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# Bioengineering Case Studies

Sustainable Stream Bank and Slope Stabilization

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Sustainable Stream Bank and Slope Stabilization

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## Bioengineering Case Studies

TABLE 1

# **BIOENGINEERING CASE STUDIES: BY GEOGRAPHIC REGION AND COMPLETION DATE**

## **GREAT LAKES AREA:**

<b>PROJECT NUMBER</b>	<b>PROJECT NAME</b>	<b>TYPE OF PROJECT</b>	<b>TECHNIQUES EMPLOYED</b>	<b>GEOGRAPHIC LOCATION</b>	<b>COMPLETION DATE</b>
<b>1</b>	Fleming Creek	Stream bank repair and protection	<i><b>Rock vanes Pole planting</b></i>	Northfield TWP, MI	May 2006
<b>2</b>	Gateway Garden	Runoff and erosion control	<i><b>Stepped pools Riparian planting</b></i>	Ann Arbor, MI	Aug 2003
<b>3</b>	School Girls Glen	Erosion control and slope failure repair	<i><b>Boulder cascade VMSE Live staking Revegetation Invasive removal</b></i>	Ann Arbor, MI	Sept 2002
<b>4</b>	River Landing	Riverbank restoration and stabilization	<i><b>Vegetated riprap Live fascine ECB Revegetation</b></i>	Ann Arbor, MI	Oct 2005
<b>5</b>	Nichols Drive	Stream bank and road stabilization	<i><b>Rock vanes VMSE Chimney drain Revegetation</b></i>	Ann Arbor, MI	May 2008
<b>6</b>	Harvard Road	Gully repair and watershed restoration	<i><b>Rocked pools Sinuous channel ECB Live staking</b></i>	Ann Arbor, MI	Oct 2009
<b>7</b>	Malletts Creek	Stream bank repair and stabilization	<i><b>Rock vanes Low flow channel Coir logs ECB w/live stakes</b></i>	Malletts Creek watershed Southeastern Ann Arbor, MI	2011
<b>8</b>	Toboggan Hill	Erosion control	<i><b>Live fascines Live stakes</b></i>	Garden City, MI	2008
<b>9</b>	Arbor Cascades	Dam bypass channel	<i><b>Stepped pools Boulder spurs ECBs and grass seeding</b></i>	Ann Arbor, MI	2011



**Western USA**

<b>PROJECT NUMBER</b>	<b>PROJECT NAME</b>	<b>TYPE OF PROJECT</b>	<b>TECHNIQUES EMPLOYED</b>	<b>GEOGRAPHIC LOCATION</b>	<b>COMPLETION DATE</b>
<b>10</b>	Asaayi Lake	Watershed repair and restoration	<b><i>Landform grading Rock ramps Revegetation</i></b>	Chuska Mtns. New Mexico	2006
<b>11</b>	Hollywood Hills	Mass grading and canyon fills	<b><i>Landform grading Drainage swales Revegetation</i></b>	Lake Hollywood Los Angeles, CA	2005
<b>12</b>	Geyserville	Stream bank stabilization	<b><i>Rock vanes LSTP Live siltation Pole planting</i></b>	Geyserville, CA	2010
<b>13</b>	Buckhorn Mountain	Hwy. cut slope repair and stabilization	<b><i>Modified VMSE ("soil flaps") Veg. gabion baskets Soil amendments</i></b>	Hyw. 299W 0.1 mi below summit, Shasta Co, CA	Aug 2002
<b>14</b>	Buckhorn Summit	Hwy. cut slope repair and stabilization	<b><i>Live staking Brushlayers Soil amendments Stepped slope</i></b>	Hyw. 299W at summit Shasta Co, CA	2005
<b>15</b>	Stafford Watershed	Landslide repair and slope stabilization	<b><i>Pole drains Brushlayers Live staking</i></b>	Humboldt County, CA	2004
<b>16</b>	Pacifica	Landslide repair and slope stabilization	<b><i>Slope drains Live fascines Live staking</i></b>	San Mateo County, CA	Sept 1997
<b>17</b>	Branciforte Creek	Stream bank stabilization	<b><i>Veg. riprap w/pole planting and brushlayering Veg. gabion baskets</i></b>	Trib. to San Lorenzo R. in San Lorenzo Watershed	2002
<b>18</b>	San Vicente Creek	Stream bank stabilization	<b><i>Rock Vanes Rootwad revet. Veg. riprap - bent pole method Live staking</i></b>	Second-order stream in Santa Cruz Co nr city of Davenport, CA	2003

