that have the greatest potential to be adversely impacted by reductions in canal flows. Each study site is approximately 20 meters in length and includes riparian trees both downslope and upslope of the canals. However, the majority of the study trees are located downslope of the canal.

The Tree Health Assessment is comprised of the following parameters:

- Evaluations of changes in vegetation patterns over time conducted along the impacted LCC and UGVC and the DS Canal reference site;
- Data collection within each of the appropriate study years in the late summer (typically August through October) when the trees are most water stressed, but prior to abscission, or leaf shedding;
- Surveys completed by a qualified botanist and/or biologist; and
- Data collected for a total of ten years, at two-year intervals (NID 2012).

Surveys required for Baseline Year 0 (2013), Monitoring Year 2 (2015), and Monitoring Year 4 (2017) have been conducted and presented to the NID Engineering Committee. Surveys conducted in Monitoring Year 6 (2019) are detailed in this Report. Therefore, two remaining survey efforts will be conducted in 2021 and 2023 (NID 2012).

For Monitoring Year 6, visual inspections of previously tagged trees at the six study site locations were conducted by a qualified Stantec botanist and a qualified Stantec biologist on September 20, October 17 and 18, 2019 along LCC (Sites 1-4), UGVC (Site 5), and DS Canal (Site 6). Diameter at breast height (DBH) and tree health was evaluated using a variety of criteria, including the amount of canopy present, leaf and bark health, and presence of new growth, disease, parasites, and insect infestations (Appendix B). Normal seasonal variations were considered in overall health scoring. Data was documented in ArcGIS Collector, and general site conditions were also recorded. Photos were taken to document site conditions and trees assessed and are included in Appendix C. Field datasheets and notes for Monitoring Year 6 are included in Appendix E.

4.0 RESULTS AND ANALYSIS

A total of 90 live riparian trees were assessed at the six study sites along LCC, UGVC, and DS Canal. Riparian tree species surveyed included bigleaf maple (*Acer macrophyllum*), Pacific dogwood (*Cornus nuttallii*), Oregon ash (*Fraxinus latifolia*), gray alder (*Alnus incana*), and white alder (*Alnus rhombifolia*), though the species most surveyed were bigleaf maple and Pacific dogwood.

General canopy cover for the survey seasonal timing was normal to partial, and general bark health of surveyed trees was fair, with some trees exhibiting bark sloughing. All sites exhibited some foliage discoloration from normal seasonal changes and abscission, the process of deciduous plants seasonally

² Due to limited suitable study sites, only one site was established along the UGVC.



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

shedding leaves. Other observed foliage discolorations included spotting from potential disease (i.e., rust spots), other biological growths (e.g., powdery mildew), and insect and herbivory damage, which was extensive across all sites. Most trees exhibited new vascular growth of leaf buds, basal sprouts, or epicormic stems. Surface growths were mostly biological (e.g., moss, lichen, and fungi). There was very low occurrence of disease at the sites, with few trees exhibiting root rot or other diseases on trunks. In some cases, parasites were noted as vining species growing up the trunk and sometimes even into the tree canopy, and included honeysuckle (*Lonicera hispidula*), Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), California wild grape (*Vitis californica*), and poison oak (*Toxicodendron diversilobum*).

Riparian shrub and herbaceous species observed included Himalayan blackberry (*Rubus armeniacus*), cut-leaved blackberry (*Rubus laciniatus*), and English ivy (*Hedera helix*). Upland habitats and species were also present at the LCC, UGVC, and DS Canal study site locations. Upland overstory species included black oak (*Quercus kelloggii*), canyon live oak (*Quercus chrysolepis*), Douglas-fir (*Pseudotsuga menziesii*), beaked hazelnut (*Corylus cornuta*), incense cedar (*Calocedrus decurrens*), Pacific madrone (*Arbutus menziesii*), Ponderosa pine (*Pinus ponderosa*), and tanoak (*Notholithocarpus densiflorus*). Upland shrub species included coyote brush (*Baccharis pilularis*). Non-native and invasive species, including landscaping cultivars and grasses, have also encroached into the study sites from residences and roads along the canals.

The following sections outline the Tree Health Assessment findings for each study site and provides a comparison analysis for Tree Health Assessment data between years (Baseline Year 0 and Monitoring Years 2, 4, and 6) and locations (LCC, UGVC, and DS Canal). Data collection varied slightly per year based on weather and drought conditions. Flow rates, climate (i.e., the region's precipitation and temperatures), and general botanical bloom and abscission periods are considered in the analysis.

The compiled tree health data for all LCC sites (Site 1-4) yielded a relative score of 8 to 9 during the 2019 survey, and a relative score of 8 to 12 over the past six years. The tree health data for the UGVC site (Site 5) yielded a score of 10 during the 2019 survey, and a relative score of 8 to 11 over the past six years. The tree health data for the DS Canal reference site (Site 6) yielded a score of 10 during the 2019 survey and a relative score of 8 to 10 over the past six years. Overall, the tree health for all sites (including the DS Canal reference site) has been categorized as "good health", with the exception of LCC Site 4, that had a score of 12 in 2013, which falls within the "excellent health" category.

4.1 SITE SPECIFIC RESULTS AND ANALYSES

4.1.1 LCC Site 1 Results and Analyses

4.1.1.1 Monitoring Year 6

In Monitoring Year 6, 21 riparian trees were surveyed at Site 1 on LCC on September 20, 2019, including bigleaf maple, Pacific dogwood, and gray alder. No new dead trees were found. Most trees surveyed had full to partial canopy cover and good bark health, and exhibited DBH growth, new growth, surface growths, foliage discoloration, and insect damage. Disease was minimal at this site, but a few trees'



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

trunks were encroached by parasites such as honeysuckle and poison oak. Overall tree health at Site 1 is good, with a range of health scores from 5 to 13 and an average health score of 9 (Table 4.1, Figure 4.1).

General site conditions included down woody debris in the understory on both up and downslope portions of Site 1. Various upland tree species are also present at Site 1, including Douglas-fir, beaked hazelnut, incense cedar, and Pacific madrone (Appendix D).

4.1.1.2 Monitoring Year Comparisons

Since Baseline Year 0, trees at Site 1 improved from partial to medium canopy cover, and bark health remained good. However, presence of abnormal leaf color and insects increased from barely present at Site 1 to present in most trees. Presence of new growth greatly decreased from Baseline Year 0 to Monitoring Year 4 but made a substantial recovery in Monitoring Year 6. Surface growth remained highly prevalent and diseases and parasites remained minimal across monitoring years, though honeysuckle and other parasitic plants were observed in increasing quantity at Site 1. Two tree deaths were observed at Site 1 since Baseline Year 0, but no new trees were confirmed dead in Monitoring Year 6. In comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in presence of DBH and new growth, as well as less disease and insects. Overall tree health at Site 1 remains good since Baseline Year 0, oscillating on health between Monitoring Years 2 through 6 (Table 4.1, Figure 4.1).

Table 4.1 LCC Site 1 Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/12	10/7	9/12	9/20
Trees Surveyed ¹	23	23	21	21
Tree Death ²	0	1	1	0
Canopy Cover ³	2	3	3	3
Bark Health ⁴	3	3	3	3
Overall Tree Health ⁵	10	10	8	9

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study. Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

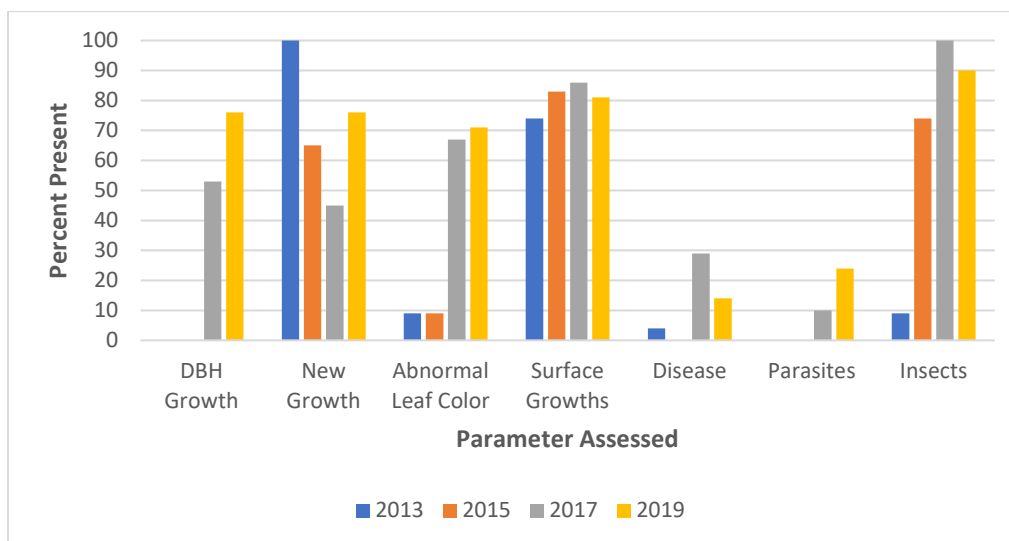
⁵ Based on a scale of 1-14.



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

Figure 4.1 LCC Site 1 Tree Health Assessment Data



4.1.2 LCC Site 2 Results and Analysis

4.1.2.1 Monitoring Year 6

During Year 6 monitoring, 12 riparian trees were surveyed at Site 2 on LCC on October 17, 2019. Tree species surveyed include bigleaf maple, gray alder, and Pacific dogwood. No new trees were found dead, but some trees were inaccessible for evaluation due to new private property fencing. Most trees surveyed had full to partial canopy cover and poor bark health, and exhibited new growth, surface growths, and insect damage and infestation. Disease was minimal at this site, but approximately half the trees surveyed exhibited foliage discoloration and parasites such as honeysuckle and Himalayan blackberry (*Rubus armeniacus*) on trunks and branches. Overall tree health at Site 2 is good, with a range of health scores from 6 to 12 and an average health score of 8 (Table 4.2, Figure 4.2).

General site conditions included excessive encroachment by non-native understory species (e.g., Himalayan blackberry) prevented safe access to three study trees downslope of the canal. Mechanical removal of upslope study trees and installation of fencing by private landowners rendered the upslope portion of the site unable to be surveyed. A drainage fed by LCC and rainfall/runoff was observed near trees surveyed downslope of LCC; it held standing water at the time of the survey. Various upland tree species are also present at Site 2, including black oak, beaked hazelnut, and incense cedar.

4.1.2.2 Monitoring Year Comparisons

Since Baseline Year 0, canopy cover of trees at Site 2 remained consistent, and bark health declined from good to fair in Monitoring Year 6. DBH growth and new growth also declined since Baseline Year 0, and abnormal leaf color, surface growths, diseases, parasites, and insect presence increased, though prevalence of diseases and insect damage dropped in Monitoring Year 6. Only one tree death was observed at Site 2 since Baseline Year 0, and no new trees were confirmed dead in Monitoring Year 6. In



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in the presence of insects and insect damage, but also exhibited poorer bark health, greater presence of parasites, and less evidence of DBH growth and new growth. Overall tree health at Site 2 remains good since Baseline Year 0, with a slight decrease between Monitoring Years 2 through 6 (Table 4.2, Figure 4.2).

Table 4.2 LCC Site 2 Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/11	10/6	9/8	10/17
Trees Surveyed ¹	20	21	20	12
Tree Death ²	0	1	0	0
Canopy Cover ³	3	3	3	3
Bark Health ⁴	3	3	3	2
Overall Tree Health ⁵	10	10	9	8

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

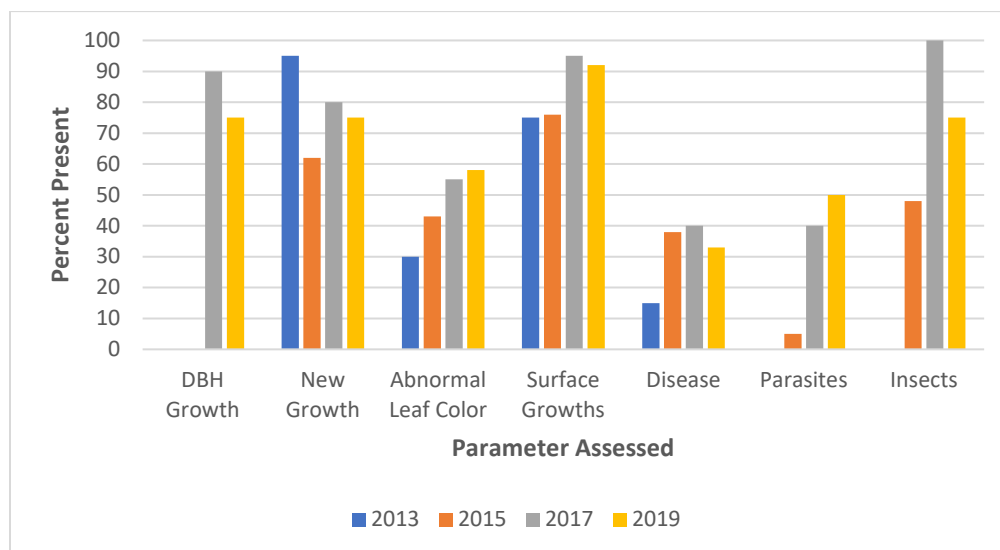
² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study. Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

⁵ Based on a scale of 1-14.

