Hydrogeomorphic Analysis of the Luckiamute Watershed, Central Coast Range, Oregon: Integrating Applied Watershed Science with Undergraduate Research and Community Outreach

Proposal Submission to the Small Grants Program
Center for Water and Environmental Sustainability (CWESt)
Oregon State University

Prepared By

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November 14, 2003

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Project Title:	Hydrogeomorphic Analysis of the Luckiamute Watershed, Central Coast Range, Oregon: Integrating Applied Watershed Assessment with Undergraduate Research and Community Outreach
Project Type(s):	Research, Undergraduate Education, Other: Community Outreach
Focus Categories:	Education, Geomorphological Processes, Hydrology, Sediments, Water Quality
Keywords:	Luckiamute Watershed, Coast Range, fluvial geomorphology, drainage morphometry, sediment budget, sediment-transport efficiency, gravel distribution, geographic information systems, water quality, land use, undergraduate research, community outreach
Start Date:	March, 2004
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Principal Investigator:	Stephen Taylor, Ph.D., Assistant Professor of Geology, Earth and Physical Sciences Department, Western Oregon University, email: taylors@wou.edu, phone: 503-838-8398, fax: 503-838-8072
Congressional District	Fifth Congressional District

PROJECT ABSTRACT

Mountainous watersheds are fundamental landscape elements that form an important setting for local ecological interactions, human occupation, and water resource development. They also represent the foundational components for mass sediment transfer from continental regions to ocean basins. As such, the understanding of hydrogeomorphic variables and related process interactions is critical for designing sustainable water resource and habitat conservation plans. From the perspective of undergraduate training in the Earth Sciences, watersheds represent the ideal natural laboratory for student application of quantitative techniques to multivariate systems with interdependent process-response mechanisms.

The purpose of this project is to use the Luckiamute River basin (A_d = 815 km^2) of western Oregon as a model watershed to integrate select components of applied research into a sequence of surface-process courses at Western Oregon University (WOU). The Luckiamute will be used as a natural laboratory for integrated studies in fluvial geomorphology, environmental geology, hydrology, and GIS analysis. Primary research objectives include: (1) characterization of bedrock control on topography and geomorphic processes in the upper Luckiamute, (2) calculation of valley-bottom sediment storage volumes, as related to item 1 above, (3) characterization of channel-bed composition with respect to sediment-transport functions, and (4) collection and analysis of water quality data in the context of geologic and anthropogenic variables.

From a training perspective, the proposed watershed-based curriculum will (1) incorporate research into the undergraduate Earth Science program at WOU, (2) engage students in socially-relevant watershed-based science, (3) improve quantitative skills via coursework, lab exercises, and applied research, (4) develop problem-solving and scientific skills within a regional watershed setting, and (5) foster an interconnected perspective of watershed processes across several linked courses.

The research model will be placed in the context of community outreach via collaboration with a local watershed council and disseminated for application to other watersheds. This project will also contribute to the understanding of upland watershed dynamics in the Pacific Northwest.

Proposed Budget for CWESt / USGS Small Grants Program **Start Date: Feb. 15, 2003 End Date: Aug 31, 2004**
Project Short Title: Hydrogeomorphic Analysis of the Luckiamute Watershed **Principle Investigator: Steve Taylor, Ph.D.**

	Federal	Non-Federal	Explanation / Comments
1. Salaries and Wages			
Faculty Salary (Academic Yr 2003-2004, 0.1 FTE)		$2,725	0.1 FTE x $41,283 x 0.66 (2/3rd of Academic Year: Winter and Spring Terms 2004)
Faculty Salary (Summer 2004, 0.2 FTE)	$1,486		0.2 FTE x 0.18 x $41,283
Faculty Salary (Academic Yr 2004-2005, 0.1 FTE)		$4,128	0.1 FTE x $41,283
Faculty Salary (Summer 2005, 0.2 FTE)	$1,486		0.2 FTE x 0.18 x $41,283
Student Salary (Academic Yr 2003-2004)	$800		1 to 2 Student Reseach Associates: 100 hrs x $8.00 / hr
Student Salary (Summer 2004)	$720		1 to 2 Student Reseach Associates: 90 hrs x $8.00 /hr
Student Salary (Academic Yr 2004-2005)	$1,200		1 to 2 Student Reseach Associates: 150 hrs x $8.00 /hr
Student Salary (Summer 2005)	$720		1 to 2 Student Reseach Associates: 90 hrs x $8.00 /hr
2. Fringe Benefits			
Faculty Salary (Academic Yr 2003-2004, 43% Salary)		$1,172	0.43 x $2,725
Faculty Salary (Summer 2004, 43% Salary)	$639		0.43 x $1,486
Faculty Salary (Academic Yr 2004-2005, 43% Salary)		$1,775	0.43 x $4,128
Faculty Salary (Summer 2005, 43% Salary)	$639		0.43 x $1,486
Student Salary (Academic Yr 2003-2004; 3.4% Salary)	$27		0.034 x $800
Student Salary (Summer 2004; 3.4% Salary)	$24		0.034 x $720
Student Salary (Academic Yr 2004-2005;3.4% Salary)	$41		0.034 x $1,200
Student Salary (Summer 2005; 3.4% Salary)	$24		0.03 x $720
3. Supplies			
Plotter Supplies (Paper / Ink)	$300		In support of GIS Lab; project-related maps and graphics
Sample Bottles / Reagents	$300		In support of water quality sampling
4. Equipment			
Field / Water Quality Testing Equipment		$3,000	Earth Science / LAS S&S Budget (AY 03-04 and 04-05)
Software Licensing		$1,000	18 month fee for GIS and related analytical software
5. Services or Consultants			
Luckiamute Watershed Council Advisory Panel Fees		$2,790	(3 science advisors x 6 meetings x 3 hr/meeting x $40/hr) + (1 education advisor x 6 meetings x 3 hr/meeting x $20/hr) + (1 community advisor x 6 meetings x 3 hr/meeting x $15/hr)
Laboratory / Water Quality Analyses (CCAL / OSU)	$5,180		7 samples/round x 4 rounds x $185/sample
WOU Lab Analysis: Total Coliform Counts		$840	7 samples/round x 4 rounds x $30/sample
WOU Server / Network Support		$540	18 mo x $30/mo
WOU Phone/FAX/Communication/Duplication		$180	18 mo x $10/mo