**Western USA (cont)**

<b>19</b>	Opal Cliffs	Slope stabilization	<b>Anchored TRM Live staking Hydroseeding</b>	Opal Cliffs Dr. Santa Cruz, CA	Aug 2007
<b>20</b>	Sulfur Creek	Stream bank stabilization	<b>Pole planting LWD and rock strucs Newbury rock riffle LPSTP w/live silt Stream realignment</b>	Turtle Bay, Redding Arboretum Redding, CA	2001
<b>21</b>	Secret Canyon	Slope repair and stabilization	<b>Toe protect w/brush layers Woven willow fences Pole planting</b>	Tributary to Sulphur Creek Redding, CA	2002

**Eastern USA**

<b>22</b>	Greenfield Road	Hwy. cut slope repair and stabilization	<b>Live brushlayers Live fascines Coir netting</b>	Colrain, MA	Dec 1989
<b>23</b>	Buffalo Bayou	Riverbank repair and stabilization	<b>Vegetated MSE Chimney drain Live fascines Live staking Live boom</b>	Buffalo Bayou Houston, TX	1996
<b>24</b>	Little Topashaw	Riverbank repair and stabilization	<b>LW structures Willow posts and poles</b>	Topashaw Cr. Yalobusha R. watershed central, MS	2006
<b>25</b>	New Concord	Hwy embankment stabilization	<b>Willow poles</b>	Intersection I-70 & SR83 near New Concord, OH	2003
<b>26</b>	Water Treatment Facility	Shoreline stabilization	<b>Coconut fiber rolls Bioswales Green roof Live brushlayering</b>	New Haven, CT	1999

## Eastern USA (cont)

PROJECT NUMBER	PROJECT NAME	TYPE OF PROJECT	TECHNIQUES EMPLOYED	GEOGRAPHIC LOCATION	COMPLETION DATE
27	Walden Pond	Shoreline stabilization	<i>Vegetated MSE Live staking Live brushlayering Blueberry sod</i>	Concord, MA	1993
28	Hearthstone Quarry Brook	Channel stabilization	<i>Cross vanes Coconut fiber rolls Veg. gabion baskets Live brushlayering</i>	Chicopee, MA	1993
29	Mill Creek	Stream bank stabilization	<i>Vegetated MSE ECBs Live poles Live fascines and stakes</i>	Cincinnati, OH	1996
30	Charles River	Riverbank stabilization	<i>Coconut fiber rolls Live brushlayering Live staking ECBs</i>	Watertown, MA	1998
31	Connecticut River	Stream bank stabilization Erosion control	<i>Vegetated MSE Live brushlayering Live staking</i>	Northfield, MA	1995
32	Cumberland River	Stream bank stabilization	<i>Willow poles Live staking Live brushlayering Live fascines</i>	Nashville, TN	1996
33	Manhan River	Stream bank stabilization	<i>Coconut fiber rolls Bendway weirs Rock vanes</i>	Easthampton, MA	1997
34	Walgreen Slope	Erosion control	<i>Live fascines Live poledrains Live staking ECBs</i>	Marshfield, MA	2007
35	Creek Road	Stream bank repair and stabilization	<i>Rock vanes Bendway weirs Revegetation LSTP</i>	Yorkshire Cattaraugus Co New York	2009



