Appendix 1

Independent Science Panel Review of the Stormwater Management Manual for Western Washington: February 12, 2003 Workshop Documentation

I. BACKGROUND

As part of their review of the Washington Department of Ecology 2001 *Stormwater Management Manual for Western Washington* (manual) as assigned by the Governor's Salmon Recovery Office, the Independent Science Panel (ISP) convened a Stormwater Manual Review Workshop. The purpose of the workshop was to gather and review pertinent scientific information and to provide an opportunity for interested individuals and organizations to provide information on the three key questions to which the ISP was asked to respond. The three questions are:

- *To what extent was the applicable scientific literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

- *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

- *What scientific studies would you recommend to address the most important gaps in knowledge associated with the issues?*

The workshop was held February 12, 2003 at the Radisson Hotel Seattle Airport. The agenda and a list of individuals attending the workshop are found in Table 1.

The intent of the workshop was to address matters of science. Policy issues and engineering design and application matters – though relevant to stormwater and its management – were outside the scope of the workshop.

Workshop Format

Using information requested from the Department of Ecology and others, a broad range of parties known to have an active interest in the manual were invited by the ISP to present their views in response to the three questions. In addition to present5ers, others were invited to attend and comment on the three questions at the workshop. Means were also provided for attendees to submit comments online after the workshop.

Purpose and Organization of this Appendix

The purpose of the appendix is to document the contributions of the presenters and general topics of discussion. It is not intended to reflect all of the information used by the ISP in the process of performing their review of the manual.

The appendix is organized into three sections:

I – Background
II – Presentations
III – Attendee Comments

In addition to copies of PowerPoint presentations, notes are included which briefly identify questions the ISP and their Adjunct Advisors posed to presenters, and the presenters' answers to those questions. Sue Diciple of Management Resources in Portland, Oregon facilitated the workshop on behalf of the ISP, and prepared an initial draft of the discussion notes contained herein.

II. PRESENTATIONS

Overviews

Ken Currens, ISP Chair, introduced the workshop and provided an overview of the purpose of the ISP review and the process used to complete it. He introduced the group of five national recognized scientific experts on stormwater that the ISP convened as the Adjunct Advisors to assist the panel with its review.

Tom Schueler, Center for Watershed Protection, Maryland, made an opening presentation on the science of stormwater management from a national and regional perspective.

The Science of Stormwater: national and regional perspectives

T. Schueler, Center for Watershed Protection

- Research on the Stormwater Problem
- Scientific Basis for Performance Standards
- Other Considerations

Key Differences In Pacific Northwest

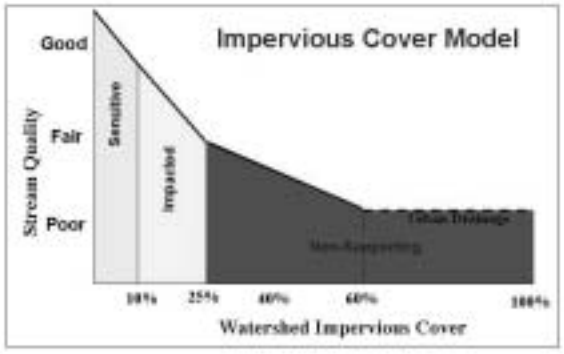
- Specific resource objective (stream integrity/salmon recovery)
- Continuous vs. event-based hydrology
- Unique rainfall frequency spectrum
- Forest hydrology as baseline