6. Travel	Federal	Non-Federal	
Field Travel / Water Quality Sampling			
Mileage	$136		Water Quality Sampling: 4 rounds x 100 mi/RT x $0.34 / mi
Food (2 team members)	$80		4 days x $10.00/day x 2 team members (lunch only)
Field Travel / Geomorphic Data Collection			
Mileage	$680		20 days x 100 mi / day x $0.34 / mi
Food (2 team members)	$400		20 days x $10.00/day x 2 team members (lunch only)
Professional Meetings (Project Dissemination)			
Registration/Abstract Fee		$400	Fall 2004 Scientific Meeting
Air Fare		$500	Fall 2004 Scientific Meeting
Hotel (3 nights x $200 /night)		$600	Fall 2004 Scientific Meeting
Rental Car		$150	Fall 2004 Scientific Meeting
Parking / Shuttle		$50	Fall 2004 Scientific Meeting
Food (4 days x $42.00 /day)		$168	Fall 2004 Scientific Meeting
LWC Advisory Panel / Consultant Travel			
Panel Travel Stipend (to / from WOU)		$300	$10/advisor/meeting x 5 advisors x 6 meetings =
7. Other Direct Costs			
LWC Advisory Panel-Meeting Facility Rental at WOU		$540	$30/hr x 6 meetings x 3 hrs/meeting =
8. Total Direct Costs	$14,883	$20,858	
9. Indirect Costs			
Federal Portion (41.5 %)	N/A	$6,176.59	0.415 x $14,883
Non-Federal Portion (41.5%)	N/A	$8,655.97	0.415 x $20,858
10. Total Estimated Costs	$14,883	$35,690	Budget Item 8 + Budget Item 9

	Federal	Non-Federal
Match Ratio:	**1**	**2.40**

Summary of Funds Requested from CWESt-USGS for Luckiamute Project

	Cost	% of Total
Faculty Summer Salary and Fringe	$4,250	28.6
Student Academic Year-Summer Salary and Fringe	$3,557	23.9
Supplies	$600	4.0
Contracted Lab Services (Water Quality)	$5,180	34.8
Field Travel (Mileage and Per Diem)	$1,297	8.7
Total	$14,884	100

BUDGET JUSTIFICATION

Project Number:
Project Title: Hydrogeomorphic Analysis of the Luckiamute Watershed, Central Coast Range, Oregon: Integrating Applied Watershed Assessment with Undergraduate Research and Community Outreach

Salaries and Wages:

Faculty Salary		
	Academic Year 2003-2004	(0.1 FTE) x (0.66 of academic year) x ($41,283 9-mo)
	Summer 2004	(0.2 FTE) x (0.18) x ($41,283)*
	Academic Year 2004-2005	(0.1 FTE) x ($41,283 9-mo)
	Summer 2005	(0.2 FTE) x (0.18) x ($41,283)*
Student Salary		
	Academic Year 2003-2004	100 hrs x $8.00 /hr
	Summer 2004	90 hrs x $8.00 /hr
	Academic Year 2004-2005	150 hrs x $8.00 / hr
	Summer 2005	90 hrs x $8.00 /hr

*Summer rate set by faculty union contract

Fringe Benefits:
Faculty Rate: 43% of salary
Student Rate: 3.4% of salary

Supplies:
$300 for office supplies; $300 for field sampling / lab supplies

Equipment:
None charged to grant, field water quality meters will be purchases as match by WOU

Services:

Advisory Panel Consulting Fees	$2790 (donated as match)
Analytical Services (CCAL/OSU)	28 samples x $185/sample
WOU Lab Analyses (coliform)	28 samples x $30 / sample (donated as match)
WOU Server/Network Support	18 mo x $30/mo (donated as match)
WOU Communications	18 mo x $10/mo (donated as match)

Travel:
Purpose of travel will be for field data collection. Travel will be by personal vehicle to local areas within the Luckiamute Watershed. See budget sheet for estimated mileage and per diem costs.

Other Direct Costs:
WOU facility rental for advisory panel meetings $30/hr x 18 hr total

Hydrogeomorphic Analysis of the Luckiamute Watershed, Central Coast Range, Oregon: Integrating Applied Watershed Science with Undergraduate Research and Community Outreach

INTRODUCTION

Mountainous watersheds, less than 250,000 ac (~100,000 ha), are fundamental landscape elements that form an important setting for local ecological interactions, human occupation, and water resource development. As components of the global hydrosphere, they encompass a set of physical and biological variables that interact via complex systems response and interdependent feedback mechanisms (Schumm, 1977; Bull, 1991). Upland watersheds also represent the foundational components for mass sediment transfer from continental regions to ocean basins. Study of the production, transport, and storage of sediment in drainage basins is essential for deciphering their evolution and geomorphic behavior (Dietrich and Dunne, 1978). As such, the understanding of hydrogeomorphic variables and related process interactions is critical for designing sustainable water resource and habitat conservation plans. From the perspective of undergraduate training in the Earth Sciences, watersheds represent the ideal natural laboratory for student application of quantitative techniques to multivariate systems with interdependent process-response mechanisms (Woltemade and Blewett, 2002).

The purpose of this proposal is to integrate select components of applied watershed research into a sequence of upper division surface-process courses at Western Oregon University (WOU). The Luckiamute Watershed of Polk and Benton Counties, Oregon (USGS HUC = 1709000306; Figure 1) will serve as a local "proof-of-concept" model for undergraduate training in hydrogeomorphic data collection and analysis. The Luckiamute is associated with a unique combination of geomorphic and land-use conditions that are well suited for the study of interdependent watershed variables. It is also in close proximity to the WOU campus and is logistically well situated for student access during the academic year. The research objectives are to: (1) understand the influence of varying bedrock lithology on sediment transport and storage mechanisms, (2) characterize channel-bed composition with respect to sediment-transport functions, and (3) evaluate the effects of geologic and anthropogenic variables on surface water-quality. Project activities will include surficial mapping, geomorphic analysis, water quality sampling, land-use evaluation, and compilation of GIS data. The products of this preliminary work will be used to delineate subsequent undergraduate research topics and will form the basis for problem-based learning activities.

This proposal solicits seed funds from CWESt to support a pilot program and to form the foundation for more comprehensive program development. The research model will be placed in the context of community outreach via collaboration with a local watershed council and disseminated for application to other watersheds. This project will also contribute to the understanding of upland watershed dynamics in the Pacific Northwest.

