John A. McCullah
Autobiography

2021 Lifetime Achievement Award - EnviroCert International

John McCullah was born in Santa Cruz, California in early 1950s. Growing up a block from Pleasure Point surf area, John spent a majority of his formulative years Surfing and hunting with his dad during the season. "I loved the outdoors and decided to become a Forest Ranger when I grew up. California State University Humboldt State University seemed to be the best bet for a Degree in Forestry, but the fates had a big part to play in when I'd attend. Upon graduating from high school, I made a trip up to HSU to check out the campus, but I soon discovered I wasn't ready to leave Santa Cruz. The climate at HSU was foggy and cold during my visit – plus the waves were good back at Pleasure Point and I'd just learned I was about to become a young father. My plans for a Bachelor of Science were put on hold for over a decade. My dad's admonitions that I'd become a "surf bum" seemed to become a self-fulfilling prophesy – at least until I turned 28 years old."

John did attend Cabrillo College and eventually completed his undergrad requirements for an AA in Biology at Shasta College in 1979. In the interim John gained work experience in Construction, Firewood cutting, scuba diving in Hawaii and Gold Dredging in Trinity County. He eventually attended Humboldt State University nearly fulfilling a degree in Geology. Focusing on Environmental Geology and Stratigraphy this discipline of geomorphology helped John find the placer gold he 'hunted' during summer breaks spent in Trinity County.

He then transferred to Natural Resources, and his degree path increased, - now requiring 30 additional semester units in courses that truly fulfilled his interdisciplinary interests and inclination, classes including soils, erosion, slope stability, river engineering and watershed management.

It's ironic that it took John four tries to pass speech and interdisciplinary communication, looking at his vocation / avocation now that involves speaking in public - teaching dozens of classes in Erosion Control, Slope Stabilization (bioengineering), and Stream Restoration, and writing technical materials, such as BMP Manuals.

John acquired his BS in Watershed Geology / Forest and Range Hydrology in 2004 from HSU. He followed his 2nd wife back to Santa Cruz where she obtained her MS in Mathematics, while John acquired a California Contractors License and started a Landscaping Business. His most memorable jobs involved soil stability and erosion control work on the steep Cliffs between Pleasure Point and Capitola – the same cliffs he spent his juvenile years climbing and exploring. The Opal Cliffs job, for example was commissioned by John's older brother to stabilize the cliff to protect the family home coastal bluff erosion and ultimately, from foreclosure – this location at Sharks Cove had also received their mothers' ashes.

John and his crew prepared the slope by carefully 'grading' the cliff face prior to applying Green Armor System, a effective application of Enka Mat TRM combined with Profile's Flexterra hydromulch. Intimate contact between soil surface was critical so the Enka Mat was anchored by repelling down the cliff and installing 20-60 penny nails with washers. Then the crew "shot" Flexterra into the Enka mat.

While the native grasses selected only had 20% establishment, the willow stakes taken from a neighbors 50 yr.-old willow, (John remembered from his childhood) grew well. The Green Armor system provided 100% protection for over 4-5 years, until the inevitable foreclosure and re-build occurred. See www.dirttime.tv/opalcliffs

Figure 1 John's brothers house on Opal Cliffs Drive in Santa Cruz, CA needed innovative steep slope soil stabilization. Here John applies Green Armor System to the 'cliff'. The stabilization methods stopped erosion for over 4-yrs, until the property was repossessed. The native maritime blend establishment was sparse, probably for failing to do soil test.

In 1987 John discovered the Santa Cruz Resource Conservation District and began working part time for them-preparing Soil Erosion and Drainage Inspection Service (SEDIS), this service, which was similar to a Termite Inspection Report. The SEDIS reports were valuable to homeowners and / or homebuyers in the area. Santa Cruz County was quite notorious from a slope stability and erosion perspective because of the steep mountains, high rainfall intensities, and drainage-related slope erosion."

"Once I met Rich Casale, Ward Hastings and the SCRCD Board of Directors I felt I'd arrived home – they we actually talking about Erosion Control. I was soon encouraged by Rich and staff to become a Certified Professional in Erosion and Sediment Control. I was bestowed CPESC #0311 in 1988".