Stormwater Approaches of Other States

- Georgia
- New York
- Vermont
- Maryland
- Florida

SMMWW thickest in US

Summary of Stream and Stormwater Research



Assumptions of the ICM

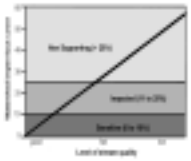
1st to 3rd Order Streams

Potential rather than Actual Quality

Predicts Average Behavior of a Group of Indicators

Continuous Decline rather than sharp Thresholds

Initial Diagnosis rather Than Final Classification



Impervious Cover and Stream Quality

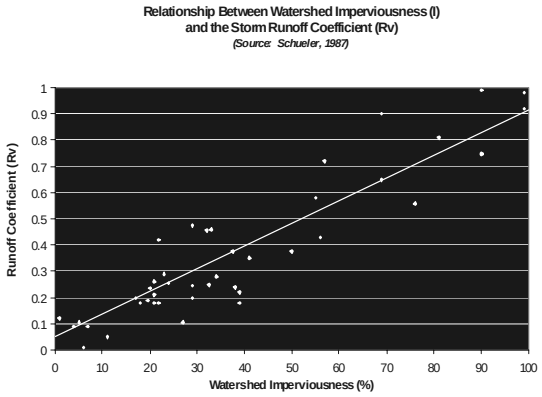
- alteration of channel network*
- increased flooding
- diminished baseflow*
- stream channel enlargement*
- loss of riparian continuity*
- Reduced floodplain connection*

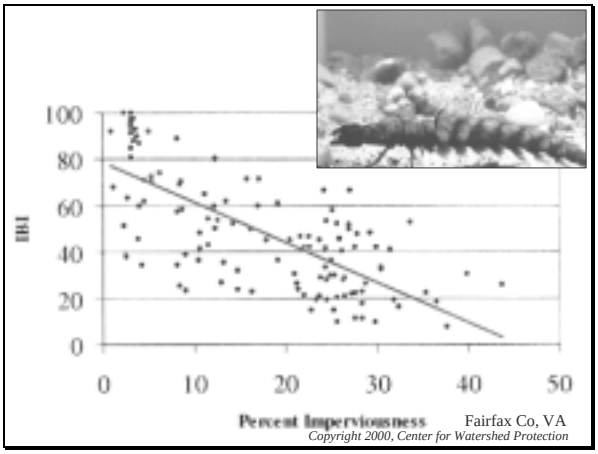
Impervious Cover and Stream Quality

- decline in stream habitat quality*
- higher stream temperatures*
- greater nutrient loads
- trash and debris loads
- turbidity violations
- bacterial standards violations
- metal and hydrocarbon loads

Impervious Cover and Stream Quality

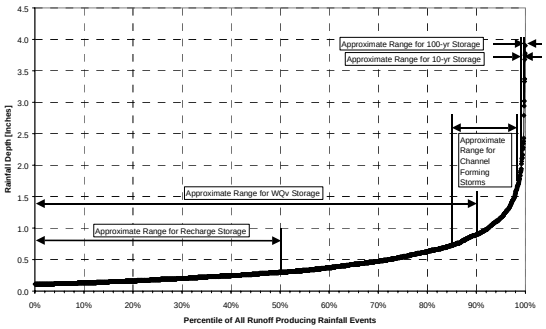
- pesticides in dry and wet weather flow
- contaminated sediments*
- degraded wetlands
- decline in aquatic insect diversity
- decline of fish diversity
- increased fish barriers





Scientific Basis for Setting Stormwater Performance Standards

The Rainfall Frequency Spectrum; VT



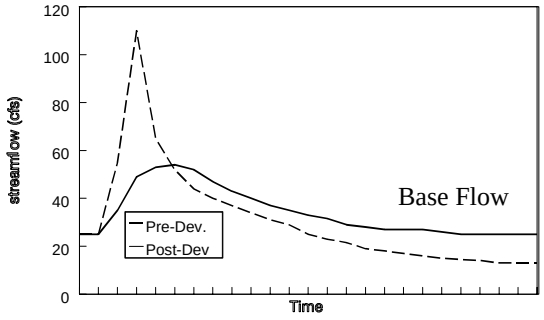
Types of Stormwater Performance Criteria

- 1. Groundwater Recharge
- 2. Water Quality
- 3. Channel Protection
- 4. Overbank Flood Protection
- 5. Credits for Better Site Design

Groundwater Recharge

- Adopted in a few states
- Requires infiltration of frequent rainfall events
- not directly required in SMMWW, although infiltration is a preferred practice
- Goal: Maintain pre-dev. rates of groundwater recharge to sustain small stream flows & promote greater use of onsite practices

Declining Streamflow Due to Diminished Groundwater Recharge



Groundwater Recharge Criteria (Re_v)

Re_v target based on hydrologic soil group and amount of impervious cover

- Re_v ranges from 0.05 to 0.40 inches maximum, and is inclusive of WQ_v
- No Re_v for stormwater hotspots

Re_v can be achieved by many on-site practices.