PROJECT HISTORY

Multidisciplinary study of the Luckiamute Watershed has been ongoing since the summer of 2001 under the aegis of the Environmental Science Institute (ESI) at Western Oregon University (WOU). A field-based course was convened that integrated science modules including geomorphology, field botany, and environmental chemistry (Dutton and others, in review). The geomorphology module focused on landscape analysis, geographic information systems, and surficial mapping methodology. The botany module emphasized characterization of riparian habitats, floristic changes over time, impacts of invasive plant species, and field monitoring methodologies. The environmental chemistry module examined land use and water quality issues in the Luckiamute basin.

The ESI 2001 summer institute formed the framework for publication of a field guide (Taylor and others, 2002) and preliminary results from a study of bedrock controls on watershed morphometry (Taylor, 2002).

Connections with the Luckiamute were more recently advanced via a cooperative agreement between WOU and the Luckiamute Watershed Council (LWC), a community organization dedicated to conservation, habitat restoration, and sustainable land use in the river basin (www.wou.edu/luckiamute). With funding from the Oregon Watershed Enhancement Board (OWEB), LWC is currently conducting a phase I assessment to document existing data, and to establish priorities for future conservation projects (Earth Design Consultants, In Preparation). The linked research-curriculum initiative proposed herein will provide a platform for ongoing monitoring and assessment of the Luckiamute, and will form an important part of this community-based watershed enhancement effort.

PHYSIOGRAPHIC SETTING OF THE LUCKIAMUTE WATERSHED

Topography and Climate

The Luckiamute River comprises a portion of the Willamette basin in west-central Oregon (Figure 1). This seventh-order watershed (sensu Strahler, 1957) drains eastward from the Coast Range into the Willamette River and occupies a total drainage area of 815 km^2. The Luckiamute basin is bounded by the Willamette River to the east, the crest of the Coast Range to the west, Green Mountain and Mary's River to the south, and Rickreall Creek watershed to the north (Figure 1). Land surface elevations range from 46 m (150 ft) at the confluence with the Willamette River to 1016 m (3333 ft) at Fanno Peak. The Luckiamute has an average gradient of 3 m/km, a total stream length of 90.7 km, and an average basin elevation of 277 m (910 ft) (Rhea, 1993; Slack and others, 1993). Fanno Ridge separates the watershed into two tributary sub-basins, with the Little Luckiamute to the north and the main stem of the Luckiamute proper to the south (Kings Valley) (Figure 1).

Taylor and Hannan (1999) summarized historic climate data for western Oregon. The Luckiamute straddles Oregon Climate Zones 1 (Coastal Area) and 2 (Willamette Valley), with westerly Pacific marine air serving as the primary moisture source. Precipitation patterns are strongly seasonal with 75% of annual total occurring from October to March. Annual precipitation varies greatly from west to east across the Luckiamute watershed, as governed by westerly airflow and lee-side rain shadow effect in the Coast Range. Precipitation ranges from 3600 mm/yr along the northwestern boundary to 1140 mm/yr in the center of the Willamette Valley, a west-to-east precipitation gradient of 95 mm/km (Figure 1). Analyses of stream flow records at Helmick State Park reveal that flooding and high discharges on the Luckiamute directly correspond to seasonal precipitation patterns.

Bedrock Geology

Yeats and others (1996) and Snavely and Wells (1996) provided comprehensive summaries of the bedrock geology in the Luckiamute region. Lithostratigraphic units are grouped into four spatial domains in the Luckiamute, as recognized on the basis of outcrop pattern (Figure 2). These domains include the Siletz River Volcanics domain (south), the Tyee domain (west-southwest), the Yamhill-Intrusive domain (north-northwest), and the Spencer-Valley Fill domain (east) (Taylor, 2002). The Siletz River Volcanics domain comprises 19% of the watershed and is associated with outcrop of submarine basalts. The Tyee domain (29% of total area) is underlain primarily by Tyee Formation with local mafic intrusives supporting ridge tops. The Yamhill-Intrusive domain occupies 23% of the watershed and is characterized by outcrop of equal portions Yamhill Formation and mafic intrusives.

The Spencer-Valley Fill domain (29%) is underlain by a patchwork of Spencer Formation and Quaternary alluvium. Each of these bedrock spatial domains is associated with unique landform assemblages and surficial processes.

Surficial Geology

Geomorphic systems of the Luckiamute watershed can be divided into a valley-floor regime to the east and hillslope-colluvial regime to the west (Figure 3). Style of surficial process and landform associations are controlled by topographic position, underlying bedrock geology, and resistance to erosion. Hillslope landforms and colluvial processes dominate the Siletz River, Tyee, and Yamhill-Intrusive domains, while fluvial landforms and alluvial processes are characteristic of the Spencer-Valley Fill domain.

The lower Luckiamute is characterized by a mix of alluvial stratigraphic units and geomorphic surfaces. Landforms include active channels, floodplains, fill terraces, and strath-pediment surfaces (McDowell, 1991). In addition to these fluvial landforms, the lower Luckiamute is also associated with swaths of low-relief colluvial hillslopes supported by the Spencer Formation (Figure 3). Pleistocene through Holocene terrace development records a complex history of base level fluctuation, internal erosion-deposition cycles, and glacial-outburst floods (Missoula Floods) from the Columbia River system. The active channel of the lower Luckiamute is incised 8 to 9 m below the floodplain, with higher level terrace surfaces at 12 to 15 m above mean annual stage (Reckendorf, 1993). The higher-level terrace surfaces are covered with rhymically-bedded, silty slack-water deposits of the Willamette Formation (Missoula Flood deposits; 13.5-12 Ka). These late Pleistocene surfaces are inset with lower terrace and floodplain deposits that are predominantly Holocene in age (post-Missoula Flood; <12 Ka) (Figure 3; O'Connor and others, 2001).

Parsons (1978) presented a geomorphic overview of the Coast Range portion of the Luckiamute. On average, hillslope gradients range from 25 to 30% with maxima up to 90%. Local relief is on the order of 300 to 500 m. This portion of the Luckiamute watershed is dominated by colluvial hillslope processes including slide, debris flow, creep, tree throw, and faunal turbation. Fluvial transport and erosion occur in narrow, low-order tributary valleys. Upland landforms include ridge tops, side slopes, hollows, landslide scars, and dissected pediments. Narrow valley-bottoms are geomorphically active with channels, floodplains, low terraces, and small-scale debris fans (Balster and Parsons, 1968).