TABLE 2

**BIOENGINEERING CASE STUDIES: BY PROJECT DESIGNER  
AND/OR DIRECTOR**

**GREAT LAKES AREA:**

PROJECT NUMBER	PROJECT NAME	TYPE OF PROJECT	GEOGRAPHIC LOCATION	CLIENT/ OWNER	PROJECT DESIGNER AND/OR DIRECTOR
1	Fleming Creek	Stream bank stabilization	Northfield TWP, MI	University of Michigan	<i>Sarah Weiss</i> , School of Natl. Resources University of Michigan and <i>Donald Gray</i> , Dept. of Civil and Envl. Engr. University of Michigan
2	Gateway Garden	Runoff and erosion control	Ann Arbor, MI	University of Michigan	Ayres, Lewis, Norris & May Inc. Construction & Bldg. Engineers Ann Arbor, MI
3	School Girls Glen	Erosion control and slope failure repair	Ann Arbor, MI	University of Michigan	<i>Tammy Orlow</i> , School of Natural Resources University of Michigan and <i>Donald Gray</i> , Dept. of Civil and Envl. Engr. University of Michigan
4	River Landing	Riverbank restoration and stabilization	Ann Arbor, MI	University of Michigan	Envl. Consulting & Technology [ECT] Environmental Consultants Ann Arbor, MI
5	Nichols Drive	Stream bank and road stabilization	Ann Arbor, MI	University of Michigan and City of Ann Arbor	Envl. Consulting & Technology [ECT] Environmental Consultants Ann Arbor, MI
6	Harvard Road	Gully repair and watershed restoration	Ann Arbor, MI	University of Michigan and City of Ann Arbor	OHM Advisors Architects, Engineers & Planners Ann Arbor, MI
7	Toboggan Hill	Erosion Control	Garden City, MI	Wayne County Parks Dept.	NTH Consultants Infrastructure Engr. & Envl. Services Northville, MI
8	Malletts Creek	Stream bank repair and stabilization	Malletts Creek watershed Southeastern Ann Arbor, MI	City of Ann Arbor	OHM Advisors Architects, Engineers & Planners Ann Arbor, MI
9	Argo Cascades	Dam bypass channel	Ann Arbor, MI	City of Ann Arbor	Recreation Engineering and Planning Stream Design & Restoration Boulder, CO

**Western USA**

<b>PROJECT NUMBER</b>	<b>PROJECT NAME</b>	<b>TYPE OF PROJECT</b>	<b>GEOGRAPHIC LOCATION</b>	<b>CLIENT/ OWNER</b>	<b>PROJECT DESIGNER AND/OR DIRECTOR</b>
<b>10</b>	Asaayi Lake	Watershed repair and restoration	Chuska Mtns. New Mexico	Navajo Nation	<i>H.J. Schor</i> H.J. Schor Consulting Anaheim, CA
<b>11</b>	Hollywood Hills	Mass grading and canyon fills	Lake Hollywood Los Angeles, CA	Los Angeles DWP	<i>Horst J. Schor</i> H.J. Schor Consulting Anaheim, CA
<b>12</b>	Geyserville	Stream bank stabilization	Geyserville, CA	CALTRANS	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>13</b>	Buckhorn Mountain	Hwy. cut slope repair and stabilization	Hyw. 299W 0.1 mi below summit, Shasta Co, CA	CALTRANS	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>14</b>	Buckhorn Summit	Hwy. cut slope repair and stabilization	Hyw. 299W at summit Shasta Co, CA	CALTRANS	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>15</b>	Stafford Watershed	Landslide repair and slope stabilization	Humboldt County, CA	Pacific Lumber Company	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>16</b>	Pacifica	Landslide repair and slope stabilization	San Mateo County, CA	Local homeowners association	Alan Kropp Alan Kropp & Assoc [AKA] Berkeley, CA
<b>17</b>	Branciforte Creek	Stream bank stabilization	Trib. to San Lorenzo R. in San Lorenzo watershed	Public Works Department Santa Cruz County	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>18</b>	San Vicente Creek	Stream bank stabilization	Second-order stream in Santa Cruz Co nr city of Davenport, CA	Public Works Department Santa Cruz County	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>19</b>	Opal Cliffs	Slope stabilization	Opal Cliffs Dr. Santa Cruz California	Local homeowner	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>20</b>	Sulfur Creek	Stream bank stabilization	Turtle Bay Redding, CA	Sacramento Watershed Action Group (SWAG)	<i>John McCullah</i> Salix Applied Earthcare Redding, CA
<b>21</b>	Secret Canyon	Slope repair and stabilization	Tributary to Sulphur Creek Redding, CA	CRMP and SWAG	<i>John McCullah</i> Salix Applied Earthcare Redding, CA

