Rivanna Forests to Faucets (F2F) Initiative Payments for Watershed Services and the Optimum Infrastructure Expenditure (OIE) Version I System

Interim Program Report



By:



Funded by:



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I. Abstract

A 3-year payment for watershed services initiative is being tested in the Rivanna River Basin of Virginia. Protocols to compensate landowners for tree planting, forest stewardship management plans, harvest site stabilization, enhanced conservation easement, forest establishment, riparian buffer tax credit match, and fencing from livestock have been developed. Actual payments totaling approximately \$200,000 have been provided to date. A prototype Optimum Infrastructure Expenditure (OIE) Version I System was created to provide a financial linkage between urban water consumers and rural landowners. The system is designed for water supply utility and local government watershed managers to optimize annual expenditures for afforestation, forest conservation easements, and dredging. A system metric, the Watershed Reservoir Wellness Index (WRWI) was created to provide an optimization goal. Use of the system on the South Fork Rivanna River Watershed Reservoir, Virginia reveals four findings. Afforestation has similar impact on reservoir lifetime as does dredging for approximately the same expenditures during a 30 year planning horizon. The lifetime cost effectiveness of afforestation as compared to dredging ranges from approximately the same to significantly greater, due to sediment load reduction that continues beyond the planning horizon, depending upon the likelihood of afforestation reversion. Forest conservation easements have a high lifetime cost effectiveness to mitigate future increases in sediment loading, when future forestland conversion is certain. A combination of expenditures for afforestation, easements, and dredging maximizes reservoir lifetime and WRWI at least infrastructure lifetime cost. Creation of a Joint Grey/Green Infrastructure Optimization Committee for the Charlottesville region and a future OIE Version II are recommended. Deliverables include a Program Document, OIE Version I Manual, and the OIE Version I System written using Excel software (2010 and 2003).

II. Acknowledgements

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IV. Introduction

Background

The concept of ecosystem services, upon which the Forests to Faucets (F2F) Initiative is partially based, was widely articulated for the first time by Dr. Gretchen Daly in her 1997 book Nature's Services – Societal Dependence on Natural Ecosystems. Approximately a decade later, "ecosystem services" was publicly discussed at a March, 2009 conference hosted by the Virginia Department of Forestry (VDOF), called Ecosystem Services: Marketing Environmental Solutions. The event was well attended and included participation by private industry, academics, and government representatives. It helped propel Virginia and VDOF as a national leader in this emerging arena.

Around the same time, a group of citizens and elected/appointed officials in Charlottesville/Albemarle County called the South Fork Rivanna Reservoir Maintenance Task Force completed a Final Report about sedimentation and nutrients. The Task Force's recommendations included:

Finding III: Support Efforts to Reduce sedimentation and excess nutrients Finding V: Investigate Dredging for selected purposes

The report also called for officials to set *grey infrastructure expenditure* priorities, i.e., water treatment plant upgrades, transmission upgrades, storm water upgrades, sewer upgrades, and begged the question where dredging fell in expenditure prioritization. The report also noted the need to reduce pollution at its source, while noting that the effect of conservation efforts is unknown.

Presently, the greatest threat to Reservoir water quality is the large amount of sediment that enters the Reservoir every year. Measures to decrease the sediment are on-going and should be continued. The County has over the years implemented increasingly aggressive water protection ordinances supported by citizens who are concerned about the health of waterways. *It is difficult to quantify the degree of success these ordinance have had* (emphasis added), but sedimentation of the Reservoir has been less than was estimated at the time of the Reservoir's construction.

Creation of a tool to begin to help to quantify water protection efforts (*green infrastructure expenditures*) is part of the reason for the creation of the F2F Initiative.

Also in 2009, the U.S. Endowment for Forestry and Communities, Inc. issued a call for proposals specifically focused on payments for water ecosystem services. At the time, this was groundbreaking, as at that time, most of the energies in this arena were being directed at payments for carbon sequestration.

In late, 2009, VDOF, with the assistance of Conserv, submitted the proposal *Using Payments for Ecosystem Services (PES) to Improve Ecosystem Health and Forest Cover of the South Fork Rivanna Reservoir Watershed*. VDOF's proposal was one of three selected from this national solicitation and led to a three year contract, executed January, 2010, to begin March 2010 and to end October, 2012.

Purpose

F2F was conceived as a prototype project to create a financial process to link urban water consumers and rural landowners in a water supply reservoir watershed. F2F was proposed with three primary efforts:

- 1) a prototype payment for ecosystem services (PES) system using a limited pool of real dollars;
- 2) a cost benefit analysis that would provide this linkage process described above; and
- 3) development of a related Watershed Health Index.

A year later, item #2 was amended to create a more specialized tool for the project, called the Optimum Infrastructure Expenditure Model (OIE), to optimize the mix of expenditures for green and grey infrastructure. The model was proposed as a way to conduct sensitivity testing to compare payments to landowners to implement conservation practices to enhance soil retention services, nutrient retention services, and groundwater baseflow (green infrastructure) to dredging (grey infrastructure). The OIE was conceived as a generic tool to have applicability in any water supply reservoir watershed yet focused on the South Fork Rivanna River Watershed as an application or case study. The OIE was proposed to be coupled to a new index or watershed/reservoir goal called the Watershed-Reservoir Wellness Index – allowing the user to evaluate the outputs of the tool against the score(s) provided by the index.

In summary, the project aimed to develop a prototype PES system, including a tool (the OIE) that guides how much to pay for PES, plus a program for payment distribution to landowners in a water supply watershed, designed for use by water supply utility and local government staff and policy makers.

V. PES Program Development

Program Design

Development of the F2F PES program first required design of the following elements:

- Eligible Practice Description
- Landowner Enrollment
- Watershed Subarea Prioritization
- Community Outreach
- Landowner Screening
- Marketing

Eligible Practice Description and Protocol

In early 2010, the Project Team considered the following conservation practices for program eligibility.

- Preharvest Planning
- Harvest Site Stabilization
- Riparian Buffer Tax Credit
- Stream Stabilization
- Incentivize CREP
- Conservation Easement Enhancement

The legitimacy of each was considered (see Appendix I - Protocols Meeting Summary with DOF Staff (March, 2010)). After additional discussion and meetings, the following practices were decided upon for implementation through F2F:

- Forest Stewardship Management Plan
- Harvest Site Stabilization
- Enhanced Conservation Easement
- Forest Establishment
- Riparian Buffer Tax Credit Match
- Fencing from Livestock

Forest Stewardship Management Plan

The Forest Stewardship Management Plan (FSMP) practice described strategies for achieving unique landowner objectives and sustaining forest health and vigor. Actively managed forests provide timber, wildlife habitat, watershed protection, recreational opportunities and many other benefits for landowners and society. The FSMP could be prepared by a VDOF forester or private consultant. If prepared by a VDOF forester, a completed VDOF Form 127 (FSMP application form) was required. If prepared by a private forestry consultant, a copy of the plan and a copy of the consultant's billing invoice for the plan was required.

Currently, reimbursement for plan preparation costs is capped at \$4.50 per acre. The minimum acreage eligible for a FSMP was 10 contiguous acres with a minimum reimbursement of \$200 per plan. The deadline for all plans to be completed and approved by the Assistant Regional Forester was September 1, 2013.

If a timber harvest was recommended in the FSMP, preharvest planning language designed specifically for the recommended harvest was required. The preharvest planning section also needed to incorporate approved practices as described in the "Virginia's Forestry Best Management Practices for Water Quality" handbook.

Harvest Site Stabilization

The Harvest Site Stabilization practice reimbursed landowners for costs associated with stabilizing skid trails, haul roads, and log decks used during the timber harvest. Upon completion of the harvest, the landowner was eligible for full reimbursement up to a cap of \$5000. Eligible expenditures included items such as seed, labor, and structural work (e.g. water bar installation, skid trail grading). Work was to have been completed in accordance with guidelines found in the "Virginia's Forestry Best Management Practices for Water Quality" handbook. Costs were required to be submitted on a VDOF Form 23 (Certification of Work Completed Form) and signed by the approving VDOF forester. The harvest must have been completed after October 1, 2010 with stabilization work also completed by August 1, 2013.

Enhanced Conservation Easement

The Enhanced Conservation Easement provided a financial reward to landowners who donate a conservation easement that provides direct protection of water quality and/or quantity by permanently retaining forest cover. Graduated scales of payments, based upon select easement "enhancements" chosen by landowners, were available to landowners who donated either "whole property easements" or "riparian buffer easements".

Whole property easement payments were available to landowners who donated a conservation easement to a qualified easement holder approved by the VDOF on properties that met the following standards:

- At least seventy-five percent forested
- Borders or includes a perennial or intermittent stream as identified on USGS topo maps

- Include at least a 50' no-cow-no-plow buffer on all perennial and intermittent streams
- Permanent retention of at least 50% of existing forest cover on the property, and
- Follows VDOF criteria for permitted divisions, dwellings, and structures.

Landowner payments on the following sliding scale were available according to property size:

- < 40 acres \$3,500
- 40-99 acres \$7,500
- 100-149 acres \$8,000
- 150-199 acres \$8,500
- 200-249 acres \$9,000
- 250-299 acres \$9,500
- 300 + acres \$10,000

In addition to this base payment, landowners were eligible for funding based on the following voluntary enhancements that increase the water quality protection afforded by the easement:

- \$500 Per 1,000 feet of perennial stream buffered
- \$500 Per additional 50' of buffer width up to a maximum of 100' in forested areas and 300' for open land. Buffers would have to be at least 250' feet long and be no-cow and no-plow
- \$1000 If all riparian buffers (minimum width of fifty feet and length of 250') are forested or are converted to forest cover (planting or natural regeneration)
- \$1000 To increase the requirements of forest cover retention from 50% of the existing forest on the property up to 80%
- \$1000 For each forfeited division right that would be permitted under the terms of a typical easement

The minimum payment for a whole property easement was set at \$3500. The maximum payment was set at \$15,000.

Riparian Buffer Easement payments were available to landowners who placed a conservation easement on riparian buffers on intermittent and perennial streams on their property. The minimum buffer width was 50'. The minimum length was 250'.

Landowners received a base payment of \$2.50 per linear foot of stream protected. The maximum base payment for a riparian buffer easement was \$15,000; there was no minimum payment. Landowners were also eligible for the same bonus payments provided for whole property easements.

Forest Establishment

The Forest Establishment practice provided a one time payment to rural landowners to plant seedlings. The payment included a twenty year land rental payment, project maintenance payment, and reimbursement of reasonable planting costs, such as livestock fencing. Landowners were required to enter into a twenty year contract with the Virginia Department of Forestry.

There were two components to the landowner payment. The first component was reimbursement of reasonable planting costs such as site preparation and seedlings. For the F2F initiative, only bare rooted seedlings were allowed. Balled and burlapped and potted saplings were not eligible. Planting labor and other VDOF recommended supplies such as tree shelters and mats (when planting hardwoods in a riparian area) were also eligible for reimbursement. Two categories of Forest Establishment projects were created; Riparian Buffer and Open Land Planting.

The minimum project size for the Riparian Buffer Planting category was one contiguous acre. Plantings were required to be adjacent to the stream and a minimum of 50 feet in width measured from the top of the stream bank. Both hardwood and pine species were appropriate species for planting. The actual species used, recommended spacing, and site preparation needed was left to the discretion of the approving forester. Due to limited available funding, pine plantings were preferred. Up to ten percent of the project area could be a perennial wildlife planting. Livestock were required to be excluded from the planting site for the life of the twenty year contract.

The minimum project size for General Open Land Planting was five contiguous acres. Only pine species were eligible for planting. The actual species used, recommended spacing, and site preparation needed was left to the discretion of the approving forester. Up to 10% of the project area could be a perennial wildlife planting. Livestock were required to be excluded from the planting site for the life of the twenty year contract.

An establishment payment cost cap of \$600 per acre for hardwood plantings (when completed as a part of any riparian buffer planting) and \$200 per acre for pine plantings (when completed as part of any riparian or open land planting) was set. In addition to the reimbursement of planting costs, landowners were eligible to receive a \$50/acre maintenance payment. The maintenance payment could be applied to replanting, stand maintenance (mowing, spraying), or fencing costs.

In addition to the establishment payment, a land rental payment was provided. This was calculated as the Present Value of a series of terminating annual payments, based on the rental rate, total project acres, 7% discount rate, and the required twenty year contract. The rental rate used was determined by the hydrologic unit (HUC) the project area was found in. The rental rate payment for HUCs JR02 and JR07 was \$847/acre. The rental rate payment for all other HUCs in the Rivanna River Basin was \$636/acre.

Riparian Buffer Tax Credit Match

The Riparian Buffer Tax Credit Match provided a cash-match incentive payment for timber harvests that left intact, uncut riparian buffers. The cash-match was equivalent to the amount of the Virginia Riparian Buffer Tax Credit, up to a cap of \$5000 per landowner. Only timber harvests that occur between October 1, 2010 and September 1, 2013 are eligible.

Fencing from Livestock

This practice was created to pay for livestock fencing to protect new seedlings from livestock. Reimbursement up to \$3.50 per foot is available.

Landowner Enrollment

Phase I: Reverse Auction in the South Fork Rivanna River Reservoir Watershed (SRRRW)

In an attempt to identify a "market price" for Forest Establishment, and specifically the price of land rental, the Project Team tested the use of a reverse auction "bidding" process. Two types of projects were identified; General Open Land Tree Planting and Riparian Buffer Tree Planting. General Open Land Tree Planting was defined as:

- Planting of pine seedlings on Open Land
- 10% of the project can be wildlife planting
- VDOF Forester approves details
- Livestock must be excluded from area
- Minimum of five contiguous acres

Riparian Buffer Tree Planting was defined as:

- Planting of pine and hardwood seedlings on Open Land within stream buffers (50' width)
- VDOF Forester approves details
- Livestock must be excluded from areas
- Minimum of one contiguous acre

The rates for maintenance and establishment were set set apart from the process at \$50 per acre and \$200 for pines and \$600 for hardwoods respectively. Bids were accepted via the Forests to Faucets (F2F) website from 8 a.m., Monday, July 12 until 5 p.m., Friday, July 30 (see Figures 3 and 4 below). Multiple bids could be submitted by the same landowner.

The land rental payment was determined using the following formula:

- Lump Sum Payment
- Net Present Value of 20 years of payments
- Discount rate of 7%
- Payment ceiling of \$100.00 per acre

For information about how this phase was marketed to landowners, see "Phase I F2F Marketing" below.