"Shortly after starting to work for the RCD, I developed my first BMP. The SEDIS often needed BMP detailed fact sheets to accompany the "prescriptions" provided in the final reports. In this case I needed a Typical Drawing for an Energy Dissipator. I researched the topic and developed a one-page Technical Sheet showing a recycled tire located at the drainpipe outlet, anchored to the ground, and then filled with gravel/rock. I also included design considerations and construction details – I had developed my first BMP!"

"I soon came to realize that I had no experience building this type of structure so with my future endeavors in the development of BMPs I tried to gain first-hand knowledge of the techniques first. I'm proud to say that, in 1994 I removed the Straw Bale Barrier/Straw Bale Check Dam from all the BMP Manuals I had authored, (then numbered at 3 editions). There was no way I could find that a straw bale could be called a "BEST" practice unless it was broken-up and spread as Straw Mulch!".

John relocated back to Trinity County and then Shasta County in 1988. Lower Back injuries forced him to rethink his career as a landscaper and he volunteered for the Trinity County Resource Conservation District (TCRCD) and the Western Shasta Resource Conservation District (WSRCD). He was the first employee that the districts had hired. The $56 million Trinity River Restoration Program was midway through its 10-year program to restore the declining anadramous fisheries. But the first 5-years were primarily 'times of study' for the 14 State and Federal and Native stakeholders.

The initial studies revealed the main reason for 'salmon' decline was two-fold; 1. Dam building between 1964 and 1986 had reduced Trinity River hydrologic discharge by 90% while 2., during the same period sedimentation from the highly erodible upper Sub-watershed - Grass Valley Creek- was estimated to produce thousands of cubic yards of sandy Decomposed Granite (DG) sediment material which buried and destroyed the dwindling aquatic habitat.

"It was very fortuitous for me and the RCD to come on the scene when the I did – the Task Force members were rather desperate to be able to show 'projects on the ground. I didn't realize at the time that my studies and personal construction experience made me an excellent candidate for my position. Within a year or so of volunteering as Project Manager, often utilizing CDC Inmate crews and specially trained CCC crews to complete individual erosion works, I found myself with a $2 million budget and over 30 'District' employees. For the staff Project Coordinators, who were mostly Humboldt State graduates, this 17,000 ac watershed became a massive design/build project."

"The first year we treated over 1000 erosion sites *, which were primarily active gullies on abandoned logging roads and landings. Access to the remote sites was limited so the check dam components included logs, DG-filled geotextile bags, and willow (bioengineering) branches. We soon realized that treating gullies with check dams was ineffective for fishery restoration because the gullies we were treating had already 'blown-out' - an estimated 50-80 percent of sediment had already been delivered to the stream system. Photo and ground surveys revealed a road density of 31 miles of logging roads per square mile. Check dams were never going to provide the sediment reduction needed."

In a paper presented by Luna Leopold, 1997, Oakland CA, "Let Rivers Teach Us", Leopold states "It is obvious to most of us today that a grade control structure (check dam) flattens the channel gradient upstream for only a

short distance and intrudes an un-natural anomaly into the fluvio system. Such an anomaly will be attacked by the flow and, given time, will be eliminated. It will ultimately be destroyed by undercutting, by lateral erosion of the abutments, by scour hole erosion at the toe, or by some combination of these."

"A far better strategy would be to use landform grading (restoring historic hillslope drainage patterns) to remove the road crossings or log landings before they gully. So, we reached out to Redwood National Park, CA State Parks and other experienced heavy equipment operators on how to identify when 'landform grading' was going to get the best return for our restoration dollars. The GVC program then was an incredible learning ground because the DG was so erodible, and the road density was so great. We realized that DG could not survive concentrated flows and virtually all the significant sediment sources were logging landings and/or stream crossings – viz. DG sand placed in waterways by logging activities. By 1991 our paradigm was to restore drainage patterns by removing any DG that a bulldozer pushed into a stream or channel. If we could remove that sediment it, simultaneously, had to be placed back where it came from, usually the nearby road cut was the source of the 'fill'. We also learned that once we started removing the "dozer fill" from the channels we needed to continue until we restored the channel to its native ground". The TCRCD new mantra became "if a bulldozer placed it in the channel, we should use heavy equipment, usually of the same size, to cost effectively remove DG fill from channels (shaped by flowing water)."

