APPENDIX G

Calapooia River Watershed Analysis
Water Quality Assessment

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INTRODUCTION

This report documents the water quality assessment results for the Calapooia River Watershed Administrative Unit (WAU). This assessment was conducted in accordance with the Water Quality Module (approved June 20, 1997) of the Watershed Analysis Manual, Version 4.0 (Washington Forest Practices Board 1997). The purposes of this water quality assessment are to determine: 1) location and type of waterbodies in the WAU; 2) vulnerability of waterbodies to potential changes in input variables based on current and past water quality conditions, and; 3) sources of inputs to vulnerable waterbodies to establish hazard calls.

METHODS

This assessment follows the module protocols outlined in the Water Quality Assessment Module. Only minor deviations from the standard methodology were made including:

- A simplified equation presented during the Water Quality Module training session (June 20, 1997; instructor Dave Parks) was used to determine Potential Skyview. Where: $\alpha=\tan^{-1}(2h/w)$ and Skyview$=1-\alpha/90$

- The Reference Temperature relation to View-to-Sky Difference in Figure G4 is different than that calculated in Figure G1 (Appendix G, Water Quality Assessment). Numeric data provided in the Manual suggests that Figure Ga12 is more accurate. Vulnerabilities were determined from the reference temperature from Figure G4 and its related vulnerability from Figure Ga12.

- Figure G1, provided by Chris Earle (Beak Consultants), is a combination of the two module figures and was used to determine vulnerability.

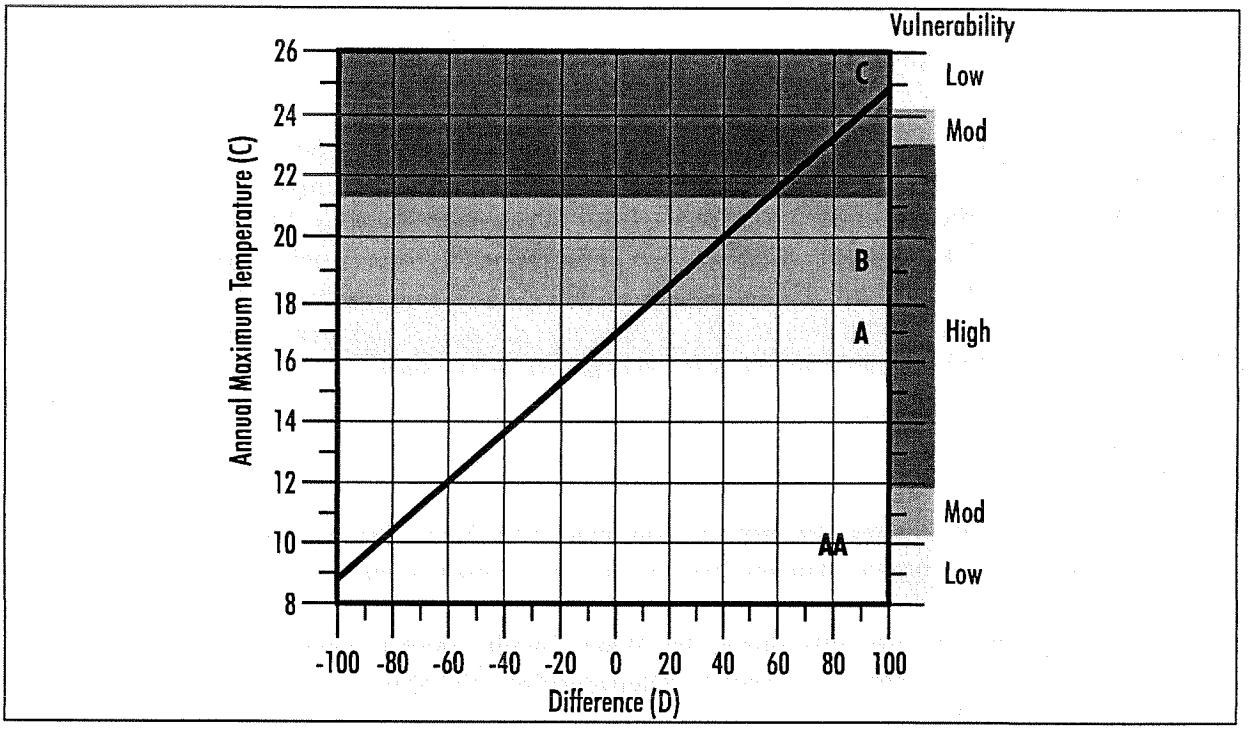


Figure G1 Graph of relation of difference in view-to-sky and maximum allowable view-to-sky and the vulnerability to temperature increase based on Module Manual Figures Ga12 and G4 (source: Chris Earle, Beak Consultants).

Data sources

Several data sources were used in preparing this report including aerial photographs, field data and water quality data collected outside the WAU. These sources are listed in Table G1.

Table G1 Sources of data used in water quality assessment.

Type	Description	Source
Photos	Aerial photos 1:12000 scale; July 1997	Weyerhaeuser
Photos	Orthophoto maps 1:24000	Weyerhaeuser
Map	7.5 minute topographic maps	United States Geological Survey
Map/GIS	National Wetlands Inventory, USFWS	Weyerhaeuser
Map/GIS	Soil types and soil series	Soil Conservation Service (now Natural Resources Conservation Service), Linn Co. Soil Survey
Map/GIS	Weyerhaeuser biotope classification	Weyerhaeuser
Map/GIS	Land ownership map	Weyerhaeuser
Water quality standard	303(d) List	Department of Environmental Quality (DEQ)
Data	Ambient monitoring at the Calapooia River near Albany, Oregon	DEQ

REGULATORY SETTING

The majority of the Calapooia River WAU is covered by second growth forests and is managed for timber production (Map 1 in Synthesis Section shows ownership patterns). Industrial forest lands are in the middle and lower portion of the WAU while the upper portion of the WAU is managed by the United States Forest Service (USFS). The Forest Service lands have interspersed old growth and 2nd growth forests. There is some agricultural usage in the lower portion of the WAU. Since the majority of land is used for timber production, Oregon Department of Forestry (ODF) rules governing the protection of water quality apply (ODF 1994). These rules address sediment, temperature and nutrients (nitrogen from fertilization). Federal rules addressing water quality apply to the Forest Service lands in the headwater reaches.

Water quality standards

The primary water quality ambient monitoring station along the Calapooia River (DEQ Station 402860) is located near the mouth of the Calapooia River (River Mile 3) near Albany. The period of record for this station is from May, 1972 to present. Some data were collected from a station on the lower Calapooia River near Highway 34 (DEQ Station 402681), though this station was only in operation from may, 1971 to August, 1975. Table G2 shows standards for selected water quality parameters monitored at the lower Calapooia River station.

Table G2 Standards for water quality parameters monitored near the mouth of the Calapooia River.

Parameter	Department of Environmental Quality Standard
Water Temperature (°F)	Mean 7 day maximum of 64 °F
Chlorophyll a	Waterbodies that do not thermally stratify: 0.015 mg/l
pH	Willamette River Basin 6.5 to 8.5
Dissolved oxygen (mg/l)	Cool-water streams at least 6.5 mg/l.
Fecal coliform colonies/ml)	Geometric mean greater than 200 per 100 milliliters in more than 10% of the samples and a minimum of at least 2 exceedances greater than 400 per ml during the season of interest

The water quality of the lower Calapooia River is considered poor by the DEQ (Cude 1998) based on data collected at the mouth of the Calapooia River, which is approximately 46 river miles (RM) below the WAU boundary. Most of the water quality issues in the lower part of the river are related to the extensive agricultural usage in the lower 35 miles of the basin (Cude 1998). The water quality is considered poor in the fall, winter and spring months due to high concentrations of nitrate and ammonia nitrogen, biochemical oxygen demand, total phosphates, fecal coliforms and total solids. In the summer, high stream temperatures combine with high concentrations of total phosphates, nitrate and ammonia nitrogen and total solids to lower water quality and cause eutrophication of the river (Cude 1998).

Calapooia River 303(d) list status

The Calapooia River is on the 303(d) list (DEQ 1996) for fecal coliform and temperature standard exceedences (Table G3). The listing extends from the mouth of the Calapooia River near Albany to Brush Creek, which is approximately 6 miles below the WAU boundary (see Synthesis Map 1).

Table G3 Calapooia River 303(d) list water quality parameters, season of impact and data source.

Parameter	Season	Data Source
Water Temperature (°F)	Summer	USGS Data (90); DEQ Data (Temperature Issue Paper 1994)
Fecal coliform colonies/ml	Annual	DEQ Data-Ambient monitoring (305(b), 1994)

WATERBODY INVENTORY

Wetlands and streams of the WAU are shown on **Map G1**. The inventory of wetlands is on Form G1, cross-referenced with Map G1 by identification number. The following section summarizes the landscape setting of wetlands in the Calapooia River WAU.

Soils

The soils of the Calapooia River WAU range from moderately well-drained deep clay loams associated with earthflows in the lower portion of the watershed to well-drained silt loams and gravelly loams in upslope areas (Table G4). More information on the soils of the WAU can be found in Appendix B. Surface Erosion Assessment.