Are you EQIP Eliplease read EQIP	igible? * eligibility requirements		
 yes 			
ino no			
Name *			
Address *			
Project Number	·	former number "4 of 2" "2 o	1.2° at a
provise est montpa	e projects on separate ard.	name, number i u z., z.c	1 a 1996.
	ur preferred method of cont	lact	
Phone Number * please give us you			
Phone Number * please give us you			
Phone Number *			
Phone Number * please give us you omail addross *			
Phone Number * please give us you email address *			

Figure 1

Total acrea	ge of proposed tree planting project *
please give u	s your best estimate
Does the pr	oposed project include a stream? *
🗇 yes	
⊜ no	
If yes, how	many linear feet of stream are in the proposed project?
please give t	s your best estimate
Have you re	ad and do you understood F2F protocol for Forest Establishment Practices? *
🖾 yes	,
is this an up	date of an earlier bid?
🛄 yes	
i no	
*****BID**	****
0.0	
bid (dollars please give t	per acre) * he lowest per-acre compensation you would accept for converting project acreage to

Figure 2

The Funding Application for this Phase of the project is shown in Appendix I. The process generated 3 responses; 5 acres @ \$55 per acre and about 3 acres @ \$32 per acre. A third participant noted inability to meet EQIP eligibility. Casual screening of parties

that had expressed interest but failed to bid yielded the following issues with use of the bidding process:

- Not enough money to entice people in this watershed.
- People don't really view their land in this watershed as "working lands" and so even if more money that might not make much difference.
- People want a sure thing...the uncertainty is a turn off.
- 20 year contract is a red flag.
- Other federal programs are out there that "compete" with F2F and make it less attractive.
- A lot of work for an amount of funds that are uncertain

Phase II: Continuous Enrollment for South Fork Rivanna River Reservoir Watershed

A meeting was held at VDOF to brainstorm how to modify the program after end of the bidding period in August, 2010. The summary of that meeting is shown in Appendix II.

A second alternative program protocol to contract with rural landowners for Forest Establishment was created with the following components:

- Ongoing enrollment, "continuous sign-up" based on specific per acre payment amounts.
- First come, first served.
- Two payment amounts identified one for high priority and one for low priority watersheds. Mechums River Beaver Creek (HUC JR02) and Ivy Creek Little Ivy Creek (HUC JR07) were selected as high priority. All other subwatershed I the South Fork Rivanna watershed were selected as low priority.
- Program kick off October 1.
- Limited marketing to prepare the public (see Phase II Marketing below).
- Two categories of payments a rate for top two priority subwatersheds and a rate for all the others. The rate of \$80/acre (Lump sum payment of \$847/acre per 20 year contract) was selected for landowners in the high priority area. The rate of \$60/acre (Lump sum payment of \$636 /acre per 20 year contract) was selected for landowners in the low priority area.
- Payments are for hardwood and pine <u>seedling</u> projects. Balled and burlap (B&B) trees are not allowable.

Phase III: Continuous Enrollment for entire Rivanna River Reservoir Watershed

To gain additional participation in the program, it was expanded in June, 2011 to the entire Rivanna River Basin watershed. The final protocol is shown below generally as it appeared on the F2F website:

The first step for a landowner interested in the F2F initiative was to determine if their land was in the Rivanna River watershed. A map of



Figure 3

the watershed was provided on the F2F website to determine location (Figure 1). After confirmation of location within the watershed, the landowner could proceed to the second step – submission of EQIP forms to a nearby Farm Services Administration (FSA) office. To do this, the landowner was instructed to contact the FSA (Farmers Service Agency) for copies of the necessary forms proving eligibility. It was the landowner's responsibility to work directly with FSA to complete the all forms.

Once EQIP eligibility was determined, the landowner could proceed to work with VDOF staff on practice design. For landowner's interested in Forest Establishment payments, the next step was to determine whether location is within the South Fork Rivanna River Sub-basin. This sub-basin, highlighted in blue as shown in Figure 2, was determined by the project team to have greater potential for sediment reduction. Therefore, a higher land rental payment of \$847 per acre was assigned for parcels within this area. Parcels that fell outside of the sub-basin but within the Rivanna River Basin contain less potential for sediment reduction and were determined to be eligible for a land rental payment of \$636 per acre. It is important to note that these payments represent the Net Present Value of the 20 year contract.

The next step was to contact the Virginia Department of Forestry (VDOF) to request a field visit and additional information on the program. During the field visit, landowners had the chance to better understand the program requirements and potential eligibility. During this visit, the forester provided information on estimate of total project acreage, recommended tree species, planting density, site preparation, maintenance practices, estimated total payment, financial



Figure 4

eligibility determination, explanation of contractual obligations (replanting, maintenance, livestock exclusion, transfer of ownership, etc.), and completion of the Application for Funding Contract Form (see Appendix III – F2F Program Funding Application).

After completion of the Application for Funding Contract the landowner received additional information on ordering seedlings, securing planting labor, necessary site preparation, and any other issues related to having the project area planted. Upon successful completion of the planting project, the VDOF forester verified that the work was satisfactorily completed and payment was made.

If a survival re-inspection made after year one for pines and year two for hardwoods showed that an insufficient number of seedlings were present to develop into a forest stand, funds for one replanting were provided. No additional replanting funds were made available, however, landowners were free to voluntary replant later during the life of the twenty year contract.

Watershed Subarea Prioritization

Overview

The need for a prioritization scheme was based on the concept of targeting funding where the greatest ecosystem services "bang for the buck" could be realized. As the concept of prioritization evolved, payments for the six practices were affected in different ways. For Forest Establishment, during the Reverse Auction Phase, the team created a gameplan to prioritize *after bids* were received based on biophysical characteristics of the watershed. How the prioritization was to occur in this phase was unknown to the landowner. After that process was changed to the Continuous Enrollment Phases, the prioritization concept also changed, and was expressed through higher payment rates, known to landowners, for portions of the watershed thought to be more preferable based again on biophysical characteristics. In a similar manner, for Enhanced Conservation Easement and Riparian Buffer Tax Credit Match, the prioritization was built into the dollar values provided. There was no prioritization scheme for the remaining practices.

Prioritization for Phase I Forest Establishment Reverse Auction

In preparation for the Forest Establishment Reverse Auction, the team conducted a reconnaissance of existing biophysical information about the SFRRRW (see Appendix IV: F2F Land Parcel Prioritization: Background for Technical Session). This exercise resulted in identification of the following prioritization methodology:

- 1) Mechums River and Ivy Creek watersheds receive priority.
- 2) Parcels that contain riparian lands adjacent to main stem and tributaries to Mechums & Ivy receive priority.

Prioritization for Phases II/III Forest Establishment Ongoing Enrollment

Two methods to prioritize expenditures were contemplated for this phase of Forest Establishment. The first was to use InFOREST to estimate the impact of converting a specific subwatershed from non-forested to forested land cover in terms of sediment, nitrogen, and phosphorus loadings. The second was to create a multidimensional matrix existing in a GIS environment, with the following layers and values (the higher the value, the greater the priority).

Criteria		Points
watershed	Mechums, Ivy Creeek	1
	Moormans, Buck Mt	0
landscape position	flood plain	3
	Side slope	2
	Interfluves	0
proximity to main channel		0,1,2,3
geology	bedrock erodibility	0,1,2
soils	erodibility	0,1,2,3
forestry priority	-	0,1,2,3

For a variety of reasons, the team eventually decided to use InFOREST to rank the subwatersheds for greatest impact of increase of forest cover on reduction of sediment, nitrogen, and phosphorus (see Appendix V: InFOREST Ranking of SFRRRW subwatersheds). This resulted in a two-tier prioritization, with two of the eight subwatersheds determined to be high priority with the other six determined to be low priority.

<u>High Priority</u> Mechums River – Beaver Creek Ivy Creek – Little Ivy Creek

<u>Low Priority</u> South Fork Rivanna River Mechums River – Stockton Creek Moormans River – Wards Creek Buck Mountain Creek Moormans River – North Moormans River Doyles River

Payment rates for Forest Establishment to landowners in these subwatersheds were adjusted to account for differences in prioritization. When the project scope was expanded to include the entire Rivanna River watershed, the same high priority subwatersheds were used, with all other subwatersheds in the Rivanna becoming low priority.

Community Outreach

F2F Advisory Council and Technical Sessions

A project group called the F2F Advisory Council was convened early in the project to provide input and guidance. Invitations were sent to the following parties. Most participated in at least one meeting.

- Rivanna Water and Sewer Authority
- City of Charlottesville
- County of Albemarle
- Rivanna River Basin Commission
- Thomas Jefferson Soil and Water Conservation District
- Thomas Jefferson Planning District Commission
- Blue Ridge Homebuilders
- Free Enterprise Forum
- Charlottesville Regional Chamber of Commerce
- American Waterworks Association
- Thomas Jefferson Partnership for Economic Development
- Albemarle County Farm Bureau
- Piedmont Environmental Council
- The Nature Conservancy
- Shenandoah National Park
- Streamwatch
- Virginia Department of Conservation and Recreation
- NGIC
- University of Virginia
- C'ville Tomorrow
- Albemarle County Service Authority Virginia Outdoors Foundation
- Virginia Department of Game and Inland Fisheries
- Virginia Department of Environmental Quality
- USGS
- Sally Thomas
- VDOF Staff
- Conserv Board of Directors

In addition, occasional "Technical Sessions" to discuss and debate various project issues were held.

Discussions with Rivanna River Basin Commission, Charlottesville City and Albemarle County, Virginia Chapter of the American Water Works Association, and the Rivanna Water and Sewer Authority

Discussions were also held with the Rivanna River Basin Commission Technical Advisory Committee, Charlottesville and Albemarle County environmental and watershed staff, the Virginia Chapter of the American Water Works Association, and Rivanna Water and Sewer Authority staff primarily on the Optimum Infrastructure Expenditure (OIE) model.

Landowner Prioritization and Marketing



Figure 5

Landowner Prioritization and Marketing was designed either specifically for Forest Establishment or for the F2F program in general.

General F2F Landowner Prioritization and Marketing

Forests to Faucets Website

An F2F website was developed in the first few months of the program

(www.foreststofaucets.info). The website was designed as an information portal for interested landowners to learn about the program before contacting VDOF staff. The website was regularly updated throughout the project with news and revised project documents.

Print, Radio, and Television/Video

Marketing for the project was designed for "word of mouth" advertising via occasional newspaper commentaries circulated in area newspapers, such as a Daily Progress Op-Ed Commentary that ran in the first year of the project and an Orange County Review Letter to the Editor that ran in the final year. In addition, local station WVTF and Washington, D.C. NPR radio stations ran audio news stories with web/video links early and midway though the project. Also the local Charlottesville television filmed an interview with an interested landowner in the first year. Appendix VI contains excerpts from some of these news items.

Community Group Presentations and Newsletter Outreach

Other forms of marketing such as a Ruritan Club group presentation, Farm Bureau newsletter, and American Tree Farm outreach (Figure 5) were also used. In addition, a project brochure was prepared and distributed to area foresters and posted online (Figure 6).

Landowner Workshops

Two evening landowner workshops at VDOF were held. Interested rural landowners and forestry consultants attended the meetings, along with VDOF and FSA staff, and Conserv.

Forest Establishment Landowner Prioritization and Marketing

To specifically target potentially interested landowners in the South Fork Rivanna River Reservoir watershed, posters and a targeted mailing in county real estate bills were used. Twice during the project lifetime, full color posters were distributed to rural post offices, bulletin boards, and country stores (Figure 7).



Landowners were screened through a flyer (included in real estate bills) sent to landowners in the South Fork Rivanna

Figure 6



Reservoir watershed by the Albemarle County Real Estate office. The screening criteria for selecting parcels was five acres of total open space owned by any given entity at least part of which is in the South Fork Reservoir Watershed.

Using this list, VDOF foresters attempted to personally visit every landowner to direct market the program.

Results (as of August, 2012)

As of August, 2012 the Forests to Faucets program has resulted in 75 acres of Forest Establishment, 32 acres of Tax Credit Match, 326 acres of Forest Stewardship Management Plans, and 1087 acres of Enhanced Conservation Easements. \$184,187 of

landowner payments have been provided.

Figure 7

VI. Optimum Infrastructure Expenditure (OIE) Decision Support System

OIE Overview

The OIE is a prototype Decision Support System (DSS) to optimize capital expenditures for green and grey infrastructure. It has been created for use primarily by local governments, water utilities, and organizations, interested in reducing pollution to a reservoir at least cost. The OIE has been created by Conserv under a contract with the Virginia Department of Forestry and is part of the Forests to Faucets Initiative (F2F) funded by the U.S. Endowment for Forestry and Communities, Inc.

The OIE has been built using Microsoft Excel software. It is available for both Excel 2003 and 2010 versions. To use the tool, input data is required. Summary comments are provided to explain data and information found within cells on the sheets. An OIE User's Manual explains use of the model.

The OIE provides the user the ability to optimize expenditures for green and grey infrastructure to reduce sediment flowing into a water supply reservoir. An index to determine "optimization", called the Watershed-Reservoir Wellness Index (WRWI) is also provided as part of the tool. The tool is designed to allow the user to achieve the highest WRWI score, while also maximizing cost effectiveness and reservoir lifetime.

Version 1 OIE provides full functionality to optimize expenditures for sediment reduction only. The OIE Version I provides capability to optimize green and grey infrastructure for sediment reduction to a reservoir and to optimize green infrastructure for nitrogen and phosphorus reduction from a watershed.

This report contains technical information for the OIE Version I not found in the OIE User's Manual. Likewise, this report does not contain instructions on how to use the system found in the User's Manual. Also found in this report are findings based on system output from the OIE South Fork Rivanna River Reservoir Watershed Case Study.

About the OIE

Version I Prototype

The OIE Version I is a prototype decision support system that uses facts, equations, and rules to provide outputs to assist users with decisions on expenditures for green and grey infrastructure. The three primary components of the OIE are the Calculator (containing equations), Watershed Parameters Input (containing information), and the Dashboard (user interface).