Figure 4.2 LCC Site 2 Tree Health Assessment Data



4.1.3 LCC Site 3 Results and Analysis

4.1.3.1 Monitoring Year 6

During Year 6 monitoring, 20 riparian trees were surveyed at Site 3 on LCC on October 17, 2019. Tree species surveyed include bigleaf maple, gray alder, and Pacific dogwood. No new trees were found dead. Most trees surveyed had full to partial canopy cover and fair bark health and exhibited surface growths and insect damage and infestation. Over half the trees surveyed exhibited new growth and foliage



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

discoloration. Very little disease was observed at this site, but parasites such as California wild grape and english ivy were present on several trees' trunks and branches. Overall tree health at Site 3 is good, with a range of health scores from 4 to 13 and an average health score of 8 (Table 4.3, Figure 4.3).

General site conditions included encroachment by non-native and invasive understory species that also were vining up the tree trunks (e.g., English ivy). Various upland tree species are also present at Site 3, including Douglas-fir and incense cedar.

4.1.3.2 Monitoring Year Comparisons

Since Baseline Year 0, trees at Site 3 improved from partial to medium canopy cover, as well as fair to good bark health, and the prevalence of disease greatly decreased. However, presence of new growth declined and abnormal leaf color and parasites steadily increased. Presence of insects also increased from barely present at Site 3 to present in most trees, though the prevalence of insect damage dropped in Monitoring Year 6. Surface growths remained highly and consistently prevalent. No tree deaths were observed at Site 3 since Baseline Year 0. In comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in the presence of disease and insect damage, but also exhibited greater presence of abnormal leaf color and parasites, as well as less evidence of DBH and new growth. Overall tree health at Site 3 remained consistently good, though it decreased slightly in Monitoring Year 6 (Table 4.3, Figure 4.3).

Table 4.3 LCC Site 3 Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/11	10/8	9/8	10/17
Trees Surveyed ¹	21	19	20	20
Tree Death ²	0	0	0	0
Canopy Cover ³	2	3	3	3
Bark Health ⁴	2	3	3	3
Overall Tree Health ⁵	9	9	9	8

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study.

Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

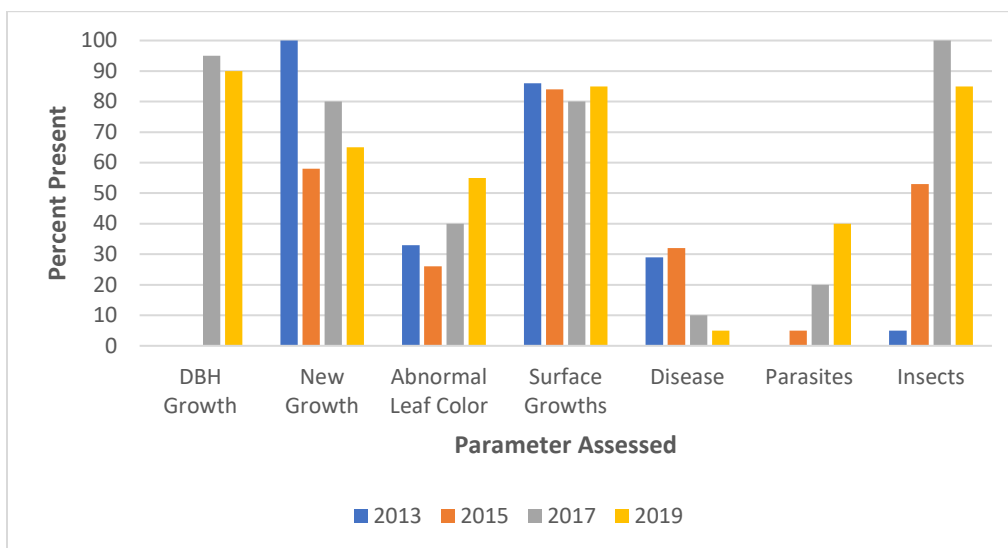
⁵ Based on a scale of 1-14.



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

Figure 4.3 LCC Site 3 Tree Health Assessment Data



4.1.4 LCC Site 4 Results and Analysis

4.1.4.1 Monitoring Year 6

During Year 6 monitoring, 18 riparian trees were surveyed at Site 4 on LCC on September 20, 2019. Tree species surveyed include bigleaf maple, gray alder, tanoak, and Oregon ash. One tree had been crushed under another fallen tree and was noted as dead. All trees surveyed exhibited insect damage and infestation. On average, trees surveyed had full to partial canopy cover and fair bark health, and over half the trees surveyed exhibited new growth and foliage discoloration. Disease, surface growth, and parasites were minimal at this site, though english ivy and root rot was present on some trees' trunks. Overall tree health at Site 4 is good, with a range of health scores from 6 to 12 and an average health score of 9 (Table 4.4, Figure 4.4).

General site conditions included beaked hazelnut, thimbleberry (*Rubus parviflorus*), and poison oak. Various upland tree species are also present at Site 4, including black oak, Douglas-fir, incense cedar, and tanoak.

4.1.4.2 Monitoring Year Comparisons

Since Baseline Year 0, trees at Site 4 remained consistent in canopy cover (medium) and bark health (good). However, presence of new growth declined, and abnormal leaf color and insects increased from barely present at Site 4 to present in most to all trees. Surface growths, diseases, and parasites remained low but also generally increased since Baseline Year 0, though the prevalence of surface growths dropped in Monitoring Year 6. One tree death was observed at Site 4 in Monitoring Year 6. In comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in the presence of DBH growth and surface growths, but also exhibited greater presence of abnormal leaf color, disease, and parasites, as well as less evidence of new growth. Overall tree health at Site 4 decreased from



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Results and Analysis

excellent to good since Baseline Year 0, but remained consistently good between Monitoring Years 2 through 6, although exhibiting a slight decrease over the monitoring years (Table 4.4, Figure 4.4).

Table 4.4 LCC Site 4 Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/11	10/6	9/12	9/20
Trees Surveyed ¹	18	21	19	18
Tree Death ²	0	0	0	1
Canopy Cover ³	3	3	3	3
Bark Health ⁴	3	3	3	3
Overall Tree Health ⁵	12	11	9	9

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

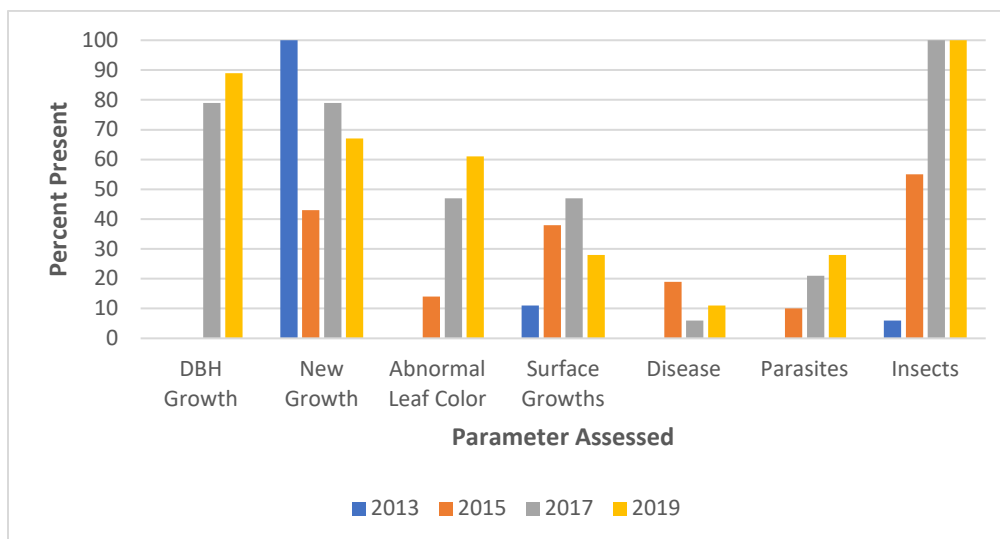
² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study. Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

⁵ Based on a scale of 1-14.

Figure 4.4 LCC Site 4 Tree Health Assessment Data



4.1.5 UGVC Site 5 Results and Analysis

4.1.5.1 Monitoring Year 6

During Year 6 monitoring, six riparian trees were surveyed at Site 5 on UGVC on October 17, 2019. Tree species surveyed include bigleaf maple, Pacific dogwood, and white alder. No new dead trees were observed. All trees surveyed exhibited insect damage and infestation, as well as surface growths. Most trees surveyed exhibited new growth, largely of epicormic stems, full to partial canopy cover, fair bark health, and no abnormal foliage discoloration nor disease. Parasitic honeysuckle was present on some trees' trunks and adjacent saplings. Mechanical damage to trees from roadside tree-trimming was observed, as well as new growth of various riparian tree species saplings within the site. Overall tree



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

health at Site 5 is good, with a range of health scores from 8 to 12 and an average health score of 10 (Table 4.5, Figure 4.5).

General site conditions included some mechanical damage to trees due to proximity to the road. Various upland tree species are also present at Site 5, including black oak and incense cedar.

4.1.5.2 Monitoring Year Comparisons

Since Baseline Year 0, trees at Site 5 exhibited oscillating canopy cover and bark health, though both criteria declined in Monitoring Year 6. From Monitoring Year 4 to 6, canopy cover decreased slightly from full to medium canopy and bark health went from excellent to good health. DBH growth increased, and abnormal leaf color, diseases, and parasites remained minimal, with some fluctuations in presence. However, the presence of new growth generally decreased since Baseline Year 0, and surface growths and insects remained highly prevalent, present in most to all trees. Only one tree appeared to be mechanically removed at Site 5 since Baseline Year 0, however, no new trees were confirmed dead or missing in Monitoring Year 6. In comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in the presence of DBH growth, abnormal leaf color, and disease, but also exhibited greater presence of parasites, less evidence of new growth, and declining canopy cover and bark health. Overall tree health at Site 5 remains good since Baseline Year 0, oscillating in health over the years and slightly increasing in health since Baseline Year 0 (Table 4.5, Figure 4.5).

Table 4.5 UGVC Site 4 Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/10	10/7	9/7	10/17
Trees Surveyed ¹	8	7	6	6
Tree Death ²	0	1	0	0
Canopy Cover ³	2	3	4	3
Bark Health ⁴	2	3	4	3
Overall Tree Health ⁵	9	8	11	10

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study.

Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

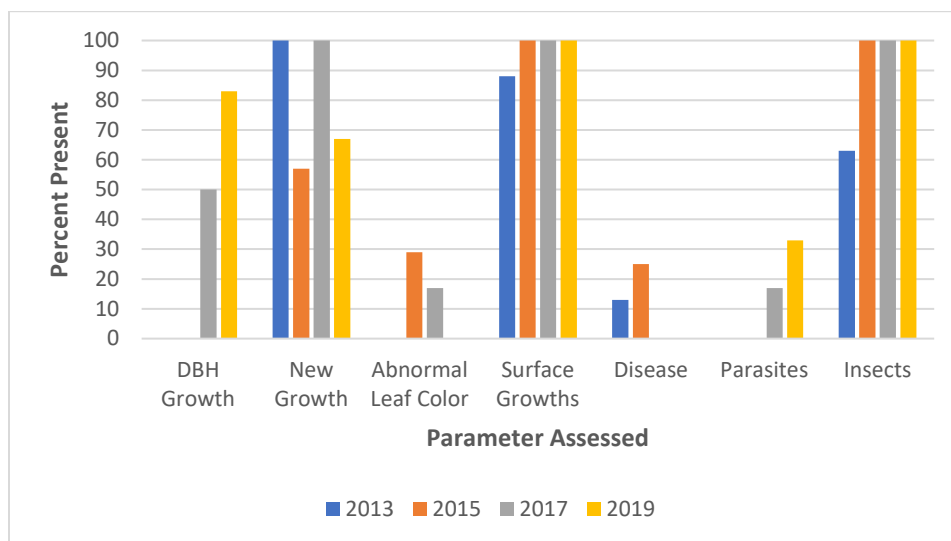
⁵ Based on a scale of 1-14.



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Results and Analysis

Figure 4.5 UGVC Site 4 Tree Health Assessment Data



4.1.6 DS Canal (Reference Site) Site 6 Results and Analysis

4.1.6.1 Monitoring Year 6

During Year 6 monitoring, 13 riparian trees were surveyed at the reference site, Site 6, on DS Canal on October 18, 2019. Tree species surveyed include bigleaf maple, gray alder, and Pacific dogwood. Two new trees were found dead. All trees surveyed exhibited insect damage and infestation, though new growth, full to partial canopy cover, and fair bark health was also observed in most trees. Foliage discoloration and surface growth was observed on approximately half of the trees surveyed. Little disease or parasitic presence was observed, though there was some root rot and parasitic honeysuckle was present on some trees’ trunks and branches. Overall tree health at Site 6 is good, with a range of health scores from 7 to 12 and an average health score of 10 (Table 4.6, Figure 4.6).