Table G4 General soil characteristics of the Calapooia River WAU (based on Langridge 1987).

General Location	Dominant Soil Group	Common series and textural class
Floodplains, terraces (low areas in watershed)	Deep clay loams associated with earthflows	• Fluvents and Fluvaquents* • Saturn clay loam* • McAlpin silty clay loam • Peavine silty clay loam
Upland Benches	Shallow upland silt loams	• Keel gravelly silt loam • Hummington very gravelly loam
Headwater slopes	Shallow, rocky upland gravelly loams	• similar to upland benches but steeper slope class
Midslope areas	Midslope cobbly loams	• Kinney cobbly loam • Klickitat stony loam

* may have hydric inclusions

The amount of wetland (hydric) soil is limited in this watershed. There are only 67 acres of Fluvents-Fluvaquents complex of which approximately 35% (SCS estimate for series) or 23 acres are Fluvaquents, mapped which are hydric soils. The Saturn series has inclusions of the hydric Fluvents-Fluvaquents complex, though these are not extensive. Throughout the WAU, the majority of the wetlands are not necessarily associated with mapped hydric soils.

Waterbody types

The only waterbody types in the WAU are streams and wetlands, no lakes are present. The extent of wetlands identified in this assessment is small, comprising only 0.15% of the total WAU area. Five hydro-geomorphic types (WFPB 1997) were identified: riverine flow-through, depressional flow-through, depressional closed, slope connected and slope unconnected wetlands (Figure G2 and Map G1).

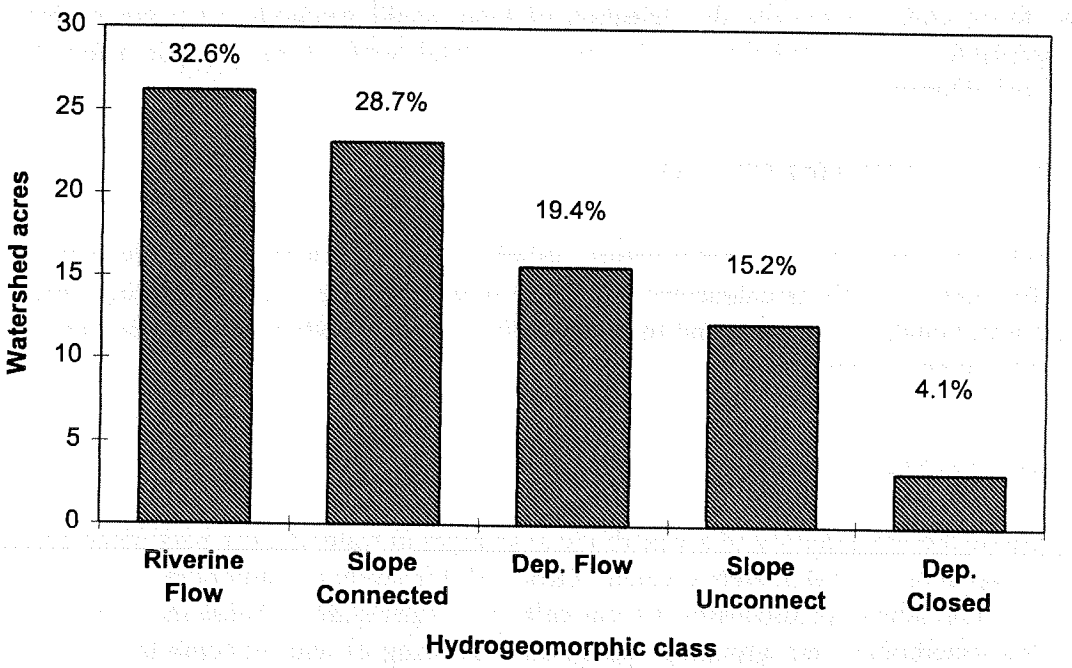


Figure G2 Total acreage of each of the five wetland types of the Calapooia River WAU with percentage of each indicated above column.

Though the riverine flow-through type has the most acreage, it is second most common in frequency. Depressional flow-through are most common in the WAU (19 mapped) while slope unconnected wetlands are the least common (5 mapped). Other findings from the wetland assessment include:

- Wetlands are found in areas ranging from low elevation stream-adjacent areas to higher elevation upland areas.
- Most wetlands are associated with flowing water. The reason that flow-through wetlands are common here is the generally steep topography and relatively confined stream channels.
- Many riverine flow-through wetlands were mapped along the mainstem of the Calapooia River. These wetlands occur on the National Wetlands Inventory (NWI) map, which is based on the Cowardin system (Cowardin et al. 1979). Photo interpretation and field visits indicate that these areas are fluvially influenced, but may lack the soil and vegetation characteristics to be classified as wetlands under the hydrogeomorphic scheme used in this assessment. However, these wetlands were still included as riverine flow-through wetlands until a more comprehensive inventory is conducted.

- The presence of some wetlands is strongly influenced by forest roads. For example, wetlands Township 15S Range 2E Section 19 have apparently formed in low gradient areas behind forest roads. The larger of these areas were then colonized by beaver (*Castor canadensis*) which constructed dams across culverts. These wetlands are typically small and most are classified as slope-type wetlands.
- Major portions of the watershed are underlain by large persistent deep-seated landslides (see Mass Wasting Module, Appendix A), which create small slope-type wetlands in slumps. Because forest canopy prevents the detection of these small wetlands, they are probably under-represented in this inventory. However, the total actual area of these features is probably not substantial.

WATERBODY VULNERABILITY CALLS

The vulnerability of a waterbody to temperature, sediment and other water quality constituents depends on the input as well as characteristics of the receiving water. The following section describes the water quality map units and the vulnerability of waterbodies in those map units to changes in water quality parameters.

Water Quality Map Units

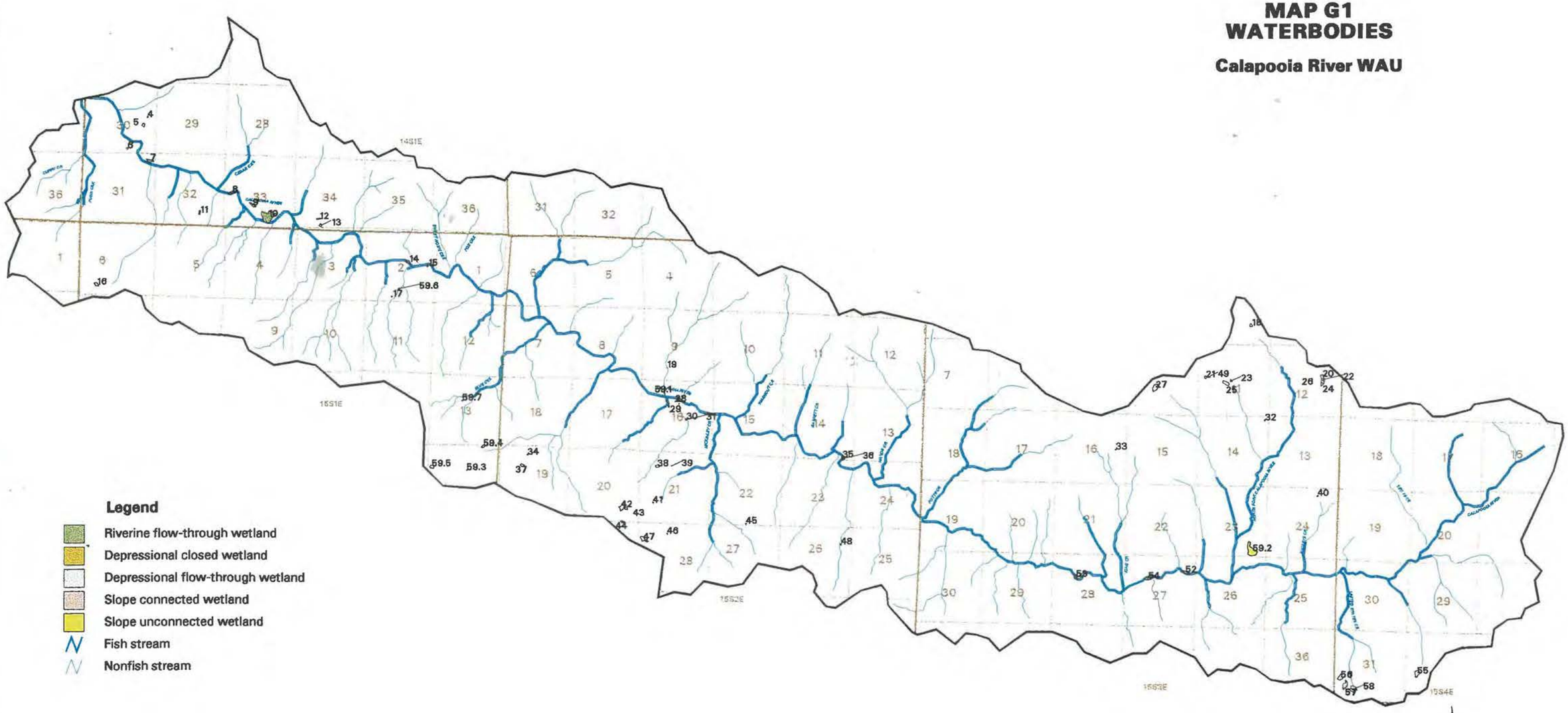
To help determine the vulnerability of a waterbody to changes in water quality parameter inputs, water quality map units (WQMU) were created. These WQMUs group waterbodies in areas that are subject to similar landscape processes that can influence water quality. These map units serve to organize the waterbodies into groupings based on processing of and vulnerability to inputs such as heat, sediment and other potential contaminants. The following six water quality map units (WQMUs) were defined based on the previously described waterbody inventory and the vulnerability to selected water quality constituents (discussed in upcoming section). Geomorphic Map Units (GMUs) were used as the basis for determining these groupings since similar processes that determine stream morphology also determine wetland type. Complete GMU descriptions are in Appendix E. Stream Channel Assessment (Table G5).