Target Recharge Volumes

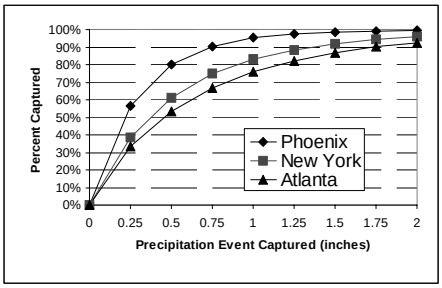
Hydrologic Soil Group	Recharge Volume (in AF)
A	(0.40 inches)(I)/12
B	(0.25 inches)(I)/12
C	(0.10 inches)(I)/12
D	(0.05 inches)(I)/12 or waived

Derived from regional NRCS data

Water Quality Criteria

- Goal: capture and treat 90% of the annual runoff volume
- Criteria achieves 80% TSS and 40% TP removal
- Presumptive compliance with an approved BMP design
- More stringent sizing for hotspots and sensitive geographical areas
- SMMWW meets or exceeds these criteria

Rainfall depth vs. capture



Water Quality Criteria

- $WQ_v = (R)(R_v)(A)$

  where: R = 90% storm depth

  R_v= volumetric runoff coeff. (base on %I)

  A = Site area (in acres)

- R ranges from 0.8 to 1.2 inches in most regions of country
- Minimum WQ_v of 0.2 in/ac when I is less than 15%

Removal Rates for STP Groups

STP Group	Total P	Total N	TSS
Dry Ponds	19%	25%	47%
Wet Ponds	51%	33%	80%
Wetlands	49%	30%	76%
Filters	59%*	--	81%
WQ Swales	34%	38%	86%

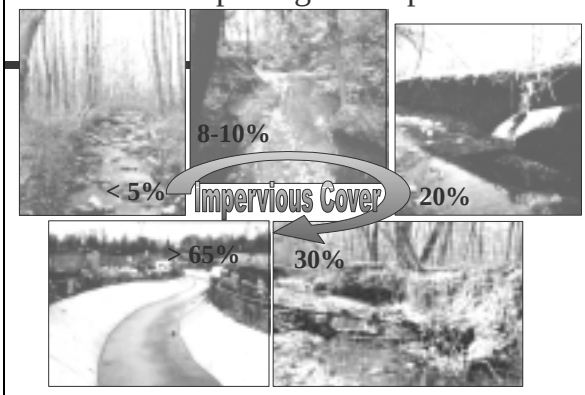
MEAN STP EFFLUENT CONCENTRATIONS (mg/l)

STP Group	Total P		Total N		TSS	
Dry Ponds	0.19		2.1		25.3	
Wet Ponds	0.13	0.03	1.5	0.4	23.2	7.3
Wetlands	0.17	0.04	1.9	0.5	20.7	6.3
Filters	0.16	0.06	1.7	0.6	23.8	16
WQ Swales	0.21	0.06	1.3		19.6	14

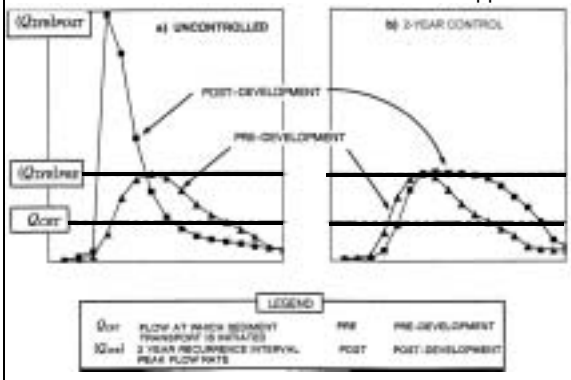
Channel Protection Criteria

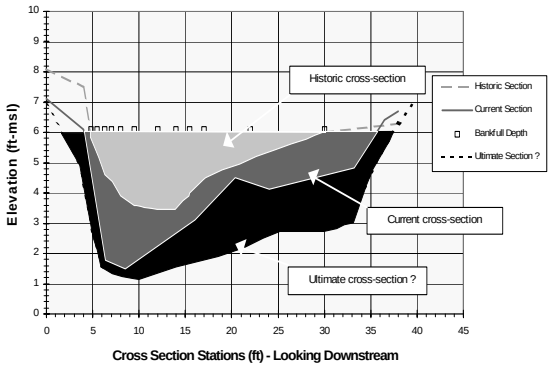
- Adopted in a few states
- Requires extended detention of the volume of the one year, 24 hour rainfall event
- not directly required in SMMWW, although flow duration rule may help
- Goal: reduce erosion and habitat alteration downstream channels by detaining bankfull and sub-bankfull flows