General site conditions included down woody debris, and vining plant encroachment on tree trunks primarily by honeysuckle. Various upland tree species are also present at Site 6, including Douglas-fir, incense cedar, and Ponderosa pine.

4.1.6.2 Monitoring Year Comparisons

Since Baseline Year 0, trees at Site 6 exhibited improvements in canopy cover and bark health, though canopy cover declined in Monitoring Year 6. However, abnormal leaf color, surface growths, diseases, parasites, and insects increased since Baseline Year 0, though observations of all but parasites and insects dropped in Monitoring Year 6. Presence of new growth also greatly decreased from Baseline Year 0 to Monitoring Year 2 but recovered to baseline by Monitoring Year 6. One new tree was confirmed dead in Monitoring Year 6. In comparison with Monitoring Year 4, trees surveyed in Monitoring Year 6 exhibited improvements in the presence of new growth, abnormal leaf color, surface growths, and disease, but presence of parasites and insects remained consistent and canopy cover declined. Overall tree health at Site 6 remained consistently good between Baseline Year 0 through Monitoring Year 6. The health score



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Results and Analysis

decreased slightly during Monitoring Year 4, but recovered to baseline health scores by Monitoring Year 6 (Table 4.6, Figure 4.6).

Table 4.6 Site 6 UGVC Tree Health Assessment Data

Monitoring Year	2013 (Year 0)	2015 (Year 2)	2017 (Year 4)	2019 (Year 6)
Survey Date	9/10	10/7	9/15	10/18
Trees Surveyed ¹	22	20	14	13
Tree Death ²	0	3	2	1
Canopy Cover ³	2	3	4	3
Bark Health ⁴	2	3	3	3
Overall Tree Health ⁵	10	10	8	10

¹ Tree Health Assessment criteria values are averages of all individual live trees surveyed per site (dead stems were not included in final calculations).

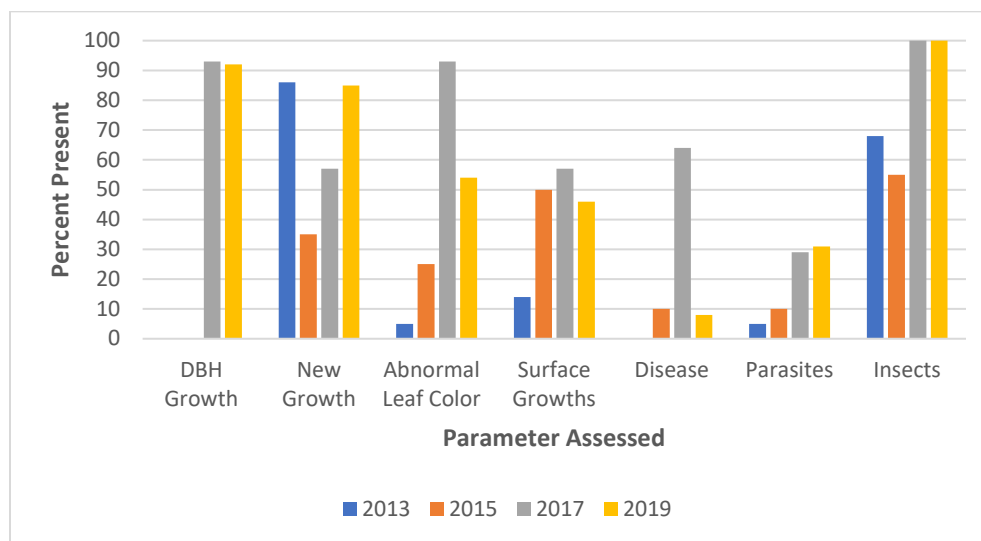
² Number of new trees confirmed dead each year; not cumulative.

³ Individual tree foliage cover values, not total canopy cover as assessed in the canopy cover study. Based on a scale of 1-4.

⁴ Based on a scale of 1-4.

⁵ Based on a scale of 1-14.

Figure 4.6 DS Canal Site 6 Tree Health Assessment Data



4.2 SITE COMPARISONS

Overall tree health at Sites 2, 3, and 4 on LCC decreased, and increased at Site 1 on LCC, from Monitoring Years 4 to 6 (Figure 4.7). Overall tree health at all four sites on LCC was lower than sites on the other two canals. Increased parasite presence (e.g., honeysuckle and blackberry) and abnormal leaf color, as well as decreased observations in new growth, were drivers in leading to lower overall health scores at the study sites along LCC. Canopy cover remained consistent at all sites, so it can be concluded that associated riparian shade canopy remains intact. There was also minimal loss of riparian tree species along the LCC study sites, with four total confirmed tree deaths out of 84 trees total amongst the sites for the duration of the study; however, all sites had notable decreases in new growth



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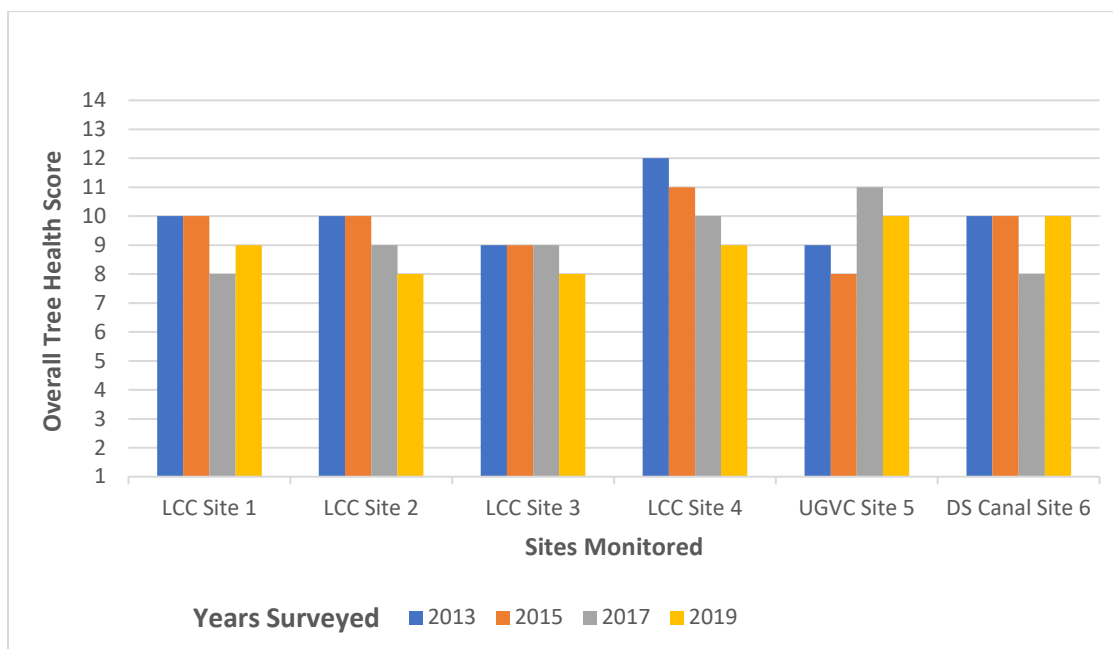
Results and Analysis

observations (i.e., riparian forest regeneration) from baseline levels, and there was some loss of trees due to private property management (upslope of LCC Site 2).

Overall tree health at Site 5 on UGVC decreased from Monitoring Year 4 to 6, though greater than Baseline Year 0 (Figure 4.7). In Monitoring Year 6, overall tree health at Site 5 was better than all sites on LCC and the same as Site 6 on DS Canal. Declining bark health, decreased canopy cover, presence of new growth, and increased presence of parasites contributed to the decrease in overall health at Site 5. Canopy cover similarly decreased from Monitoring Year 4 to 6 but was overall greater than in Baseline Year 0, so it may be concluded that associated riparian shade canopy remains intact. There was also a loss of riparian tree species at Site 5, with one confirmed tree death out of 8 trees; however, there was a notable decrease in new growth observations.

Overall tree health at DS Canal increased from Monitoring Year 4 to 6, recovering to baseline overall health levels (Figure 4.7). In Monitoring Year 6, overall tree health at Site 6 was better than all sites on LCC and the same as Site 5 on UGVC. Increased presence of new growth, and decrease of abnormal leaf color, disease, and surface growths on the trees are the primary drivers leading to higher overall health at Site 6. Canopy cover was similarly less from Monitoring Year 4 to 6 but generally increased from Baseline Year 0, so it may be concluded that associated riparian shade canopy remains intact. There was also moderate loss of riparian tree species at Site 6, with six total confirmed tree deaths out of 22 trees; however, there was measurable increase in new growth observations.

Figure 4.7. Average Overall Tree Health Scores³ by Study Site



³ Health scores – 1-4: poor health; 5-7: fair health; 8-11: good health; 12-14: excellent health



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Discussion

5.0 DISCUSSION

The riparian tree species along NID canals are predominantly in upland habitats (i.e. surrounded by mixed coniferous forest). As such, it was hypothesized that the canals sustain these trees and a reduction in flows would reduce the hydraulic head, water infiltration, root uptake and eventually cause potential loss of the existing riparian trees.

As discussed in the previous monitoring reports, riparian forests along rivers are complex ecological systems that have the potential to support dynamic levels of biodiversity and special-status species, exhibit high rates of nutrient cycling, and perform important ecological functions. As these vegetation communities are located at the land-water margin, riparian plant species are greatly dependent on hydrology and generally more vulnerable to water-induced stress (Naimen and Bilby 2001).

Decreased water availability subsequently can drive increases in non-native and upland species encroachment and decreases native growth, whereas wet years can drive increases in tree growth and in the overall density of vegetation (Naiman et al. 2000). Shifts in climate may also inflate broad-scale tree disease, as well as insect infestation (Liebhold and Bentz 2011). The aforementioned factors may compound with a decrease in overall canal flows to impact tree health at the sites on LCC and UGVC, complicating the differentiation between the effects of decreased canal flows and drought in the region.

During monitoring year 2015, the region experienced an ongoing drought (2014 and 2015) and decreased annual precipitation. Literature research states that there is a highly significant overall effect of drought on the amount of total biomass (dry weight) of riparian wetland plants which becomes critical when droughts last longer than approximately 30 days. It is noted that different species display a different tolerance to drought (Garssen et al. 2014). In addition, trees often have a delayed response to water and temperature stress. This may explain why at the study site tree health remained relatively stable at the LCC and UGVC and DS Canal reference site during these drought years.

Since 2016 the region has experienced an end to drought conditions; however, a slight decrease in tree health was documented (from an average health score of 10 to 8.5) on the LCC that was not observed on the DS Canal reference site. This may be due to a latent reaction to drought. Specifically, the drought conditions may have had an effect on riparian species and the more recent above average precipitation may compensate for such impacts. Continued monitoring of conditions related to the recent wet years should provide additional insights.

Overall, the Tree Health Assessment results indicate an ever-changing habitat that is likely continuously responding to changes in water regimes, private property management (i.e. fencing installation at LCC Site 2), climate, and non-native vegetation encroachment. Thus far, there is a slight indication of diebacks in riparian trees due to the lowering of canal flows in LCC and UGVC relative to DS Canal, and there is a slight trend of declining overall tree health at the sites on LCC and UGVC. This is potentially due to the latent impact of drought potentially compounded by lower canal flows. However, this slight decline appears to have oscillated throughout the years and the overall tree health remains in the “good health” category, as defined in the Executive Summary. Therefore, at Year 6 of monitoring, it appears that the canal flow reductions and drought may have slightly reduced the overall riparian tree health, but not to a



LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

References

significant degree. If necessary, upon completion of the 10 year program, as a part of MM 3.8-1, replacement standards will be developed based on canopy cover that is lost as a result of disease, parasitism, and/or water stress caused directly from the reduced flow in the canal (NID 2006).

This Report provides data and analysis for the Monitoring Year 6 (2019) of the Monitoring Plan. Two more monitoring years will be conducted (i.e., Year 8 [2021] and Year 10 [2023]), after which additionally informed conclusions can be made and replacement standards can be developed if necessary.