Restoring the natural drainage was like road building in reverse except the removal often required heavy equipment team consisting of a high-powered bulldozer with U-shape blade (we are now pushing the sediment uphill) and an excavator which was needed to excavate the final layer of sediment and logs. Restoring hillslope drainage patterns became the name of the game and, after being trained, the RCD's geomorphic site managers and local 'logging road builders' became excellent landform restorationists. In 1992 the TCRCD treated over 22 miles of roads, eliminating many thousands of cubic yards of salmon-killing sediment from ever reaching the Trinity River at Lewiston. By the second full year of landform grading, we found that native shrubs and wood removed could cost-effectively replace straw mulching, another paradigm shift. Native grasses were used to facilitate the successional restoration process that was started.

Figure 2 This potential gully site treated with landform grading - logging road removal involved removal of "dozer placed DG sediment from the waterways. This was one of our first examples of the dozer - excavator team "restoring its way out of the watershed.

John became a member of IECA in 1991 and attended his first Annual Conference in Reno. Since then, he has not only attended an estimated 28 conferences, but also became consistent paper presenter and a Pre-conference Trainer – teaching over 25 day-long Courses on Best of the BMPs and Environmentally-Sensitive Streambank Stabilization Methods, aka, E-SenSS, aka, Alternatives to Rip Rap. John fulfilled over 5-yers on the IECA Board of Directors serving as VP of Education. "I was twice invited as Keynote Speaker for IECA International Chapters, 2 times for the Iberoamerican Chapter, once in Buenos Aires Argentina and once in Belo Horizonte, Brazil. Likewise John was invited as Keynote Speaker for Australasia Chapter. This is "not a bad resume' for someone who dropped speech 4 times!".

John formed his own business, Salix Applied Earthcare LLC, in 1994. The consulting firm providing BMP and SWPPP Training, along with Bioengineering design/build work. In the late 1990s John joined, along with Carol Forrest, Mike Harding and others, the CalTrans Stormwater Task Force. He became a designated QSD/QSP and then a Trainer of Record (ToR). He helped develop and implement the extensive CalTrans Storm Water Training Courses: for instance, Module 2, Field Erosion Control, two-day course "was presented predominately by David Franklin and me over a 5-year period."

"The Field Erosion Course was an opportunity, for training in the classroom and in the field. Over a period of 4-years the field courses were presented to thousands of CT staff from all the 13 Districts who had an opportunity to observe and participate in BMP installations. CT staff got to touch and feel the various Hydromulches and observe how to properly load the FINN T-60 provided. It was enlightening for the District SWPPP designers to experience how difficult it was to dig a trench and properly install a silt fence – we soon saw a drop in the utilization and the misuse of Silt Fence BMP, and an increase in temporary Fiber Rolls. The SWPPP designers and

Inspectors learned how to properly configure install Gravel Bag curb inlet protection, configured as a J-hook instead of blocking the inlets.

The CT attendees, and importantly the inspectors, got to compare products applied at the correct rates and at rates that were under-applied. For instance, we applied Flexterra BFM at 2000#/ac and at the specified rate of 4000#/ac. The same exercise was done with Straw Mulch plots when applied at 1T/ac and at 2T/ac, side by side. "We got informative feedback when CT staff admitted that the lower rates were all too commonly seen." The application rates accompanying mulches seemed to be meaningless until they are 'calibrated' by having opportunity to make visual comparisons.

"We, Dave and I must have taught the Module 2 Course over 300 or 400 times, and it was evaluated very high in the post-training evaluations. This experience eventually led to hugely popular 2-day, Classroom and Field BMP SUMMIT at Shasta College."