The OIE Version I was designed to determine if it was possible to build a predictive system that could be used to optimize grey and green infrastructure expenditures. Much of the effort that went into the development of the system was used to develop concepts, data structure, and algorithms. Additional effort was spent testing and revising structure and algorithms. With the creation of the OIE Version I, the team has succeeded in creating a prototype testing the following aspects of the system:

- Proof-of-Concept Prototype: A Proof of Concept Prototype is used to test design without attempting to build more advanced functionality users might demand in a commercial version. The OIE Version I provides a format to integrate financial expenditures, an ecosystem services model, a sediment budget, reservoir bathymetric and dredging data, and land cover data. A future OIE Version II would logically include nutrient and hydrologic budget capability.
- User Experience Prototype: A User Experience Prototype invites active human interaction. While intentionally not addressing possible aesthetic treatments, this prototype system represents the overall size, proportions, interfaces, and articulation of a promising concept. The OIE Version I contains a user dashboard with excel-based graphical user interface (GUI) elements. These are not commercial grade GUI but are sufficient to test the utility of a graphical interface to communicate information about green and grey infrastructure.

OIE Version I Limitations

As a prototype the OIE Version I has limitations. These include:

- It may fail to perform acceptably under some user specified scenarios. Although the Valid Entry system was designed to reduce the likelihood of this happening, due to limited testing, the possibility remains for particular combinations of data entry to cause erroneous output.
- It may fail to provide financial expenditure input categories that match the manner that a user might wish for. For example, OIE Version I only allows annual expenditures, rather than input of one expenditure covering a capital item's lifetime.
- The OIE Version I does not allow financial discounting.
- OIE Version I was built in Excel 2010 and exported to Excel 2003. The user should avoid altering the locations of the graphics on the dashboard and any other aspect of the system unless specially identified as a cell for "user input". Modification of any cells not specifically identified for user input may cause the elements of the system to fail to render properly.
- It is important to carefully follow directions in the OIE Manual. For instance, failure to follow the instruction to ensure that all sheets be set at the same zoom level may cause elements of the system to fail to render properly.

OIE Development

The F2F project was initially conceived with the development of a cost-benefits analysis that would be completed to reveal the comparative values of green and grey infrastructure. Papers discussing the merits and methods associated with "benefits transfer" were reviewed (Splash, Vatn, 2006, Iovanna, Griffiths, 2006, Bateman, Day, Georgiou et al., 2006, Troy, Wilson, 2006, Rosenberger, Stanley, 2006, Bergstrom, Taylor, 2006, Loomis, Rosenberger, 2006). Because this method of valuation appears to be best suited for policy analysis rather than project appraisal, project team members began considering if another approach could be used to financially link urban water consumers with rural landowners, which would allow the testing of scenarios for users to determine the value of green and grey infrastructure. The concept of a Decision Support System (DSS) for water system utility and local government watershed managers was proposed. As it appeared a DSS of the type envisioned had not been previously created (Faust, 2010), the team moved forward to create a new prototype. The advent of the Virginia Department of Forestry's InFOREST tool was a major breakthrough in the ability to create the OIE system.

The OIE was conceived as a predictive system that would allow public utility and local government watershed managers the ability to optimize capital expenditures for green and grey infrastructure to achieve needed services at least cost. It grew from a desire to create a "business case" for expenditure of funds for green infrastructure. Therefore, the system needed to be able to integrate financial and environmental data.

The model was deigned to be:

- linear its calculator uses simple algebraic equations to return output values to the Dashboard;
- dynamic meaning that it accounts for the passage of time and recalculates every time new input values are selected; and
- customizable meaning that it allows the user to input specific watershed parameters.

During project development, the project team worked to find ways to allow the user to optimize green and grey infrastructure to achieve the following services at least cost:

- Sediment reduction in reservoir
- Nitrogen reduction in reservoir
- Phosphorus reduction in reservoir
- Summer groundwater baseflow enhancement

The Team began by gathering information about the InFOREST ecosystem services calculator, and sediment budget related studies and information (Black, Veatch, 1994, Glaspey, 1981, Hjutstrom, 1939, Sobeck, 1999, Bowler, 2003, U.S. EPA, 2010). Based

upon this information, the Team became confident that a system to optimize green and grey infrastructure expenditures for sediment retention by linking afforestation, conservation easements, and dredging could be created.

The Team also attempted to optimize green and grey infrastructure expenditures for nitrogen and phosphorus reduction by linking afforestation, conservation easements, and algae treatment/removal. Although sediment is a significant water quality concern in the piedmont of Virginia, for coastal plain water managers, eutrophication is a more significant issue (D. Morris, personal communication). Therefore, the Project Team attempted to create structure within the model that would allow linkage between watershed/reservoir nutrient loads, the amount of chlorophyll-a produced, the resulting quantity of biomass, and the cost of algae treatment to remove a particular quantity of algae. The Team attempted to use the report, Reservoir Water Quality Protection Study, by the City of Newport News Department of Public Utilities, 1985 the Corps of Engineers models Bathtub and Flux32, and other research (Longmore, Roberts, Light, 2003, Noe, Hupp, 2009, U.S. EPA, 2010, Gellis, Hupp, Pavich et al., 2009, Langland, Cronin, 2003, Ibison et al., 1992) to create input elements allowing the establishment of the proposed model framework. Unfortunately, for a variety of reasons, the Team was unable during the project timeframe to integrate this information into the system architecture. The Team is optimistic that this functionality can be added for a future version of the OIE. OIE Version I does allow the user to determine the impact of afforestation and conservation easement expenditures on watershed (not reservoir) nutrient loadings.

Finally, the Team also attempted to optimize green and grey expenditures for summer water supply. The concept was that green infrastructure expenditures can affect watershed infiltration and increase summer baseflows. Summer baseflows can be readily captured by a reservoir because the reservoir is below capacity. The more that rainfall is captured in long term storage in the soils and underlying geology, the more water is available during critical summer months. It is during the summer when the combination of increased demand and reduced flows increases the likihood of inadequate supply. As this threat grows, the need for more water, through a larger dam or another reservoir, increases. Through summer baseflow, the Team hoped to be able to optimize expenditures for afforesation, conservation easements, and an impoundment.

Research relating land cover to summer base flows was reviewed (Price, Jackson, Parker et al., 2011, Mark, Dickinson, 2008, Rowe, Jackson, Fahey, 2002, Rowe, 2003, Rowe, Jackson, Fahey, 2001, Pijanowski, Ray, Kendall et al., 2007, Brandes, Cavallo, Nilson, 2005, Johnson, 1998, Rose, Peters, 2001, DeFries, Eshleman, 2004, Barton, Kyker-Snowman, Lyons, 1998, Barton, Ernst, 2004, Bosch, Hewlett, 1982, Bond, Jones, Moore et al., 2002) in hopes that a quantitative relationship between land cover and the portion of rainfall that is released as summer baseflow could be developed. Unfortunately, the Team was unable to develop a quantitative relationship between these variables in a way that would allow expenditures leading to more forest to be linked to more summer baseflow. It is worth noting that the Team did conclude that qualitatively, baseflow chould be maximized by what was called Dynamic Forest Land Cover (DFLC). "DFLC"

was conceived as managed forestland that allowed the manager to pair older growth areas with harvested areas to create a forest patch maximized to enhance summer baseflow. The pairing of older growth with harvested areas was thought to allow maximum infiltration of water into the ground with minimum transpiration of water into the air. The Team feels that inclusion of baseflow functionality in a future version of the OIE system would require a significantly greater effort than that needed to add nitrogen and phosphorus.

The OIE Version I is an expenditure driven system. An "expenditure driven system" means that a scenario begins with the input of annual expenditures for green and grey infrastructure. Green infrastructure expenditures are currently limited to annual expenditures for afforestation and conservation easements. Grey infrastructure is currently limited to annual expenditures for maintenance dredging. "Maintenance Dredging" is defined to be yearly dredging for every year during the user-specified Planning Horizon.

OIE Theory

The OIE has been designed as a capital planning tool for water authority and government technical staff. The dashboard has specifically been created to facilitate conversations about optimum watershed and reservoir management between civil engineers and land conservation managers. Theory about model design was based in part on the precepts of holistic medicine – where emphasis is placed on the proper functioning of the human body system. The project team applied this same thinking to water supply management resulting in a new lexicon used to describe model functionality. *Fitness* is introduced as a land cover attribute and defined as the amounts of forest cover and impervious surface in the watershed. *Health* is introduced as the rate of annual pollution received by the reservoir. Together, Fitness and Health defines the *Wellness* of the watershed-reservoir system. In summary, information provided by the OIE is "screening level" for water supply utility and local government policy makers to conduct "what if" discussions.

OIE Architecture

The design of the OIE is represented in the following flowchart:





Note: A dashed line indicates functionality not completed for OIE Version I





This organizational architecture has been designed into the spreadsheet structure described below:

Readme File

The Readme sheet was created as the first thing for a new user to see prior to using the model. It contains an OIE model overview and first steps to begin use.

Dashboard

The Dashboard sheet was created as the cockpit for the model. Dropdown boxes are provided for the user to enter input values. Output values are shown graphically on the dashboard.

Dashboard Input Data

The Dashboard Input Data sheet was created as a data table for the dropdown boxes and graphical elements used on the dashboard. This sheet is not enabled for use by the general public.

Watershed Parameters Input

The Watershed Parameters Input sheet was created to enable model customization for specific watershed and reservoir attributes by the user. The OIE Version I comes with average values entered. Each input cell contains a recommended range of values should the user not have local data available.

Calculator

The calculator takes Dashboard input values and uses algebraic formulas to provide Dashboard output values. This sheet is not enabled for use by the general public.

Summary Output

The Summary Output combines input and output values from the Dashboard and Calculator in a tabular form.

VII. OIE Version I South Fork Rivanna River Reservoir Watershed (SFRRRW) Case Study

Introduction

The OIE Version I was conceived during a time when new environmental data and models became recently available in Virginia and particularly in the Charlottesville region. This information is necessary to use the OIE system and includes:

- Land cover based sediment, nitrogen, and phosphorus loadings
- Watershed sediment budget
- Reservoir bathymetric data
- Reservoir dredging data

Land Cover

2010 land cover data came from the Albemarle County Office of Geographic Data and the Virginia Department of Forestry's InFOREST tool. The OIE Version I uses three land cover classifications; forestry, impervious, and other. These classifications were selected based on the Fitness Metric used in the OIE Version I Watershed Reservoir Wellness Index; % Forest Cover - % Impervious Cover.

Total Watershed Acreage:	164,943 acres
Forestry Acreage:	39,878 acres
Impervious Acreage:	3,586 acres
Other Acreage:	121,479 acres

Ecosystem Service Calculator to Translate Land Cover to Pollutant Loads

InFOREST was used to calculate average sediment loads for the South Fork Rivanna watershed. Annual loadings were calculated for each land cover classification for each of the following subwatersheds:

Mechums River – Beaver Creek Ivy Creek – Little Ivy Creek Mechums River – Stockton Creek Moormans River – Wards Creek Buck Mountain Creek Moormans River – North Moormans River Doyles River A per acre per year average load for the entire South Fork Rivanna Watershed for each land cover classification was then determined based on the 2010 land cover data.

Sediment Budget

The OIE Version I system requires that the user characterize the transport of sediment in a watershed. The following crude sediment budget was conceived for OIE Version I:

Chn = Stot - Ov - Xsed

Stot = Res + Dst

Where:

Res: Overall capture rate of reservoir since construction

Dst: Sediment washed downstream over dam

Stot: Total overall sediment influx from above reservoir

Ov: InFOREST predicted sediment output due to overland flow above reservoir (does not include channel erosion)

Chn: Sediment output due to channel and bed erosion

Xsed: Sediment due to sources not accounted for in InFOREST (dirt roads, ditches, land disturbance not controlled by erosion and sediment control)

Information from existing reports was analyzed to estimate the budget for the South Fork Rivanna River Reservoir watershed. In May of 2001, the Thomas Jefferson Water Resources Advisory Committee (WRAC) published a report entitled "Sediment Sources and Mitigation Strategies, South Fork Rivanna Reservoir Watershed." A particularly relevant section of this report finds that storm events remove and transport sand particles from bed and banks of the main stem and tributaries resident in geologic formations.

While the previous studies provide a basis for beginning to understand the sedimentation problem, in some respects they raise as many questions as they answer. Further geologic investigations are essential, for example, to clarify Sobeck's (1999) conclusions, to the extent that his modeling and analysis did not consider the role of silt-and clay-size sediment. According to Glaspey (1981), clay is the dominant sediment in SFRR. The research of Hjulstrom (1939) demonstrated that erosion of clay requires the kind of energy which great storms generate.

Importantly, all investigators report a paucity of information on streamflow and sediment transport at exceptionally high flows, e.g., during the several hurricanes which have visited the area since 1966. This is critical, for lacking actual measurements at the upper end of rating curves, the correlation of watershed sediment yield to sediment deposited in the reservoir has been obtained largely by extrapolation from other watersheds and by drawing rating curves to obtain a "best fit." None of the previous studies have included mineralogic and petrologic analyses that could trace reservoir sediment to geologic sources in the watershed. Further, a search of files, reports and publications reveals no determination of trapping efficiency of the SFRR.

In the 10 years that have elapsed since the WRAC report was written, there have been additional bathymetric and dredging feasibility studies, but there has been no additional research on the subject of tracking actual sediment sources. The conventional wisdom is that there are two broad categories of sediment origin:

- "primary" erosion of mineral grains from soils, saprolite and rock exposed at the surface, followed by overland transport into streams; and
- "secondary" remobilization and transport of existing "historic" sediment previously deposited in flood plains and channels of rivers & tributaries.

For the OIE South Fork case study, it was necessary to go beyond this qualitative understanding and find a way to quantitatively estimate sediment input into the reservoir.

2010 South Fork Rivanna River Reservoir Sediment Budget

To provide input for the South Fork OIE Version I Case Study, the following methodology was used:

1. Determine Overall Yearly SFRRR Capture Rate Since Reservoir Was Built

Historic data (Betz Environmental, 1976, Glaspy, 1980, James R. Reed Associates, 1988, Black and Veach, 1994, HDR Engineering, 2002, and HDR Engineering, 2009) from known bathymetric studies was compiled to create Table 1 below.

SFRRR Volume Data as Reportred by HDR Engineering, Inc., 2010					
year	surveyed reservoir storage volume (MG)	interval duration, years	annual sedimentation rate during interval (MG/yr)	survey volume calculation method	reference
1966	1700	10	0	unknown	
1976	1620	10	8	unknown	Betz Environmental Eng.
1980	1520	4	25	unknown	Glaspy, RG
1988	1420	8	12.5	unknown	James R. Reed Assoc.
1994	1330	6	15	End Area	Black & Veach
		8	9.3		
2002	1256			End Area	HDR Engineering, Inc. (recalculation of RWSA 2002 data using End Area methodology)
2009	1197	7	8.4	End Area	HDR Engineering, Inc.