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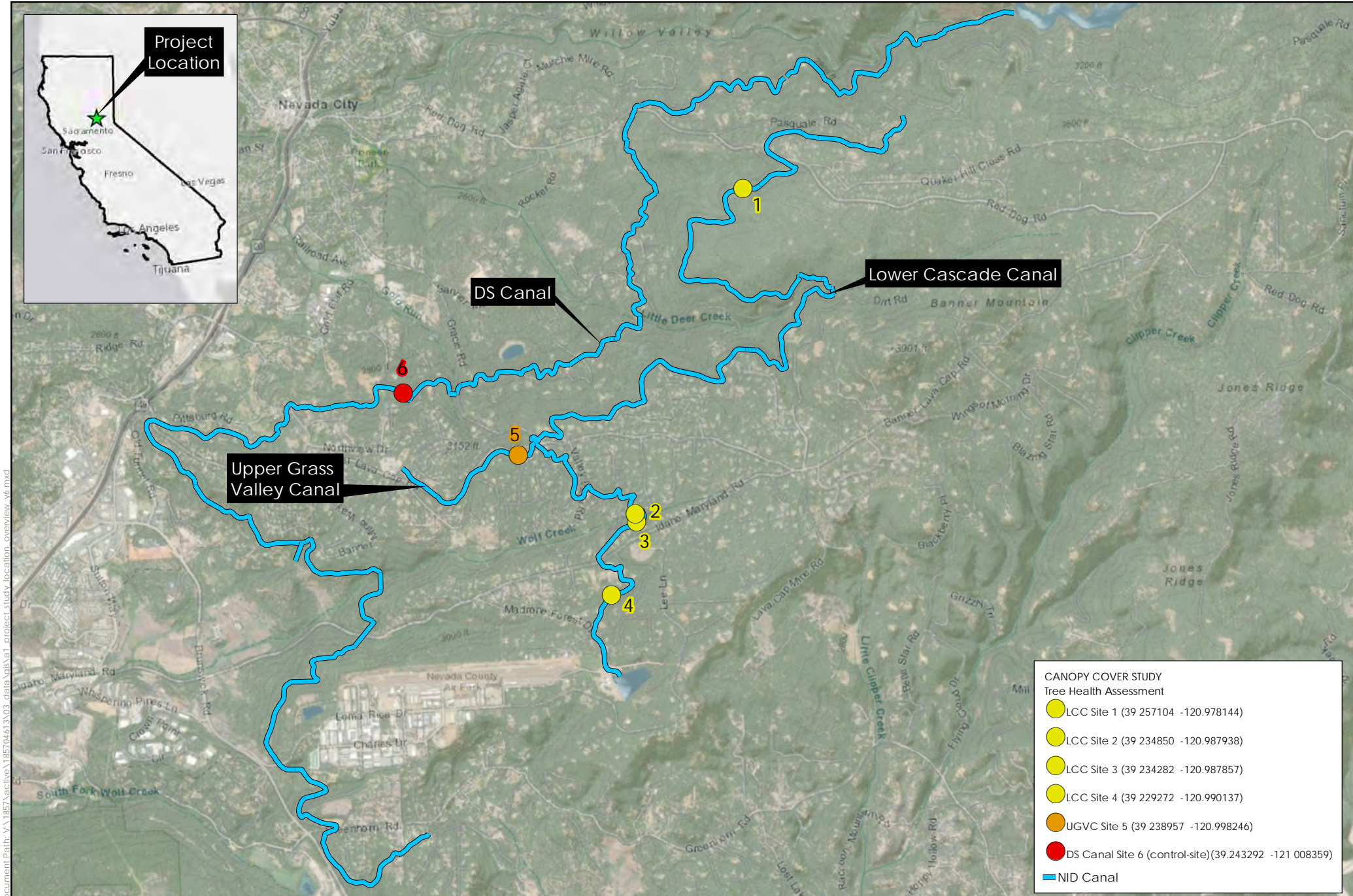
APPENDICES

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix A Project Maps

Appendix A PROJECT MAPS

A.1 PROJECT AND STUDY LOCATION OVERVIEW MAP



Project Location

DS Canal

Lower Cascade Canal

Upper Grass Valley Canal

**CANOPY COVER STUDY
Tree Health Assessment**

- LCC Site 1 (39 257104 -120.978144)
- LCC Site 2 (39 234850 -120.987938)
- LCC Site 3 (39 234282 -120.987857)
- LCC Site 4 (39 229272 -120.990137)
- UGVC Site 5 (39 238957 -120.998246)
- DS Canal Site 6 (control-site)(39.243292 -121 008359)
- NID Canal

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**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix A Project Maps

A.2 TREE HEALTH ASSESSMENT RESULTS MAPS

A.2.1 LCC Site- Tree Health Assessment Results Map

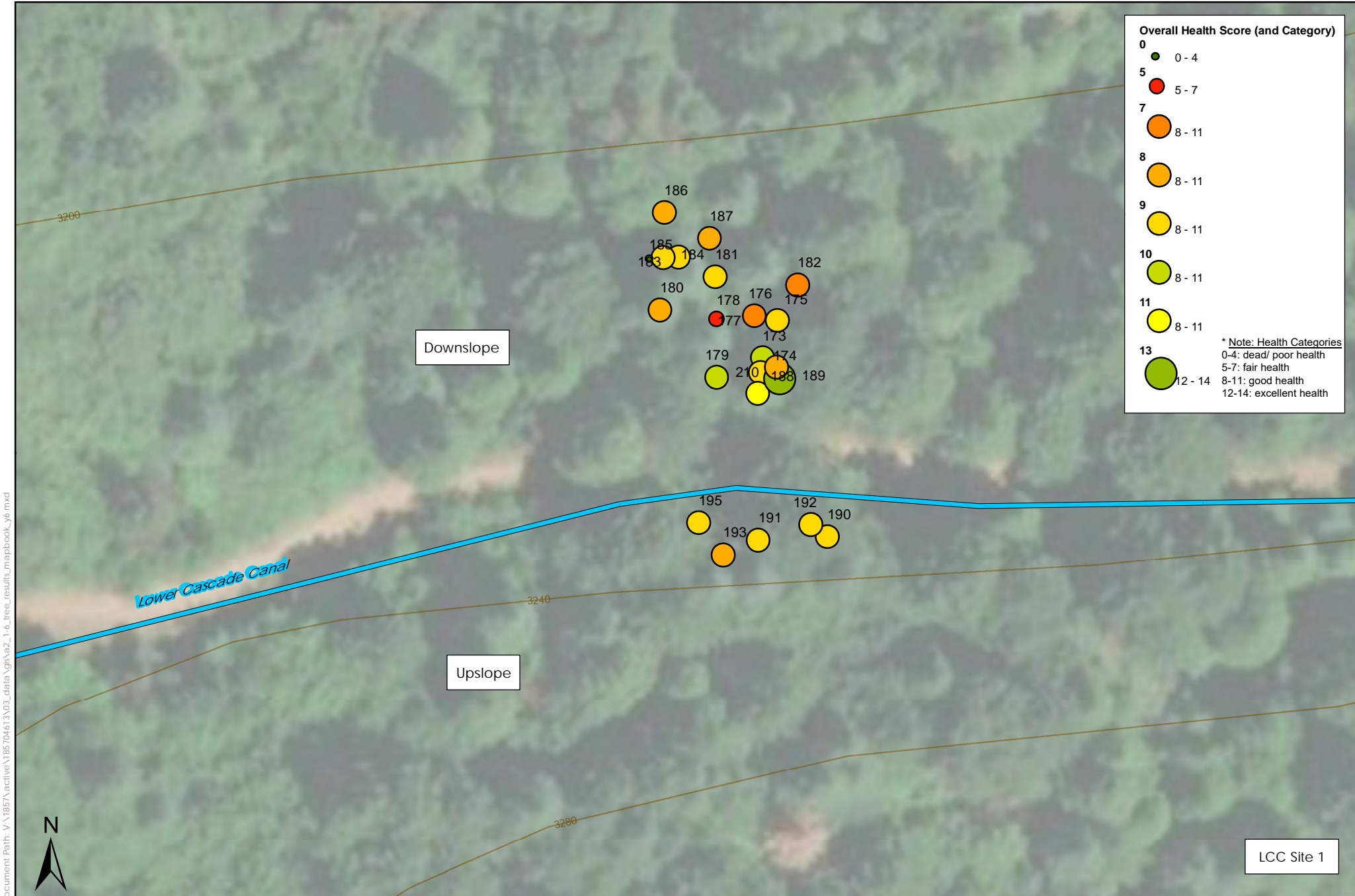
A.2.2 LCC Site 2- Tree Health Assessment Results Map

A.2.3 LCC Site 3- Tree Health Assessment Results Map

A.2.4 LCC Site 4- Tree Health Assessment Results Map

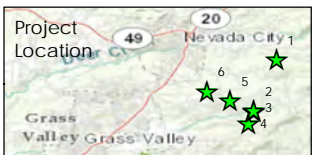
A.2.5 UGVC Site 5- Tree Health Assessment Results Map

A.2.6 DS Canal (Reference Site) Site 6- Tree Health Assessment Results Map



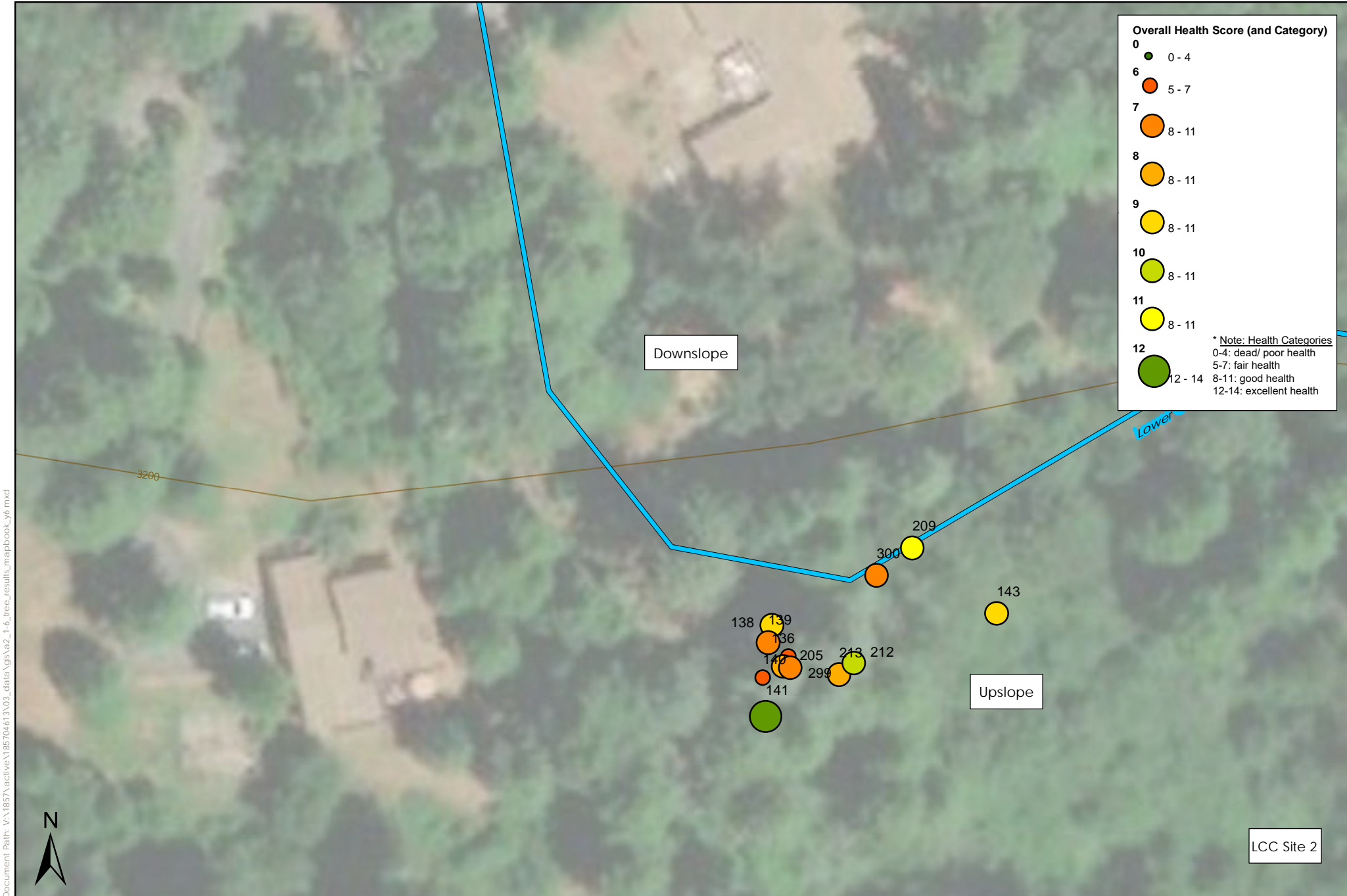
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Project Location	Nevada County, CA
Client/Project	Nevada Irrigation District Banner Cascade Project
Figure No.	A.2.1
Title	LCC Site 1 - Tree Health Assessment Results Map Monitoring Year 6 (2019)

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Overall Health Score (and Category)

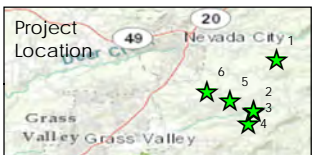
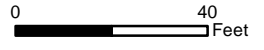
0	0 - 4
6	5 - 7
7	8 - 11
8	8 - 11
9	8 - 11
10	8 - 11
11	8 - 11
12	12 - 14