Vegetation and Land Use

The Coast Range portion of the Luckiamute watershed lies in the *Tsuga heterophylla* Zone of Franklin and Dyrness (1988). Dominant forest species include *Pseudotsuga menziesii* (Douglas fir), *Tsuga heterophylla* (western hemlock), and *Thuja plicata* (western red cedar), with lesser occurrence of *Abies grandis* (grand fir). These species formed part of the classic old growth timber stands that were logged extensively in the Pacific Northwest during the early 1900's. Disturbed upland zones are characterized by *Alnus rubra* (red alder) and *Rubus spp* (blackberry). *Acer macrophyllum* (big leaf maple) is a common late succession species in valley bottoms and hollows. Balds with meadow grasses and mosses occur locally along higher elevation ridge tops. Lower reaches of the Luckiamute watershed lie in agricultural crop and pasture land, with local patches of mixed *Quercus garryana* (Oregon white oak) and urban mosaic species.

Since European settlement, the dominant economic activities in the Willamette Valley have centered on agriculture in the lowlands and timber harvesting in upland forests. Over the past several decades, industrialization and rapid population growth have resulted in significant impact to the habitat of the region. A large portion of the upper Luckiamute is owned by private timber companies and 67%

of the watershed classified as forest. In contrast, the eastern valley section is comprised of a mix of agricultural lands (15% of total), native vegetation (3%), and urban development (1%) (Urich and Wentz, 1999). Primary commodities in the agricultural zones include grass seed, wheat, hay, oats, and mixed crops (clover, sweet corn, mint, alfalfa, filberts) (Wentz and others, 1998).

STATEMENT OF THE PROBLEM

Sediment-Transport Dynamics

Study of the production, transport, and storage of surficial sediment in drainage basins is essential for understanding their evolution and geomorphic behavior. Fluvial regimes are intimately related to hillslope sediment delivery and storage systems (Dietrich and Dunne, 1978). The central Coast Range of Oregon represents an unglaciated, humid-mountainous landscape. Active mountain building and extreme precipitation patterns result in a dynamic geomorphic system characterized by seasonal flooding, slope failure, and debris flow activity (Benda, 1990). As such, forested drainage basins export sediment by colluvial and alluvial processes in high-gradient channel systems. Understanding the controls for routing and storage of sediments in this region are a critical component of habitat management plans (Swanson and others, 1990; Gregory and others, 1989; FEMAT, 1993).

Taylor (2002) conducted GIS-based analyses in the Luckiamute to elucidate associations between lithospatial domain (i.e. Tyee, Siletz, Yamhill-Intrusive, Spencer-Valley Fill) and slope gradients. The study revealed that the Tyee domain is associated with significantly steeper slopes, wider valley bottoms, and higher occurrence of slope failure compared to the other three domains. Previous studies similarly documented the debris-flow-prone nature of Tyee landscapes in the Oregon Coast Range (e.g. Benda and Dunne, 1987; Mills and Ziolko, 2002). Taylor (2002) postulated that the comparatively steep slopes and wide valley bottoms in the Tyee domain are associated with hillslope transport rates greater than the ability of the channel system to export sediment. The model suggests a net deficit of unit stream power along the higher-order portions of the Luckiamute tributary. As slope gradients and valley-width morphology vary according to lithospatial domain, the model implies that spatial variation of bedrock lithology is a primary factor controlling slope gradients, hillslope delivery rates, and the resulting sediment-transport efficiency of the channel system. A portion of the work proposed herein will test this hypothesis via large-scale surficial mapping, channel-reach characterization, and sediment-storage volume estimates.

Water Quality

The relationship between land use and water-quality degradation in the Willamette Valley is well documented (Wentz and others; 1998). Given that greater than 75% of all water use in the Willamette Basin is derived from surface sources, land-use and river quality issues are at the forefront of environmental planning in western Oregon. The greatest potential for water-quality degradation in the lower Luckiamute is from fertilizer-related nitrates, pesticides (herbicides, insecticides, and fungicides), and high concentrations of suspended sediment. Available surface water quality data for the Luckiamute Basin is limited to a few select field parameters (e.g. turbidity, dissolved oxygen, pH, conductivity) that were collected mostly in the late 1960's and early 1970's (Oregon Dept. of Environmental Quality, 2003). The most consistent water data are associated with the Soap Creek tributary near Coffin Butte Landfill, Benton County. Given the relative paucity of data and lack of a systematic sampling distribution, little is known about the effects of anthropogenic activity and regional geology on surface-water quality in the Luckiamute Watershed. As the Luckiamute Basin is increasingly being used for domestic and agricultural water supplies in the mid-Willamette Valley, the need for water-quality sampling was recently identified as a priority for future conservation planning,

erosion control, and habitat restoration (T. Arkley, Luckiamute Watershed Council, Personal Communication). A significant component of the work plan described below addresses this need and calls for systematic sampling throughout the Luckiamute drainage network.

Undergraduate Training

Integrating undergraduate research and education in the sciences is recognized as an important model for preparing students to participate in the 21st century workforce (National Science Foundation, 2003). College graduates are increasingly required to understand complex integrated systems by applying multi-disciplinary problem solving skills. As such, there is a general lack of linked science curricula in which students systematically build a set of problem-solving skills that are applied to a real-world problem (Heins and Walker, 1998). Watershed systems represent the interaction of physical and biological processes at spatial and temporal scales that are highly relevant to the community at large (Woltemade and Blewett, 2002). This project will serve as a framework for undergraduate training in applied fluvial geomorphlogy, environmental geology, and watershed science at Western Oregon University.

PROJECT GOALS AND OBJECTIVES

The purpose of this project is to integrate research, undergraduate education, curriculum development, and community outreach with watershed science as a unifying theme. The Luckiamute Watershed will be used as a natural laboratory for integrated studies in fluvial geomorphology, environmental geology, hydrology, and GIS analysis. The scientific objective of this project is to contribute to the understanding of mountainous watershed dynamics in the Pacific Northwest. Primary research objectives include: (1) characterization of bedrock control on topography and geomorphic processes in the upper Luckiamute, (2) calculation of valley-bottom sediment storage volumes, as related to item 1 above, (3) characterization of channel-bed composition with respect to sediment-transport functions, and (4) collection and analysis of water quality data in the context of geologic and anthropogenic variables.

From a training perspective, the proposed watershed-based curriculum will (1) incorporate research into the undergraduate Earth Science program at WOU, (2) engage students in socially-relevant watershed-based science (e.g. Woltemade and Blewett, 2002), (3) improve quantitative skills via coursework, lab exercises, and applied research, (4) develop problem-solving and scientific skills within a regional watershed setting, and (5) foster an interconnected perspective of watershed processes across several linked courses.