Figure 3 John, David Franklin, and Colin Ewert demonstrate to CT staff the proper grael bag barrier placement, so not to plug curb inlet and demonstrating the use and application rates of hydromulches and straw mulch.

"In 1996 I was hired by Shasta College as a part-time Instructor – teaching a course I developed in Watershed Restoration. At that time the Timber Industry was in decline and the Shasta College (SC) Agriculture Program was "flat". I was hired to explore an expanded curriculum in "restoration", and thereby provide certificated education in, not only Salmonid Restoration but also Erosion and Sediment Control."

"In 1997-98 Shasta College (SC), Whiskeytown NRA, and my NR-66 class won an award and we were sent to the Capitol in Washington DC to accept recognition for our work in Whiskeytown NRA. The SC Watershed Restoration class conducted the geomorphic analysis of a sub-watershed impacted by an old, badly "blown-out", logging road referred to as "Satan's

Crack", (described by a widely read Bike Trail Book , cautioning the trail riders that, "years of erosion have lead this challenging Bike Track to the ways of the devil."). Actually, the track now named Logging Camp Trail, was a 30-years old, abandoned, 1-mile-long logging road, which was impacted by several diversion gullies. Defined as gullies that form when natural drainages get "captured" by a road when the sometimes-culverted stream crossing become overwhelmed. An instream sediment pond was installed at the downstream extant of the Satan's Crack drainage. Two weeks before the road restoration was started, the Satan's crack trail produced over 100 CY of sediment. The restoration, using the SC Dozer/excavator team, took 10 days to complete. Unseasonable weather resulted in 0ver 10" of rain during the work period. The downstream sediment pond only collected 1 CY! This experiment provided evidence that restoring hillslope drainage patterns are extremely effective way to eliminate the sediment delivered from upslope road systems. This one-mile conversion of road to trail cost an estimated $10K. Considering impacted downstream fisheries habitat, the importance of the abandoned road impacts and the effectiveness of treatments become especially important given the analysis that Whiskeytown NRA, like it's neighboring DG Grass Valley Creek Watershed, revealed a road density of over 30miles of road sq. mile!. Johns Class and Heavy Equipment eventually converted the road to a moderate class, 2-ft wide trek that is challenging but no longer deadly.

Over the 24-yrs John has been a part-time instructor with SC the curriculum of his has morphed – his students now have a bimodal curriculum. Half time is spent covering topics in watershed restoration and half time covering construction BMPs and the NPDES program.

In 2005 the SC Administration approved the use of 6-acres of the Farm Area for developing an Erosion Control Training Facility (ECTF). The ECTF concept was based on the CT Field Erosion Control without the challenges of trying to demonstrate an array of BMPs on a highway ROW, which was not only dangerous but also extremely limiting. How, for instance, could we demonstrate Track Walking or the use of TRMs in a flowing channel situation? McCullah's vision of having a state-of-the-art field site and making Shasta College a "Center for Excellence" for BMPs and Storm Water compliance was coming to fruition. SC already had Heavy Equipment and a Heavy Equipment Operations class and that was an existing benefit that reinforced a grant that John wrote to 'run' 2000LF of 4-in water main to the ECTF. The field site could now construct a demonstration channel, with flowing water, to mimic a "real-life" construction site.

McCullah, with the support of SC BAITS Division and the Economic and Workforce Development held the first BMP SUMMIT at Shasta College in 1995, an event attended by over 70 storm water professionals, State and Federal Resource Agencies, and Exhibitors. The second, two-day SUMMIT, held in 2016, attracted over 100 attendees and a dozen Exhibitors. Erosion specialists from as far as Mariana Islands and French Federal Environmental Agency (ONEMA) attended this SUMMIT. In fact, the technology transferred during this event, which included the dirttime.tv Video Clips, the BMP Guidance Manual, along with the field demonstrations, were used by the entourage to create the first Federal French BMP guidance document.

Some of the BMPs and Installation Tips showcased included Hydraulic Mulch types and applications, EC Blankets and Mats, the Faircloth Skimmer outlet, silt fence by static slicing, the Theory of Turf Reinforcement Mats, Fiber Rolls as slope interrupters and for sediment barriers., Velocity Transition Mats, and the Green Armor System.