*** Note: Health Categories**
 0-4: dead/ poor health
 5-7: fair health
 8-11: good health
 12-14: excellent health



LCC Site 2

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Client/Project	Nevada Irrigation District Banner Cascade Project
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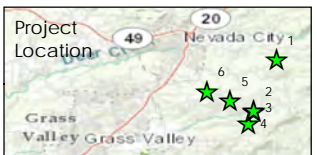


Overall Health Score (and Category)

4	0 - 4
5	5 - 7
6	5 - 7
7	8 - 11
8	8 - 11
9	8 - 11
10	8 - 11
12	12 - 14
13	12 - 14

* Note: Health Categories
 0-4: dead/ poor health
 5-7: fair health
 8-11: good health
 12-14: excellent health

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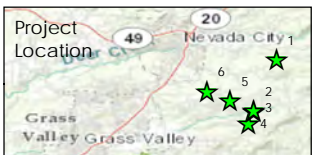
Project Location	Nevada County, CA
Client/Project	Nevada Irrigation District Banner Cascade Project
Figure No.	A.2.3

LCC Site 3 - Tree Health Assessment Results Map
 Monitoring Year 6 (2019)

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Project Location
 Nevada County, CA
 Client/Project
 Nevada Irrigation District
 Banner Cascade Project
 Figure No.
 A.2.4
 Title

LCC Site 4 - Tree Health Assessment Results Map
 Monitoring Year 6 (2019)



Overall Health Score (and Category)

8 8 - 11

9 8 - 11

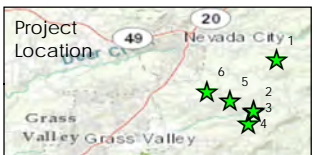
12 12 - 14

** Note: Health Categories*
 8-11: good health
 12-14: excellent health

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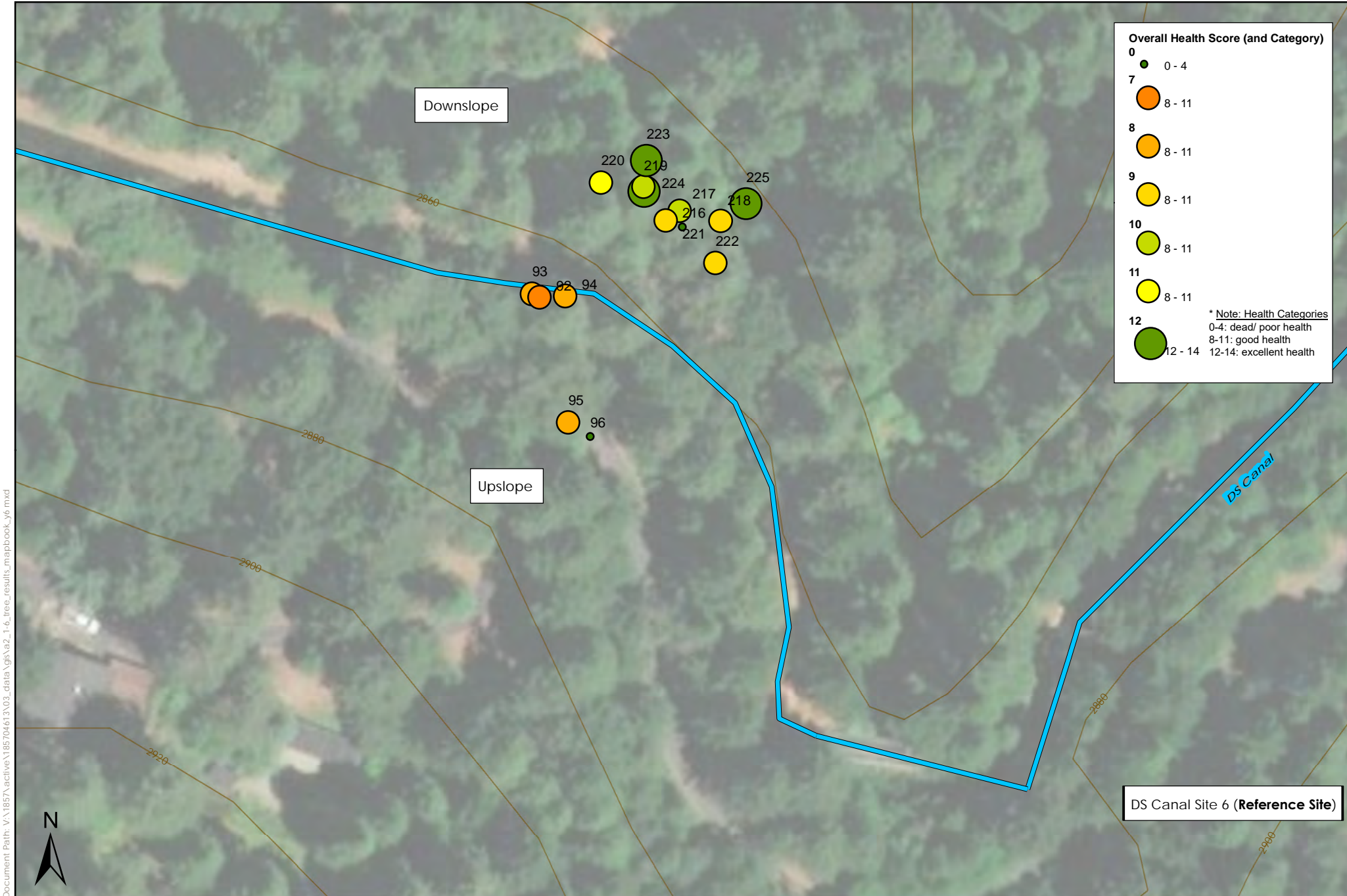
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Project Location	Nevada County, CA
Client/Project	Nevada Irrigation District Banner Cascade Project
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UGVC Site 5 - Tree Health Assessment Results Map Monitoring Year 6 (2019)

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Overall Health Score (and Category)

- 0 ● 0 - 4
- 7 ● 8 - 11
- 8 ● 8 - 11
- 9 ● 8 - 11
- 10 ● 8 - 11
- 11 ● 8 - 11
- 12 ● 12 - 14

** Note: Health Categories*
 0-4: dead/ poor health
 8-11: good health
 12-14: excellent health

DS Canal Site 6 (Reference Site)

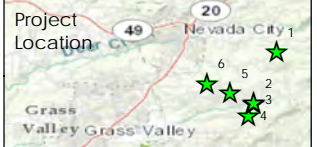
Project 185704613 Sources Created By M. Oats 1/31/2020. Service Layer Credits Sources Esri HERE Garmin Intermap ncrement P Corp. GEBCO USGS FAO NPS NRCAN GeoBase IGN Kadaster NL Ordnance Survey Esri Japan METI Esri China (Hong Kong) swisstopo © OpenStreetMap contributors and the GIS User Community
Sources Esri Garmin USGS NPS
Source Esri DigitalGlobe GeoEye Earthstar Geographics CNES/Airbus DS USDA USGS AeroGRID IGN and the GIS User Community

Project Location Nevada County, CA

Client/Project Nevada Irrigation District
Banner Cascade Project

Figure No. A.2.6

Title



DS Canal (Reference Site) - Tree Health Assessment Results Map Monitoring Year 6 (2019)

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix B Tree Health Assessment Criteria

Appendix B TREE HEALTH ASSESSMENT CRITERIA

The following table of Tree Health Assessment Criteria was updated in Monitoring Year 4 (2017) to be consistent with study requisites and on-going monitoring efforts.

Table 6.1 Summary of Tree Health Assessment Parameters

Assessment Type	Assessment Description	Assessment Score
Canopy Cover	Canopy cover is based on the density and presence of foliage.	1- None 2- Sparse 3- Partial 4- Full
Bark Health	Bark health is based on the integrity and vigor of bark on the bole and limbs of the tree; abnormalities include bark discoloration, damage, sluffing, or absence.	1- Dead 2- Poor 3- Fair 4- Good
New Growth	New growth is any new vascular growth, including leaf buds, basal sprouts, or epicormic stems.	0- Not present 1- Present
Abnormal Leaf Color	Abnormal leaf color includes spotting, insect tracks, necrotic tips, etc., that are not typical for the species or season and are present throughout most foliage.	0- Abnormal 1- Normal
Surface Growth	Surface growth on the trunk and stems includes lichen, moss, and all other normal terrestrial algal plants (i.e., non-vascular plants, bryophytes).	0- Present 1- Not present
Disease	Disease includes fungal/mold presence and other pathogens, tubers, cankers, basal decay, root and heart rot, etc.	0- Present 1- Not present
Parasites	Parasites include mistletoe, honeysuckle, red pustules, etc.	0- Present 1- Not present
Insects	Signs of insects include burrowing/bore holes, leaf notching, frass, larvae or larva galleries, galls, insect presence, etc.	0- Present 1- Not present
Overall Tree Health	Overall tree health was calculated as the sum of all the tree health characteristics above.	0-4- Poor 5-9- Fair 10-14- Good
DBH Growth	DBH growth is based on the increase in DBH measurements, or lack thereof, from previous survey efforts. This metric was not used to calculate Overall Tree Health.	0- No growth 1- Growth

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix B Tree Health Assessment Criteria

Table 6.2 Overall Tree Health Score Descriptions

Overall Score	Score Type	Score Description
1 to 4	poor health	Absent to little canopy cover (<25%), no new growth, bark damaged or absent, surface growth present, foliage present is discolored and/or damaged
5 to 7	fair health	Sparse to partial canopy cover (25-50%), minimal to no new growth present specifically in the canopy, bark sluffing off or damaged yet intact in some places, abnormal surface growths, potential disease presence, some parasite and/or insect damage and/or infestation
8 to 11	good health	partial to intact canopy cover (50-75%), new growth present, minimal bark and leaf discoloration, no significant disease, normal surface growth, minimal insect infestations/damage
12 to 14	excellent health	Intact to full canopy cover, new growth present, no surface growth, excellent bark and leaf health, no disease present

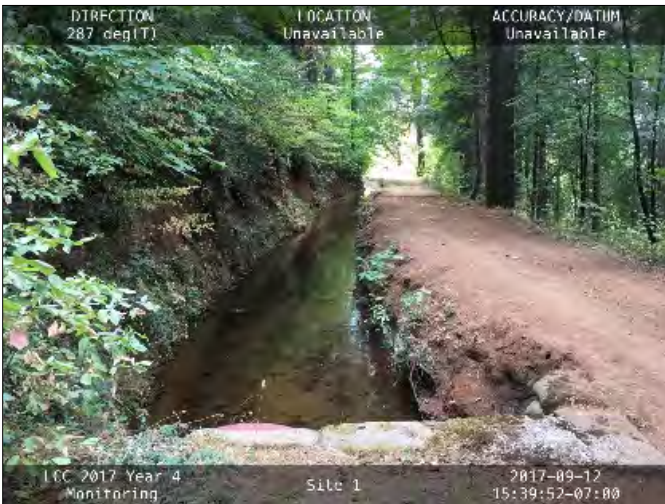
LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix C Photo Record

Appendix C PHOTO RECORD

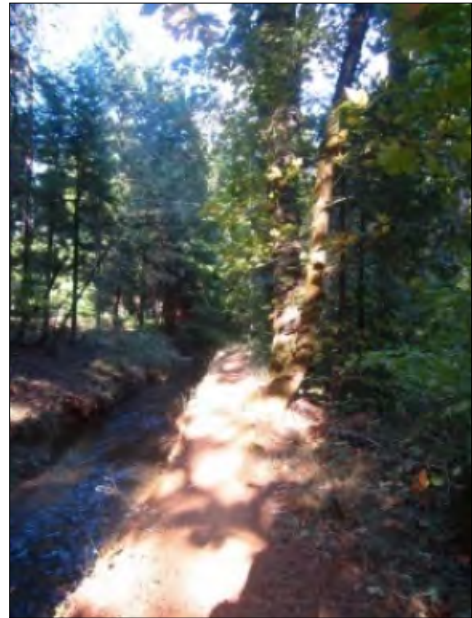
The following Photo Record is documentation of the site conditions present for Lower Cascade Canal (LCC) and Upper Grass Valley Canal (UGVC) Long Term Canopy Cover Study. This Photo Record provides a photographic comparison for sites and years of the study in which Tree Health Assessments were conducted (i.e., Baseline Year 0 [2013] and subsequent Monitoring Year 2 [2015], Year 4 [2017], and Year 6 [2019], at Sites 1-4 on LCC, Site 5 on UGVC, and Site 6 on the reference site DS Canal). General site conditions and notable observations from Monitoring Year 6 Tree Health Assessments have also been provided.

Tree Health Assessment Site Condition Comparisons Between Monitoring Surveys Spanning Six Years (2013-2019)

	
<p>LCC Site 1 (Year 0, 2013). Facing east.</p>	<p>LCC Site 1 (Year 2, 2015). Facing west.</p>
	
<p>LCC Site 1 (Year 4, 2017). Near upslope location.</p>	<p>LCC Site 1 (Year 6, 2019). Downslope location.</p>

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record



LCC Site 2 (Year 0, 2013). Facing southwest.

LCC Site 2 (Year 2, 2015). Facing east.