ACTION PLAN

Proposed research activities focus on hydrogeomorphic assessment of the Luckiamute Watershed, explicit action items include:

(1) Design and implementation of undergraduate research modules in a series of Earth Science courses at WOU: G322 Geomorphology, G473 Environmental Geology, G476 Hydrology, and G492 GIS Applications in Earth Science.

(2) Weave select portions of Earth Science course curricula with assessment and monitoring activities associated with the Luckiamute Watershed Council.

(3) Creating linked research modules in the courses listed above, each focusing on different aspects of the Luckiamute Watershed:

(A) G322 Geomorphology: Assessment of valley-bottom sediment storage volumes, sediment-transport efficiency, and channel bed composition.
  (i) Surficial mapping of Luckiamute valley bottom
  (ii) Channel reach characterization

(B) G473 Environmental Geology: Assessment of surface water quality and land-use impacts in the Luckiamute basin.
  (i) Baseline water quality monitoring
  (ii) Land use analysis

(C) G476 Hydrology: Characterization of drainage composition and slope-area relationships in the context of bedrock associations
  (i) Morphometric analyses

(D) G492 GIS Applications: Compilation of geospatial products.
  (i) Building spatial data bases
  (ii) Assembling web-based GIS products

(4) Cultivate community involvement via advisory panel meetings with Luckiamute stakeholders and students.

(5) Web-based dissemination of research products.

Geomorphic Techniques

Surficial mapping techniques will follow those presented by Taylor and others (1996) for mountainous landscapes. Valley-bottom storage compartments (channel, floodplain, terrace, fan) will be the focus as they reflect the ability of watersheds to export sediment. Detailed surficial mapping, with measurement of surface heights above channel grade, will allow first-order approximation of valley-bottom storage volumes. Channel-reach surveys will include: (1) channel classification (after Rosgen, 1994; Kondolf, 1995; Montgomery and Buffington, 1997), (2) clast-size analysis (after Wolman, 1954 and Hack, 1957), (3) measurement of bankful stage, gradient, channel width, total valley width, and (4) spatial distribution of bedrock-alluvium reaches (after Montgomery and others, 1996). Morphometric analyses and slope-area relationships will be analyzed using GIS, as modified from procedures outlined by Hack (1957), Strahler (1957), and Dalla Fontana and Marchi (2003). Volume estimates will be examined in tandem with clast-size analysis, bedrock-channel distribution, and slope-area relationships to make inferences regarding controls on long-term sediment-transport efficiency.

Water Quality Sampling

Four quarterly rounds of surface water samples will be collected at seven monitoring points distributed throughout the Luckiamute Watershed (approximate locations shown on Figure 1). Samples will be analyzed for a suite of baseline parameters including: pH, alkalinity, specific conductivity, select cations (Na, K, Ca, Mg, Fe), choride, sulfate, total nitrogen, nitrates, total phosphorous, total dissolved solids, suspended solids, dissolved organic carbon, and total coliform. The selected set of water quality parameters are relatively affordable and will serve as baseline indicators for impacts related to forestry practice, agriculture, and bedrock-related weathering. Four quarters of samples distributed across seven localities will establish an initial data set from which to

devise a more extensive sampling strategy. GIS anayses will be used to identify associations between water quality, land use, and geologic setting.

Data Compilation-Dissemination-Community Outreach

All data and reports completed as part of this project will be compiled and distributed via internet technologies. A project web site will be established in the early phase of the work. The web site will be the primary information source for students and watershed stakeholders. Spatial data will be compiled into a GIS and distributed via a dedicated map-server housed at Western Oregon University. Research results and related curriculum products will be disseminated by presentation at national geoscience meetings (GSA/ AGU) and publication in peer-reviewed journals.

An advisory panel will be assembled from members of the Luckiamute Watershed Council with six meetings convened throughout the life of the project, approximately one per quarter. The panel will consist of 3 scientific advisors from government agencies and private industry (EPA, BLM, Boise), 1 environmental education specialist, and 1 watershed resident. The purpose of the advisory panel to offer formative project guidance, create positive linkages between the scientific enterprise and local community, and provide a venue for undergraduates to formally present their research findings.

PROJECT TIMELINE

Project activities will be conducted over an 18-month period from March 2004 to September 2005 (Table 1). The 18-month time period will be necessary to integrate the varied assemblage of research activities into the selected courses. In addition, the teaching load at WOU is such that release time for focused research during the academic year is not feasible. The project timeline as planned in Table 1, allows for 2 summers and 1.5 academic years to develop the related curriculum modules and complete the proposed research. This time frame will be necessary to offset the persistent teaching commitments related to working at a primarily undergraduate institution.

PROJECT JUSTIFICATION

While the Coast Range of Oregon is well known as an intellectually fertile setting for geomorphic research on hillslope and fluvial processes (e.g. Swanson et al, 1977; Montgomery and Dietrich, 1988; Benda, 1990), most of this work has been limited to headwater landscapes underlain by the Tyee Formation. Relatively little is known about how Tyee-based process-response models apply to other portions of the Coast Range, underlain by different lithologies. The proposed geomorphic research modules provide an excellent opportunity to apply concepts and models derived in Tyee landscapes to other lithologic domains in the Luckiamute (i.e. Siletz River Volcanics, Yamhill-Intrusive). This project will potentially yield significant returns in further understanding of upland watershed dynamics in the Pacific Northwest.

The water quality, land use, GIS, and web-based components are intended to augment the ongoing assessment efforts by the Luckiamute Watershed Council. To this end, the channel-reach surveys and valley-bottom mapping will also be of great value in assessing the quality of fish habitat (after Kondolf and Wolman, 1993). In addition to its scientific value, this work represents both a community service and a vehicle for promoting development of effective conservation and restoration plans.

Given the scale of the Luckiamute basin and proximity to Western Oregon University, it represents an ideal outdoor laboratory in which to build an applied watershed science curriculum. This research-based initiative will prepare students for advanced graduate studies or work as water resource professionals in the state of Oregon. As such, approximately 20 to 30 Earth Science students will be

directly and indirectly affected by this project during the proposed grant period. Three to four students will serve as research associates with exposure to more intensive training and research opportunities. If funded, this pilot project will serve as a catalyst for wholesale reorganization of the surface process curriculum at Western Oregon University, and offers great potential for adaptation and implementation at the national level.