**Eastern USA**

22	Greenfield Road	Hwy. cut slope repair and stabilization	Colrain, MA	Massachusetts State Department of Highways	Robbin B. Sotir & Assoc. Soil Bioengineering Consultants Marietta, GA
23	Buffalo Bayou	Riverbank repair and stabilization	Buffalo Bayou Houston, TX	Riparian home owner	Robbin B. Sotir & Assoc. Soil Bioengineering Consultants Marietta, GA
24	Little Topashaw	Riverbank repair and stabilization	Topashaw Cr. Yalobusha R. watershed, no central, MS	USDA-NRCS and Chickasaw Co. Conservation District	F. Douglas Shields, Jr. Res. Hydraulic Engineer USDA-ARS Nati. Sedimentation Lab Oxford, Miss
25	New Concord	Hwy embankment stabilization	Intersection I-70 & SR83 near New Concord, OH	Ohio DOT	<i>Patrick Fox, T.H. Wu</i> Dept. of Civil & Envl. Engr. Ohio State University Columbus, OH
26	Water Purification Facility	Shoreline stabilization	New Haven, CT	South Central Connecticut Regional Water Authority	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
27	Walden Pond	Shoreline restoration	Concord, MA	Massachusetts Department of Conservation and Recreation	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
28	Hearthstone Quarry Brook	Channel stabilization	Chicopee, MA	Department of Public Works City of Chicopee	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
29	Mill Creek Landfill	Stream bank stabilization	Lower Mill Creek Cincinnati, OH	Municipal Sewer District City of Cincinnati	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
30	Charles R. Watertown Arsenal	Riverbank stabilization	Watertown, MA	US Army Corps of Engineers New England District	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
31	Connecticut River	Stream bank stabilization	Northfield, MA	Western Mass. Electric Co.	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA



**Eastern USA (cont)**

<b>PROJECT NUMBER</b>	<b>PROJECT NAME</b>	<b>TYPE OF PROJECT</b>	<b>GEOGRAPHIC LOCATION</b>	<b>CLIENT/ OWNER</b>	<b>PROJECT DESIGNER AND/OR DIRECTOR</b>
<b>32</b>	Cumberland R. Shelby Bottoms Park	Bank stabilization	Nashville, TN	US Army Corps of Engineers Nashville District	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
<b>33</b>	Manhan River	Bank stabilization	Easthampton, MA	Tennessee Gas Pipeline Company	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
<b>34</b>	Walgreens Slope	Erosion control	Marshfield, MA	BRT Management	<i>Wendi Goldsmith</i> Bioengineering Group Salem, MA
<b>35</b>	Creek Road	Stream bank repair and stabilization	Yorkshire Cattaraugus Co New York	Town of Yorkshire, NY	<i>Todd Swackhamer</i> McMahon & Mann Consulting Engineers Buffalo, NY

## Preface

Vegetation is likely the most natural, self-sustaining, and cost-effective method for protecting exposed soils, slopes and, streambanks from the erosive forces of raindrops, the tractive forces of flowing water, and the exfiltration of subsurface water.

Vegetative measures for stabilization purposes have developed rapidly during the past three decades, and have been applied frequently in practice to stabilize stream banks and restore watersheds so too have the use of related measures to stabilize upland slopes. Several guidance manuals and “how to do it” books have been published during this time period. However, to date no detailed compilation of the results of projects has been published. **Bioengineering Case Studies: Sustainable Stream Bank and Slope Protection** addresses this need. The book describes many different types of case histories of biostabilization projects and their outcomes including the restoration and maintenance of geomorphic and ecological functions.

In this book two experienced practitioners along with the principal author of two prior books on biotechnical engineering have collaborated to share a diverse set of project case studies from several regions of the USA. These projects were developed for different purposes and by project owners with distinct needs, constraints, and preferences. The projects described in this book were selected in order to reflect not only sound application of typical treatments but also to convey some more nuanced variations and innovations that reflect the practice of bioengineering in the twenty-first century.

The main purpose of **Bioengineering Case Studies: Sustainable Stream Bank and Slope Protection** is twofold, namely, to build upon the wealth of information provided in prior guidance manuals (such as the 2005 report 544, Environmentally Sensitive Channel and Bank Protection Measures, by the National Cooperative Highway Research Program (NCHRP)), and to describe different types of projects using functional living vegetation and evaluate their performance. The original NCHRP 544 report provided a detailed literature review of available knowledge and methods relating to environmentally sensitive channel and stream bank protection practices and their use by different practitioners and agencies. The NCHRP report mainly targets highway design engineering criteria. This book, on the other hand, focuses more on short- and long-term performance history, maintenance issues, and lessons learned from actual projects.