Table 1

The bathymetric data imply that the annual rate of sediment influx to the reservoir (expressed as millions of gallons capacity lost) has varied over time, between a maximum of 25 MG/yr and a minimum of 8 MG/yr. The reasons for this apparent fluctuation in sedimentation rate could be (1) variations in rates of occurrence of major storm events; (2) episodic spikes in land conversion and construction-related erosion; or (3) survey error. Based upon this data, the overall sedimentation rate over the life of the reservoir from construction in 1966 through the most recent survey in 2009 has been about 12.5 million gallons per year, or 60,844 tons/yr.¹

2. Determine Total Annual Baseline Sediment Loading to the Reservoir

Total sediment loading to the SFRR consists of (*the annual amount of sediment that is trapped in the reservoir above the dam*) plus (*the annual amount of sediment that is washed over the dam*). Sediment grains that are transported downstream through the watershed to the head of the reservoir range in size from gravel (2 to 4mm) to sand (.05 to 2mm), silt (.004 to .05mm) and clay (less than .004mm). All sediment requires moving water for transport. However larger grain sizes such as sand and gravel need faster water in order to continue moving downstream, while smaller grains such as silt and clay can remain in suspension for a long time in water that moves very slowly. For a given set of hydraulic conditions, a percentage of sediment grains transported to the head of the reservoir. Under the same set of conditions, the remainder, consisting of smaller silt and clay grains, will remain in suspension while travelling through the reservoir, and get washed over the dam.

¹ Based on the following conversion factors: 1Acre Foot (AF) = .326 MG=1613 yds; 1 yd. sediment (wet) = .9837 tons; 1AF=1587 tons, therefore, 12.5 MG = 38.34 AF = 60,844 tons/yr.

The OIE model allows the user to specify the proportion of sediment that gets trapped in the reservoir, and the proportion that gets washed over the dam. The USGS has estimated that 70 percent of the sediment load reaching the Conowingo Reservoir on the Susquehanna River is trapped by the dam, and that 30 percent washes over the dam (Ott et al., 1991). While there are significant differences between the Conowingo and Rivanna watersheds and reservoirs, the 70% trapping rate is broadly consistent with available sediment grain size data available for the Rivanna, and we have used those figures in the model (Sobek, 1999; HDR, 2009). Annual sediment load above the dam was calculated by applying the trapping ratio (70%) to the annual sediment influx value obtained from the bathymetric data (60,844T/yr), giving a total annual baseline influx of 86,922T/yr.

3. Determine Proportions of Annual Sediment Loadings to the SFRR Attributable to Overland Flow and to Erosion of Legacy Deposits

Sediment input to the South Fork Rivanna Reservoir is attributable to two mechanisms: (1) erosion by overland flow across non-riparian landscapes, and (2) erosion of legacy (historic) deposits that reside in stream channels and adjacent riparian zones. Sediment input due to overland flow was calculated using InFOREST (2010 land cover data), and applying Sediment Delivery Ratios to adjust raw values relative to transport distances downstream from individual sub-watershed (HUC) outflows. The resulting baseline sediment load due to overland erosion is 20,941 T/yr. The portion of sediment input due to overland erosion (20,941 T/yr) from the total annual baseline load (86,922 T/yr), giving a baseline legacy load of 65,981 T/yr. An important implication of this simple mathematical relationship is that both overland flow erosion and legacy deposit erosion need to be addressed in order to substantially mitigate sediment influx into the SFRR.

South Fork Rivanna River Reservoir Dredging Data

To determine the cost of dredging, data from the HDR Engineering, Inc. report, South Fork Rivanna Reservoir Dredging Feasibility Study, was used. According to this report, the cost of Dredging River Segments 1-3, with no cost offset through sale of dredged material, was estimated to be 27\$-45\$ per cubic yard (cy). For Segments 4-9, again with no materials recovery, the cost was estimated to be \$33/cy. Combining Part I and II, the cost was estimated to be \$31-\$36/cy. These numbers are in the range reported by others (Ramsey-Washington Metro Watershed District, 2007). A conversion factor of 1.8 was used to convert yards to tons (NRCS Agricultural Experimental Reduction Project and Lee, L.T., 2004), and using the \$27 figure, a cost figure of \$15 per ton is estimated.
Watershed Parameters Input Data for South Fork Rivanna River Reservoir Watershed

Based on the information above and (Gannett Fleming, 2004), input data for the South Fork Rivanna Reservoir Case Study was entered into the system as shown below:

Dashboard - Defined Variables in Green	SFRR Case Study
Technician - Defined Variables in Orange	
OIE - Defined Variables in Blue	
Planning Horizon (Years)	5
Baseline Land Cover (all baseline SFRR values documented in comment balloon)	105.110
Total Watershed Acreage	165,140
Forested Land Cover Acreage	70.0
Impenious Land Cover Acreage	8 257
Impervious Land Cover Percent of Watershed	5
Impervious Land Cover Acres Gained per Year	5
Baseline Sediment Budget	
Total Annual Sediment Tonnage Captured by Reservoir	60844.00
Capture Rate of Reservoir (%)	70.0
Sediment Loss Rate Over Dam (%)	30.0
Total Annual Sediment Tonnage Arriving at Head of Reservoir	86,920
Annual Sediment Load to Head of Reservoir Due to Ovenand Flow (1)	20941.00
Conversion Eactor, Sediment Wet Weight (T) to Volume (CV)	1.20
Total Appual Sediment Volume Cantured By Reservoir (CV)	33,802
Usable Reservoir Volume, New Reservoir (Volume of Water Above Intake) (CY)	6 436 600
Baseline Reservoir Life (Years)	76
Year 1 Usable Reservoir Volume (Volume of Water Above Intake) (CY)	6,436,600
Minimum Safe Reservoir Volume (as percentage of New Reservoir Usable Volume)	60
Baseline 2010 SERR Nitrogen & Phosphorous Budgets	
Watershed Nitrogen Loading (Ibs/vr) Due to Overland Flow	330.707
Watershed Nitrogen Loading (lbs/yr) Due to Instream Legacy Sediment Erosion (@3.0 lb/T)	197,937
Nitrogen Bound to Sediment Conversion Factor in lbs./T	3.00
Watershed Phosphorous Loading (Ibs/yr) Due to Overland Flow	51,003
Watershed Phosphorous Loading (lbs/yr) Due to Instream Legacy Sediment Erosion (@1.15 lb/T)	75,876
Phosphorus Bound to Sediment Conversion Factor in Ibs./T	1.15
	•
Arrorestation	0.79
Overland Sediment Reduction (hacle/year) due to land conversion from Agriculture to Forest	4.5
Overland Displayer Neddelion (105/acre/year) due to land conversion from Agriculture to Forest	4.5
Afforestation Payment per Acre	\$800
Afforestation Term	20
Afforestation Liklihood of Conversion (ALOC)	0.5
Afforestation ramp-up period to reach full load reduction (years)	8
Forest Conservation Easements	•
Easement Payment Amount	\$100
Predicted annual % of baseline forested land converted to residential	0.0
Predicted annual acreage of baseline forested land converted to residential	0
Easement Liklihood of Conversion (ELOC)	0
Lasement Legal Litetime	200
Maintenance Dredging Cost (\$/T)	\$15
Portion of Expenditure Allocated Among Ecosystem Services I (must total 1.00)	
Nitrogen Cycle	0.20
Phosphorus Cycle	0.20
Sediment Cycle	0.20
Hydrologic Cycle	0.20
Doulversity	0.20
	1.00
Nutrient and Sediment Load Changes due to Forest conversion to residential land cover	ı
Delta N lb/acre/yr, (change in load reduction) forest to residential land cover conversion	-1.778
Delta P Ib/acre/yr, (change in load reduction) forest to residential land conversion conversion	-0.2097
Delta Sed T/acre/yr, (change in load reduction) forest to residential land conversion conversion	-0.01594

Results

Using the input data as shown above, four scenarios for the South Fork Rivanna River Watershed were evaluated for this report:

- 100% of Expenditures for Afforestation
- 100% of Expenditures for Easements
- 100% of Expenditures for Dredging
- Optimization of Expenditures using Afforestation, Easements, and Dredging

Each was created to examine the impacts of expenditures without regard to likelihood of funding.

It is important to note that the OIE Version I system assumes that the South Fork Rivanna Reservoir has been dredged to create a new reservoir usable volume. The usable volume is defined as the volume above the intake pipe and below the spillway. For the scenarios below, this was estimated to be 6,436,600 CY. Green and grey expenditures are then selected to remove annual baseline sediment entering the reservoir and reducing this volume on an annual basis. The system also allows the user to specify a minimum safe reservoir volume below which some form of mitigation would be enacted in order to ensure safety of the water supply. "Reservoir Lifetime" as discussed below is the number of years until the minimum safe volume is reached. As shown above, for the South Fork Rivanna River Reservoir Case Study, minimum safe volume was set at 60% of usable volume.

It is also important to note that the primary purpose of the OIE is a tool to compare the efficacy of green and grey infrastructure. Because the modeling of a watershed-reservoir relationship is highly complex, subject to climatic impacts, and dependent upon the knowledge of the user, output results can only be rough estimates of actual future conditions. This is also why the project team created a system allowing user input of important values used in the system.

Scenario 1: 100% of Expenditures for Afforestation

Scenario 1 includes expenditures for afforestation only. The Afforestation Likelihood of Reversion (ALOR) was set at 0. An ALOR of 0 means that none of the afforested land is reverted and the lifetime is the same used for the maximum life of the forest conservation easement (entered as an input variable in the Watershed Parameters Input Sheet). The residential conversion yearly percentage rate was set to 0. The Planning Horizon was set to 30 years. A 20 year contract life was selected, with a contract cost of \$800.00. This contract cost is within range of the actual values paid by the Virginia Department of Forestry to landowners for planting trees in the Forests to Faucets program. Afforestation expenditures were maximized at \$1,000,000. Expenditures are limited above this value by the system boundary conditions (shown by "Invalid Entry") to prevent the "Other" land cover being driven by the user below 0%.

Water Supply Reservoir Metrics

Reservoir Lifetime in this scenario is increased from 76.17 (the lifetime of a fully dredged South Fork Reservoir with 0 expenditures) to 109.86 years. The amount of sediment in the reservoir at the end of the planning horizon is decreased from 1,014,067 CY to 999,983 CY. The Infrastructure Lifetime Cost Effectiveness (ILCE) is \$1.18/ton. The ILCE is the total load reduction that occurs in the scenario for all the acres under contract for the total amount of years (lifetime) of the afforestation practice. Note: the ILCE in this scenario is very low because the system assumes that each acre of afforestation would be reverted to agriculture/residential were it not for the afforestation contract. When the ALOR is set to 0, this same assumption continues for each acre of afforestation with ALOR = 0 may be higher than some may feel is valid. The user can mitigate this problem by setting the ALOR = 1. For this scenario, with the ALOR = 1, the ILCE increases to \$14.92/ton and the Reservoir Lifetime decreases to \$98.9 years.

Watershed Metrics

Due to the afforestation expenditures, forest land cover at the end of the Planning Horizon increases from 70% to 93%. 1.4% of the load delivered to the reservoir has been reduced by the afforestation program. However, note that this is the load delivered *during the Planning Horizon*. Afforestation also reduces the baseline beyond the planning horizon. This affect of afforestation is not captured in the metric.

Watershed-Reservoir Wellness Index

At the beginning of the Planning Horizon, watershed Fitness was scored at 65. This reflects that 70% of the reservoir is in forest cover and 5% impervious surface. Reservoir Health was scored a 100, because in the beginning of the scenario the reservoir volume is free from sediment. The Watershed-Reservoir Wellness Index (WRWI) is scored at an 82.5, indicating better than average conditions. At the end of the scenario, watershed Fitness increases significantly to a score of 87.6. Reservoir Health is decreased from 100 to 84.5 due to sediment load deposited into the reservoir. The WRWI at the end of the Planning Horizon increases from 82.5 to 86 due to increase in forest cover.

Scenario 2: 100% of Expenditures for Forest Conservation Easements

Scenario 2 includes expenditures for easements only. The Forestland Liklihood of Conversion (FLOC) was set at .5. The FLOC converts the existing forestland sediment load from forest to residential load. An FLOC of 1 causes the system to calculate 100% of existing forest cover at the residential unit load rate. An FLOC of .5 converts 50% of the difference. Note that when the FLOC is set to .5, Reservoir Lifetime decreases from 76.17 to 74.75 years, due to the increase in load. Once again the residential conversion yearly percentage rate was set to 0. The Planning Horizon was again set to 30 years. An easement cost of \$100 per acre was selected. This value is within range of the values

actually paid to landowners by the Virginia Department of Forestry in the Forests to Faucets program. The system allowed a maximum annual expenditure of \$300,000. Input of the next system increment of \$400,000 would have exceeded the total acreage of forest land in the watershed.

Water Supply Reservoir Metrics

Reservoir Lifetime in this scenario is slightly increased from 74.75 to 75.28 years. The conservation easement expenditures placed easements on 90,000 acres by the end of the Planning Horizon (note that there are 115,598 acres of forest in the watershed). The amount of sediment in the reservoir at the end of the planning horizon has decreased from 1,033,333 CY to 1,032,935 CY. The Infrastructure Lifetime Cost Effectiveness (ILCE) is \$12.55/ton. It is notable that if the FLOC is increased to "1", meaning a 100% likelihood of forestland conversion, the ILCE decreases to \$6.27/ton. This is because an easement has more value at a 100% likelihood of conversion.

Watershed Metrics

Because easements do not change land cover, there is no change in forest cover from the beginning to the end of the Planning Horizon. .1% of the load delivered to the reservoir has been reduced by the easement program.

Watershed-Reservoir Wellness Index

As above, at the beginning of the Planning Horizon, watershed Fitness was scored at 65, reservoir Health was scored a 100, and the WRWI was scored at an 82.5. At the end of the Planning Horizon, watershed Fitness is unchanged. Health has declined (from 100 to 83.7 due to accumulating legacy sediment load), and the WRWI at the end of the Planning Horizon decreases from 82.5 to 74.3, again due to the declining Health of the reservoir.

Scenario 3: 100% of Expenditures for Dredging

Scenario 3 includes expenditures for dredging only. The FLOC is set to 0. As in Scenarios 1 and 2, the residential conversion yearly percentage rate was set to 0. The Planning Horizon was once again set to 30 years. A dredging unit cost of \$15 per ton was selected. Expenditures are limited at \$900,000 by the system boundary conditions. Expenditures at the next increment above this level result in more sediment being removed from the reservoir on an annual basis than enter it.