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Western Oregon University
Monmouth, OR 97361

EDUCATION

1999 Ph.D. – Geology (Geomorphology), West Virginia University, Morgantown, WV.
1985 M.S. – Geology (Sedimentology), Washington State University, Pullman, WA.
1982 B.S. - Geology, Slippery Rock University, Slippery Rock, PA.

EMPLOYMENT HISTORY

1999-Present Assistant Professor of Geology, Western Oregon University
2001 Visiting Professor of Geography, University of Oregon
1999 Project Geologist, U.S. Filter - Chester Engineers, Inc., Pittsburgh, PA
1995-1999 Research Assistant, West Virginia University
1993-1997 Adjunct Instructor, California University of Pennsylvania
1990-1995 Adjunct Instructor, Westmoreland County Community College, PA
1990-1994 Hydrogeologist, Anderson Geological Services, Washington, PA.
1990 Adjunct Instructor, Waynesburg College, PA
1989-1990 Hydrogeologist, Geraghty and Miller, Inc, Washington, PA.
1988-1989 Research Assistant, University of New Mexico
1986-1987 Project Scientist, Washington State University
1985 Geophysics Technician, Practical Geophysics, Inc., Salt Lake City, UT.
1983-1984 Teaching/Research Assistant, Washington State University

PROFESSIONAL CERTIFICATION

2002-Present Oregon Registered Professional Geologist, G1968
1994-Present Registered Professional Geologist (PG-001002-G)

GRANTS AND FELLOWSHIPS

2002 Western Oregon University, Faculty Professional Development Grant ($750)
2002 Western Oregon University, PT3 (U.S. Dept. of Ed.) Faculty Grant ($6000)
2002 Western Oregon University Student Technology Grant ($150,000)
2001 Western Oregon University, Faculty Professional Development Grant ($3,000)
2001 Western Oregon University, PT3 (U.S. Dept. of Ed.) Faculty Grant ($8,000)
2000-2001 Murdock Trust Partners in Science Research Grant ($15,000)
2000-2001 OCEPT Faculty Fellowship (Oregon Collaborative for Science Ed.; $7,000)
2000 ESRI GIS Software Grant ($15,000).
1999 Western Oregon University, Faculty Professional Development Grant ($3000)
1997-1999 NASA Earth System Science Fellowship (ESS/97-0080; $70,000)
1997 U.S. Geological Survey - EDMAP Program (1434-HQ-97-AG-01782; $10,000)
1996 The Vehse Award for Travel and Research, West Virginia University ($500)
1996 Sigma Xi Society for Scientific Research - Research Grants ($1000)
1996 Geological Society of America - Research Grants ($2000)
1996 Office of Academic Affairs and Research, West Virginia University ($1000)
1996 U.S. Geological Survey - EDMAP Program (1434-HQ-96-AG-01561; $15,000)

RELATED PUBLICATIONS AND REPORTS

Taylor, S.B., 2002, Bedrock Control on Slope Gradients in the Luckiamute Watershed, Central Coast Range, Oregon: Implications for Sediment Transport and Storage: American Geophysical Union Abstracts with Programs, Fall Meeting 2002, San Francisco, California.

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Taylor, S.B. and Kite, J.S., 1998, Surficial and bedrock geology of the Little River basin, George Washington National Forest, Augusta County, Virginia: Submitted to the U.S. Geological Survey National Cooperative Mapping Program (EDMAP Contract 1434-HQ-97-AG-01782), Reston, VA, multiple map sheets with report.

Taylor, S.B. and Kite, J.S., 1997, Surficial and bedrock geology of the upper North Fork drainage basin, Monongahela National Forest, Pocahontas County, West Virginia: Submitted to the U.S. Geological Survey National Cooperative Mapping Program (EDMAP Contract 1434-HQ-96-AG-01561), Reston, VA, multiple map sheets with report.

Taylor, S.B., Kite, J.S., and Kuhn, K., 1996, Bedrock and surficial geology of the Fernow Experimental Forest, Tucker County, West Virginia: Submitted to the USDA Northeastern Forest Experiment Station, Timber and Watershed Laboratory, Parsons, WV, multiple map sheets with report.

Start Date: Feb 15, 2004 **End Date: Aug. 31, 2005**

Time Period	Activity
Winter Term 2004 (Feb 15 - March 29)	Design Luckiamute water quality sampling module for G473 (Environmental Geology) Design and implement Luckiamute GIS-based lab for G492 (GIS Applications) Identify and employ 1-2 student research assistants (5 hr / wk total) Convene initial meeting of Luckiamute Advisory Panel
Spring Term 2004 (March 29-June 11)	Implement Luckiamute water quality research module in G473 (Environmental Geology) Complete round 1 quarterly water quality sampling Employ 1-2 student research assistants (5 hr / wk total) Design / implement Luckiamute project web site
Summer 2004	Surficial mapping / field studies (Part 1) Employ 1-2 student research assistants (6 wk x 15 hr / wk total) Preliminary data reduction and analysis Design Luckiamute channel-reach analysis module for G322 (Geomorphology) Complete round 2 quarterly water quality sampling Continue development of Luckiamute project web site Convene second meeting of Luckiamute Advisory Panel
Fall Term 2004	Implement Luckiamute channel-reach analysis module in G322 (Geomorphology) Employ 1-2 student research assistants (5 hr / wk total) Continued data reduction and analysis Design Luckiamute morphometric research module for G476 (Hydrology) Disseminate preliminary research results and curriculum pedagogy at national meetings (GSA / AGU) Complete round 3 quarterly water quality sampling Continue development of project web site Convene third meeting of Luckiamute Advisory Panel
Winter Term 2005	Continue data reduction and analysis Implement Luckiamute morphometric research module into G476 (Hydrology) Employ 1-2 student research assistants (5 hr / wk total) Complete round 4 quarterly water quality sampling Continue development of project web site Design Luckiamute land-use analysis module for G473 (Environmental Geology) Convene fourth meeting of Luckiamute Advisory Panel
Spring Term 2005	Implement Luckiamute land-use analysis module in G473 (Environmental Geology) Continue data reduction and analysis Employ 1-2 student research assistants (5 hr / wk total) Continue development of project web site Convene fifth meeting of Luckiamute Advisory Panel

Table 1. Project timeline (cont.).