Figure 4 The Erosion Control Training Facility at Shasta College, which, each Spring Break, hosts the Annual Best of the BMPs SUMMIT at Shasta College

"In the late 1990s there were over 8 or 9 endangered salmonid runs designated as endangered and or threatened. The State of Oregon had over 40 local non-profit watershed groups implementing grant-funded Watershed Restoration Projects. California had only two such groups, the Mattole Watershed group and North Coast Watershed Association, which were developing Cooperative Agreements with State and Federal Agencies, for restoration funding and support. In 1996 John started the Sacramento Watersheds Action Group (SWAG), a 501 (3) (c) public benefit watershed restoration group. SWAG's first focus was to successfully write a Grant to perform a Watershed Management Plan for Sulphur Creek, an urban salmonid stream which prior to being impacted for over 100-years by Gold Dredging turning the creek upside down, road building and the UP Railroad transecting the watershed, and the massive Conveyor Belt delivering 5 million tons of gravel from 1938 to 1941 for Shasta Dam. In the twelve

years, between 1996 and 2008 SWAG received over $1.2 million dollars in grant funds to successfully implement projects, including over 2-miles of stream restoration, daylighting Secret Canyon, and landform grading 2 miles of the Old Highway 99, abandoned in 1934. SWAG utilized paid staff, community volunteers, and Shasta College students. Re-aligning the stream and undoing the impacts of gold dredger tailings, gravel mining and road building required skilled heavy equipment operations. This is where John's experience operating heavy equipment and project management in Grass Valley Creek, Whiskeytown National Park and Redwood National Park all came in handy.

In 2003 John and Salix Applied Earthcare won an important research proposal, the NCHRP 544 – Environmentally-Sensitive Channel and Bank Protection Methods, 2005, J.McCullah, TRB, was published after three-years of research by J. McCullah, w/ Dr. Donald Gray, and F. Douglas Shields as primary researchers. This Guidance document is often referred to as 'Alternatives to Rip Rap'. The problem statement posed by the Fed. Highway Engineers was – "are there any documented and effective methods and guidance for environmentally-sensitive areas." It seems that the biggest impediment facing the highway engineer is selecting methods that are alternatives to rip rap and simultaneously enhance aquatic habitat, provide improved aesthetics, and stream function. The average highway engineer is having great difficulty obtaining permits from State and Federal Resource agencies, especially when the proposed treatments predominately rely on rip rap.

This report will be particularly useful to professionals responsible for design and construction of channel- and bank-protection measures in environmentally sensitive areas. The CT project on SR 128 "Geyserville Bank Stabilization Project" in 2010 provides an excellent case study on how 300lf of the critical salmonid stream received the methods published in NCHRP Report 544 including; 5 rock vanes, documented to move the river's high velocity vectors away from the eroding bank, then combining treatments with habitat-enhancing "live willow siltation", and "willow and cottonwood pole planting on the low flood terrace constructed to dissipate stream energy.

John began using his Contractors License to design/build in wide-ranging locales, both locally and internationally. John became particularly practiced in Heavy Equipment operations during SWAG's fulfillment of the Sulphur Creek Salmonid Restoration grant funding and with the opportunities to implement Case Studies using the Environmentally-Sensitive Streambank Stabilization Techniques (E-SenSS).

Alberta Department of Transportation was the first big highway department with an acute desire to see how John could implement methods such as Live Siltation, Veg. Mechanically Stabilized Earth, Vegetated Rip Rap, and redirective methods (rock vanes, bendway weirs) in a sensitive stream without any increase in turbidity or sedimentation. Prior to the demonstrations of E-Senss, the DOT primary mitigation was to use isolation or in-stream separation of construction zone and the live stream – these marginally-effective mitigations often cost more than the entire bank protection! Alberta DOT, therefore sponsored workshops that implemented and demonstrated E-SenSS methods, while inviting the Department of Fisheries and Oceans (DFO) to participate or watch the dirttime.tv videos. So not only did John design the project works but the DOT also sponsored John and James Swirsky to produce dirttime.tv training videos. "In 1996 thru 1980 we produced three videos, two in the Canadian Rockies (The Hinton Projects) and one in So. Alberta (Willow Creek Project).