Water Supply Reservoir Metrics

Reservoir Lifetime in this scenario is increased from 76.17 to 105.75 years. The amount of sediment in the reservoir at the end of the planning horizon is decreased from 1,014,067 CY to 14,067 CY. The ILCE is \$15/ton.

Watershed Metrics

Because there have been no expenditures on green infrastructure, there is no change in the land cover at the end of the planning horizon. 98.6% of the sediment load delivered to the reservoir has been reduced by the dredging program.

Watershed-Reservoir Wellness Index

At the beginning of the Planning Horizon, watershed Fitness was scored at 65. This reflects the 70% of the reservoir in forest cover and 5% in impervious surface. Reservoir Health was scored a 100, because in the beginning of the scenario the reservoir volume is free from sediment. The Watershed-Reservoir Wellness Index (WRWI) is scored at an 82.5, indicating better than average conditions. At the end of the scenario, watershed Fitness is the same as the beginning of the Planning Horizon, at a score of 64.9 (slightly different only due to system rounding of data), though Health has experienced a slight decline, indicating that the dredging program is leaving a small fraction of the total load that continues to reduce reservoir volume. Consequently, Wellness is also slightly reduced.

Scenario 4: Optimization of Expenditures using Afforestation, Easements, and Dredging

Scenario 4 includes expenditures for afforestation, easements, and dredging. The ALOR and FLOC were both set to .5. The % of forest converted each year to residential development was set to .1%. Note that .1% of the forested area of the watershed converted annually results in 3,468 acres converted over 30 years. The Planning Horizon as in the other scenarios was set to 30 years. A 20 year contract life was selected, with a contract cost of \$800.00. A 1 million dollar per year afforestation expenditure was selected. A \$300,000 per year forest conservation easement expenditure @ \$100 per contract was selected. In addition, a value of \$900,000 per year expenditure on dredging @ \$15 per ton was also selected.

Water Supply Reservoir Metrics

Reservoir Lifetime in this scenario is increased from 76.12 to 148.75 years. The amount of sediment in the reservoir at the end of the planning horizon is decreased from 1,014,097 CY (amount of sediment in the reservoir at year 30 without any expenditures) to 20,233 CY (amount of sediment in the reservoir at year 30 with expenditures). The ILCE is \$4.37/ton. The ILCE is the blended lifetime cost effectiveness of the three types of expenditures at the expenditure levels selected. Note however that if the ALOR is set to 1, the Reservoir Lifetime decreases to 140.57 years and the ILCE increases to \$14.49/ton.

Watershed Metrics

Due to the afforestation expenditures, forest land cover at the end of the Planning Horizon increases from 70% to 93%. Due to .1% conversion selected, at the end of the Planning Horizon, a cumulative increase of 3% of the watersheds forested land has been converted to residential development. Of the total scenario sediment reduction *during the Planning Horizon*, 1.3% is from Green Infrastructure, while 96.8% is from Grey Infrastructure.

Watershed-Reservoir Wellness Index

At the end of the scenario, watershed Fitness increases significantly, from 65 to a score of 87.6. This is due to the increase in forest cover. In addition, reservoir Health is slightly decreased to 99.7, due to a small portion of the background load still accumulating in the reservoir. The Wellness has increased from 82.5 to 93.7, again due to the increase in forest cover.

Discussion

The OIE Version 1 South Fork Rivanna River Reservoir Case Study reveals the following key findings:

1. Afforestation in the South Fork Rivanna River Reservoir Watershed has similar impact on reservoir lifetime as does dredging for approximately the same expenditures during a 30 year planning horizon.

2. The lifetime cost effectiveness of afforestation as compared to dredging in the South Fork Rivanna River Reservoir Watershed ranges from approximately the same to significantly greater, due to sediment load reduction that continues beyond the planning horizon, depending upon the likelihood of afforestation reversion.

In Scenario 1, using afforestation only, and assuming no reversion of afforestation contracts, Reservoir Lifetime is increased from 76.17 to 109.86 years. The total of the Planning Horizon expenditures is \$30,000.00 at a range of ILCE values (\$1.18/ton - \$14.92/ton). In Scenario 3, using dredging only, Reservoir Lifetime is increased from 76.17 to 105.75 years. The total of the Planning Horizon expenditures is \$27,000.000 at an ILCE of \$15/ton. The reason that the ILCE may be less than the ILCE for grey infrastructure, is due to the fact that the load reduction may extend significantly beyond the Planning Horizon. Note however in this scenario that ALOR has been set to 0, meaning that there is no conversion of afforestation at the end of the contract period. In this situation, the afforestation contract acts as an easement with a certain likelihood of conversion.

3. Forest conservation easements have a high lifetime cost effectiveness to mitigate future increases in sediment loading, when future forestland conversion is certain.

Conservation easements provide assurance that over the long term, nutrient and sediment loadings from an eased parcel will not increase from what they are on the date when the easement document is signed. Placing an easement on a piece of forested land does not alter the biophysical reality of nutrient and sediment loadings on that parcel. Thus easements are not capable of providing a decrease in baseline loading to the reservoir. Easements ARE however capable of mitigating future increases to baseline loadings due to conversion of forest land to other land covers.

In this model, the value of easements is assessed relative to the likelihood that, in the absence of an easement, a given parcel would be converted from forest to residential land use, with resulting increase in nutrient and sediment loadings. When the user-defined Forestland Likelihood of Conversion (ELOC) value is set at 1, the model assumes (hypothetically) that 100% of forested land would convert to residential during the Planning Horizon, absent any easements. When a scenario is run, easement acreage purchased is credited toward reducing the hypothetical load increases associated with that wholesale conversion of forest land to residential development. Similarly, when FLOC is set at .5, the model decrees that 50% of the forested load will convert to residential load during the Planning Horizon. Easement acres purchased are credited toward offsetting the anticipated load increases on that portion of previously forested land (50%) that is modeled as converting to residential.

4. A combination of expenditures for afforestation, easements, and dredging maximizes the South Fork Rivanna River Reservoir reservoir lifetime and WRWI at least infrastructure lifetime cost.

Scenario (30	Reservoir	WRWI	ILCE (\$/ton	Total
year horizon)	Lifetime (years)		sediment)	Expenditures
Scenario 1	98.9 - 109.86	86	1.18 - 14.72	30 million
(afforestation)				
Scenario 2	75.28	74.3	6.27	9 million
(easements)				
Scenario 3	105.75	82.3	15	27 million
(dredging)				
Scenario 4 (all-	148.75	93.7	4.37	66 million
optimized)				

A combination of expenditures for afforestation, easements, and dredging described in Scenario 4 maximized reservoir lifetime and WRWI at least cost as shown below:

Scenario 4 was provided as a hypothetical example to illustrate the greatest possible combined effects of forest cover and dredging. It should be noted that an increase in forest cover to 93% in the South Fork Rivanna watershed is unlikely. Assuming a 10% increase in forest cover from the current 70% would provide a more realistic optimization scenario. Also, many capital planning programs work on a 10 year timeline. Adjusting for these inputs, and keeping the same other input values used in Scenario 4, the system yields interesting results.

1.4 million in annual afforestation expenditures pushed the % forest cover at the end of the planning horizon to 80%. The system also allowed the expenditure of 1.1 million per year on easements. This placed 110,000 acres of the 115,598 original forestland acres under easement. Note that the next increment in easement expenditures (1.3 million) would have exceeded the total original forestland acres, thus the system stops expenditures below this level. Finally, the system again allowed the annual dredging expenditure of \$900,000.

The input values over a 10 year planning horizon increased reservoir lifetime, from 76.17 to 97.08 years. This is a longer lifetime than dredging or afforestation only, at 84.4 and 84.5 years, respectively. The Infrastructure Lifetime Cost Effectiveness (ILCE) is \$5.68.

Scenario (10	Reservoir	WRWI	ILCE (\$/ton	Total
year horizon)	Lifetime (years)		sediment)	Expenditures
Scenario (all –	97.08	87.3	5.68	34,000,000
optimized)				

IX. Recommendations

1. Evaluate community interest in grey and green infrastructure optimization. The optimization of green and grey infrastructure represents a new policy opportunity that without F2F and the OIE system would be impossible to achieve. With the OIE, urban and rural residents can begin to consider ways they are environmentally interdependent. The western world is in search of organizational structures to better manage ecosystem health. The Rivanna F2F program provides a framework to use an existing structure – the water and wastewater public utility, to manage water related ecosystem services. For the Charlottesville region, the Team recommends the creation of a *Joint Grey/Green Infrastructure Optimization Committee* involving the County of Albemarle, City of Charlottesville, University of Virginia, Rivanna Water and Sewer Authority, Albemarle County Service Authority, and other private and public entities to be charged by the City and County to begin to consider the management of green and grey infrastructure over a century or longer lifetime.

2. **Develop OIE Version II.** OIE Version I is a prototype optimization system. A Version II is needed for eutrophication, for more advanced optimization functionalities, and for better graphical rendering of system outputs. To create a eutrophication OIE, models to translate watershed nutrient loads to algae biomass in a reservoir will need to be integrated into the OIE system. Candidate models already available include the Corps of Engineers Bathtub and Flux models. Even within the Excel environment, enhanced optimization functionalities to answer "what-if" scenarios exist. For instance, the Excel Solver add-on could be presented as an additional section on the dashboard, with a set of input boxes for defining the acceptable boundaries and conditions, a start button and an output box. Several scenarios could be run simultaneously or consecutively for comparison purposes. In addition, more complex algorithms will need to be written to provide data for these enhanced outputs. The graphical interface built in excel is unstable and contains only a fraction of possible functionality that would be useful to users. A Version II OIE should also include a more robust and stable graphical user interface (GUI).

X. References

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Appendix I: Glossary of Terms

Afforestation Post-contract Liklihood of Conversion (ALOR) – the likelihood of an acre of land with an afforestation contract to revert to residential or agricultural land cover, expressed as a value from 0 to 1

Ecosystem Service – products and processes needed by humans and provided by nature

Dynamic Forest Land Cover (DFLC) – the concept of a specific type of forest land cover designed to maximize summer baseflow through long-term dynamic management of patches of older growth areas paired with patches of harvested areas.

Existing Forestland Liklihood of Conversion (FLOC) – the likelihood of an acre of existing forestland to be converted to residential land cover, expressed as a value from 0 to 1

Fitness – % Forest cover – % Impervious Cover

Green Infrastructure – landscape practices that reduce pollution

Grey Infrastructure – machines and built systems that reduce pollution

Health - the annual rate of pollutant asset that reaches the reservoir

Infrastructure Lifetime Cost Effectiveness (ILCE) – the total annual cost of grey or green infrastructure over its lifetime divided by the amount of yearly environmental service provided

Watershed – reservoir + drainage basin

Wellness - Health + Fitness

Appendix II: Phase I F2F Program Funding Application

Virginia Department of Forestry South Fork Rivanna River "Forests to Faucets" Program Funding Application

LANDOWNER NAME: Taxpayer ID Num with your application	nber is required. Contion.	mplete a Federal W-9 (Request for Taxpa	yer Identification Number and Certification) and return
PROPERTY INFORMATION: DOP	Tract No:	DOF Parcel No:	Acres Applied For:
COU	NTY Tax Map/Par	cel No:	-
PROJECT DESCRIPTION:			
 Forest Management/ Preharvest Harvest Site Stabilization Riparian Buffer Tax Credit Mate Forest Establishment 	Plan Reimbu Reimbu ch Cash m Copy of 1) Rein 2) Lun 3) One 4) Five	ursement of cost based on current ursement of cost, not to exceed \$50 batch, not to exceed \$5000, for an <i>"VDOF Certification of Eligibility for Rip</i> mbursement of stand establishmen np-sum payment for 20 year contra- e acre minimum for Riparian Buffe e acre minimum for general open l	VDOF rates and limits 000 <u>uncut</u> riparian buffer. <i>parian Buffer Tax Incentive</i> " form required. nt costs plus \$50/acre maintenance payment act er Establishment land planting

RECOMMENDATIONS: (VDOF forester to complete Form 75 if needed)

LANDOWNER AGREEMENT: I agree.....

- 1. To install practices as prescribed by the Virginia Department of Forestry (VDOF)
- 2. To designate and assume responsibility for boundaries of the parcel where the project is to be performed, and to give VDOF employees the right to enter the property for the purpose of inspecting the progress and maintenance of the project.
- 3. To comply with recommended Best Management Practices, the Silivcultural Water Quality Law and the Virginia Seed Tree Law.
- 4. To ensure 80% of the recommended trees per acre are planted correctly based on VDOF planting quality standards, if my project involves tree planting.
- 5. To replant, should the results of the VDOF survival reinspection made at the end of the first growing season for pine plantings and/or second growing season for hardwood plantings show that an insufficient number of seedlings exist to develop into a well stocked stand.
- 6. To provide receipts, contractor statements OR a completed "Landowner Certification of Expenses" (VDOF Form 23) upon completion of the project. NOTE: For any Riparian Buffer Tree Planting or General Open Land Tree Planting project, this requirement must be met by July 1st of the same year the planting was completed or the project funding will be cancelled.
- 7. To provide to VDOF copies of documentation, obtained from the USDA Farm Service Agency (FSA) that you are an EQIP eligible landowner.
- 8. I am responsible for payment of invoices. Upon submission of appropriate documentation, payment will be made directly to me.
- 9. The applicable charges for services provided by the VDOF will be subtracted from the incentive payment.
- 10. Livestock grazing must be excluded from the project area for the life of the contract.
- 11. For the practice of Forest Establishment, I agree to refund any incentive payments along with a 10% penalty fee, if the project is not completed as prescribed, or if seedlings planted are intentionally removed or destroyed (by current or subsequent landowners) before the end of the 20 year contract.
- 12. The Department of Forestry obligation is subject to availability of funds and can be terminated at any time for any reason before implementation. In addition, in the event that by operation of law, the powers and authority of the State Forester shall be so curtailed as to prevent the continued performance of his duties, this agreement and all responsibilities of the State Forester hereunder shall cease.
- 13. That I qualify for the agricultural exemption from Virginia Retail Sales Tax on seedlings purchased from the VDOF as the trees are to be planted for future commercial production of timber.

REFORESTATION SERVICES AGREEMENT (Check the reforestation services you wish to obtain from the VDOF should you or a planting contractor be unable to provide these services. If these VDOF costs are incurred, landowner will not be billed.)