Table G5 Description of water quality map units (WQMU).

WQMU	Water Type	GMU	Description
1	Wetland	1	Calapooia River floodplain and adjacent terraces
2	Wetland	2	Upland benches (gentle slopes)
3	Wetland	3	Gentle to moderately sloping lowlands
4	Wetland	4 and 5	Upland slopes
5	Streams	1	Mainstem Calapooia River
6	Streams	3, 4 and 5	Tributary streams

MAP G1
WATERBODIES

Calapooia River WAU



Legend

- Riverine flow-through wetland
- Depressional closed wetland
- Depressional flow-through wetland
- Slope connected wetland
- Slope unconnected wetland
- Fish stream
- Nonfish stream

1.0MI 0MI 1MI 2MI 3MI 4MI

1 : 90000

1 inch = 7500 feet

Map G1 Waterbodies

Weyerhaeuser

DATE: 08/17/98

Vulnerability calls for all WQMUs are summarized and described in Form G2. Supporting information is in Form G1 (Wetland Temperature Vulnerability Worksheet) and Form G3 (Stream Temperature Vulnerability Worksheet). Reference temperatures are displayed on **Map G2**. Determinations of wetland vulnerability to input parameters were based on field observations, temperature and chemistry assessments and on discussion with other assessment team members. Vulnerabilities of individual assessments are discussed below.

Temperature

Aerial photographs taken during the summer of 1997 were used to quantify the amount of open water in each wetland, because field work was mainly done during a very wet spring (rainfall at a nearby climate station was 230% above normal for May, 1998). Only a small percent of open water (5.7% of the total wetland acreage) was observed in the 1997 aerial photographs. All wetlands that appear to lack open water during the standard TFW peak temperature monitoring interval of 15 July to 15 August (Schuett-Hames et al. 1994) were assigned a low vulnerability to temperature standard exceedance. The justification for this can be found in a previous water quality assessment (Weyerhaeuser Company 1997). That report found that shallow water tables are not significantly affected by solar radiation in hydric soils.

Temperature vulnerabilities of wetlands in the WAU are listed in Form G1. Most wetlands are directly connected to the stream network (47 out of 59), being either riverine flow-through, depressional flow-through or slope connected. These areas are typically small in size (average range from 0.8 to 2.1 total acreage) and have a high potential sky view if adjacent trees are removed. Due to the presence of open water in some of these wetlands, exposure to solar radiation can result in temperature criterion exceedances. In addition, there is a potential for water warmed from stream-connected wetlands to be delivered to downstream reaches, most of which have a high vulnerability to temperature criterion exceedances (Form G3 and **Map G3**).

Temperature vulnerabilities for fish-bearing streams vary throughout the watershed since there is a wide range of elevations (average from 618 to 3540 ft) and a corresponding wide range in maximum allowable view-to-sky (37 to 100%). Many (41%) streams in the WAU have a Low vulnerability to stream temperature standard exceedances, while 36% have a High vulnerability. The majority of the stream segments with High vulnerability are in WQMU 1.

Sediment

Wetlands can be vulnerable to sediment accretion from both chronic and catastrophic inputs of coarse and fine sediment depending on the magnitude and frequency of sediment deposition and characteristics of the receiving wetland. The following table lists hydro-geomorphic types of wetlands in the WAU and their vulnerability to sediment accretion (Table G6) The rationale behind these vulnerability calls can be found in the Manual. Within the Calapooia River WAU, sediment vulnerability is low for WQMU 1, 2 and 3, regardless of the hydro-geomorphic type due to the gentle topography and low risk of mass wasting for the map units.

Table G6 Vulnerability of wetlands to sediment accretion based on the Manual (WFPB 1997) and percent of total wetland numbers in vulnerability category.

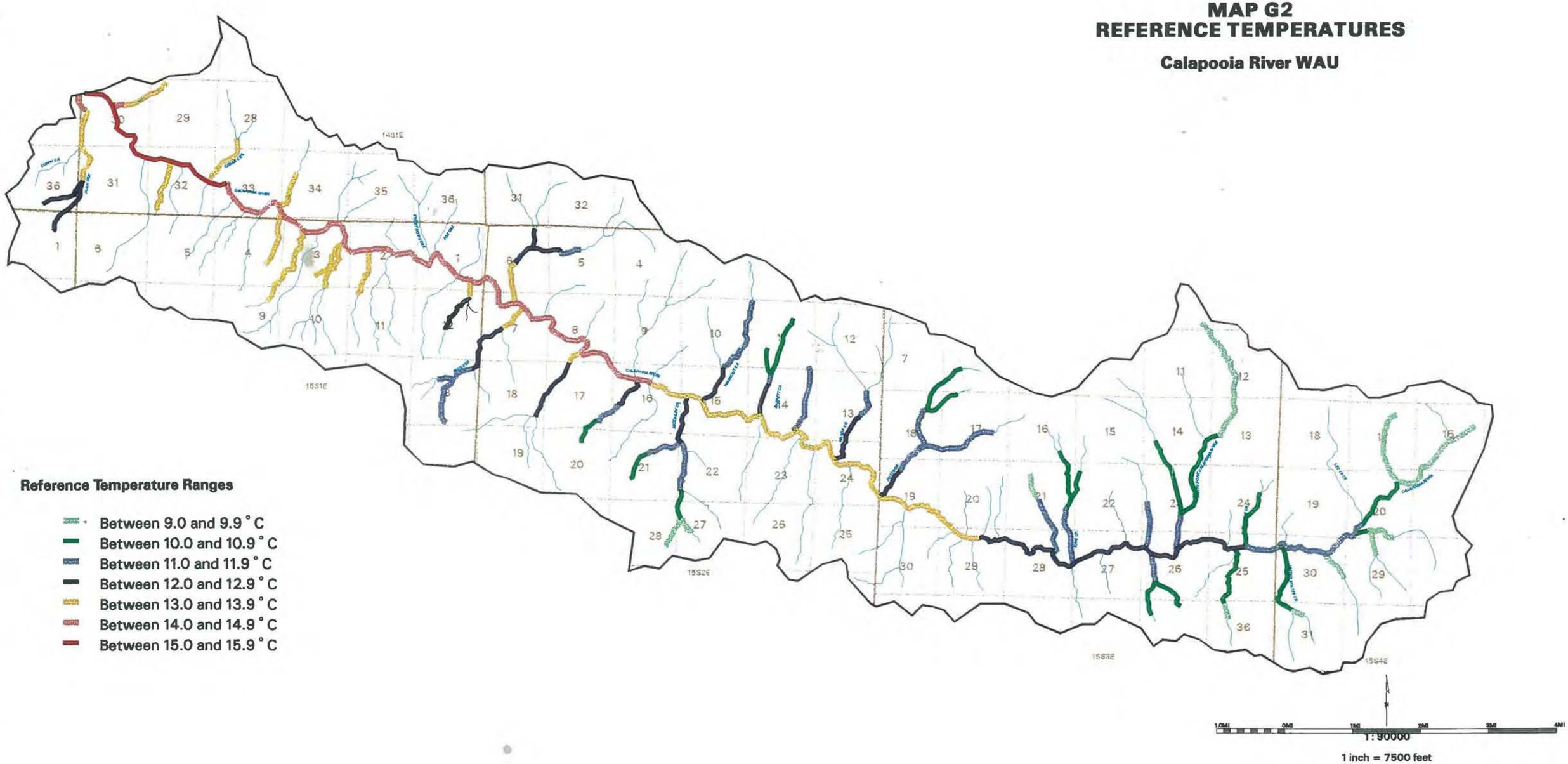
Hydrogeomorphic classification	Vulnerability to sediment accretion	Percent of total wetlands
Depressional flow-through, slope connected, slope unconnected	LOW	59
Riverine flow-through	MODERATE	29
Depressional closed	HIGH	12

Phosphorus and nitrogen

Vulnerabilities to nutrients are based on the likelihood of nutrient loading from forest practices resulting in nuisance aquatic growth (WFPB 1997). The nutrient loading is based on routing to eutrophic lakes, which would prevent recovery or worsen the condition. This vulnerability does not occur within the WAU, because there are no lakes in the WAU. In addition, there are no lakes immediately downstream from the WAU.