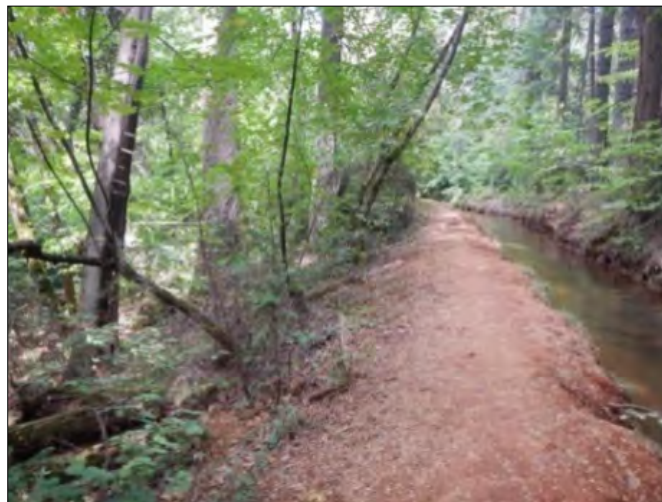
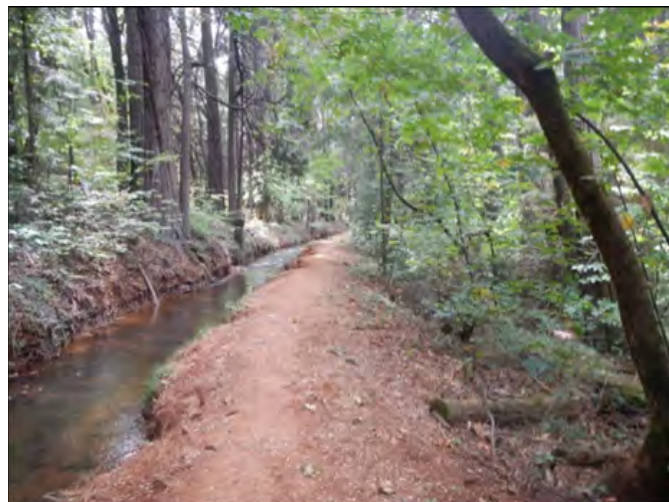


LCC Site 2 (Year 4, 2017). Downslope location.

LCC Site 2 (Year 6, 2019). Downslope location.

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record



LCC Site 3 (Year 0, 2013). Facing east.

LCC Site 3 (Year 2, 2015). Facing west.



LCC Site 3 (Year 4, 2017). Downslope location.

LCC Site 3 (Year 6, 2019). Downslope location.

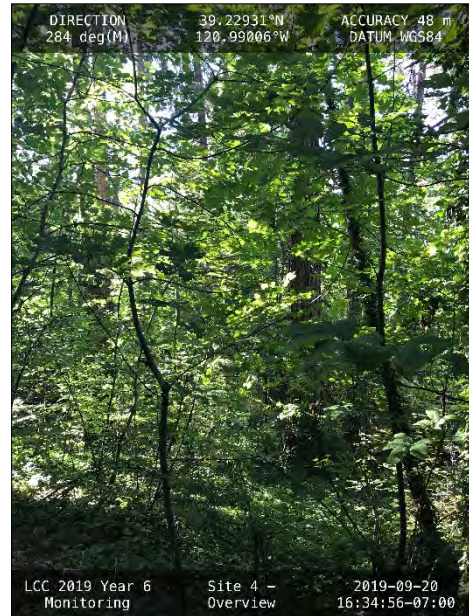
**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record



LCC Site 4 (Year 0, 2013). Facing southwest.

LCC Site 4 (Year 2, 2015). Facing northeast.



LCC Site 4 (Year 4, 2017). Downslope location.

LCC Site 4 (Year 6, 2019). Downslope location.

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record



UGVC Site 5 (Year 0, 2013). Facing west.

UGVC Site 5 (Year 2, 2015). Facing west.



UGVC Site 5 (Year 4, 2017). Downslope location.

UGVC Site 5 (Year 6, 2019). Downslope location.

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record



DS Canal Site 6 (Year 0, 2013).

DS Canal Site 6 (Year 2, 2015).







DS Canal Site 6 (Year 4, 2017) Upslope location.

DS Canal Site 6 (Year 6, 2019). Downslope location.

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

General Site Conditions and Notable Observations in Monitoring Year 6 – Tree Health Assessments

	
<p>LCC Site 1. Downslope; downed woody debris, thick duff, minimal understory, pink honeysuckle (<i>Lonicera hispidula</i>) vining on tree in foreground.</p>	<p>LCC Site 1. Downslope; example canopy cover of assessment tree (#186).</p>
	
<p>LCC Site 1. Upslope; thick duff and downed woody debris.</p>	<p>LCC Site 1. Upslope; example canopy cover of assessment tree (#191).</p>



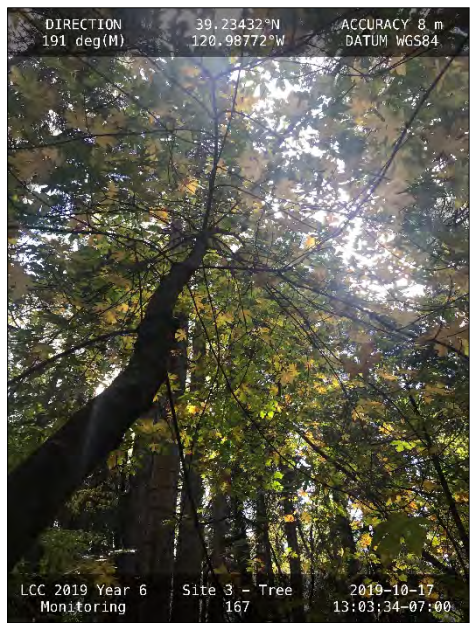

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

	
<p>LCC Site 2. Downslope; dense understory primarily comprised of cutleaf blackberry (<i>Rubus laciniatus</i>) and Himalayan blackberry (<i>Rubus armeniacus</i>).</p>	<p>LCC Site 2. Downslope; stormwater drainage sourced at least partially by canal.</p>
	
<p>LCC Site 2. Downslope; example canopy cover of assessment tree (#138).</p>	<p>LCC Site 2. Upslope; new fence installed, trees potentially removed, thick duff, understory of saplings sprouting from manually cleared stumps.</p>





**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

	
<p>LCC Site 3. Downslope; understory and downed woody debris throughout site; some areas with large fallen trees and piled debris.</p>	<p>LCC Site 3. Downslope; example assessment tree (#160), with moss surface growth and parasitic California wild grape (<i>Vitis californica</i>); English Ivy (<i>Hedera helix</i>) also present in understory and on trees.</p>
	
<p>LCC Site 3. Downslope; example canopy cover of assessment tree (#167).</p>	<p>LCC Site 3. Upslope; minimal understory and thick duff.</p>





**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

 <p>DIRECTION 131 deg(M) 39.22921°N 120.99015°W ACCURACY 8 m DATUM WGS84</p> <p>LCC 2019 Year 6 Monitoring Site 4 - Tree 202 2019-09-20 14:49:06-07:00</p>	 <p>DIRECTION 307 deg(M) 39.22923°N 120.99003°W ACCURACY 8 m DATUM WGS84</p> <p>LCC 2019 Year 6 Monitoring Site 4 - Tree 116 2019-09-20 15:38:39-07:00</p>
<p>LCC Site 4. Downslope; understory of English Ivy (<i>Hedera helix</i>) and downed woody debris.</p>	<p>LCC Site 4. Downslope; example assessment tree (#116), with heavy insect damage on leaves.</p>
 <p>DIRECTION 31 deg(M) 39.22919°N 120.99016°W ACCURACY 8 m DATUM WGS84</p> <p>LCC 2019 Year 6 Monitoring Site 4 - Tree 201 2019-09-20 15:03:49-07:00</p>	 <p>DIRECTION 261 deg(M) 39.22904°N 120.99013°W ACCURACY 8 m DATUM WGS84</p> <p>LCC 2019 Year 6 Monitoring Site 4 - Overview 2019-09-20 16:32:58-07:00</p>
<p>LCC Site 4. Downslope; example canopy cover of assessment tree (#201).</p>	<p>LCC Site 4. Upslope; understory of poison oak (<i>Toxicodendron diversilobum</i>) and large downed trees.</p>

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

	
<p>UGVC Site 5. Downslope; steep and adjacent to roadside, thick duff, understory of saplings, grasses, and pink honeysuckle (<i>Lonicera hispidula</i>).</p>	<p>UGVC Site 5. Downslope; example assessment tree (#103), with epicormic growth and evidence of prior limbing for road maintenance.</p>
	
<p>UGVC Site 5. Downslope; example canopy cover of assessment tree (#98).</p>	<p>UGVC Site 5. Upslope; largely conifer with few deciduous trees, thick duff, understory of Himalayan blackberry (<i>Rubus armeniacus</i>).</p>

**LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY,
TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6**

Appendix C Photo Record

	
<p>DS Canal Site 6 (reference site). Downslope; minimal understory, thick duff, pink honeysuckle (<i>Lonicera hispidula</i>).</p>	<p>DS Canal Site 6 (reference site). Downslope; example assessment tree (#221), with spotting on leaves.</p>
	
<p>DS Canal Site 6 (reference site). Downslope; example canopy cover of assessment tree (#225).</p>	<p>DS Canal Site 6 (reference site). Upslope; dense understory of conifer saplings and Himalayan blackberry (<i>Rubus armeniacus</i>).</p>

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix D Observed Species

Appendix D OBSERVED SPECIES

Vegetation and wildlife species observed during Year 6 monitoring (2019) for the Tree Health Assessments in September and October 2019, Nevada County, California. Species observed, or not observed, in previous monitoring years (i.e., 2013, 2015, and 2017) are also noted.

Common name	Scientific Name	Lifeform	Nativity	Observation Location					
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Plants									
bigleaf maple	<i>Acer macrophyllum</i>	Tree	Native	X	X	X	X	X	X
black oak	<i>Quercus kelloggii</i>	Tree	Native	X	X	X	X	X	X
California brome grass*	<i>Bromus carinatus</i>	Perennial grass	Native				X	X	
California wild grape	<i>Vitis californica</i>	Vine or Shrub	Native		X	X	X		X
canyon live oak	<i>Quercus chrysolepis</i>	Tree	Native	X	X				X
common cattail**	<i>Typha latifolia</i>	Perennial herb	Native						X
common ladyfern	<i>Athyrium filix-femina</i>	Fern	Native	X	X	X	X	X	X
coyote brush	<i>Baccharis pilularis</i>	Shrub	Native	X					X
cutleaf blackberry	<i>Rubus laciantus</i>	Shrub	Non-native	X	X	X	X	X	X
dock species	<i>Rumex</i> spp.	Perennial herb	Non-native				X		
dogtail grass	<i>Cynosurus echinatus</i>	Annual grass	Non-native invasive				X	X	X
Douglas-fir	<i>Pseudotsuga menziesii</i>	Tree	Native	X	X	X	X	X	X
English ivy	<i>Hedera helix</i>	Vine	Non-native invasive	X	X	X	X		

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix D Observed Species

Common name	Scientific Name	Lifeform	Nativity	Observation Location					
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
gray alder	<i>Alnus incana</i>	Tree	Native	X	X	X	X	X	X
Beaked hazelnut	<i>Corylus cornuta</i>	Tree	Native	X	X	X	X		
hedge nettle species**	<i>Stachys</i> sp.	Perennial herb	Native	X					
Himalayan blackberry	<i>Rubus armeniacus</i>	Shrub	Non-native invasive	X	X	X	X	X	X
incense cedar	<i>Calocedrus decurrens</i>	Tree	Native	X			X	X	X
interior live oak	<i>Quercus wislizeni</i>	Tree	Native	X			X		
mountain grape	<i>Berberis aquifolium</i>	Shrub	Native	X	X				
Mountain misery*	<i>Chamaebatia foliolosa</i>	Shrub	Native		X		X		
Oregon ash	<i>Fraxinus latifolia</i>	Tree	Native				X		
Pacific dogwood	<i>Cornus nutallii</i>	Tree	Native	X	X	X		X	X
Pacific madrone	<i>Arbutus menziesii</i>	Tree	Native	X	X	X	X	X	X
pink honeysuckle	<i>Lonicera hispidula</i>	Vine	Native	X	X	X	X		X
periwinkle species*	<i>Vinca</i> sp.	Perennial herb	Non-native invasive	X		X			
poison hemlock	<i>Conium maculatum</i>	Perennial herb	Non-native invasive		X	X	X		
poison oak	<i>Toxicodendron diversilobum</i>	Vine/Shrub	Native	X	X	X	X	X	X
Ponderosa pine	<i>Pinus ponderosa</i>	Tree	Native	X	X	X	X	X	X
Queen Anne's lace, wild carrot*	<i>Daucus carota</i>	Perennial herb	Non-native			X		X	
quillwort species	<i>Isoetes</i> sp.	Fern	Native	X	X		X		X

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix D Observed Species

Common name	Scientific Name	Lifeform	Nativity	Observation Location					
				Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Scotch broom	<i>Cytisus scoparius</i>	Shrub	Non-native invasive		X				
sorrel species	<i>Oxalis</i> sp.	Perennial herb	Non-native	X					
sugar pine	<i>Pinus lambertiana</i>	Tree	Native	X	X	X	X	X	X
tanoak	<i>Notholithocarpus densiflorus</i>	Tree	Native	X			X		
thimbleberry	<i>Rubus parviflorus</i>	Vine/Shrub	Native						
trail plant	<i>Adenocaulon bicolor</i>	Perennial herb	Native	X	X		X	X	
tree of heaven	<i>Ailanthus altissima</i>	Tree	Non-native invasive						X
western goldenrod	<i>Euthamia occidentalis</i>	Perennial herb	Native	X					X
western raspberry	<i>Rubus leucodermis</i>	Shrub	Native	X		X	X		
white alder	<i>Alnus rhombifolia</i>	Tree	Native	X		X		X	X
Wildlife									
band-tailed pigeon*	<i>Patagioenas fasciata</i>	Bird	Native		X				
California scrub jay	<i>Aphelocoma californica</i>	Bird	Native	X			X		X
mountain chickadee**	<i>Poecile gambeli</i>	Bird	Native						X
northern flicker**	<i>Colaptes auratus</i>	Bird	Native	X	X	X			
Steller's jay**	<i>Cyanocitta stelleri</i>	Bird	Native		X				
western gray squirrel	<i>Sciurus griseus</i>	Mammal	Native	X					

Tree Health Assessment Sites = Lower Cascade Canal (LCC) Sites 1, 2, 3, 4; Upper Grass Valley Canal (UGVC) Site 5; DS Canal (control-site) Site 6

* = Notes species observed during Year 6 (2019) field surveys, however not previously observed in Year 1 (2013), Year 2 (2015), and/or Year 4 (2017).