Coordinate Planting on the Tract	@ \$	/Acre	\$ Min.	Deliver Seedlings to Tract @ \$	/Loaded Mile S	§ Min.
•				•		

LANDOWNER NAME (PRINT)	LANDOWNER SIGNATURE	DATE

I certify that the above project(s), if properly carried out, will qualify for an incentive payment under the South Fork Rivanna River Forests to Faucets program. A copy of the project map is included with this application.

FORESTER NAME (PRINT)	FORESTER SIGNATURE	DATE
ASSISTANT REGIONAL FORESTER NAME (PRINT)	ASSISTANT REGIONAL FORESTER SIGNATURE	DATE

TO BE COMPLETED UPON PROJECT COMPLETION

I certify that	the above project was	completed according to i	recommendations prov	vided Acres Comr	leted:
reering under	and addie project was	eompreted deeording to i	eeona prov	1000 110100 00111	Tereda

FORESTER SIGNATURE

DATE

Virginia Department of Forestry South Fork Rivanna River "Forests to Faucets" Program

PROCEDURES

GENERAL: All landowners will need to document EQIP eligibility <u>at the time of funding application</u>. An application will not be accepted or considered complete without this documentation. It will be the landowners responsibility to contact the FSA (Farmers Servcie Agency) for copies of the necessary forms proving eligibility. In most cases, based on the category of land ownership, this documentation will include USDA forms AD1026, CCC 926, and CCC 901.

On the Funding Application Form, landowners should check the practice(s) being applied for. A project application must be complete before submitting to the Assistant Regional Forester for approval. This includes the landowner submitting the necessary documentation to prove EQIP eligibility, a Federal W-9 tax form, a project map, a copy of VDOF Form 75 (if applicable) and all necessary signatures on the application form. NOTE: When the management practice is Forest Establishment, the project map must show **mapped** acres. Because of the potentially significant amounts of landowner payments involved it is important to map the planting sites.

ELIGIBLE PRACTICES:

<u>Forest Stewardship Management Plans (FSMP) with Preharvest Plan Component.</u> A FSMP that incorporates preharvest planning language designed specifically for a timber harvest that is scheduled to begin on or before October 1, 2012 is eligible for an incentive payment to help with FSMP plan preparation fees. The Preharvest Planning section shall incorporate approved practices as described in the "Virginia's Forestry Best Management Practices for Water Quality" handbook.

If the plan is prepared by a VDOF forester, a completed *VDOF Form 127* (FSMP application form) must be attached when requesting the incentive payment. If the plan was prepared by a private forestry consultant, a copy of the plan and a copy of the consultant's billing invoice for the plan must be submitted. Reimbursement for plan preparation costs will be capped at \$4.50 per acre up to a maximum of \$2250. All plans must be approved by the Assistant Regional Forester.

A grand total of \$10,000 has been earmarked for this practice.

<u>Harvest Site Stabilization</u>. Upon completion of a timber harvest, costs associated with stabilizing skid trails, haul roads, and log decks used during the timber harvest site are eligible for full reimbursement up to a **cap of \$5000 per landowner**. This practice is for a timber harvest that occurred and was completed after October 1, 2010. All harvest stabilization work must be done and application successfully submitted by August 1, 2012. Eligible expenditures include items such as seed, labor, and structural work (e.g. water bar installation, skid trail grading). Work shall be done in accordance with guidelines found in the "Virginia's Forestry Best Management Practices for Water Quality" handbook. Costs shall be submitted on a *VDOF Form 23* (Certification of Work Completed Form) and signed by the approving VDOF forester. NOTE: None of these funds shall be used to satisfy a Special Order, Emergency Special Order or Water Quality

Protection Recommendations (VDOF Form 143) that has been prepared by VDOF. If all of water quality law concerns have been addressed and satisfactorily closed out per VDOF, the harvest site would become eligible for this practice.

A grand total of \$25,000 has been earmarked for this practice.

<u>Riparian Buffer Tax Credit Match.</u> Timber harvests that left intact, **uncut** riparian buffers are eligible for a cash-match incentive payment. The cash-match will be equivalent to the amount of the Virginia Riparian Buffer Tax Credit, up to a **cap of \$5000 per landowner**. This practice is applicable for a successfully filed Virginia Riparian Buffer Tax Credit. A copy of the "VDOF Certification of Eligibility for Riparian Buffer Tax Incentive" will be required with the application. Only timber harvests that occur between October 1, 2010 and September 1, 2012 **AND** have the completed "VDOF Certification of Eligibility for Riparian Buffer Tax Incentive" are eligible.

A grand total of \$20,000 has been earmarked for this practice.

<u>Forest Establishment.</u> There are two components to the landowner payment. The first component will be a full reimbursement of reasonable planting costs (site preparation, bare rooted seedlings (NOTE: balled and burlapped or potted saplings are not eligible), planting labor, and other VDOF recommended supplies such as tree shelters and mats when planting hardwoods in a riparian area). There will be a cap of \$600 per acre for hardwood plantings done as part of any Riparian Buffer Planting and \$200 per acre for pine plantings.

In addition to this full reimbursement of planting costs, landowners will receive a \$50/acre maintenance payment. This maintenance payment can be applied to replanting, stand maintenance (mowing, spraying), or fencing.

The second component will be the lump-sum, Present Value payment for the land rental. This lump-sum payment will be calculated as the Present Value of a series of terminating annual payments. It will be based on the per acre bid submitted by the landowner, total project acres, 7% discount rate, and the required 20 year contract.

There are two qualifying types of Forest Establishment, riparian buffer plantings and general open land planting. Below each of these are described.

Riparian Buffer Planting: The minimum project size for these plantings will be one contiguous acre. Plantings must be adjacent to the stream and be a minimum of 50 feet in width measured from the top of the stream bank. Both hardwood and pine species are appropriate species for planting. The actual species used, recommended spacing, and site preparation needed will be at the discretion of the approving forester. Because of limited available funding, pine plantings are preferred. Up to 10% of the project area can be a perennial wildlife planting. Livestock must be excluded from the planting site for the life of the 20 year contract.

General Open Land Planting: The minimum project size for these plantings will be 5 contiguous acres. Only pine species are eligible for planting. The actual species used, recommended spacing, and site preparation needed will be at the discretion of the approving forester. Up to 10% of the project area can be a perennial wildlife planting. Livestock must be excluded from the planting site for the life of the 20 year contract.

A grand total of \$210,000 has been earmarked for Forest Establishment projects.

PROJECT COMPLETION: Upon project completion, the VDOF forester will sign off on the completed project application form. A VDOF Form 22 (Request for Billing), along with any required supporting documentation such as copies of contractor invoices, receipts (or VDOF Form 23) will be submitted to the Assistant Regional Forester for payment approval. NOTE: For any Riparian Buffer Tree Planting or General Open Land Tree Planting project, this requirement must be met by **July 1st** of the same year the planting was completed or the project funding will be cancelled

Appendix III: F2F Phase II Methodology

Draft II Ongoing Bidding Methodology August 17, 2010 Based on 8-11-10 Meeting

DOF/Conserv will test a new program to contract with rural landowners for Forest Establishment, with the following components:

- The program will be an ongoing enrollment, "continuous sign-up" based on specific per acre payment amounts.
- The program will be first come, first served.
- Two payment amounts will be identified. One for high priority, and one for low priority watersheds.
- The program will kick off October 1.
- Limited marketing will be conducted to prepare the public.

Land Rental Payment Amounts

• Two categories of payments were discussed – a rate for perhaps the top 2-3 priority subwatersheds and a rate for all the others.

Qualifying Forest Establishment Projects

- These are hardwood and pine SEEDLING projects. B&B trees are not valid.
- Hardwoods, unlike how they were dealt with in the bidding process, ARE VALID, but DOF will tell landowners that they will only provide X\$ toward cost.

Prioritization – September 2010

- Conserv will identify priority watersheds and within them find 150-200 parcels as targets for Forest Establishment outreach over two planting seasons.
- An example of a methodology to identify parcels within priority watersheds might be to kick out parcels that are 50% or more forested.
- This list will be completed before October 1.

Tree Cost Planting Cap

• A ceiling of \$200.00 will be set.

Marketing – Beginning September 2010

- The website will be altered. The changes will include:
 - Landing Page Announcement to appear early September
 - o Instructions on program participation through Forest Establishment Tab
 - A map showing rates paid
 - Explanation of what Forest Establishment includes
 - Instructions on how a landowner can participate
- Posters will be redone and redeployed

- Some radio announcements will be attempted, for example, through WINA
- Presentations for civic groups will be sought, such as Crozet Ruritans
- A mention of the program in the Farm Bureau newsletter will also be attempted.
- Door to door canvassing of prioritized parcels
 - Conserv will prepare a list of property contacts and addresses (we will prepare a database of whatever parcel data we can find of the prioritized parcels)
 - DOF will use their staff resources (P-14 level) to visit landowners in the list of 150-200

Contracts

• Contract will need a little modification.

Forest Establishment Brochure – September 2010

- Something is needed to "standardize" message, for folks such as David Powell, Nelson Shaw, and P-14 field type personnel
- Perhaps a brochure could be developed that these folks could use to focus message. If developed, this should be completed by mid-September.

Payments for Tree Planting DRAFT Ongoing Bidding Methodology Thoughts for August 11 Meeting August 10, 2010

The Bidding process did not capture enough applicants to use all of the funding.
 Based on conversations with persons that considered bidding, but failed to submit a bid, the reasons cited include:

- Not much money
- Hassle factor
- No certainty that the bid will win
- Didn't get around to it
- Form requires too much work
- Concern about tying up land for 20 years

3. A revised system to pay landowners for Forest Establishment is needed.

4. Proposed is a pro-active, on-going enrollment of landowners. Ideas for this system include:

- Pro-active recruitment of landowners using VDOF staff. Idea here is landowner has to just contact staff, they will do a site visit to explain program.
- Set compensation levels.

- A ten year contract?
- No increase in payment amount at least for 2010... but perhaps differential payment schedule for different prioritization. What about higher rate for Mechums and lower for Moormans?
- Some way to reach out to property managers especially?
- First come first served rule for new program.
- System designed August and rolled out via the website in September.

5. Marketing Ideas (for second half of 2010)

- Farm Bureau newsletter
- Maybe some internet advertising, maybe also get active on Twitter
- Maybe also some more targeted reach out through tax map research, but this would be time intensive.

Appendix IV: Phase II F2F Program Funding Application

Virginia Department of Forestry Rivanna River Basin "Forests to Faucets" Program Funding Application

LANDO	WNER	NAME:
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Taxpayer ID Number is required. Complete a Federal W-9 (Request for Taxpayer Identification Number and Certification) and return with your application.

PROPERTY INFORMATION:	DOF Tract No:	DOF Parcel No:	Acres Applied For:

COUNTY Tax Map/Parcel No: _____

PROJECT DESCRIPTION (Check off those practices being applied for. See Procedures Addendum for payment caps):

Forest Stewardship Management Plan	Reimbursement of cost based on current VDOF rates and limits
Harvest Site Stabilization	Reimbursement of cost, not to exceed \$5000
Riparian Buffer Tax Credit Match	Cash match, not to exceed \$5000, for an <u>uncut</u> riparian buffer.
-	Copy of "VDOF Certification of Eligibility for Riparian Buffer Tax Incentive" form required.
Forest Establishment	1) Reimbursement of stand establishment costs plus \$50/acre maintenance payment
	- \$600 per acre cap for hardwood plantings Acres
	- \$200 per acre cap for pine and wildlife plantings Acres
	2) Lump-sum payment for 20 year contract
	3) One acre minimum for Riparian Buffer Establishment
	4) Five acre minimum for general open land planting
	5) 10% of project area may be a perennial wildlife planting
Enhanced Conservation Easement	Incentive payment based on the attributes of the property and the enhancements in
	the recorded deed as specified in the VDOF enhancement worksheet.
Fencing from Livestock	Reimbursement of cost, not to exceed \$3.50 per linear foot of fence.
DECOMMENDATIONS , (VDOE forester to	accumulate Form 75 if needed)

RECOMMENDATIONS: (VDOF forester to complete Form 75 if needed)

LANDOWNER AGREEMENT: I agree.....

- 14. To install practices as prescribed by the Virginia Department of Forestry (VDOF)
- 15. To designate and assume responsibility for boundaries of the parcel where the project is to be performed, and to give VDOF employees the right to enter the property for the purpose of inspecting the progress and maintenance of the project.
- 16. To comply with recommended Best Management Practices, the Silivcultural Water Quality Law and the Virginia Seed Tree Law.
- 17. To ensure 80% of the recommended trees per acre are planted correctly based on VDOF planting quality standards, if my project involves tree planting.
- 18. To replant, should the results of the VDOF survival reinspection made at the end of the first growing season for pine plantings and/or second growing season for hardwood plantings show that an insufficient number of seedlings exist to develop into a well stocked stand.
- 19. To provide receipts, contractor statements OR a completed "Landowner Certification of Expenses" (VDOF Form 23) upon completion of the project. NOTE: For any Riparian Buffer Tree Planting or General Open Land Tree Planting project, this requirement must be met by July 1st of the same year the planting was completed or the project funding will be cancelled.
- 20. To provide to VDOF copies of documentation, obtained from the USDA Farm Service Agency (FSA) that you are an EQIP eligible landowner.
- 21. That in order to receive payment for Conservation Easement Enhancements the easement must have been recorded AND approved by the VDOF between 1/1/2011 and 6/1/2012.
- 22. I am responsible for payment of invoices. Upon submission of appropriate documentation, payment will be made directly to me.
- 23. The applicable charges for services provided by the VDOF will be subtracted from the incentive payment.
- 24. Livestock grazing must be excluded from the project area for the life of the contract.
- 25. For the practice of Forest Establishment, I agree to refund any incentive payments along with a 10% penalty fee, if the project is not completed as prescribed, or if seedlings planted are intentionally removed or destroyed (by current or subsequent landowners) before the end of the 20 year contract.

- 26. The Department of Forestry obligation is subject to availability of funds and can be terminated at any time for any reason before implementation. In addition, in the event that by operation of law, the powers and authority of the State Forester shall be so curtailed as to prevent the continued performance of his duties, this agreement and all responsibilities of the State Forester hereunder shall cease.
- 27. That I qualify for the agricultural exemption from Virginia Retail Sales Tax on seedlings purchased from the VDOF as the trees are to be planted for future commercial production of timber.