Summer 2005	Surficial mapping / field studies (Part 2) Employ 1-2 student researchers (6 wk x 15 hr/wk) Continue data reduction and analysis Dissemination of results via project web site Convene final meeting of Luckiamute Advisory Panel Prepare and submit final report
Fall 2005 (Post-Project Period)	Disseminate research results and curriculum pedagogy at national meetings (GSA / AGU) Prepare publication manuscripts

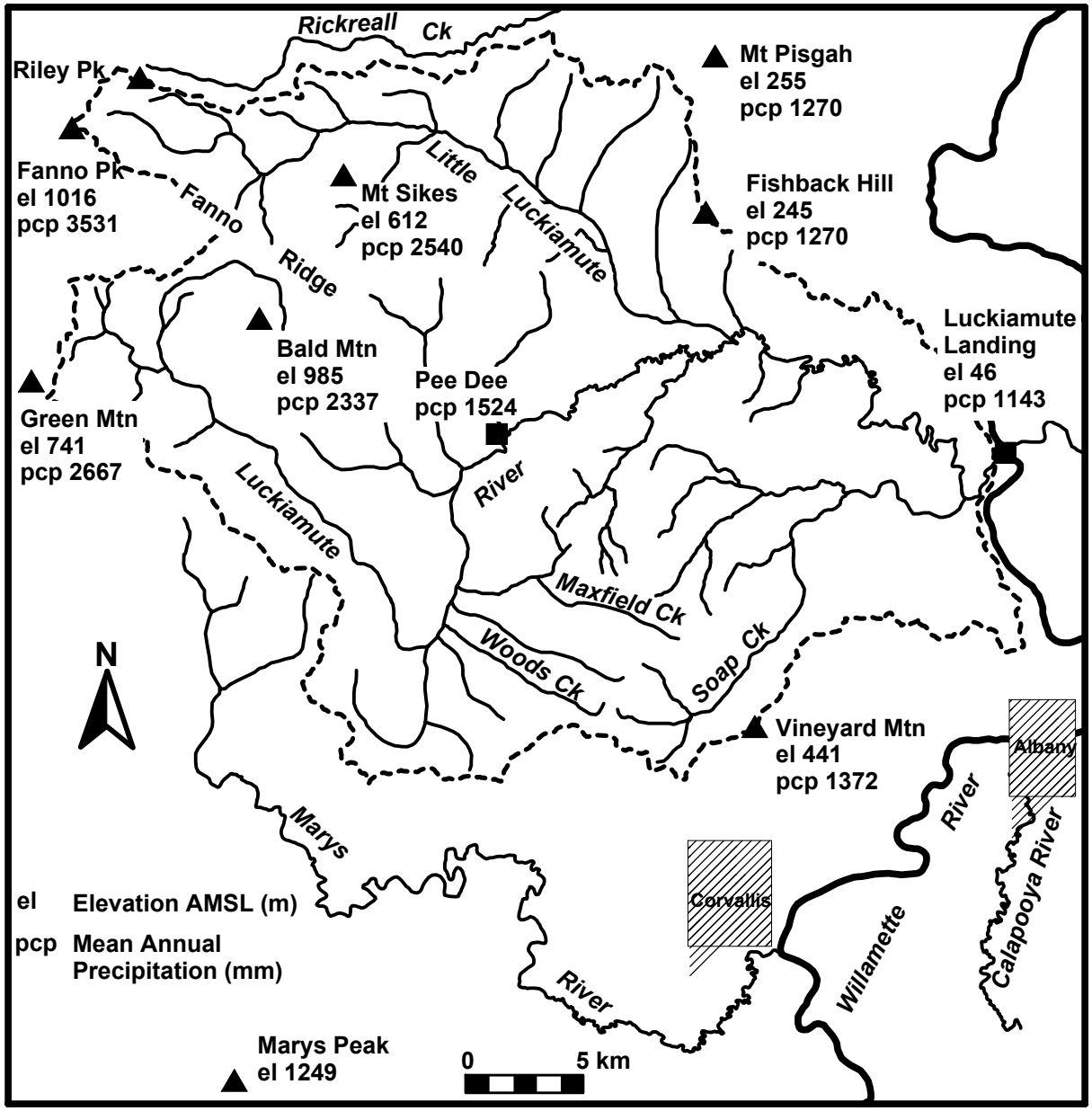

Figure 1. Physiographic map of the Luckiamute Watershed, Polk and Benton counties, Oregon.