MAP G2
REFERENCE TEMPERATURES

Calapooia River WAU



Reference Temperature Ranges

- Between 9.0 and 9.9 ° C
- Between 10.0 and 10.9 ° C
- Between 11.0 and 11.9 ° C
- Between 12.0 and 12.9 ° C
- Between 13.0 and 13.9 ° C
- Between 14.0 and 14.9 ° C
- Between 15.0 and 15.9 ° C

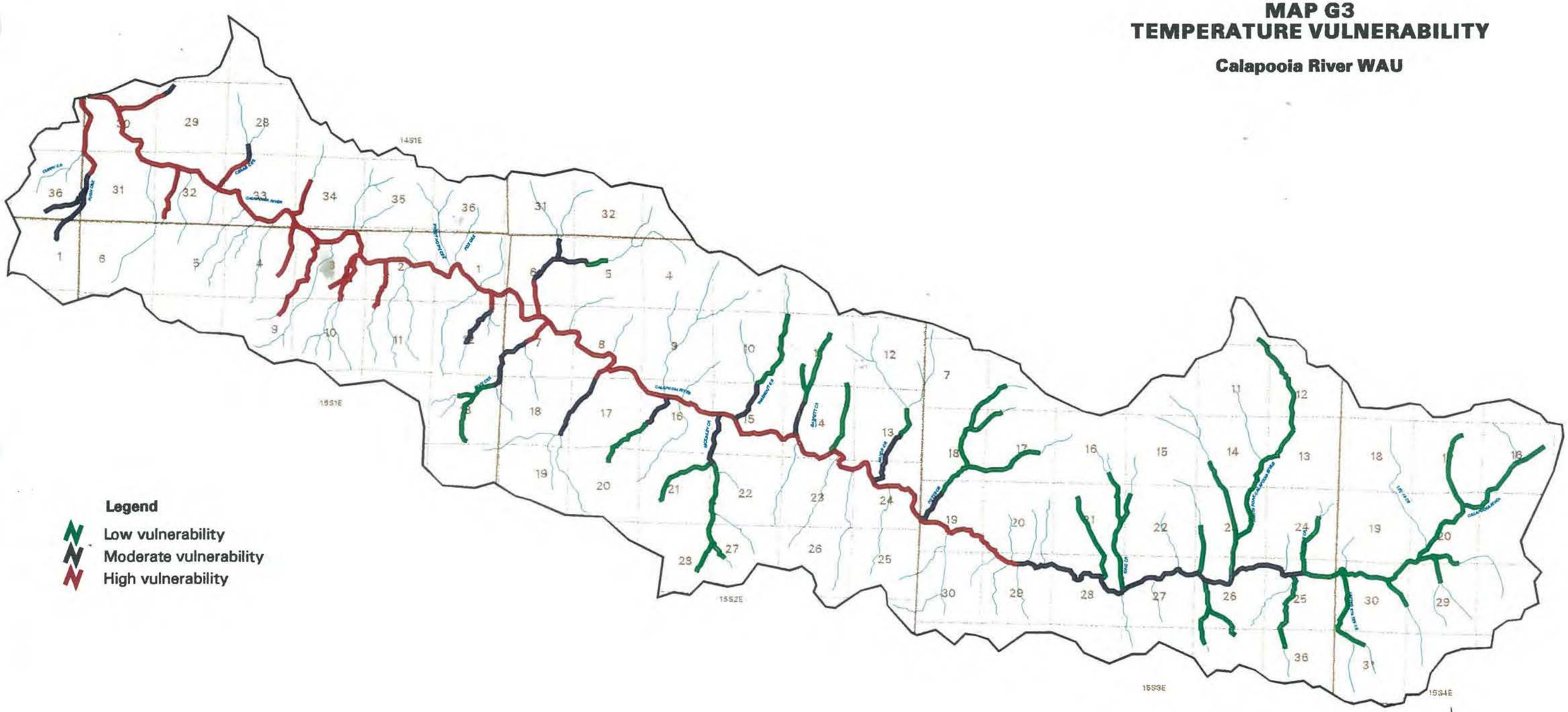
Map G2 Reference Temperatures

Weyerhaeuser

DATE: 08/17/98

MAP G3
TEMPERATURE VULNERABILITY

Calapooia River WAU



Legend

- Low vulnerability
- Moderate vulnerability
- High vulnerability

1.0MI 0MI 1MI 2MI 3MI 4MI

1 : 90000

1 inch = 7500 feet

Map G3 Temperature Vulnerability

Weyerhaeuser

DATE: 08/14/98

pH

The pH of a waterbody can have direct and indirect effects on fish and other aquatic organisms if it is less than 6.5 or greater than 9 (MacDonald et al. 1991). pH can change in response to environmental conditions such as temperature and flow. For example, pH is lower during high rainfall and runoff periods due to the reduction of base mineral concentrations. Thus, in the summer, the pH is higher from greater amounts of dissolved materials in the water (MacDonald et al. 1991). This weak inverse relationship of pH with discharge for the Calapooia River near Albany is shown in Figure G2.

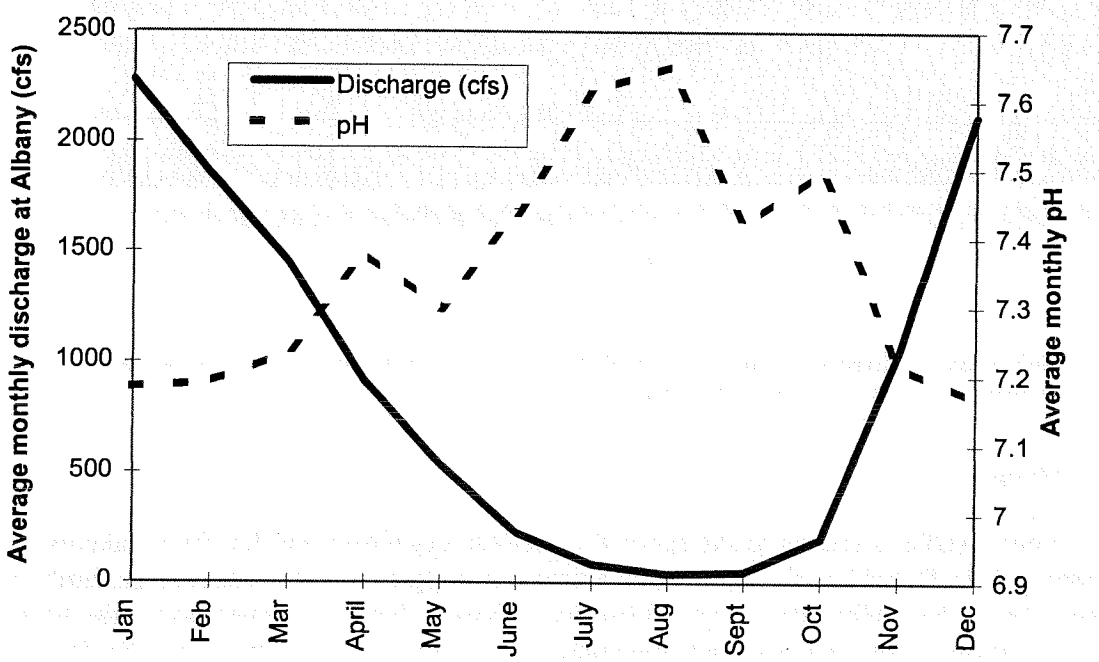


Figure G3 Average monthly pH and discharge (cfs) of the Calapooia River near Albany. Discharge data from the USGS gaging station at Albany (Station 14173500) and the DEQ ambient water quality monitoring station near Albany (DEQ station 402860).

The Calapooia River WAU has a low vulnerability to acidity/alkalinity (pH) exceedances. This low vulnerability call is supported by DEQ water quality data (1972 to 1998) from lower in the watershed where the range of pH is from 6.7 to 8.1, which is within the required range from 6.5 to 8.5 (Figure G3).