Geomorphological Impacts

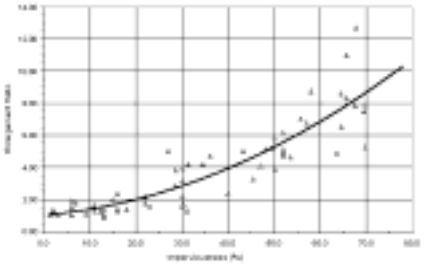


Conventional 2 Year Peak Flow Control Approach



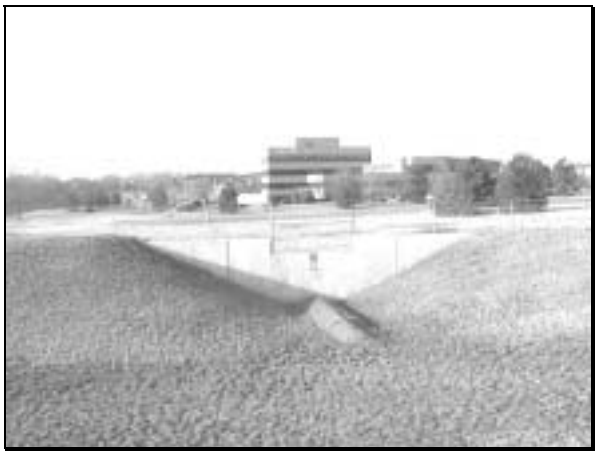


Channel Enlargement as a Function of Impervious Cover



Channel Protection (Cp_v)

- Â 12 to 24 hr detention of the One Year Storm,24 hour storm event
- Â One year storm is about 2.0 to 3.5 inches
- Â Cp_v requirement does not apply to:
  - Â Sites less than ten acres
  - Â Streams in flat terrain
  - Â Direct discharge situations



Overbank Flooding Criteria

- IC dramatically increase peak discharges for .1 to 10 year return storms
- Overbank flooding can be beneficial
- Storm drains and open channels designed to convey the 10 year return storm

Overbank Flood Criteria

- Detain 2, 5, 10 25 , 50 and/or 100 year return storm to pre-development peak discharge rates
- Duration and frequency also analyzed
- SMMWW consistent with this approach

Failure to control overbank floods causes extensive damage to public and private infrastructure:

Selection of return storms based on local risk assessment and floodplain control

Goal: Maintain boundaries of existing flood plain, & prevent flood damage from extreme storms

Stormwater Credits for Better Site Design

- Natural Areas Conservation
- Rooftop Disconnection
- Non-rooftop Disconnection
- Stream Buffers
- Vegetated Channels
- Environmentally Sensitive Rural Development

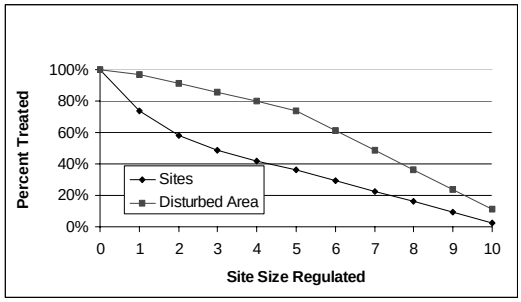
Credits can reduce required WQ_v by 10 to 35% and Re_v by 50 to 100%

Thresholds for Requiring Stormwater

- Impervious Cover
- Site Area (0.11 acre)
- Clearing of Vegetation
- Single Family Home Exemption