This book is a retrospective compilation of case studies. It is not intended to provide design procedural descriptions nor does it attempt to train practitioners on the many disciplines of science, engineering, construction, horticulture, and regulatory compliance that underlie each project. The objective is to help people visualize how projects have been configured in the past, and to understand precedents and examples so the approach will come across as both attractive and manageable. There are many guidance manuals for the reader to refer to; several are listed in the appendices or in the references at the end of each case study.

We would like to acknowledge the assistance of the following persons who helped directly in the preparation and review of the book. Horst Schor, HJ Schor Consulting, Anaheim, CA reviewed the write-ups of the Asaayi Lake (#10) and Hollywood Hills (#11) projects that he also designed. Alan Kropp, Alan Kropp & Assoc., Berkeley, CA provided useful information about the Pacifica (#16) project. Dr. F.D. Shields, Jr., USDA-ARS Natl. Sedimentation Lab, Oxford, MS provided helpful



information and photo documentation about the Little Topashaw (#24) project. Prof. T.H. Wu, Dept. Civil Engr., Ohio State University, Columbus, OH provided useful information about the New Concord (#25) project that he directed. Molly Robinson, Manager, Water Treatment Services, City of Ann Arbor, reviewed the write-up and provided helpful information about the Argo Cascades (#9) project. Todd Swackhamer, Project Manager, MacMahon and Mann, Consulting Engineers, provided a write-up for the Creek Road (#35) project. Duke Bitsko, Corey Schutzman, Danielle Kelleher, and Amanda Bibbins from Bioengineering Group all provided valuable support hunting for project information from archives, selecting useful photographs, and editing text to shape multiple project documents into succinct case studies. The staff of Salix Applied Earthcare provided much useful information for the case studies. They sometimes worked as Project Managers for the Sacramento Watersheds Action Group (SWAG). This nonprofit watershed restoration group restored over 2-miles of Sulphur Creek (Proj #20) by soliciting grant funding, acquiring environmental permits, implementing the projects, and then monitoring effectiveness.

Redding, CA  
Ann Arbor, MI  
Salem, MA

John McCullah  
Donald Gray  
Wendi Goldsmith

## About the Authors

**Wendi Goldsmith** is founder and CEO of Bioengineering Group, a Salem, Massachusetts based consulting firm whose mission is “Building sustainable communities on an ecological foundation.” Since becoming involved in bioengineering practice in 1987, she has often led interdisciplinary collaborative design teams to adopt ecologically rich strategies. Her roles span planning of large scale multi-state watershed management and restoration projects, to design of stabilization and ecological enhancement treatments for riparian sites compromised by solid and hazardous waste, to leading infrastructure design procedures that account for future hydrology and sea level rise considerations. She is known for building consensus among diverse and often antagonistic stakeholder groups to help advance some of the largest public infrastructure projects in history. Ms. Goldsmith provided technical leadership for the first large scale federal project to provide resilient and adaptable infrastructure featuring hard structures and also extensive coastal wetland restoration and management, the Greater New Orleans Hurricane Storm Damage Risk Reduction System, featuring \$14 billion of construction.

Ms. Goldsmith’s academic training and applied experience have honed her expertise in the physical, chemical, and biological processes that affect watershed quality, including restoration techniques. She has extensive experience in all phases of project design and implementation for ecological restoration, particularly in dense urban environments, as well as for stabilization of lakes, rivers, and coastal areas. She has played a key role in promoting local familiarity and acceptance of bioengineering methods and for systems-scale sustainable solutions. Evaluating change in land use and its effect on geomorphic stability, nonpoint source pollution, and habitat degradation has been an integral part of Ms. Goldsmith’s waterways assessments, stormwater management, restoration, and climate change adaptation projects. She is skilled in the areas of soil science, fluvial geomorphology, biogeochemistry, landscape design, wetland management, construction, and economics. She also has a thorough understanding of federal, state, and local environmental regulatory policies, and she has provided expert testimony on their meaning and intent on cases connected to damaged ecosystems. She has authored many peer-reviewed articles, book chapters, and lay articles; lectured at universities; and led training programs for professional audiences around the world. Her projects have received numerous awards including the AIA Top Ten Green Award, the American Academy of Environmental Engineering Award, and the American Consulting Engineers Council Grand Conceptor Award, among others.