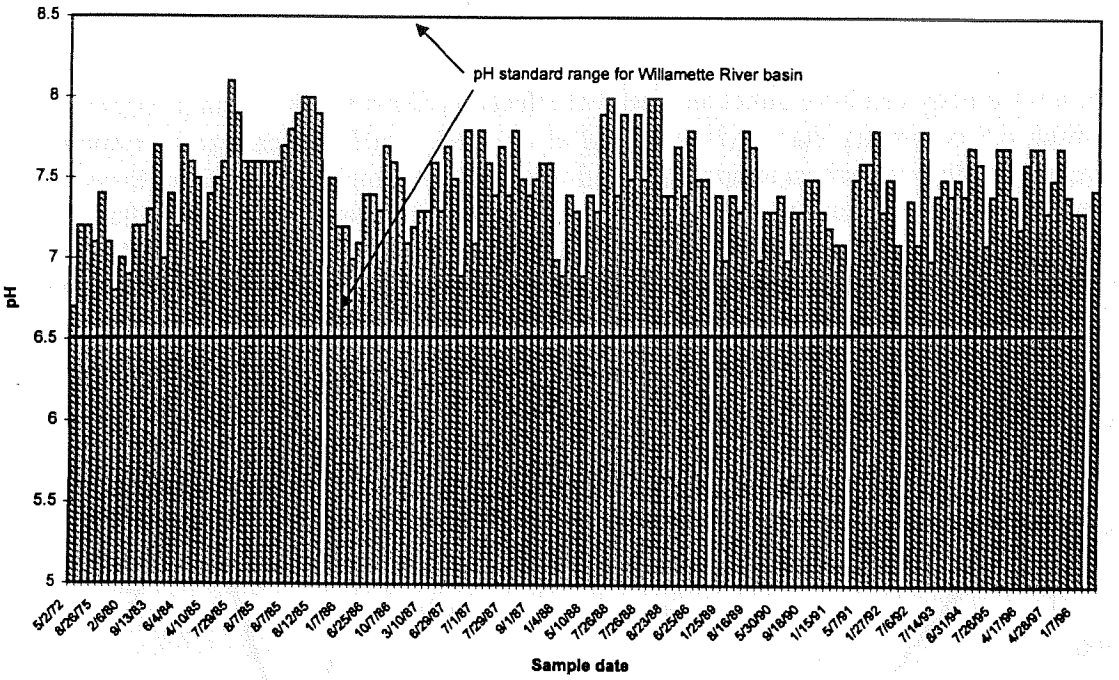


Figure G4 DEQ Calapooia River near Albany (station 402860) monitoring station pH levels for the period of record. The pH standard for the Willamette River basin is indicated.

Dissolved Oxygen

Dissolved oxygen (DO) is critical to the survival of aquatic organisms and for the breakdown of organic matter (MacDonald et al. 1991). The amount of oxygen in water depends primarily on temperature, but is also influenced by the biochemical oxygen demand of materials in the water. The inverse relationship between DO and temperature can be seen in the average monthly DO and water temperature for the Calapooia River near Albany (Figure G4).

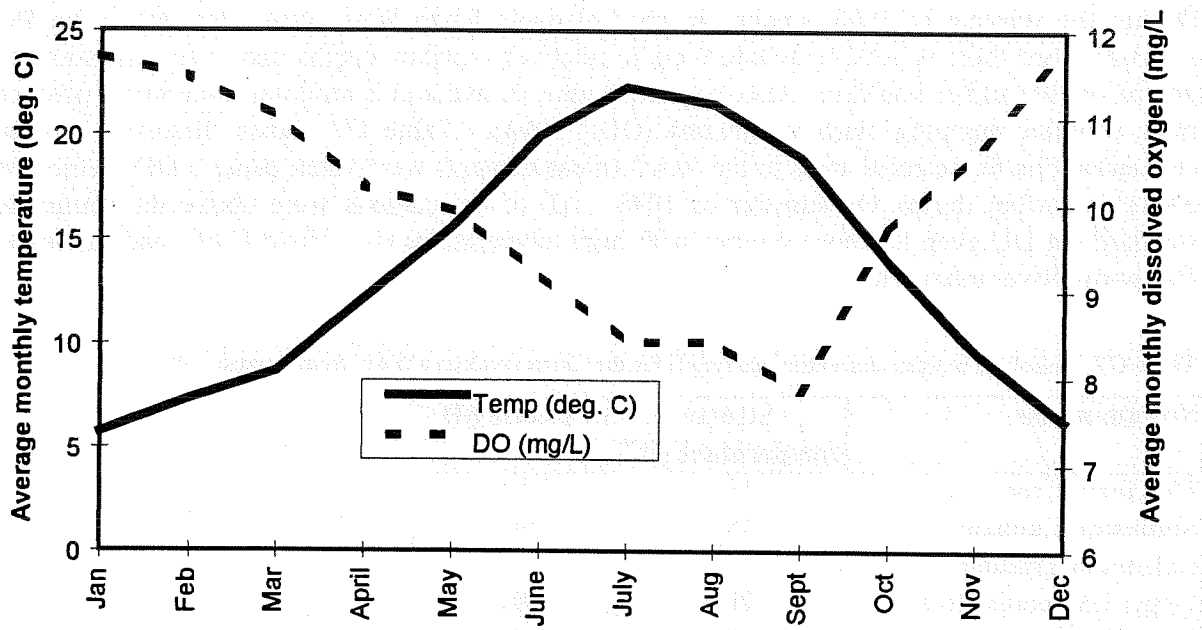


Figure G5 Average monthly temperature (°C) and average monthly DO (mg/l) for the Calapooia River near Albany. Data from DEQ ambient water quality monitoring station near Albany (DEQ station 402860).

The Calapooia River is classified as a cool-water resource with a dissolved oxygen (DO) standard of not less than 6.5 mg/l. Since there was only 1 sample date where DO was below this standard (Figure G5), the river was not listed as being water quality limited for DO (DEQ 1996).

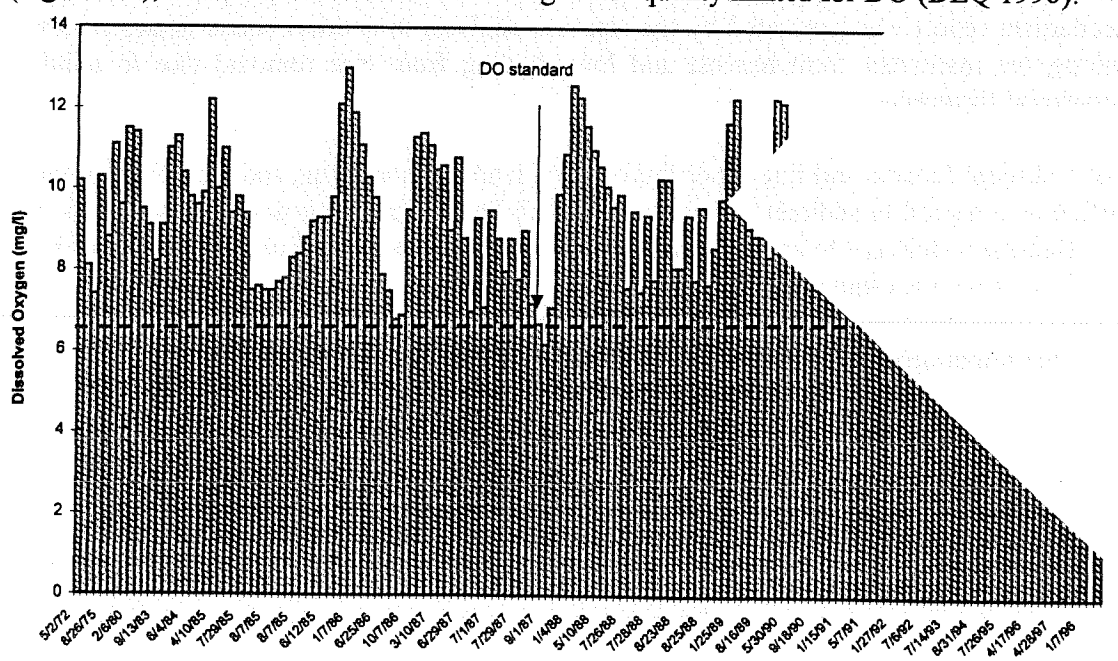


Figure G6 DEQ Calapooia River near Albany (station 402860) monitoring station DO (mg/l) for the period of record. The DO standard for the Calapooia River is indicated.

During the summer of 1998, streams in the Calapooia River WAU were also above the DO standard since there is good re-areation due to relatively shallow depths and coarse substrate of gravel, cobble and/or boulders. Also, organic loading of material is minimal since forest practice rules prohibit dumping slash in streams (ODF 1994). Table G7 shows dissolved oxygen concentrations for selected areas in the WAU (measurements were taken using a DO membrane electrode probe) during the summer of 1998. All of the stations were above the minimum standard for DO even for those stations with high temperatures (i.e., Hand Creek and the lower Calapooia River mainstem).

Table G7 Dissolved oxygen concentrations (mg/l) for the Calapooia River WAU from August, 1998.

Stream name	Stream temperature (°C)	DO (mg/l)
McKinley Creek	18.3	9.2
Southside Unnamed Calapooia Tributary	18.7	9.3
Upper Calapooia River	20.6	9.1
Potts Creek	17.5	9.5
Hand Creek	24.3	8.1
Middle Calapooia River	22.3	8.9
Lower Calapooia River	25.9	8.3

WATER QUALITY HAZARD ASSESSMENT

Water temperature hazard is addressed by the riparian function assessment (Appendix D). One causal mechanism report was generated by the riparian analysis to address shade issues of low shading along the mainstem from harvest and low shading from tree removal due to debris torrents in several tributaries.

Delivery of sediment (coarse and fine) contributed from landslides and fine sediment from roads was identified as a hazard to sediment accretion vulnerability in depressional closed wetlands in WQMU 4. Sediment delivery to stream-related water quality map units is addressed in the fish (Appendix F) and channel (Appendix E) assessments.