An especially interesting video was shot in Fairbanks on the Chena River, another design-build workshop that became another dirttime.tv training video. "This project was interesting because the local engineering firms reported that the project, which included innovative Coir BioD Block stabilized with willow brushlayering, and Vegetated Geobags, had failed during the first spring thaw. That report implied within that John, being from California, was operating out of his "element"! When I heard of the failures, I dismissed it and thought that the engineers were probably correct."

"Until 7-years later the landowner, Ken, who had donated his bank for the project workshop, sent me photos of his back yard area. It was picturesque, with a lawn sloping down to stabilized banks, protected by a beautifully pruned willow hedge. Not only was the streambank super stable but the Coir BioD Logs had still maintained their strength and the willow had been pruned to a 5-6ft height- which maintained a willow-lined bank that seems to get stronger with time. In my subsequent trips to Fairbanks and Anchorage and Northern Climes I've noticed that rip rap, not willow, appears quite susceptible to getting "plucked" off the banks during thaw. Maybe Willow and Cottonwood cuttings, if planted deeply into rock of well-graded stone might, because of documented tensile / shear strength, might reduce "rock plucking" on frozen rivers. These works were more examples of the benefits from mimicking mother nature".

Figure 5 The Chena River, Fairbanks "alternative to riprap" workshop sponsored by USFWS. Shown at completion in May 2006 and then site after 7-years, treatments include Coir BioD Blocks and Logs combined with willow live siltation and brush (from BioDraw 3.0)

John also coordinated two, 2-day Shasta College Stream SUMMITS at. Stillwater Creek, a salmonid protected creek, runs adjacent to SC. Like many streams in the nation, Stillwater has become deeply incised, over 30-feet of downcut in 70-100 years do to "anthropogenic land use resulting in hydromodification". However, the land use resulting in the "urbanization" is not urban development, but typically the hydromodification comes from 150-years of overgrazing Northern California's harsh and brittle environments - 40 years of sheep followed by over 100-years cattle, has resulted in soil compaction, called "cow pans", and total vegetation-type conversion. Centuries of grass/ savannah lands, predominated by oak and deeply-rooted native grasses, think Nassella pulchra, with 6-ft deep roots were subsequently replaced by shallow-rooted annual grasses introduced by grazing practices.

The Shasta College Stream Summits brought together stream and salmonid fisheries professionals for an opportunity to "walk the stream" and develop stream habitat enhancing strategies. By the time of the Stream Summits John had already developed a compendium of Biotechnical and Environmentally Sensitive stream projects and case studies, projects that demonstrate habitat-enhancing methods. Techniques taken from E-SenSS included the Newbury Engineered Rock Riffle, Longitudinal Stone Toe with Live Willow Siltation, Rock Vanes and Bendway Weirs, Live Brushlayering, and VMSE.