ESTIMATED	CALCULATIONS
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REFORESTATION SERVICES AGREEMENT (Check the reforestation services you wish to obtain from the VDOF should you or a planting contractor be unable to provide these services. If these VDOF costs are incurred, landowner will not be billed.)								
Coordinate Planting on the Tract @ \$	/Acre \$	Min Deliver Seedlings to Tract @ \$	/Loaded Mile \$	Min.				
LANDOWNER RENTAL RATES, MAINTENANCE, and FENCING PAYMENT (VDOF forester to complete) Project Location (Hydrologic Unit) Rental Rate/Acre Total Rental Payment (acres X rate) = \$ Maintenance Payment Acres Total Maintenance Payment (acres X \$50) = \$								

LANDOWNER NAME (PRINT)

LANDOWNER SIGNATURE

DATE

I certify that the above project(s), if properly carried out, will qualify for an incentive payment under the South Fork Rivanna River Forests to Faucets program. A copy of the project map is included with this application.

FORESTER NAME (PRINT)

FORESTER SIGNATURE

DATE

ASSISTANT REGIONAL FORESTER NAME (PRINT)

ASSISTANT REGIONAL FORESTER SIGNATURE

DATE

TO BE COMPLETED UPON PROJECT COMPLETION

I certify that the above project was completed according to recommendations provided

Acres Completed: ______ Fencing Installed (ft.): _____

FORESTER SIGNATURE

DATE

FINAL CALCULATIONS								
REFORESTATION SERVICES AGREEMENT (Check the reforestation services you wish to obtain from the VDOF should you or a planting contractor be unable to provide these services. If these VDOF costs are incurred, landowner will not be billed.)								
Coordinate Planting on the Tract @ \$/Acre \$N	In Deliver Seedlings to Tract @ \$/Loaded Mile \$ Min.							
LANDOWNER RENTAL RATES & MAINTENANCE PAYMENT (VDOF forester to complete)								
Project Location (Hydrologic Unit) Rental Rate/Acre Maintenance Payment Acres	Total Rental Payment (acres X rate)=Total Maintenance Payment (acres X \$50)=							

Virginia Department of Forestry Rivanna River Basin "Forests to Faucets" Program

PROCEDURE ADDENDUM

GENERAL: All landowners will need to document EQIP eligibility <u>at the time of funding application</u>. An application will not be accepted or considered complete without this documentation. It will be the landowners responsibility to contact the FSA (Farmers Service Agency) for copies of the necessary forms proving eligibility. In most cases, based on the category of land ownership, this documentation will include USDA forms AD1026, CCC 926, and CCC 901.

On the Funding Application Form, landowners should check the practice(s) being applied for. A project application must be complete before submitting to the Assistant Regional Forester for approval. This includes the landowner submitting the necessary documentation to prove EQIP eligibility, a Federal W-9 tax form, a project map, a copy of VDOF Form 75 (if applicable) and all necessary signatures on the application form. NOTE: When the management practice is Forest Establishment, the project map must show **mapped** acres. Because of the potentially significant amounts of landowner payments involved it is important to map the planting sites. *NOTE: The VDOF forester will enter this mapped acreage on page 1 of the Forests to Faucets funding application in the Forest Establishment section. This acreage will be used by fiscal to determine the payment caps for tree planting projects.* For Forest Establishment projects, the VDOF forester will complete the Estimated Calculations block.

ELIGIBLE PRACTICES:

<u>Forest Stewardship Management Plan (FSMP)</u>. If the FSMP is prepared by a VDOF forester, a completed *VDOF Form 127* (FSMP application form) must be attached when requesting the incentive payment. If the plan was prepared by a private forestry consultant, a copy of the plan and a copy of the consultant's billing invoice for the plan must be submitted. Reimbursement for plan preparation costs will be capped at \$4.50 per acre. The minimum acreage eligible for a FSMP is 10 contiguous acres with a minimum reimbursement of \$200 per plan. All plans must be completed and approved by the Assistant Regional Forester by September 1, 2013.

If a timber harvest is recommended in the FSMP, it should incorporate preharvest planning language designed specifically for the recommended harvest. The preharvest planning section shall incorporate approved practices as described in the "Virginia's Forestry Best Management Practices for Water Quality" handbook.

<u>Harvest Site Stabilization</u>. Upon completion of a timber harvest, costs associated with stabilizing skid trails, haul roads, and log decks used during the timber harvest site are eligible for full reimbursement up to a **cap of \$5000 per landowner**. This practice is for a timber harvest that occurred and was completed after October 1, 2010. All harvest stabilization work must be done and application successfully submitted by August 1, 2012. Eligible expenditures include items such as seed, labor, and structural work (e.g. water bar installation, skid trail grading). Work shall be done in accordance with guidelines found in the "Virginia's Forestry Best Management Practices for Water Quality" handbook. Costs shall be submitted on a *VDOF Form 23* (Certification of Work Completed Form) and signed by the approving VDOF forester. NOTE: None of these funds shall be used to satisfy a Special Order, Emergency Special Order or Water Quality

Protection Recommendations (VDOF Form 143) that has been prepared by VDOF. If all of water quality law concerns have been addressed and satisfactorily closed out per VDOF, the harvest site would become eligible for this practice.

<u>Riparian Buffer Tax Credit Match.</u> Timber harvests that left intact, **uncut** riparian buffers are eligible for a cash-match incentive payment. The cash-match will be equivalent to the amount of the Virginia Riparian Buffer Tax Credit, up to a **cap of \$5000 per landowner**. This practice is applicable for a successfully filed Virginia Riparian Buffer Tax Credit. A copy of the "VDOF Certification of Eligibility for Riparian Buffer Tax Incentive" will be required with the application. Only timber harvests that occur between October 1, 2010 and September 1, 2012 **AND** have the completed "VDOF Certification of Eligibility for Riparian Buffer Tax Incentive" are eligible.

<u>Forest Establishment.</u> There are two components to the landowner payment. The first component will be a reimbursement of reasonable planting costs (site preparation, bare rooted seedlings (NOTE: balled and burlapped or potted saplings are not eligible), planting labor, and other VDOF recommended supplies such as tree shelters and mats when planting hardwoods in a riparian area). There will be a cap of \$600 per acre for hardwood plantings and \$200 per acre for pine plantings and perennial wildlife plantings.

In addition to this reimbursement of planting costs, landowners will receive a \$50/acre maintenance payment. This maintenance payment can be applied to replanting, stand maintenance (mowing, spraying), or fencing.

The second component will be the lump-sum, Present Value payment for the land rental. This lump-sum payment will be calculated as the Present Value of a series of terminating annual payments. It will be based on the per acre bid submitted by the landowner, total project acres, 7% discount rate, and the required 20 year contract.

The rental rate used will be determined by which hydrologic unit (HUC) the project area is found in. <u>The rental rate</u> payment per acre for HUCs JR02 and JR07 will be \$847. The rental rate per acre for all other HUCs in the Rivanna River Basin will \$636.

There are two qualifying types of Forest Establishment, riparian buffer plantings and general open land planting. Below each of these are described.

Riparian Buffer Planting: The minimum project size for these plantings will be one contiguous acre. Plantings must be adjacent to the stream and be a minimum of 50 feet in width measured from the top of the stream bank. Both hardwood and pine species are appropriate species for planting. The actual species used, recommended spacing, and site preparation needed will be at the discretion of the approving forester. Because of limited available funding, pine plantings are preferred. Up to 10% of the project area can be a perennial wildlife planting. Livestock must be excluded from the planting site for the life of the 20 year contract.

General Open Land Planting: The minimum project size for these plantings will be 5 contiguous acres. The actual species used, recommended spacing, and site preparation needed will be at the discretion of the approving forester. Up to 10% of the project area can be a perennial wildlife planting. Livestock must be excluded from the planting site for the life of the 20 year contract.

<u>Enhanced Conservation Easement.</u> Landowners that record a perpetual conservation easement between 1/1/2011 and 7/31/2012 that includes enhanced provisions for water quality protection are eligible for an incentive payment. The amount of the incentive payment will be based on the extent of enhancements as outlined in the VDOF Conservation Easement Enhancement Worksheet, with a maximum payment of \$15,000. The easement must be held by a qualified conservation easement holder approved by the VDOF. The VODF will review the recorded conservation easement deed to determine which, if any, of the Easement Enhancement payments the easement is eligible for.

<u>Fencing from Livestock</u> Fencing practice is applicable only when necessary to protect planted areas from livestock. Fencing shall adhere to the appropriate standards found in the Virginia Tech publication 442-131 entitled "Fencing Materials for Livestock Systems". This website for this document is: <u>http://pubs.ext.vt.edu/442/442-131/442-131.html</u>.

UPON PROJECT COMPLETION:

- VDOF forester will sign off on the completed project on the application form
- For Forest Establishment, the VDOF forester will complete the Final Calculations block on the application form.
- Enter the mapped acres on page 1 of the application form in the Forest Establishment section (to insure payment is within the cap).
- A VDOF Form 22 (Request for Billing) will be used to capture any VDOF costs such as seedling delivery or planting coordination costs.
- <u>All</u> other landowner costs will be documented on the VDOF Form 23. Landowner receipts and/or contractor invoices are not required when using the Form 23. Landowners must sign the Form 23 to properly document their expenditures.
- *NOTE:* For any Forest Establishment projects, the landowner must return the Form 23 by <u>July 1st</u> of the same year the planting was completed or the project funding will be cancelled.
- The Grand Total of landowner costs on the Form 23 will then be entered on the Form 22 on the LANDOWNER COST line (these numbers must match).
- When the Form 22 lists VDOF costs to be billed (seedling deliver, planting coordination, etc.), the VDOF forester will <u>make a notation</u> at the bottom of the Form 22 for Fiscal to do an Automatic Transfer Voucher (ATV) from CC 673.
- When any Forest Establishment project is completed, the VDOF forester will <u>make a notation</u> on the Form 22 the applicable caps (\$600 X acres for hardwood plantings, \$200 X acres for pine and wildlife plantings) for Fiscal to use in making landowner payments.
- When any Fencing project is completed, the VDOF forester will <u>make a notation</u> on the Form 22 the applicable cap (\$3.50 X feet of fence) for Fiscal to use in making landowner payments.
- Fiscal will capture the landowner rental payment and maintenance payment from the landowner funding application form (Final Planting Acres block). These payment amounts do not need to entered on any other document.
- For Conservation Easement Enhancement payments, the VDOF forester will include a copy of the conservation easement enhancement worksheet.
- Attach EQIP eligibility documentation to the paperwork submitted to Fiscal for recordkeeping.

Forest Establishment Rental Rate Schedule

In the South Fork Rivanna River Reservoir (SFRR) watershed, there are two hydrologic units that contribute a high level of nutrient and sediment loading. Forest establishment projects in these two hydrologic units will receive a higher rental payment to reflect that. The Net Present Value (NPV) should be used in the Landowner Contract to determine total landowner rental payment. The NPV was calculated using a 7% discount rate and a 20 year contract.

Hydrologic Unit Code Name (HUC)	HUC Number (VAHU6)	Rental Rate (\$/ac)	NPV (\$/ac)
Mechums River – Beaver Creek Ivy Creek – Little Ivy Creek	JR02 JR07	80/ac 80/ac	847/ac 847/ac
South Fork Rivanna River	JR08	60/ac	636/ac
Mechums River – Stockton Creek	JR 01	60/ac	636/ac
Moormans River – Wards Creek	JR05	60/ac	636/ac
Buck Mountain Creek	JR06	60/ac	636/ac
Moormans River - North Moormans Rive	r JR03	60/ac	636/ac
Doyles River	JR04	60/ac	636/ac

*NOTE: The HUCs can be identified using InFOREST found at the web site <u>http://www.ifris.dof.virginia.gov/inforest/</u>. These HUCs can be identified by turning on the "HYDROLOGIC UNITS – 12 DIGIT" mapping layer.

Appendix V: F2F Land Parcel Prioritization: Background for Technical Session

F2F land parcel prioritization: background for technical session

Introduction

In May of 2001, the Thomas Jefferson Water Resources Advisory Committee published a report entitled "Sediment Sources and Mitigation Strategies, South Fork Rivanna Reservoir Watershed: Analysis and Recommendations ". Portions of the 2001 WRAC report are excerpted below:

Previous Work: What Is Known About Sedimentation of the Reservoir?

South Fork Rivanna Reservoir (SFRR) is an elongate, shallow body of water, completed in 1966 to receive runoff from a watershed area of 261 square miles. With an area of less than one square mile, the reservoir is very small relative to the size of the watershed that drains into it. Five distinct sub-watersheds are recognized. Ranked by land size and mean streamflow, these are: Mechums River, Moormans River, Buck Mountain Creek, Ivy Creek, and lands riparian to SFRR. In terms of the estimated sediment load each contributes to SFRR, however, the rank of the subwatersheds shifts to the following: Mechums, Moormans, Ivy Creek, and a virtual tie between riparian lands and Buck Mountain Creek.

Over the years since the reservoir was constructed, as concern has mounted about decline in usable capacity, several studies and bathymetric surveys have been conducted to investigate the origin, transport to, and deposition of sediment within the reservoir (Glasbey, 1981; Black and Veatch, 1994; Sobeck, 1999). Although the results of the various studies and surveys differ quantitatively, there is general agreement that the rate of sediment yield is higher from pastureland than from forest, and higher from development areas, for example, Ivy Creek, than from either of these. Glaspey (1981) and Black and Veatch (1994) derived similar results for predicted sediment yield, and the predicted yields correlate fairly well with bathymetric measurements of sediment thickness on the bottom of SFRR. Sobeck, (1999) applies a sediment transport model and concludes that common annual peak flows in the Mechums River—are not rare and major storm events scour out and transport sand particles already resident in geologic formations in the bed and banks of river, contributing half the overall sediment load to the SFRR.

While the previous studies provide a basis for beginning to understand the sedimentation problem, in some respects they raise as many questions as they answer. Further geologic investigations are essential, for example, to clarify Sobeck's (1999) conclusions, to the extent that his modeling and analysis did not consider the role of silt-and clay-size sediment. According to Glaspey (1981), clay is the dominant sediment in SFRR. The research of Hjulstrom (1939) demonstrated that erosion of clay requires the kind of energy which great storms generate.