Hazards to other water quality constituents (N, P, DO, pH) were not identified in the WAU.

CONFIDENCE

Data sources-high
Confidence in data sources is high due to the presence of a DEQ water quality station lower in the Calapooia River basin and the collection of dissolved oxygen data within the WAU.

Waterbody inventory—moderate
Based on the overlap of the wetlands identified from photo interpretation and fieldwork with other maps developed in the area (NWI map and Weyerhaeuser biotope map), confidence is moderate that most of the wetlands have been inventoried. Some wetlands that cannot be observed through the canopy or have difficult access may have been missed. Area of most wetlands was calculated by GIS from the mapped polygons.

Temperature assessment—moderate
Thirty-six percent of the entire stream network was found to be highly vulnerable to increases in water temperature, although reference temperatures estimated in the water quality assessment were well below the state standard. Because fieldwork was conducted in the spring, it is difficult to predict if some of these wetlands will be dry in the summer, though aerial photographs were useful as a preliminary call. Therefore, the vulnerability of each wetland (Form G1) should be considered as a preliminary call until further detailed data are collected.

Water chemistry—high
The confidence is high that water chemistry vulnerabilities were adequately determined due to over 20 years of data from a station lower down in the Calapooia River watershed as well as water quality monitoring within the WAU.

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FORMS

Form G1 List of wetlands identified in the Calapooia River WAU and vulnerability to temperature increases. Identification number (ID) indicates wetland shown on Map G1. Abbreviations for each column are at end of table.

WQMU	ID	BASIN	TWP-RNG	SEC	NWI code* or biotope	HGM code**	Total acres	Open Water area (acres)	Temperature vulnerability
1	7	Lower Calapooia	14S1E	31	PEMC	RF	1.6	0	Low
1	8	Lower Calapooia	14S1E	33	PSSC	RF	1.3	0	Low
1	9	Lower Calapooia	14S1E	33	PEMC	RF	1.5	0	Low
1	10	Lower Calapooia	14S1E	33	PFOC	RF	13.7	0	Low
1	14	Lower Calapooia	15S1E	2	PSSC	RF	0.9	0	Low
1	15	Lower Calapooia	15S1E	2	PSSA	RF	0.4	0	Low
1	35	Washout Creek	15S2E	14	PFOA	RF	0.3	0	Low
1	52	King Creek	15S3E	27	PSSA	RF	1.6	0	Low
1	53	King Creek	15S3E	28	PSSA	RF	0.8	0	Low
1	54	King Creek	15S3E	27	PSSA	RF	2.3	0	Low
2	44	Washout Creek	15S2E	20	PSSB	DC	1.0	0	Low
2	47	Washout Creek	15S2E	28	PSSB	DF	2.5	0	Low
2	59.3	Bigs Creek	15S1E	24	Biotope	DF	0.1	0	Low
2	59.4	Bigs Creek	15S1E	13	Biotope	DF	0.6	0.2	High
2	59.5	Bigs Creek	15S1E	24	Biotope	DF	1.6	0.0	Low
2	34	Bigs Creek	15S2E	19	PUBF	SC	0.2	0.2	High
2	37	Bigs Creek	15S2E	19	PSSB	SC	1.1	0.5	High
2	42	Washout Creek	15S2E	20	PSSB	SC	3.2	0.5	High
2	43	Washout Creek	15S2E	20	PSSB	SC	0.8	0	Low
2	16	Lower Calapooia	15S1E	6	PSSC	SU	1.5	0	Low
2	46	Washout Creek	15S2E	28	PUBFh	SU	0.2	0	Low
3	4	Lower Calapooia	14S1E	30	PUBFh	DC	0.2	0.2	High
3	5	Lower Calapooia	14S1E	30	PUBFx	DC	1.1	1.1	High
3	6	Lower Calapooia	14S1E	30	PEMF	DF	0.5	0.5	High
3	11	Lower Calapooia	14S1E	32	PSSB	DF	0.6	0	Low
3	12	Lower Calapooia	14S1E	34	PEMC	DF	0.6	0.6	High
3	13	Lower Calapooia	14S1E	34	PSSC	DF	0.7	0.7	High
4	17	Lower Calapooia	15S1E	2	PUBF	DC	0.1	0	Low
4	23	North Fork Calapooia	15S3E	11	PEMC	DC	0.5	0	Low
4	32	North Fork Calapooia	15S3E	14	PUBF	DC	0.3	0	Low
4	33	King Creek	15S3E	16	PUBF	DC	0.1	0	Low
4	45	Washout Creek	15S2E	22	PSSB	DF	0.2	0	Low
4	20	North Fork Calapooia	15S3E	12	PFOC	DF	1.5	0	Low
4	22	North Fork Calapooia	15S3E	12	PUBF	DF	0.7	0	Low

WQMU	ID	BASIN	TWP-RNG	SEC	NWI code* or biotope	HGM code**	Total acres	Open Water area (acres)	Temperature vulnerability
4	24	North Fork Calapooia	15S3E	12	PFOC	DF	1.0	0	Low
4	25	North Fork Calapooia	15S3E	11	PSSB	DF	2.4	0	Low
4	26	North Fork Calapooia	15S3E	12	PUBF	DF	0.8	0	Low
4	29	Washout Creek	15S2E	16	PEMC	DF	0.1	0	Low
4	38	Washout Creek	15S2E	21	PEMB	DF	0.9	0	Low
4	40	North Fork Calapooia	15S3E	24	PUBFh	DF	0.3	0	Low
4	59.1	Washout Creek	15S2E	16	Biotope	DF	0.3	0	Low
4	59.7	Bigs Creek	15S1E	13	Biotope	DF	0.2	0	Low
4	19	Washout Creek	15S2E	9	PUBFx	RF	0.1	0	Low
4	30	Washout Creek	15S2E	16	PUBF	RF	0.1	0	Low
4	31	Washout Creek	15S2E	16	PEMC	RF	0.2	0	Low
4	36	Washout Creek	15S2E	14	PSSC	RF	0.2	0	Low
4	41	Washout Creek	15S2E	21	PUBFh	RF	0.3	0	Low
4	48	Washout Creek	15S2E	26	PUBF	RF	0.4	0	Low
4	59.6	Lower Calapooia	15S1E	2	Biotope	RF	0.5	0	Low
4	28	Washout Creek	15S2E	16	PEMC	SC	0.1	0.1	High
4	18	North Fork Calapooia	15S3E	2	PUBFh	SC	0.9	0	Low
4	27	North Fork Calapooia	15S3E	10	PSSB	SC	4.0	0	Low
4	55	Upper Calapooia	15S4E	32	PSSB	SC	3.2	0	Low
4	56	Upper Calapooia	15S4E	31	PSSB	SC	2.4	0	Low
4	57	Upper Calapooia	15S4E	31	PSSB	SC	3.2	0	Low
4	58	Upper Calapooia	15S4E	31	PSSB	SC	4.0	0	Low
4	21	North Fork Calapooia	15S3E	11	PSSB	SU	0.9	0	Low
4	39	Washout Creek	15S2E	21	PUBF	SU	0.0	0	Low
4	59.2	North Fork Calapooia	15S3E	23	Biotope	SU	9.6	0	Low

*NWI Code First letter: P= Palustrine 2nd two letters: SS=scrub shrub, FO=Forested, UB=Unconsolidated bottom, EM=Emergent. 4th letter: B= Saturated, C=Seasonally flooded, F=Semi-permanently flooded. Special qualifiers: h=diked/impounded, x=excavated

**HGM: rf=riverine flow-through, dc=depressional closed, df=depressional flow-through, sc=slope connected

Form G2 Waterbody identification and vulnerability calls.

WQMU number and description	Water type	GMU	Variable	Vulnerability	Rationale
1	Riverine flow-through wetlands	1	Temperature	Low	No open water apparent in summer
			N/P (for all waterbodies)	Low	No downstream lakes vulnerable to delivery.
			DO (for all waterbodies)	Low	Though low gradient downstream water quality data show within standard of >6.5 mg/L.
			Sediment	Low	Low for riverine wetlands since sediment is generally transported through
2	Wetlands	2	Temperature	High	Wetland numbers 34, 37, and 42 and 59.4 due to small areas of open water. The rest are low.
			Sediment	Low	Flat upland benches, low sediment transport few roads contributing
3	Wetlands	3	Temperature	High	Most have open water (<3 acres), wetland number 11 only one with no apparent open water and low vulnerabilty
			Sediment	Low	Lower gradient hillslopes
4	Wetlands	4 and 5	Temperature	Low	All low because there is no open water, except wetland 28 which is high.
			Sediment	Low to High	Only ones with high vulnerability are depressional closed wetlands #17, 23, 32 and 33
5	Mainstem Calapooia River	1	Temperature	Low to High	Variable (see Map G4)
			Sediment	Low to Moderate	Varies by confinement within GMU, see Appendix E. Stream channel Assessment
6	Tributary streams	3, 4 and 5	Temperature	Low to High	Varies by segment
			Sediment	Low to High	Varies by GMU, see Appendix E. Stream Channel Assessment

Form G3 Stream temperature vulnerability worksheet.