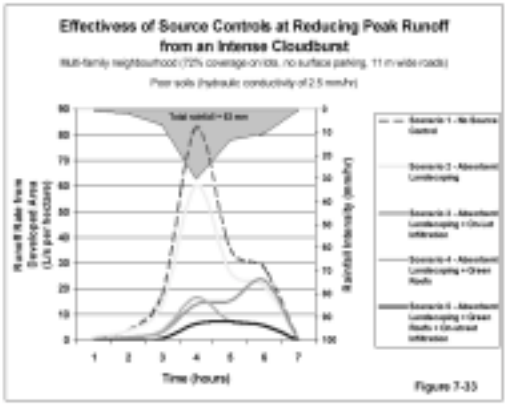
SMMWW thresholds generally consistent with national ones, although this mesh size may not result in full watershed treatment

Watershed Treatment vs. Site Size



Range of Stormwater Treatment Practices

- **Ponds:**
  - **Micro-pool ED pond**
  - **Wet pond**
  - **Wet ED pond**
  - **Multiple pond**
  - **Pocket pond**
- **Wetlands**
  - **Shallow marsh**
  - **ED wetland**
  - **Pond/marsh system**
  - **Gravel wetland**
- **Infiltration**
  - **Infiltration trench**
  - **Infiltration basin**
- Stormwater Filters
  - Surface sand filter
  - Underground sand filter
  - Perimeter sand filter
  - Organic filter
  - Bioretention
- Open Channels
  - Dry Swale
  - Wet Swale
  - Grass Channel



Source: Stephens, K., P. Graham, and D. Reid. 2002. Stormwater Planning A Guidebook for British Columbia. GVRD.

Ed O'Brien, Washington Department of Ecology, provided an overview of the manual in the context of the ISP's assigned review.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Stormwater Management Manual for Western Washington

Purpose

- **Provide Background for and Clarify:**
  - **Thresholds**
  - **Treatment**
  - **Flow Control**
- **Explain Role in Protecting Salmonid Resources**

Objective of the Manual

- **Protect aquatic natural resources by**
- **Providing a commonly accepted set of standards and technical guidance for**
- **Improving the quality & and controlling the flow rate of runoff from new development and redevelopment**

What the Stormwater Manual is…

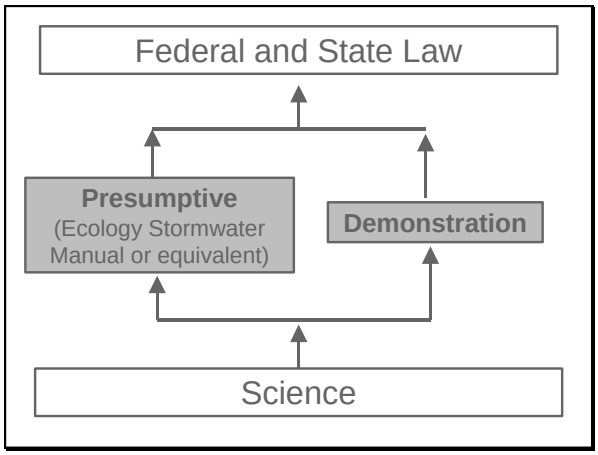
- **A link between the legal requirement to properly manage stormwater and the science and research which shows the impacts of improperly managed stormwater**

Federal and State Laws

- **Federal Clean Water Act & State Water Pollution Control Act**
  - **Technology-based requirement**
  - **Water quality-based requirement**
- **Endangered Species Act**
- **Other**
  - **Safe Drinking Water Act**
  - **Hydraulic Code**

Federal & State Stormwater Strategy

- **Apply BMP's**
- **Non-numeric**
- **Presume BMP's protect water quality**
- **Monitor for success**
- **Modify BMP's**



The Manual Consist of 5 Volumes:

I. Minimum Technical Requirements & Site Planning
II. Construction Stormwater Pollution Prevention
III. Hydrologic Analysis and Flow Control Design/BMPs
IV. Source Control BMPs
V. Runoff Treatment BMPs

Chapter 2 Minimum Requirements

For New Development & Redevelopment

Minimum Requirements Section 2.5

1. Preparation of Stormwater Site Plans
2. Construction Stormwater Pollution Prevention
3. Source Control of Pollution
4. Preservation of Natural Drainage Systems and Outfalls
5. Onsite Stormwater Management