** = Notes species observed in monitoring Year 1 (2013), Year 2 (2015), Year 4 (2017), however not observed during monitoring Year 6 (2019).

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix E Tree Health Assessment Datasheets

Appendix E TREE HEALTH ASSESSMENT DATASHEETS

Baseline Arborist Survey Datasheet

Project LCC - 2019 Monitoring (Year 6) Site LCC site #1, Red Dog Rd. (Tree Health Assessment)
 Client Nevada Irrigation District Date September 20, 2019
 Weather 55°, sunny Observer(s) Meaghan Oats, Eian Carnahan
 Site Conditions steep downslope; downed debris on site (~15% understory in herb/shrub layer); TRAIL PLANT, LOTH lady fern, TDDI, cutleaf blackberry Himalayan blackberry
 Notes

Baseline Data				Tree Health Assessment										Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score		
186	D	ACMA	5.8, 9.3, 8.5	3	2	1	0	0	1	1	0	8	Rusting on leaves, heavy insect damage on leaves	
183	D	CONU	3.5	3	3	1	0	0	1	1	0	9	leaning downslope, leaves insect	
184	D	CONU	5.4	4	3	1	0	0	1	0	0	9	white spotting, potential fungus	
181	D	ALIN	2.1	2	3	1	1	0	1	1	0	9	leaning downslope, shaded out	
177	D	CONU	N/A	—	—	—	—	—	—	—	—	—	Dead, uprooted recently	
176	D	CONU	1.7	1	4	0	0	0	0	1	1	7	leans almost dead, leaves dead, canopy for fall	
175	D	CONU	2.1	3	3	1	0	0	1	1	0	9	horizontally leaning downslope;	
182	D	ACMA	7.6, 8.1, 2.8	3	2	1	0	0	0	1	0	7	multistem, lots of new growth	
187	D	ALIN	1.3	1	1	1	1	1	1	1	1	8	horizontal, close to ground; min canopy	
180	D	ALIN	5.2	2	3	1	0	0	1	1	0	8	uprooted, but epicormal sprouts	
185	D	CONU	N/A	—	—	—	—	—	—	—	—	—	Dead	
178	D	ACMA	7.9, 6.1, 7.3	2	2	1	0	0	0	0	0	5	1 dead stem, 3 alive; bark shell stiff, fine crack	
179	D	CONU	6.4	4	3	1	0	0	1	1	0	10	Healthy	
173	D	CONU	2.3, 5.4, 0.0	4	3	1	0	0	1	1	0	10	Healthy	
174	D	CONU	1.2, 1.9, 5	3	3	1	0	0	1	1	0	9	leaning downslope	
189	D	CONU	3.2	4	4	1	1	1	1	1	0	13	Healthy	

⑤ 5.0, 4.7, 6.4, 6.5, 6.3, 7.7, 5.2, 8.7, 5.7, 5.3, 5.1, 8.3
 ⑥ 9.1, 7.3

Baseline Data				Tree Health Assessment									Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score	
210	D	CONU	1.3	2	3	1	0	0	1	1	0	8	leans downslope
188	D	CONU	5.1	4	4	0	1	0	1	1	0	11	healthy
195	U	ACMA	(*)	3	3	1	0	1	1	0	0	9	upslope; rusty leaves; TWD & wts. of insect damage; LWHI um
191	U	CONU	4.3, 4.9	4	3	0	1	0	1	0	0	9	lower canopy absent
193	U	CONU	2.2	3	3	0	1	0	1	0	0	8	
190	U	CONU	6.0	3	3	1	0	0	1	1	0	9	
192	U	ACMA	2.4	2	4	0	0	1	1	1	0	9	leans over canal
194	missing												

pping up

ASSESSMENT KEY

- Canopy Cover** 1- Sparse to full die-back (0-25%); 2- Partial (25-50%); 3- Medium (50-75%); 4- Full (75-100%)
- Bark Health** 1- Poor to No bark (75-100%); 2- Fair (50-75%); 3-Good (25-50%); 4- Excellent (0-25%)
- New Growth** 1- Present; 0- Not present
- Leaf Color** 1- Normal; 0- Abnormal
- Surface Growth** 1- Not Present; 0- Present
- Disease** 1- Not Present; 0- Present
- Parasites** 1- Not Present; 0- Present
- Insects** 1- Not Present; 0- Present
- Overall Tree Health** 1-3 Poor Health/Dead; 4-7 Fair Health; 7-10 Good Health; 11-14 Excellent Health

TREE SPECIES REFERENCE KEY

(*) 2.0, 3.1, 2.5, 3.5, 1.1, 0.5



Baseline Arborist Survey Datasheet

Project LCC 2019 Monitoring (Year 6) Site LCC Site #2, TREE HEALTH ASSESSMENT
 Client Nevada Irrigation District Date Oct. 17, 2019
 Weather 50°, cloudy, some rain Observer(s) M. Pats, E. Carnahan
 Site Conditions dense understory (Himalayan blackberry), some CONU saplings (understory)
 Notes lots of debris on ground (branches & leaf litter)

Baseline Data				Tree Health Assessment										Notes
Tree Number	Tree Location	Species	DBH (inches)	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score		
138	D	ACMA	12.4, 8.0	4	2	1	0	0	1	1	0	9	Broken trunk, lots of new sprouts	
139	D	ACMA	3.1	3	2	1	0	0	0	1	0	7	Rust spots on leaves, disease spots	
136	D	ACMA	2.7	3	2	0	0	0	0	1	0	6	Rust spots on leaves, possible disease on trunk	
(134) 205	D	ACMA	9.6	4	2	1	0	0	0	1	0	8	Rust, possible disease on trunk, lots of moss	
140	D	ACMA	4.7	2	2	1	0	0	1	0	0	6	Rust, many insect damage, top canopy loss	
141	D	CONU	2.1	4	4	1	1	1	1	0	0	12	Near drainage, lots in canopy	
(133) 204) 211) 299	D	ACMA	4.7	2	2	1	0	0	1	1	0	7	leaves greatly damaged, lost bark every year, base is very dark	
213	D	CONU	4.2*	4	1	1	1	0	0	0	1	8	multistem, some dead branches, fungal disease on trunk	
(135) 207) 230) 212	D	CONU	1.7, 2.1, 3.8	4	3	0	1	0	1	0	1	10	multistem, moss on low trunk, one trunk dead	
300	D	ACMA	9.8, 11.1	3	2	1	0	0	1	0	0	7	two stem, rust on leaves, lots of moss on trunk, archaic	
209	D	ACMA	12.8	4	3	1	1	0	1	1	0	11	close to canal, healthy	
143	D	ALIN	5.5	3	3	0	1	0	1	0	1	9	too dense to access, blackberry & dense understory	
144	D	ALIN	6.5											

site has stormwater drainage at bottom of slope with some water present (close to TREE 141)
 * avg. of multistem

Baseline Arborist Survey Datasheet

Project LCU-2019 Monitoring (Year 6)

Site LCU Site #3- Tree Health Assessment

Client Nevada Irrigation District

Date October 17, 2019

Weather 50°F, Cloudy

Observer(s) Mechan Oats, Ian Carnahan

Site Conditions CA wild grape is predominant understory

Notes water temp = 12.1°C; English ivy present growing on trunks/booms.

Baseline Data				Tree Health Assessment									Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score	
1163	D	ACMA	4.1	1	1	1	1	0	0	1	0	5	Mostly dead, w/ conical growth lots of moss.
1164	D	ACMA	4.5	2	2	1	0	0	1	1	0	7	leaves greatly down slope, canopy over trail
1164	D	ACMA	4.7	3	2	1	0	0	1	1	0	8	leaves greatly up slope, canopy over trail. bark is dark
1165	D	ACMA	5.0	2	3	1	0	0	1	1	0	8	lots of moss on trunk, leaves side canopy taking on trail
1162	D	ACMA	9.7	1	1	0	0	0	1	1	0	4	upper 2/3 missing canopy hinges low; rust spots
1160	D	ACMA	9.5	3	3	1	0	0	1	0	0	8	English ivy & CA grape winding rust spots on leaves.
1159	D	CONU	2.5	4	4	1	0	1	1	1	0	12	Tag being engulfed in trunk spots on leaves, leaves down slope
1158	D	ACMA	9.7	1	1	1	0	0	1	0	0	4	Top 3/4ths dead, upper canopy English ivy & CA grape growing up
1167	D	ACMA	3.6	3	2	0	1	0	1	0	0	7	Dark color off bark of trunk CA grape, winding on branches
1154	D	ACMA	2.1	2	3	1	1	0	1	1	0	9	leaves slightly up slope; spots on trunk
1153	D	ACMA	19.24	3	3	1	0	0	1	0	0	8	tag is engulfed in tree; one stem attached from space; CA grape on trunk
1152	D	ACMA	8.4, 6.5, 7.0	4	2	1	0	0	1	1	0	9	white spots on trunk; canopy over trail moss on trunk
(156) 214	D	ACMA	7.0	3	2	0	0	0	1	0	0	6	one stem dead; English ivy, CA wild moss on trunk; bark on leaves
1155	D	ACMA	9.7	3	2	1	0	0	1	0	0	7	moss on trunk; raspberry & wild grape on trunk & branches
1157	D	ALIN	2.4	2	2	1	1	0	1	0	0	7	fallen over, but still alive CA wild grape, bark still fine
(161) 376	D	ALIN	1.5	2	2	1	1	0	1	0	0	7	trunk choked; competing w/ adjacent cedar; CA wild grape growing black residue on trunk.