Segment number	GMU	Bankfull Width (m)	Stand height (m)	Potential skyview (%)	Elevation (m)	Max. allowable skyview (%)	Shade difference (d=p-m)*	Referncee temp (°C)	Vulner-ability
1	3	4	39.6	3.21	205	39	-35.50	14.0	High
2	3	4	39.6	3.21	223	41	-37.40	13.8	High
3	3	4	39.6	3.21	275	46	-42.85	13.4	High
4	5	6.4	33.5	6.06	352	54	-48.06	13.0	Moderate
5	3	4	39.6	3.21	220	40	-37.16	13.8	High
6.1	3	4	39.6	3.21	261	45	-41.35	13.5	High
6.2	3	4	39.6	3.21	315	50	-47.06	13.0	Moderate
10	3	4	39.6	3.21	269	45	-42.28	13.4	High
30	5	6.4	33.5	6.06	310	50	-43.72	13.3	High
31	5	6.4	33.5	6.06	345	53	-47.31	13.0	Moderate
32	5	6.4	33.5	6.06	358	55	-48.70	12.9	Moderate
33	5	6.4	33.5	6.06	382	57	-51.17	12.7	Moderate
34	5	6.4	33.5	6.06	430	62	-56.22	12.3	Moderate
38	5	6.4	33.5	6.06	446	64	-57.87	12.2	Moderate
39	5	6.4	33.5	6.06	536	73	-67.31	11.4	Low
57	5	6.4	33.5	6.06	415	61	-54.66	12.4	Moderate
59	5	6.4	33.5	6.06	508	70	-64.36	11.7	Low
60	5	6.4	33.5	6.06	557	76	-69.56	11.2	Low
62	5	6.4	33.5	6.06	449	64	-58.22	12.1	Moderate
63	5	6.4	33.5	6.06	534	73	-67.15	11.4	Low
63.1	5	6.4	33.5	6.06	646	85	-78.86	10.5	Low
64	5	6.4	33.5	6.06	492	69	-62.75	11.8	Low
65	5	6.4	33.5	6.06	407	60	-53.88	12.5	Moderate
65	5	6.4	33.5	6.06	445	64	-57.82	12.2	Moderate
66	5	6.4	33.5	6.06	513	71	-64.87	11.6	Low
77	4	6.5	39.6	5.21	432	62	-57.27	12.2	Moderate
78	4	6.5	39.6	5.21	447	64	-58.91	12.1	Moderate
79	4	6.5	39.6	5.21	471	67	-61.33	11.9	Low
80	5	6.4	33.5	6.06	516	71	-65.19	11.6	Low
81	5	6.4	33.5	6.06	542	74	-68.00	11.4	Low
82	5	6.4	33.5	6.06	618	82	-75.86	10.7	Low
84	5	6.4	33.5	6.06	616	82	-75.70	10.7	Low
85	5	6.4	33.5	6.06	688	89	-83.24	10.1	Low
88	5	6.4	33.5	6.06	500	70	-63.61	11.7	Low
89	5	6.4	33.5	6.06	529	73	-66.62	11.5	Low
90	5	6.4	33.5	6.06	588	79	-72.73	11.0	Low
96	5	6.4	33.5	6.06	586	79	-72.60	11.0	Low
97	5	6.4	33.5	6.06	729	94	-87.53	9.8	Low
98	5	6.4	33.5	6.06	521	72	-65.78	11.5	Low
99	5	6.4	33.5	6.06	577	78	-71.65	11.1	Low
100	5	6.4	33.5	6.06	614	82	-75.54	10.8	Low
101	5	6.4	33.5	6.06	642	84	-78.39	10.5	Low
104	5	6.4	33.5	6.06	631	83	-77.26	10.6	Low
108.1	5	6.4	33.5	6.06	571	77	-71.04	11.1	Low
110	4	6.5	39.6	5.21	536	73	-68.21	11.3	Low
110	4	6.5	39.6	5.21	547	75	-69.29	11.3	Low

Segment number	GMU	Bankfull Width (m)	Stand height (m)	Potential skyview (%)	Elevation (m)	Max. allowable skyview (%)	Shade difference (d=p-m)*	Referncee temp (°C)	Vulner-ability
111	4	6.5	39.6	5.21	563	76	-71.00	11.1	Low
112	5	6.4	33.5	6.06	606	81	-74.61	10.8	Low
113	5	6.4	33.5	6.06	661	86	-80.42	10.4	Low
114	5	6.4	33.5	6.06	688	89	-83.20	10.1	Low
119	4	6.5	39.6	5.21	584	78	-73.22	10.9	Low
120	4	6.5	39.6	5.21	601	80	-75.00	10.8	Low
121	4	6.5	39.6	5.21	617	82	-76.69	10.7	Low
122	5	6.4	33.5	6.06	633	84	-77.52	10.6	Low
123	5	6.4	33.5	6.06	643	85	-78.54	10.5	Low
124	5	6.4	33.5	6.06	663	87	-80.61	10.4	Low
125	5	6.4	33.5	6.06	684	89	-82.84	10.2	Low
129	5	6.4	33.5	6.06	705	91	-84.97	10.0	Low
130	5	6.4	33.5	6.06	738	95	-88.49	9.7	Low
131	5	6.4	33.5	6.06	770	98	-91.76	9.5	Low
132	5	6.4	33.5	6.06	890	100	-93.94	9.3	Low
134	5	6.4	33.5	6.06	602	80	-74.20	10.9	Low
135	5	6.4	33.5	6.06	649	85	-79.16	10.5	Low
143.1	5	6.4	33.5	6.06	789	100	-93.85	9.3	Low
143.1	5	6.4	33.5	6.06	828	100	-93.94	9.3	Low
143.2	5	6.4	33.5	6.06	973	100	-93.94	9.3	Low
145	3	4	39.6	3.21	191	37	-34.05	14.1	High
146	3	4	39.6	3.21	219	40	-37.03	13.8	High
150	3	4	39.6	3.21	280	47	-43.43	13.3	High
151	3	4	39.6	3.21	323	51	-47.93	13.0	Moderate
152	3	4	39.6	3.21	359	55	-51.67	12.7	Moderate
153	3	4	39.6	3.21	364	55	-52.23	12.6	Low
162	3	4	39.6	3.21	251	44	-40.38	13.6	High
182	3	4	39.6	3.21	245	43	-39.70	13.6	Moderate
183	3	4	39.6	3.21	269	45	-42.28	13.4	Moderate
192.1	3	4	39.6	3.21	250	43	-40.25	13.6	Moderate
192.1	3	4	39.6	3.21	280	47	-43.35	13.3	Moderate
192.2	3	4	39.6	3.21	286	47	-44.00	13.3	Moderate
201	3	4	39.6	3.21	260	45	-41.32	13.5	High
202	3	4	39.6	3.21	293	48	-44.72	13.2	Moderate
219	5	6.4	33.5	6.06	310	50	-43.64	13.3	High
220	5	6.4	33.5	6.06	407	60	-53.86	12.5	Moderate
225	5	6.4	33.5	6.06	308	50	-43.51	13.3	High
226	5	6.4	33.5	6.06	338	53	-46.65	13.1	High
227	5	6.4	33.5	6.06	366	56	-49.49	12.8	Moderate
228	5	6.4	33.5	6.06	421	61	-55.30	12.4	Moderate
229	5	6.4	33.5	6.06	483	68	-61.81	11.9	Low
230	5	6.4	33.5	6.06	518	72	-65.49	11.6	Low
231	5	6.4	33.5	6.06	547	75	-68.46	11.3	Low
236	5	6.4	33.5	6.06	551	75	-68.90	11.3	Low
242	5	6.4	33.5	6.06	327	52	-45.51	13.2	High
243	5	6.4	33.5	6.06	370	56	-49.99	12.8	Moderate
243	5	6.4	33.5	6.06	392	58	-52.22	12.6	Moderate
244	5	6.4	33.5	6.06	434	63	-56.64	12.3	Moderate