Minimum Requirements

6. Runoff Treatment
7. Flow Control
8. Wetlands Protection
9. Basin/Watershed Planning
10. Operation and Maintenance

Section 2.4 - Project Thresholds

- Who needs to do what?
- Depends upon size of the project
  - Amount of impervious surface
  - Extent of land disturbed

New Development Thresholds

- ❑ **Min. Req. #2 -Erosion control**
  - ö **all projects regardless of size**
- ❑ **Basis**
  - ÷ **Every land disturbance should take action to minimize erosion**

New Development Thresholds

- ❑ **Min. Requirements #1 - #5:**
  - ÷ **2,000 sq. ft. impervious area, or 7,000 sq. ft. land disturbance**
- ❑ **Basis**
  - ÷ **Capture most single family residences and equivalent commerical**
  - ÷ **Cumulative impact of individual homes can cause significant impacts**

  (See Booth & Jackson, 1997, p. 16)

New Development Thresholds

- ❑ **Min. Requirements #1 - #10:**
  - ÷ **5,000 sq. ft. new impervious area, or**
  - ÷ **3/4 acre native vegetation to lawn/landscape, or**
  - ÷ **2.5 acres native vegetation to pasture**
- Ç **Basis**
  - ÷ **5,000 sq. ft. from '77manual for King/Snohomish; 1992 manual holdover**
  - ÷ **reasonable size to operate and maintain treatment facilities (See Kulzer, 1994)**
  - ÷ **¾ acre and 2.5 acre conversions correspond to 0.1 cfs increase in 100-year flow. 1/2–inch orifice minimum size for frequent plugging avoidance**

Minimum Requirement #6
Runoff Treatment

- **Thresholds**
- **Facility Sizing**
- **Level of Treatment**
- **Design**
- **Maintenance**

Runoff Treatment Thresholds

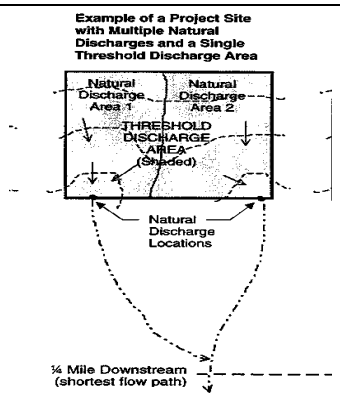
Table 2.1 Treatment Requirements by Threshold Discharge Area

	< ¾ acres of PGPs	≥ ¾ acres PGPs	< 5,000 sf PGIS	≥ 5,000 sf PGIS
Treatment Facilities		✔		✔
Onsite Stormwater BMPs	✔	✔	✔	✔

PGPS = Pollution-generating pervious surfaces

PGIS = Pollution-generating impervious surfaces

sf = square feet



Minimum Requirement #6
Runoff Treatment

- **Threshold Discharge Area**
  - **To prevent application of engineered facilities to small areas of large projects**
  - **To allow small areas of larger projects to maintain their natural drainage location**
  - **To prevent drainage games to circumvent intent of guidance**

Minimum Requirement #6
Runoff Treatment

- **Pollution-Generating Impervious Surfaces**
  - **Significant sources of pollutants in treatable concentrations**
    - **Vehicular traffic**
    - **Industrial activities**
    - **Storage of erodible or leachable materials, wastes, chemcials**
    - **Excluded: Most res. & comm. roofs; sidewalks**

Minimum Requirement #6
Runoff Treatment

- **Pollution-Generating Pervious Surfaces**
  - **Significant sources of pollutants in treatable concentrations**
    - **Use of pesticides, fertilizers, loss of soil**
    - **Lawns, landscaping, golf, parks, sports**
    - **Excluded: Natural areas; areas w/o chemicals**

Treatment Facility Sizing

- **Target: Treat 91% of annual runoff**
  - **Basic Cost-Effective Analysis**
    - **Incremental cost of pond size per cubic foot of volume treated**
  - **Herrera Cost Analysis – 1993; 2001**
- **Other States**

Sizing Volume-Based Treatment Facilities

- **Water Quality Design Storm**
  - **6-month, 24-hour event**
    - **88th to 93rd percentile, 24-hr event**
  - **New Estimate: 72% of 2-year, 24-hour (11% increase)**
- **Applies to Wetpool Facilities**
  - **Wet Ponds, Wet Vaults, Wetlands, Combined Detention/Wetpool**