(tag gone in slope in

up

spot

grape

up

Baseline Arborist Survey Datasheet

Project LCC - 2019 Monitoring (Y6) Site LCC site #4 TREE HEALTH ASSESSMENT
 Client Nevada Irrigation District Date 9/20/2019
 Weather 105° F ; sunny Observer(s) M. Oats, E. Carnahan
 Site Conditions Ground cover - English Ivy (downslope); plants: ladyfern, TUDI, RUTG,
 Notes OH1; Bromus sp., dooptail grass, Rubus leucodermis

Baseline Data				Tree Health Assessment										Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score		
110	D	ACMA	2.8	3	2	1	1	1	1	0	0	9	HEHE winding up trunk	
109	D	ACMA	5.1	2	3	1	0	1	1	0	0	8	Tag getting eaten by tree	
202	D	ALIN	1.9	3	2	0	1	1	1	0	0	8	peeling bark; OH1 up trunk	
201	D	CONU	2.0	4	3	0	0	1	1	1	0	10	; prev. 121	
215	D	ACMA	2.8	3	4	0	0	1	1	1	0	10	canopy over trail; prev. 120	
113	D	ACMA	1.8	3	3	1	1	1	1	1	0	11	lots of insect damage on leaves	
114	D	ACMA	2.2	2	3	1	1	1	1	1	0	10	leans downslope; partly absent canopy	
123	D	NODE	2.9	4	4	0	1	1	1	1	0	12	canopy over TRAIL	
200	D	ACMA	1.7	3	3	1	0	1	1	1	0	10	one limb broken off; insect dam. prev #122	
116	D	ACMA	1.7, 1.1	2	4	1	0	1	1	0	0	9	insect damage on leaves; HEHE growing on trunk	
117	D	ALIN	1.3	3	2	0	1	1	1	1	0	8/9	" shaded out	
115	D	ALIN	1.9	2	2	0	0	1	1	1	0	7	canopy partially missing, shaded out	
119	D	ALIN	2.4	3	3	0	1	1	1	1	0	10	bark slightly sluffing	
203	D	ACMA	7.4	4	3	1	0	0	1	0	0	9	HEHE winding up trunk (lots); tagged as 291	
199	U	ACMA	9.4	3	2	1	0	0	1	1	0	8		
197	U	ACMA	4.6	3	2	1	0	0	0	1	0	7	DIS = soft spot on bark w/ oozing	

* Hedera helix overgrowing on site (downslope)
 * Rubus arm. " " (upslope)

Project LCC-2019 Monitoring (Y6)

Site #4

Date 9/20/2019

Tree Health Assessment Datasheet pg 2 of 2

Baseline Data				Tree Health Assessment										Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score		
196	U	ACMA	6.8	2	2	1	0	0	0	1	0	7	pot. root rot.; one broken trunk not measured	
198	U	ACMA	7.6	3	2	1	0	0	1	1	0	8		

new
292

ASSESSMENT KEY

- Canopy Cover** 1- Sparse to full die-back (0-25%); 2- Partial (25-50%); 3- Medium (50-75%); 4- Full (75-100%)
- Bark Health** 1- Poor to No bark (75-100%); 2- Fair (50-75%); 3-Good (25-50%); 4- Excellent (0-25%)
- New Growth** 1- Present; 0- Not present
- Leaf Color** 1- Normal; 0- Abnormal
- Surface Growth** 1- Not Present; 0- Present
- Disease** 1- Not Present; 0- Present
- Parasites** 1- Not Present; 0- Present
- Insects** 1- Not Present; 0- Present
- Overall Tree Health** 1-3 Poor Health/Dead; 4-7 Fair Health; 7-10 Good Health; 11-14 Excellent Health

TREE SPECIES REFERENCE KEY



Baseline Arborist Survey Datasheet

REFERENCE SITE

Project Banner Cascade 2019 Monitoring Yr 6

Site DS Canal; Site #6 Tree Health Assessment

Client Nevada Irrigation District

Date October 18, 2019

Weather 48°F; Cloudy

Observer(s) M. Oats; E. Carnahan

Site Conditions canal temp: 10.0°C

Notes LOH present throughout study area; vining up trees.

Baseline Data				Tree Health Assessment										Notes
Tree Number	Tree Location	Species	DBH	Canopy Cover	Bark Health	New Growth	Leaf Color	Surface Growth	Disease	Parasites	Insects	Overall Health Score		
(81)	D	CONU	2.4, 3.6	4	4	1	1	0	1	1	0	12	two stems; curved trunk (50' from canal)	
(79)	D	CONU	1.9	3	3	1	0	1	1	1	0	10	leans greatly downslope; dots on stem	
(82)	D	CONU	DEAD	—————								0	Appears to have been strangled at base by LOH; bark still apparent	
(90)	D	CONU	2.5	3	2	1	1	1	1	1	0	10	leans downslope; bark is very dark; w/ some spotting	
(88)	D	CONU	2.1	4	2	1	0	1	1	0	0	9	white spots on leaves; LOH vining up on stem dead (cut)	
(80)	D	CONU	2.6	4	4	1	0	1	1	1	0	12	LOH present at base but not vining up tree yet.	
(85)	D	CONU	2.5	4	4	1	1	1	1	0	0	12	Adjacent dead tree leans on trunk; leans downslope; LOH	
(89)	D	CONU	1.6, 1.2	3	3	1	0	1	1	0	0	9	white spots on leaves; on stem crushed by fallen tree; LOH on branches	
(86)	D	CONU	6.4, 4.4	3	3	1	0	0	1	1	0	9	large broken stem but still alive; lots of epicormal sprouting on trunk	
(76)	D	CONU	2.4	3	4	1	0	1	1	1	0	11	leans downslope; white spots on leaves	
93	U	ACMA	3.8	3	2	0	1	0	1	1	0	8	leans slightly upslope;	
92	U	ALIN	7.3	2	2	0	1	0	1	1	0	7	canopy sparse; competing w/ adjacent ACMA	
94	U	ACMA	11.5	4	2	1	0	0	0	1	0	8	prev. multi-stem but other trunks dead; bark sluffing; possible root rot	
96	U	—	Dead	—————								0	epicormal sprouting; lots of LOH on trunks & branches; heavy insect damage	
95	U	ACMA	3.2, 0.7	2	3	1	1	0	1	0	0	8		

179 tags
 (81)
 (79)
 (82)
 (90)
 (88)
 (80)
 (85)
 (89)
 (86)
 (76)

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix F Ten-Year Canopy Cover Study Monitoring Plan

Appendix F TEN-YEAR CANOPY COVER STUDY MONITORING PLAN

PURPOSE

The purpose of the Ten-Year Canopy Cover Study Monitoring Plan is to summarize and detail requirements for the future monitoring efforts for the Canopy Cover Study, and to comply with Mitigation Measure 3.8-1 defined in the Final EIR for the Lower Cascade Canal- Banner/Cascade Pipeline Project (NID 2006). The Canopy Cover Study is comprised of the Tree Health Assessment Study and the Canopy Cover Assessment for the Lower Cascade Canal, and Upper Grass Valley Canal, and DS Canal (control-site). This Ten-Year Canopy Cover Study Monitoring Plan is specific to a study timeline and data collection methods which are detailed below.

STUDY TIMELINE

- Tree Health Assessments – Assessment data will be collected over a period of ten years, at an interval of every two years, for a total of six surveys (i.e., 2013-2023; Years 0, 2, 4, 6, 8, 10). Surveys shall be conducted in the late summer (i.e., August to September/ October).
- Canopy Cover Assessments – Canopy cover data will be collected every four years, with one final assessment to conclude the study on Monitoring Year 10 (i.e., Years 0, 4, 8, and 10). Surveys shall be conducted in the late summer (i.e., August to September) and concurrent with the Tree Health Assessments.

Table- Summary of Canopy Cover Studies and Monitoring Timeline Requirements

Canopy Cover Study	Monitoring Year & Requirement					
	2013- Year 0	2015- Year 2	2017- Year 4	2019- Year 6	2021- Year 8	2023- Year 10
Tree Health Assessment	X	X	X	X	X	X
Canopy Cover Assessment	X		X		X	X

X- Indicates a study year for monitoring to be completed

STUDY LOCATIONS

The study sites locations for the Tree Health Assessment, and Reach locations for the Canopy Cover Assessment are detailed below.

Tree Health Assessment

- Lower Cascade Canal
 Site 1: Latitude 39.257104, Longitude -120.978144
 Site 2: Latitude 39.234850, Longitude -120.987938

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix F Ten-Year Canopy Cover Study Monitoring Plan

Site 3: Latitude 39.234282, Longitude -120.987857

Site 4: Latitude 39.229272, Longitude -120.990137

- Upper Grass Valley Canal

Site 5: Latitude 39.238957, Longitude -120.9982466

- DS Canal (control-site)

Site 6: Latitude 39.243292, Longitude -121.008359

Canopy Cover Assessment

Table- Summary of Canopy Cover Assessment Locations and Reach Lengths

Canal	Lower Cascade Canal	Upper Grass Valley Canal	DS Canal (control-site)
Canal Reach Length (miles)	7	0.5	1
Reach Start Coordinate (North)	39.259642872, -120.966559692	39.238985195, -120.998306278	39.245783455, -120.992624265
Reach End Coordinates (South)	39.225052309, -120.990948424	39.23597992, -121.005289880	39.243120641, -121.010794363

DATA COLLECTION

Tree Health Assessments

Data should be recorded and assessed considering the following factors (Zobrist 2011):

- Presence of foliage decline or evidence of crown fading;
- Color of foliage: out of season discoloration of foliage; and
- Evidence of disease, parasite, and/or insect damage.

To capture the data above, visual inspections of each tagged tree at each of the six Tree Health Assessment study sites should be made using the criteria listed in the table below. Each tree should be assigned a score for each category or criteria using the Project specific datasheets associated with this Monitoring Plan.⁴ Data shall be documented with a Trimble Series 6000 GeoXH GPS, and post-processed in GIS.

⁴ The Tree Health Assessment data collection form was updated in 2015, Year 2 Monitoring, to be consistent with study requisites and on-going monitoring efforts.

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix F Ten-Year Canopy Cover Study Monitoring Plan

Table- Tree Health Assessment Data Criteria

Assessment Type	Assessment Description	Assessment Score
Canopy Cover	Canopy cover die-back by a percentage based on density and presence of foliage at the crown of the tree.	1- None: no canopy present, 0% 2- Sparse: most canopy absent, 0-25% 3- Partial: canopy 25-50% 4- Medium: canopy 50-75% 5- Full: canopy 75-100%
Bark Health	Bark health is assessed through the absence/ sluffing of bark on the bole and limbs of the tree.	1- Dead: 100% sluffing off, extensive damage 2- Poor: decaying or dead; 75-100% bark absent from bole and limbs of tree; abundant root rot; extensive insect damage; overall discoloration and bark shape irregularities; abundant surface growth 3- Fair: 50-75% bark absence; some root rot and insect damage; discoloration and bark shape irregularities; bark sluffing 4- Good: 25-50% bark absence; some root or heart rot present; bark only missing from tree limbs 5- Excellent: 0-25% bark absence. Present bark generally intact and of high vigor
Leaf Color	Leaf color is assessed based on abnormal colorations that are not typical for the species or season, uniform throughout all present foliage, etc.	1- Normal: no abnormalities present, color normal 0- Abnormal: abnormal color present (e.g., spotting, insect tracks, necrotic tips, etc.)
New Growth Presence	"New growth" is any new vascular growth including leaf buds, basal sprouts, epicormic stems, and saplings.	0- Present 1- Not present
Surface Growth Presence	Surface growth on trunk and stems includes lichen, moss, and all other normal terrestrial algal plants (i.e., non-vascular plants, bryophytes).	0- Present 1- Not present
Disease	Disease includes fungal/mold presence and other pathogens, tubers, cankers, structural decay (e.g., basal decay, irregular growth pattern of tree), root and heart rot, etc.	0- Present 1- Not present
Parasites	Parasites can include, but are not limited to, the presence of mistletoe, red pustules, etc.	0- Present 1- Not present
Insect Infestation	Signs of insects include burrowing/bore holes; frass, larvae or larva galleries, or insect presence; leaf notching; epicormics stems, galls, etc.	0- Present 1- Not present
Overall Tree Health	Overall tree health was assessed through leaf/ foliage health and other associated physical leaf characteristics, the amount of canopy foliage present, stem, and bark health (e.g., decay), abnormal tree shape, and/or increased presence of disease, parasites, and insect infestations. Normal seasonal variations were considered in overall health scoring.	1- Dead Overall 2- Poor Overall: partial-full discoloration; severe insect damage; disease presence; tissue damage 3- Fair Overall: partial discoloration; some insect damage, heart rot 4- Good Overall: some discoloration 5- Excellent Overall: no physical abnormalities

Canopy Cover Assessment

The Canopy Cover Assessment data will be collected along each canal study Reach using a densiometer following the methods described in The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment State Water Resources Control Board Standard Operating Procedure for

LOWER CASCADE CANAL AND UPPER GRASS VALLEY CANAL LONG TERM CANOPY COVER STUDY, TREE HEALTH ASSESSMENT REPORT- MONITORING YEAR 6

Appendix F Ten-Year Canopy Cover Study Monitoring Plan

Measuring Canopy Cover Using a Seventeen Point Spherical Convex Densiometer (Burrell 2010; Ode 2007). Field data for each site will be collected on the datasheet within this Monitoring Plan as well as using a sub-meter Trimble GPS.⁵ Post-processed will be completed using GIS. The analysis will average the overall canopy cover data collected based on densiometer readings along each canal Reach. Results will then be synthesized from the canopy cover data. Data collection and canopy density percentages will be calculated based on methods and formulas described in Use of the Densiometer to Estimate Density of Forest Canopy on Permanent Sample Plots (Strickler 1959).

STUDY REPORTING

Reporting shall be completed at the end of each monitoring year and will be drafted to summarize the Canopy Cover Study findings (i.e., Tree Health and Canopy Assessment data and results) for that year. The data for the study year will also be discussed in conjunction with previous monitoring years and California's water year data and NID LCC and the UGVC flow data. Each report will include adaptive management recommendations, if necessary. NID is not required to adhere to any interim recommendations but may want to take them into consideration when reducing or limiting flow that may have canopy impacts, should they be documented. On the last year of study (i.e., Year 10, 2023) a comprehensive final report will be compiled summarizing data collection methods, results, analysis as well as make findings and recommendations.

⁵ The Canopy Cover Assessment data collection form was updated in 2017, Year 4 Monitoring, to be consistent with study requisites and on-going monitoring efforts.