Segment number	GMU	Bankfull Width (m)	Stand height (m)	Potential skyview (%)	Elevation (m)	Max. allowable skyview (%)	Shade difference (d=p-m)*	Referncee temp (°C)	Vulner-ability
253	5	6.4	33.5	6.06	395	59	-52.57	12.6	Moderate
254	5	6.4	33.5	6.06	498	69	-63.34	11.7	Low
255	5	6.4	33.5	6.06	567	77	-70.56	11.2	Low
256	5	6.4	33.5	6.06	610	81	-75.03	10.8	Low
259	5	6.4	33.5	6.06	389	58	-51.93	12.6	Moderate
259	5	6.4	33.5	6.06	445	64	-57.79	12.2	Moderate
260	5	6.4	33.5	6.06	502	70	-63.78	11.7	Low
261	5	6.4	33.5	6.06	590	79	-72.94	11.0	Low
262	5	6.4	33.5	6.06	640	84	-78.22	10.5	Low
263	5	6.4	33.5	6.06	473	67	-60.69	11.9	Low
264	5	6.4	33.5	6.06	538	74	-67.52	11.4	Low
265	5	6.4	33.5	6.06	648	85	-79.05	10.5	Low
266	5	6.4	33.5	6.06	727	93	-87.26	9.8	Low
267	5	6.4	33.5	6.06	725	93	-87.10	9.8	Low
301	5	6.4	33.5	6.06	555	75	-69.27	11.3	Low
302	5	6.4	33.5	6.06	598	80	-73.83	10.9	Low
304	5	6.4	33.5	6.06	598	80	-73.87	10.9	Low
308	5	6.4	33.5	6.06	600	80	-74.02	10.9	Low
309	5	6.4	33.5	6.06	637	84	-77.92	10.6	Low
310	5	6.4	33.5	6.06	680	88	-82.41	10.2	Low
311	5	6.4	33.5	6.06	720	93	-86.58	9.9	Low
314	5	6.4	33.5	6.06	600	80	-74.04	10.9	Low
314	5	6.4	33.5	6.06	712	92	-85.70	9.9	Low
317	5	6.4	33.5	6.06	716	92	-86.13	9.9	Low
319	5	6.4	33.5	6.06	686	89	-82.99	10.2	Low
320	5	6.4	33.5	6.06	716	92	-86.18	9.9	Low
323.1	5	6.4	33.5	6.06	711	92	-85.64	9.9	Low
324	1	21	39.6	16.50	188	37	-20.52	15.2	High
324	1	21	39.6	16.50	198	38	-21.54	15.1	High
324	1	21	39.6	16.50	209	39	-22.64	15.0	High
324	1	21	39.6	16.50	210	39	-22.80	15.0	High
324	1	21	39.6	16.50	212	39	-22.98	15.0	High
324	1	21	39.6	16.50	212	39	-22.99	15.0	High
324	1	21	39.6	16.50	214	40	-23.19	14.9	High
324	1	21	39.6	16.50	214	40	-23.25	14.9	High
324	1	21	39.6	16.50	224	41	-24.21	14.9	High
324	1	21	39.6	16.50	226	41	-24.45	14.8	High
324	1	21	39.6	16.50	227	41	-24.59	14.8	High
324	1	21	39.6	16.50	230	41	-24.92	14.8	High
324	1	21	39.6	16.50	236	42	-25.47	14.8	High
324	1	21	39.6	16.50	238	42	-25.75	14.7	High
324	1	21	39.6	16.50	239	42	-25.77	14.7	High
324	1	21	39.6	16.50	240	42	-25.90	14.7	High
324	1	21	39.6	16.50	243	43	-26.22	14.7	High
324	1	21	39.6	16.50	249	43	-26.84	14.7	High
324	1	21	39.6	16.50	256	44	-27.62	14.6	High
324	1	21	39.6	16.50	257	44	-27.68	14.6	High
324	1	21	39.6	16.50	262	45	-28.26	14.5	High

Segment number	GMU	Bankfull Width (m)	Stand height (m)	Potential skyview (%)	Elevation (m)	Max. allowable skyview (%)	Shade difference (d=p-m)*	Referncee temp (°C)	Vulner-ability
324	1	21	39.6	16.50	267	45	-28.70	14.5	High
324	1	21	39.6	16.50	267	45	-28.77	14.5	High
324	1	21	39.6	16.50	270	46	-29.01	14.5	High
324	1	21	39.6	16.50	286	47	-30.71	14.3	High
324.1	1	21	39.6	16.50	209	39	-22.72	15.0	High
324.2	1	21	39.6	16.50	218	40	-23.63	14.9	High
324.2	1	21	39.6	16.50	220	40	-23.86	14.9	High
324.3	1	21	39.6	16.50	241	42	-25.99	14.7	High
324.4	1	21	39.6	16.50	244	43	-26.38	14.7	High
324.5	1	21	39.6	16.50	252	44	-27.16	14.6	High
324.5	1	21	39.6	16.50	255	44	-27.46	14.6	High
324.6	1	21	39.6	16.50	280	47	-30.12	14.4	High
325	1	21	39.6	16.50	285	47	-30.62	14.4	High
325	1	21	39.6	16.50	293	48	-31.43	14.3	High
325	1	21	39.6	16.50	303	49	-32.47	14.2	High
325	1	21	39.6	16.50	322	51	-34.48	14.0	High
325	1	21	39.6	16.50	329	52	-35.23	14.0	High
325	1	21	39.6	16.50	329	52	-35.28	14.0	High
325	1	21	39.6	16.50	340	53	-36.38	13.9	High
325	1	21	39.6	16.50	350	54	-37.46	13.8	High
325	1	21	39.6	16.50	365	55	-38.96	13.7	High
325	1	21	39.6	16.50	384	57	-40.99	13.5	High
325	1	21	39.6	16.50	390	58	-41.61	13.5	High
325	1	21	39.6	16.50	400	59	-42.69	13.4	High
325	1	21	39.6	16.50	411	60	-43.81	13.3	High
325.1	1	21	39.6	16.50	288	47	-30.95	14.3	High
325.2	1	21	39.6	16.50	312	50	-33.41	14.1	High
325.2	1	21	39.6	16.50	312	50	-33.41	14.1	High
325.2	1	21	39.6	16.50	313	50	-33.54	14.1	High
325.3	1	21	39.6	16.50	396	59	-42.26	13.4	High
326	1	21	39.6	16.50	406	60	-43.28	13.3	High
326	1	21	39.6	16.50	407	60	-43.41	13.3	High
326	1	21	39.6	16.50	408	60	-43.46	13.3	High
326	1	21	39.6	16.50	409	60	-43.65	13.3	High
326	1	21	39.6	16.50	416	61	-44.29	13.3	High
326	1	21	39.6	16.50	421	61	-44.83	13.2	High
326	1	21	39.6	16.50	421	61	-44.91	13.2	High
326	1	21	39.6	16.50	422	61	-44.93	13.2	High
326	1	21	39.6	16.50	425	62	-45.32	13.2	High
326.1	1	21	39.6	16.50	411	60	-43.78	13.3	High
326.2	1	21	39.6	16.50	417	61	-44.46	13.2	High
327	1	21	39.6	16.50	439	63	-46.70	13.1	High
327	1	21	39.6	16.50	445	64	-47.33	13.0	High
327	1	21	39.6	16.50	448	64	-47.67	13.0	Low
327	1	21	39.6	16.50	449	64	-47.80	13.0	Low
327	1	21	39.6	16.50	455	65	-48.39	12.9	Low
327	1	21	39.6	16.50	478	67	-50.78	12.7	Moderate
327	1	21	39.6	16.50	548	75	-58.10	12.2	Moderate

Segment number	GMU	Bankfull Width (m)	Stand height (m)	Potential skyview (%)	Elevation (m)	Max. allowable skyview (%)	Shade difference (d=p-m)*	Referncee temp (°C)	Vulner-ability
327	1	21	39.6	16.50	554	75	-58.79	12.1	Moderate
327	1	21	39.6	16.50	561	76	-59.55	12.0	Moderate
327	1	21	39.6	16.50	565	76	-59.90	12.0	Moderate
327	1	21	39.6	16.50	568	77	-60.25	12.0	Moderate
327	1	21	39.6	16.50	578	78	-61.27	11.9	Moderate
327	1	21	39.6	16.50	588	79	-62.28	11.8	Low
327.1	1	21	39.6	16.50	434	63	-46.17	13.1	Moderate
327.2	1	21	39.6	16.50	493	69	-52.44	12.6	Moderate
327.2	1	21	39.6	16.50	496	69	-52.66	12.6	Moderate
327.2	1	21	39.6	16.50	503	70	-53.46	12.5	Moderate
327.2	1	21	39.6	16.50	515	71	-54.70	12.4	Moderate
327.2	1	21	39.6	16.50	522	72	-55.44	12.4	Moderate
327.2	1	21	39.6	16.50	527	72	-55.93	12.3	Moderate
327.2	1	21	39.6	16.50	533	73	-56.57	12.3	Moderate
327.2	1	21	39.6	16.50	536	73	-56.87	12.3	Moderate
327.2	1	21	39.6	16.50	539	74	-57.19	12.2	Moderate
328	1	21	39.6	16.50	592	79	-62.77	11.8	Low
328	1	21	39.6	16.50	613	81	-64.94	11.6	Low
328	1	21	39.6	16.50	636	84	-67.38	11.4	Low
328	1	21	39.6	16.50	649	85	-68.69	11.3	Low
328	1	21	39.6	16.50	661	86	-70.00	11.2	Low
328	1	21	39.6	16.50	673	88	-71.23	11.1	Low
329	1	21	39.6	16.50	699	90	-73.94	10.9	Low
329	1	21	39.6	16.50	740	95	-78.21	10.5	Low
330.1	5	6.4	33.5	6.06	804	100	-93.94	9.3	Low
330.2	5	6.4	33.5	6.06	880	100	-93.94	9.3	Low
330.2	5	6.4	33.5	6.06	945	100	-93.94	9.3	Low
331	5	6.4	33.5	6.06	1079	100	-93.94	9.3	Low