Sizing Flow Rate-Based Treatment Facilities

- **Off-line**
  - **91% of annual volume passes thru at WQ flow rate or less.**
  - **9% bypasses untreated**
  - **WQ flow rate = 72nd to 79th percentile rate**
- **On-line**
  - **All flows through the facility**
  - **9% of annual volume passes thru at higher rates than WQ design rate**
  - **WQ flow rate = 91st percentile rate**

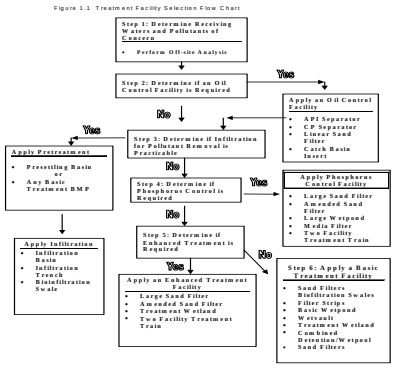
Treatment Levels
Vol. V, Chapter 3

- **Basic Treatment**
- **Enhanced Treatment**
- **Phosphorus Treatment**
- **Oil Control**
- **Each Level has a Menu of BMPs**
  - **Volume V, Ch. 4**

Treatment Levels

- **Intent: Meet federal & state laws**
- **Basic & Oil Control Treatment = Presumptive; technology-based**
- **Phosphorus/Enhanced = Presumptive; water quality-based**
- **Adjustment of Presumptive Requirements through case-by-case or watershed analysis**

Treatment Facility Selection



Oil Control

- **Applies to High-Use Sites**
  - **High rates of parking or stopping**
  - **Frequent oil transfer**
- **Not Stand Alone BMPs**
  - **upstream of other BMPs**

Oil Control

- **Performance Goal: (Not Effluent Limits!)**
  - **No ongoing, recurring visible sheen**
  - **TPH ≤ 10 mg/l daily average; ≤ 15 mg/l peak**
- **4 BMP Options**

Phosphorus Treatment

- **Phosphorus sensitive watersheds**
  - **local designation or acceptance in a Water Clean-up Plan (TMDL)**
- **Performance Goal: 50% total P**
  - **WQ Design Volume/Flow Rate**
- **Options - 5 BMPs; 7 BMP trains**

Basic Treatment

- Discharges to ground, unless soil criteria met
- Residential projects not in Phosphorus area
- Projects to large waters
  - Use Appendix I-C
- Projects not to fish-bearing waters or tributary

Basic Treatment

- **Performance Goal:**
  - 80% TSS removal, or
  - 20 mg/l TSS if influent < 100 mg/l
  - Applies to WQ design volume/flow rate
  - Applies on Annual Average basis, including bypass
- **Nationwide performance data and federal Nonpoint program goals**

Basic Treatment

- **8 BMP Options listed**
  - Upgrade of '92 manual
  - Typical BMP's used nationwide

Enhanced Treatment

- ***Key Question*** **– Can we presume that use of basic treatment BMPs will generally achieve compliance with WQ standards and protect the resources?**
- ***Ecology's answer*** **– NO, for some combinations of development types and receiving waters**

Enhanced Treatment Basis

- Nationwide & PNW stormwater runoff data
- Available data on BMP removal of dissolved metals
- Water Quality Standards for Copper & Zinc
  - Acute Criteria: 1-hour concentration, not to exceed > 1x per 3 yrs
  - Chronic Criteria: 4-day average, not to exceed > 1x per 3 yrs

Factor by Which Dissolved Copper Acute WQ Standards Are Exceeded in Untreated Runoff

Hardness	20	50	75
Commercial	5.4X	2.2X	1.5X
Industrial	4.6X	1.9X	1.3X
Residential	2.4X	1X	0.7X
Transportation	4.6X	1.9X	1.3X

Other Factors

- **Reported concentrations are EMC's**
- **Treatment standard allows bypass of 9% annual runoff volume**
- **Urban streams dominated by urban stormwater**
- **Little information on dissolved metals removal**