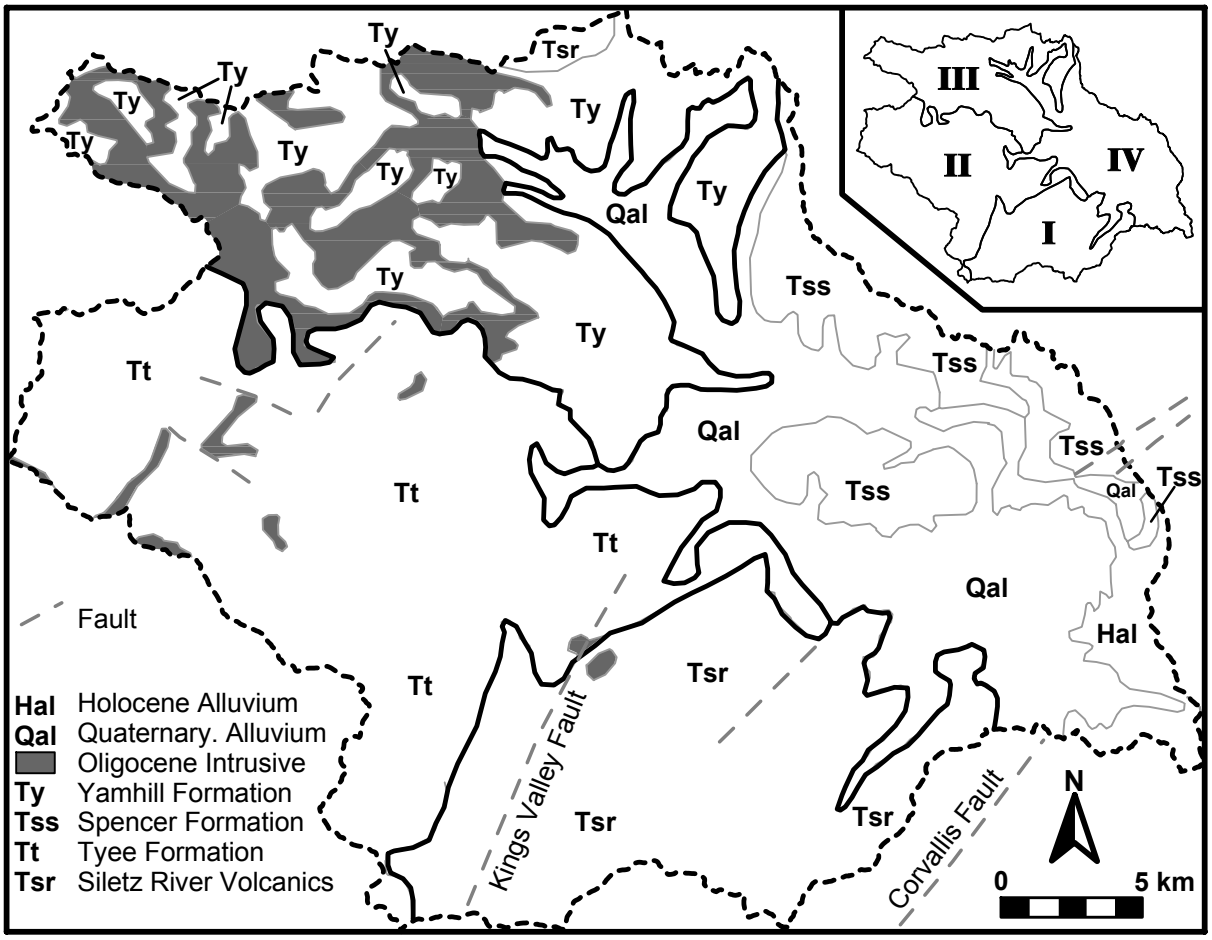

Figure 2. Generalized geologic map of the Luckiamute Watershed, Polk and Benton counties, Oregon.

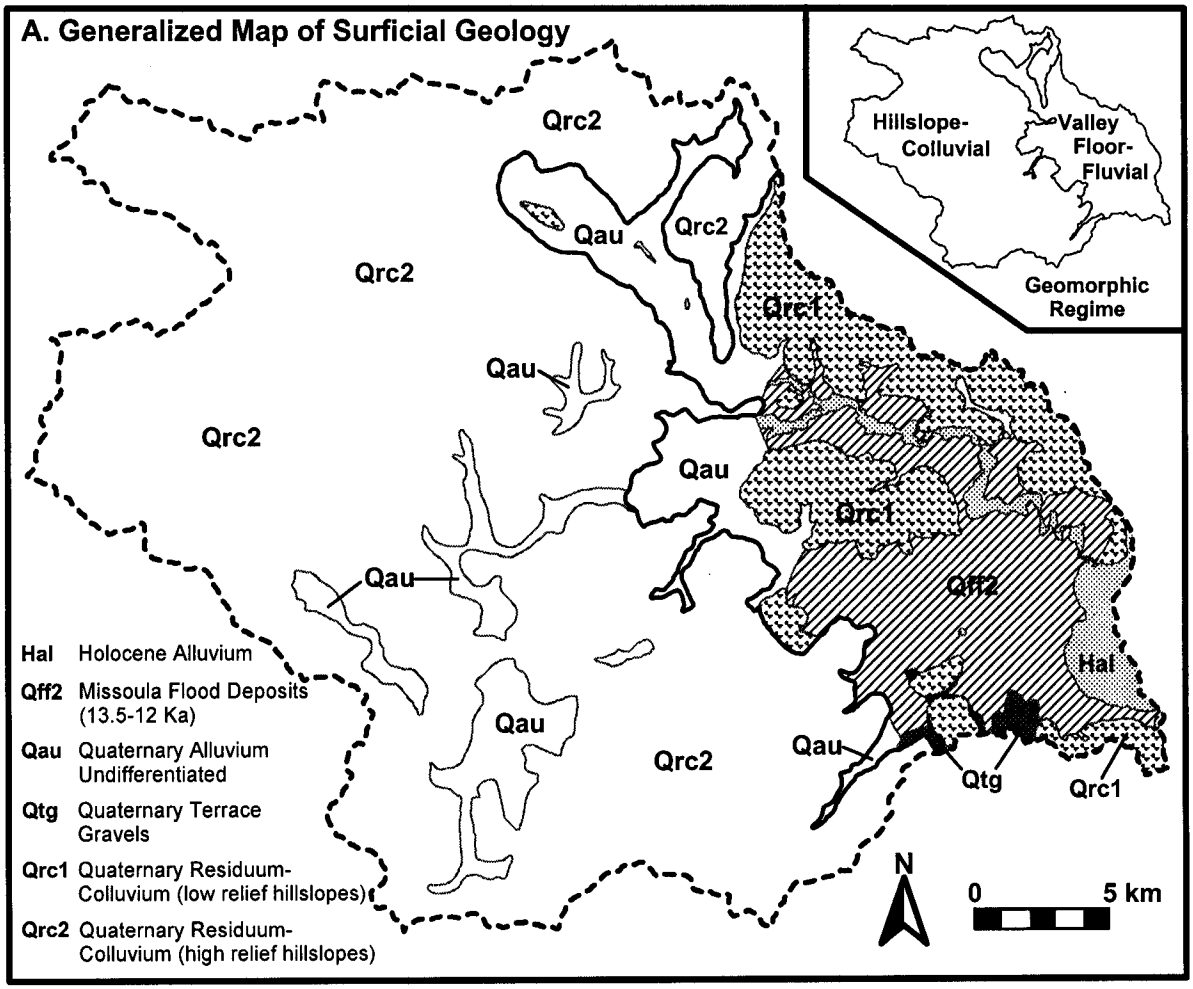

Figure 3. Generalized geomorphic map of the Luckiamute Watershed, Polk and Benton counties, Oregon.

LUCKIAMUTE WATERSHED COUNCIL
9775 Hultman Road
Independence, OR 97351
503 838-4886

November 13, 2003

Small Grant Program
Center for Water and Environmental Sustainability
Oregon State University
Corvallis, Oregon

Dear Sir,

The Luckiamute Watershed Council (LWC) supports the attached grant proposal being submitted by the Earth & Physical Sciences Department at Western Oregon University (WOU), Monmouth, Oregon.

The Luckiamute Watershed Council is a community based organization with a 13 person Board of Directors, formed and recognized by Polk County in 1999.

In support of this proposal the LWC will create a Luckiamute Advisory Panel of no less than five appropriate individuals from the Board and community to provide technical advice and review of the progress and implementation of this proposal.

The LWC and WOU have established an ongoing working relationship focusing on our mutual efforts towards habitat restoration, conservation and various land uses in the watershed basin.

Our council strongly recommends your support and approval of this grant application.

Please contact me if you have any questions.

Sincerely,

Tremaine Arkley
Chair, Luckiamute Watershed Council