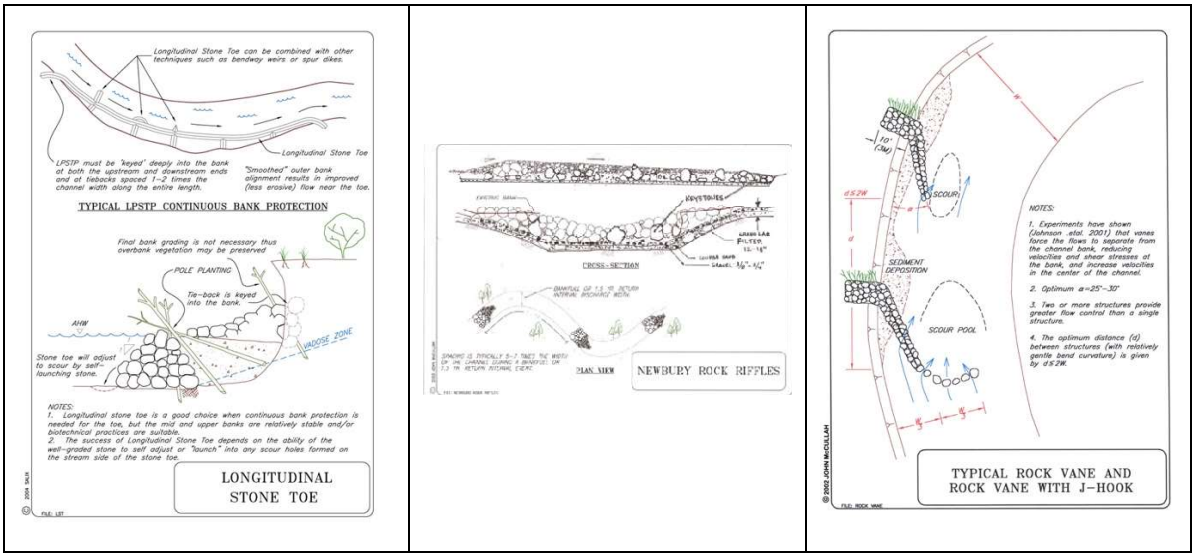

Figure 6 Report 544 Environmentally Sensitive Bank and Channel Protection provides guidance, construction specification and "Typical Drawings" for 54 E-Senss methods.

In 2010, during an invitation to Keynote at the Australasia IECA in Nelson, New Zealand, John was asked to design and eventually oversee the initial construction of an urban stream, Lucas Creek, in the Auckland Council. Not only are the E-SenSS methods important but John needed to demonstrate construction methods. John was able to demonstrate construction methods revealing how this project, involving restoration of functioning channel morphologyby and widening of over 8000 linear feet, excavating thousands of tons of soil and installing thousands of linear feet of Compost Socks. All this restoration work was able to proceed without discharging any turbidity or disturbing the critical native eel species. "By Googling Lucas Creek Restoration, Auckland Council, you can open a video showing the environmentally sensitive methods employed.

In 2014, John, similarly, was asked by the Department Chief of Kedah State, in Northern Malaysia to design and oversee building of an engineered grade control structure intended to replace a failed rock gabion check dam that was designed and built to raise the upstream water elevation by over 9-ft. The huge gabion structure only lasted 2 years. The Pedu River reach, about 20km downstream from Thailand had downcut by 9-ft and thereby had rendered a $25 million dollar agricultural water pump system unusable.

John designed what he calls, unverified, the largest Engineered Grade Control Structure in Asia. There were many limitations such as the biggest rock that could be delivered dumped by the lorries needed to be less than 2.5-ft dia. "The project required 11000 T of rock that was 'well-graded' (poorly sorted). The belief that bigger rock, sorted in 1 or two gradations, is better is not true, especially when the riffle rocks need 'as many points of

contact as possible'. The rock riffle must, as I learned from following David Derrick around for several years, be build from the toe upstream and its imperative to place the rocks under compression (with the excavator)." The riffle needed large keystones that form buttresses and arches such that the roughness will help the river dissipate energy as it flows over the riffle.

The project took about 24 days to build, punctuated by occasional 6"/hr. rainstorm and watching the stream rise by 4 ft in an hour. The design flows were more than 5000cfs, set by controlled releases upstream in Thailand but with intense storms 10,000cfs is expected. "After returning home, I got to see videos, shot by locals on smart phones and uploaded to Facebook. A few video clips captured flows at an estimated 8000cfs, three foot high over the crest, yet the riffle (aka, Newbury Rock Riffle) was able to successfully dissipate excess energy over the 150-ft long Environmentally sensitive riffle!

Figure 7 John designed and spent 18 days building, with Wing Leong, what John calls, the largest Newbury Engineered Rock Riffle built in Asian countries. This statement is not scientifically supported. The 154-ft long riffle built on the Pedu River, in Malaysia, raises water surface elevation by 9-ft, needed to resurrect 6 giant agricultural area pumps. It required over 11,000 CY of well-graded, angular granite rock. A bendway weir, seen in left upper of first photo, also a first in Malaysia, was designed to "direct" high flows through the middle of the riffle.

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