Ms. Goldsmith holds an MS degree in plant and soil science from UMass, an MA degree in landscape design from the Conway School, and a BA degree in geology and geophysics/studies in the environment from Yale University. Additionally she trained under Europe’s leading river and coastal bioengineering expert, Lothar Bestmann. She is a licensed Professional Geologist and holds multiple professional certifications.

**Dr. Donald Gray** is a Professor (Emeritus) of Civil and Environmental Engineering at the University of Michigan. He specializes in geotechnical engineering with a focus on slope stability, soil erosion, and bioengineering. Dr. Gray has taught graduate and undergraduate courses on the engineering properties of soils, soil/site improvement, slope stability, engineering geology, foundation engineering, and bioengineering for slope protection at the University of Michigan as well as many professional short courses and workshops. He has carried out research for decades on



soil reinforcement and the influence of woody vegetation on the stability of slopes. His principle research interests lie in the areas of slope stability, earth reinforcement, and bioengineering.

Dr. Gray has served as a consultant to the National Park Service, US Forest Service, Natural Resources Conservation Service, US Army Corps of Engineers, and most recently to the California Levee Vegetation Research Program. Professor Gray's industrial experience includes a position as Petroleum Engineer with Mobil International Oil Company. He was also employed as Research Engineer with Chevron Research Company. He has served as a consultant on numerous occasions to both private and government agencies. On many occasions he provided expert testimony related to a broad range of engineering and resource management topics.

Dr. Gray is the principal author of two leading reference books on slope biostabilization which helped establish a basis for widespread adoption of design and construction methods in the US. More recently he was co-author of a publication entitled *Landforming: An Environmental Approach to Hillside Development, Mine Reclamation, and Watershed Restoration*. He was also a principal investigator in a 3-year project funded by the National Cooperative Highway Research Program on "Environmentally Sensitive Channel and Streambank Protection Measures." The goal of this project was to produce a guidance manual on this topic for use by highway engineers and their consultants.

He received all his degrees, including a BS in Geological Engineering and a PhD in Civil Engineering, from the University of California at Berkeley. His extensive and pioneering research combined with his well regarded publications has established him as the pre-eminent authority on bioengineering of our time.

**John McCullah** is President of Salix Applied Earthcare, a consulting firm located in Redding, California, and practicing in the fields of erosion and sediment control, watershed restoration, stream restoration, and bioengineering. His career has focused on practical solutions applicable in the arid and semi-arid conditions of the Sierra Nevada Mountains, emphasizing hands-on methods and guidance to contractors. He brings over 21 years of experience training others in erosion and sediment control, watershed restoration, stream restoration, and bioengineering through multiple channels including online video trainings. He has been an adjunct instructor at Shasta College since 1998, teaching Watershed Restoration and Construction Site Erosion Control.

Drawing on his training and experience as a Watershed Geologist, he has worked to support effective stabilization and revegetation on complex construction projects in CA and elsewhere for more than three decades. His projects have tackled saprolitic bedrock materials, creeks populated with endangered species, and sites where prior construction measures have failed. McCullah authored the first Erosion and Sediment Control BMP Manuals for Shasta County in 1992 and then published the award-winning Erosion Draw Manual with AutoCad Typical Drawings in 1994. As a member (and instructor) with the International Erosion Control Association (IECA), John also served on its Board of Directors for 5 years. He served as co-author on the report for the National Cooperative Highway Research Program on "Environmentally Sensitive Channel and Streambank Protection Measures."

John managed the Caltrans 24-hour Certified Stormwater Training at the College and is the Project manager for the Shasta College Erosion Control Training Facility, a six-acre site built to replicate construction site conditions in order to research and demonstrate the proper use of BMPs. For over six years John was the co-instructor for "Field Application Training for Erosion and Sediment Control BMPs on Caltrans Construction Sites", two-day field courses provided to personnel at each

Caltrans District. This hands-on training led John to develop and produce the erosion control training video series “Dirt Time” with John McCullah. It has been said that “Dirt Time is to Erosion Control as *This Old House* is to home renovation”. Salix has also developed the popular design manuals on CD; ErosionDraw, BioDraw, and ESenSS.

Mr. McCullah has been a Certified Professional in Erosion and Sediment Control (CPESC #311) since 1986, has a BS in watershed geology from Humboldt State University, and is a California Contractor.