Importantly, all investigators report a paucity of information on streamflow and sediment transport at exceptionally high flows, e.g., during the several hurricanes which have visited the area since 1966. This is critical, for lacking actual measurements at the upper end of rating curves, the correlation of watershed sediment yield to sediment deposited in the reservoir has been obtained largely by extrapolation from other watersheds and by drawing rating curves to obtain a "best fit." None of the previous studies have included mineralogic and petrologic analyses that could trace reservoir sediment to geologic sources in the watershed. Further, a search of files, reports and publications reveals no determination of trapping efficiency of the SFRR.

References

Black & Veatch (May, 1994), "Bathymetric Survey and Safe Yield of South Rivanna Reservoir," Interim memorandum prepared for Rivanna Water & Sewer Authority, Charlottesville, VA.

Glaspey, R.G. (1981), "A Sediment Budget of the South Fork Rivanna River." Unpublished thesis, Dept. of Civil Engineering, University of Virginia.

Hjutstrom, F. (1939), "Transportation of detritus by running water," Am. Assoc. Petrol. Geol., Tulsa, Oklahoma. [data published in Krumbein, W.C. and Sloss, L.L. (1951), "Stratigraphy and Sedimentation," W.H. Freeman, San Francisco.]

Sobeck, R.G., Jr. (1999), "Modeling the Source, Fate, and Transport of Watershed Sediments with Application to the South Fork Rivanna River." Unpublished thesis, Engineering and Applied Science, University of Virginia.

In the 10 years that have elapsed since the WRAC report was written, there have been additional bathymetric and dredging feasibility studies. But there has been no additional research on the subject of tracking actual sediment sources...considerable uncertainty remains as to how best to target mitigation strategies.

Reservoir sedimentation, 2010: conventional wisdom

- 1) There are two broad categories of sediment origin:
 - "primary" erosion of mineral grains from soils, saprolite and rock exposed at the surface, followed by overland transport into streams;
 - "secondary"remobilization and transport of existing "historic" sediment previously deposited in flood plains and channels of rivers & tributaries.
- 2) The Mechums River and Ivy Creek are more significant contributors of sediment to the reservoir than the Moormans River and Buck Mountain Creek (Exhibit A, below). There are several possible explanations for this:
 - Mechums & Ivy watersheds contain significant acreages of clay-rich saprolite, while Moormans and Buck Mountain underlain by more rocky, less chemically weathered overburden;
 - Mechums and Ivy are more extensively developed and contain less forested land cover than Moormans and Buck Mountain;

- Mechums (in particular) contains more expansive flood plain deposits of existing sediments along the main stem channel than other reservoir tributaries;
- Sobeck's (1999) hypothesis that Mechums bedrock in the main stem channel is readily erodible and supplies a large proportion of sediment to the reservoir (there is a school of thought that this hypothesis is based on flawed geological assumptions....).
- 3) Forested land cover serves to diminish sediment mobilization by
 - Increasing the proportion of rainwater that infiltrates the ground rather than running along the surface as overland flow;
 - Decreasing hydraulic energy in overland flow, as well as in streams and rivers, by decreasing flow volumes.
- 4) Increasing overall forested land cover within a given watershed theoretically will serve to decrease BOTH primary erosion and secondary sediment remobilization


regardless of where in the watershed forested land cover is created and/or protected through conservation easement.

5) Augmenting/protecting forested land in riparian zones and flood plains has the greatest potential to decrease sedimentation by providing greater stability and buffering capacity proximal to streams and rivers during high water events, and greater capacity to filter material washed in overland from more distal parcels.

Prioritization: what can we do in the absence of more detailed analysis?

Regardless of uncertainties having to do with details of sediment mobilization and transport, we already have sufficient understanding to make broad recommendations as to how to target F2F aforestation and conservation easement efforts. Interim guidelines:

- 3) Augmenting / protecting forested land cover ANYWHERE within the reservoir watershed will ultimately have a net positive effect on sedimentation. For voluntary participation, particularly conservation easements, we take all comers.
- 4) Mechums River and Ivy Creek watersheds receive priority.
- 5) Parcels that contain riparian lands adjacent to main stem and tributaries to Mechums & Ivy receive priority.

F2F Priority Areas V.1.0 (to be discussed)

We are in the process of exploring / developing analytical tools for assigning priority to specific parcels. One approach will be to use the MEASURES tool being developed by Virginia Tech and others, wherein the impact of converting a specific from non-forested land cover to forest can be quantified in terms of watershed sediment, N and P loading. Individual parcels could be assessed and ranked using this tool.

We are also developing a more detailed tool that will provide greater resolution within the reservoir watershed than MEASURES can provide. This will be a multidimensional matrix existing in a GIS environment, with the following components (open for discussion):

Criteria		<u>points</u>
watershed	Mechums, Ivy Creeek	1
	Moormans, Buck Mt	0
landscape position	flood plain	3
	Side slope	2
	Interfluves	0
proximity to main channel		0,1,2,3
geology	bedrock erodibility	0,1,2
soils	erodibility	0,1,2,3
forestry priority	-	0,1,2,3

Appendix VI: InFOREST Ranking of SFRRRW subwatersheds

HUC Name VAHU6 Mechums River - Beaver Creek JR02 Ivy Creek - Little Ivy Creek JR07	6 HUC_:	C 12 acre																	
Mechums River - Beaver Creek JR02 Ivy Creek - Little Ivy Creek JR07		C_IZ UCIC	age N loading	110% forest N	delta N 10%	P loading	110% forest P	delta P 10%	total sediment	110% forest sed	delta sed 10%	N / acre	P / acre	sediment / acre	N rank	P rank	S rank	total score	
Mechums River - Beaver Creek JR02 Ivy Creek - Little Ivy Creek JR07 Creek - Carlo Binger Binger J000																			
Ivy Creek - Little Ivy Creek JR07	2080204	2040102 108	30921.9	27695.6	-3226.3	4722.2	4285.7	-436.5	7200.9	6113.8	-1087.1	2.84	0.434	0.662	2	2	1	4	
Couth Code Diverge Diver	2080204	2040202 768	5 26277.9	24088.1	-2189.8	3736.6	3412.9	-323.7	4168.7	3377.8	-790.9	3.42	0.486	0.542	1	1	3	5	
South Fork Rivanna River JR08	2080204	2040203 653	3 17759.2	15801.8	-1957.4	2590.9	2301.9	-289	3087.1	2422.8	-664.3	2.72	0.397	0.473	3	3	6	12	
Mechums River - Stockton Creek JR01	2080204	2040101 148	8 33199.8	27971.3	-5228.5	4905.7	4269.3	-636.4	7464.3	5926.6	-1537.7	2.24	0.331	0.504	5	6	4	15	
Moormans River - Wards Creek JR05	2080204	2040105 624	2 14299.3	12063.8	-2235.5	2215.5	1866.1	-349.4	2215.5	1792.4	-423.1	2.29	0.355	0.355	4	4	7	15	
Buck Mountain Creek JR06	2080204	2040201 935	3 20163.6	16757	-3406.6	3102	2597.9	-504.1	4668.8	3353.3	-1315.5	2.16	0.332	0.499	6	5	5	16	
Moormans River - North Moormans JR03	2080204	2040103 654	6 3396.7	2389.2	-1007.5	1203.8	1072.3	-131.5	3949	3805.8	-143.2	0.52	0.184	0.603	8	8	2	18	
Doyles River JR04	2080204	2040104 722	3 10618.8	7709.9	-2908.9	1617.6	1161.2	-456.4	2203.5	1312.9	-890.6	1.47	0.224	0.305	7	7	8	22	
					0			0			0								
Totals		69	281 156637.2	134476.7	-22160.5	24094.3	20967.3	-3127	34957.8	28105.4	-6852.4								

Appendix VII: Print, Radio, and Television Marketing

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Making water work

By Michael C. Collins, Nick H. Evans and Everette "Buck" Kline

The City of Charlottesville and Albemarle County are interdependent. Most tolks understand this: In general, the city and urban Albemarle are centers of jobs and cultural activities, as well as being the area's population hub. Rural Albemarle provides views, open space and recreational opportunities to all area residents, as well as offering its own menu of employment and cultural possibilities.

But, the relationship doesn't stop there. It turns out that the lifeblood of urban Charlottesville and Albemarle residents is provided by rural Albemarle landowners — the one service without which habitation would be impossible — clean drinking water.

Recently, a new nonprofit organization, Conserv, partnered with the Virginia Department of Forestry — along with the Rivanna Water and Sewer Authority, County of Albemarle, City of Charlottesville, Albemarle County Farm Bureau, American Water Works Association, Blue Ridge Homebuilders, Charlottesville-Albemarle Regional Chamber of Commerce, Piedmont Environmental Council, Rivanna River Basin Commission, Thomas Jefferson Soil and Water Conservation District, the University of Virginia and Virginia Tech — to submit a proposal to the U.S. Endowment for Forestry and Communities Inc. for the creation of a demonstration process to financially link urban water consumers with rural owners of forestland in the South Fork Rivanna Reservoir watershed.

The project, called the South Fork Rivanna Forests to Faucets Initiative, was one of three proposals selected nationwide for three-year funding. Forests to Faucets officially launched in February of this year. The idea behind the project is simple. Rural landowners should be compensated for the environmental services, such as water quality, that their forestlands provide for others to use. These services are often referred to as "ecosystem services." Four ecosystem services are related to the health of the South Fork Rivanna Reservoir and watershed. They are: nitrogen retention; phosphorus retention; soil retention, and summer groundwater flow to streams.

For the F2F project, we are creating a process that financially links rural landowners with urban and suburban consumers of water. This process will attempt to quantify the tangible benefits to the reservoir and watershed from alternative forest cover scenarios generated as a result of alternative management programs. The dollar per quantity of ecosystem service gained from conservation management (increased forest cover) will be compared to the same metric gained through engineered capital improvements (such as dredging). The quantity of ecosystem service gained will then be translated into a currency we all understand — a gallon of drinking water.

What causes some to pause is the notion that a landowner should be paid for services that historically have been

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free to the public. Our view is founded on ecological economic theory — payment for such services would be irrational when human population densities are low and the assets that provide these are plentiful. But, when human population increases and these assets become scarce, to not internalize them into our economy is a "market failure." Payment for ecosystem services is a way to correct this problem.

Because of the grant, the Virginia Department of Forestry will have significant funds available to make payments to rural landowners in the South Fork Rivanna area. Rural landowners who offer the most efficient opportunities to enhance their water quality services (through forestry-related management practices) will be offered contracts now through the spring of 2012. Examples of these forest management practices include: tree planting on open land; assistance with placing lands into conservation easements; pre-harvest planning; timber harvest site stabilization, and leaving riparian buffers during forest harvests.

One of the most important practices that the partnership seeks to support is tree planting on open land (hay, grazed, grassed or tilled lands). This portion of the project will demonstrate a process for gaining an efficient cost for planting trees on parcels with five acres or more of open land. Another project of interest is for riparian buffer establishment. The minimum size for this type of planting project will be one acre. In addition, 10 percent of any planting project can have a wildlife habitat component.

A contract between the landowner and the Virginia Department of Forestry would specify the terms (20 years), the payment (provided as a one-time lump sum), and the forest management responsibilities. In an attempt to bring efficiency to the determination of ecosystem system service costs, the partners have created a landowner bidding program that will begin July 12 and end July 30.

Financial incentives through land rental payments for the life of the contract as well as the tree planting establishment costs are covered through the program. The likely range of payments to be provided is anticipated to be commensurate with those a rural landowner might receive for agricultural commodities, such as hay, cattle, crops or land rental.

It is noteworthy that a lump sum payment for the 20-year land rental contract will be provided to winning bidders. This could be a significant dollar amount. For example, a landowner with a 10-acre portion of a property that is currently open space might bid \$75 per acre. Using a discount rate of 7 percent, for example, would mean the landowner would be paid approximately \$7,950 plus have all the costs for trees and labor covered. (It is important to note that the ceiling on submitted bids for the land rental is capped at \$100 per acre.) The land rental rate that landowners bid for his tree planting projects will be an important factor in determining if the bid is successfully chosen for funding.

This program is open only to landowners in the South Fork Rivannna Reservoir ara. Anyone interested in the project — and particularly in the possibility of receiving payment for water quality-related land management activities — should go to the F2F Web site (www.foreststofaucets.info) or contact Dave Powell, assistant regional forester, at 434-977-5193.

If successful, this program will help ensure the quality of the water available to all in the SFRR watershed.

Michael Collins is the executive director of Conserv, a new nonprofit organization working to design and construct environmental markets to restore keystone ecosystems and former environmental planner with the Thomas Jefferson Planning District Commission. Nick Evans, Ph.D., is a professional hydrogeologist who serves as director of Research for Conserv. He is an elected director from Albemarle County and Chairman of the Thomas Jefferson Soil & Water Conservation District. Buck Kline is director of forestland conservation for the Virginia Department of Forestry, responsible for the agency's conservation easement, Forest Legacy, utilization and marketing and ecosystem services initiatives.

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Forests to Faucets

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Land owners along the South Fork Rivanna Reservoir Watershed could receive cash simply by planting trees on their property. It's part of the Forests to Faucets initiative to protect the water quality by reducing sediment that end up in nearby streams from erosion.



Don Detmer owns a 35 acre farm along the Doyles River in Albemarle County. It feeds into the Moormans River and the Sugar Hollow Reservoir. About 10 acres of his property is open land that's not being utilized, making it perfect to plant trees.

"One piece of property right across the road here, that's ideal because it slopes down a hillside and right now, if that isn't solid grass, that's going right into the river," said Detmer.

The U.S Endowment for Forestry and Communities awarded the Virginia Department of Forestry a \$400,000 grant. Roughly, \$200,000 of that will be used for water quality conservation practices by paying landowners the use of their property to plant trees to prevent erosion.

Michael Collins is Executive Director of Conserv and is on the Forests to Faucets Advisory Council.

"What we're looking for is to enter into 20 year contracts with rural landowners in return for them agreeing to plant and to maintain forested parts of their property," said Collins.

The idea is to prevent sediment from reaching the reservoir and hopefully reduce the need for dredging, which can be very costly.

"One of the things that we also want to do is compare the efficiency of a dollar spent on a conservation practice to reduce sediment versus that same dollar spent for dredging," said Collins.

The goal is to fund about 10 projects, if awarded. The 10 acres Detmer has available would give him a lump sum payment of about \$8,000. He said the monetary incentive is nice, but preserving the quality of the water is even more important.

"This water is very sacred water, it literally is the water supply for Charlottesville," said Detmer.

The project will also cover the cost of the seedlings and cost of the labor. The bidding process for landowners is expected to begin in late July.

Reported by Jennifer Von Reuter See Bio / Email



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