Enhanced Treatment

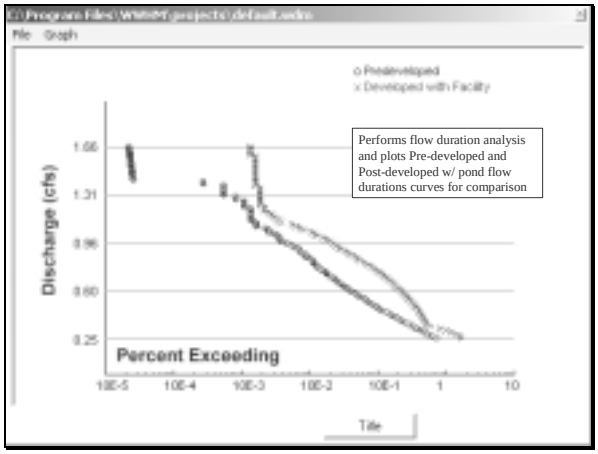
- **Industrial, Commercial, Multi-family, Arterials and Highways to:** *fish-bearing streams, lakes, or their tributaries*
- **Performance Goal: *Greater* dissolved metals removal**
  - **Reduce potential for WQ standards violations**
- **BMP Options - 4 BMPs; 7 BMP trains**

Minimum Requirement #7 Flow Control

- **Purpose: To prevent increases in stream channel instability or erosion rates**
- **Presumptive Water Quality-Based Requirement**
  - **Local hydrogeologic basis**

Standard Requirement

- **Match discharge durations to pre-developed durations for the range of pre-developed rates from 50% of the 2-year peak flow up to the full 50-year peak flow**
- **Generic requirement until replaced by a watershed-specific standard with hydrogeologic justification**



Flow Control Assumptions

- **Threshold of significant bedload movement**
  - **Protects most Puget Sound streams**
  - **Booth (1993)**
- **Converting pre-development surface flows and interflows to surface flows**
- **Estimated flow rates not adjusted for site location in a watershed**
- **Assume forested pre-developed condition unless evidence otherwise**

Method for Compliance

- **Continuous Simulation Model**
  - **Hydrologic Simulation Program-Fortran (HSPF)**
  - **WWHM is an application of HSPF for Western Washington**
- **Download from website:**

ecy.wa.gov/programs/wq/stormwater/wwhm_training

Flow Control Thresholds

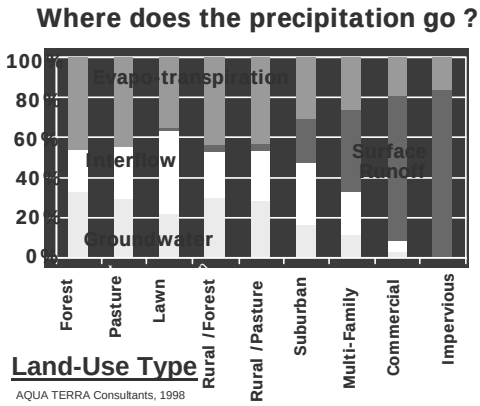
Table 2.2 Flow Control Requirements by Threshold Discharge Area

	Flow Control Facilities	On-site Stormwater Management BMPs
< ¾ acres conversion to lawn/landscape, or < 2.5 acres to pasture		)
≥ ¾ acres conversion to lawn/landscape, or ≥ 2.5 acres to pasture	)	)
< 10,000 square feet of effective impervious area		)
≥ 10,000 square feet of effective impervious area	)	)
≥ 0.1 cubic feet per second increase in the 100-year flood frequency	)	)

Significant Issues & Limitations

Approach and Scope

- **Presumptive approach – will not always be adequate**
  - **Limited opportunity for case-by-case**
  - **Basin-specific requirements**
    - **e.g. Threshold of bedload movement**
- **Project site level focus not considering cumulative watershed scale impacts**
- **Manual is a necessary but by itself insufficient tool to achieve "properly functioning conditions" for salmonids**



Limitations of Detention Facilities

- **Can't replicate the natural hydrology**
  - **Dominant flow regime changes**
    - **Not matching all flow durations**
  - **Less groundwater recharge**
    - **Lower summer base flows**
  - **Less evapotranspiration**

Limitations of Treatment Facilities

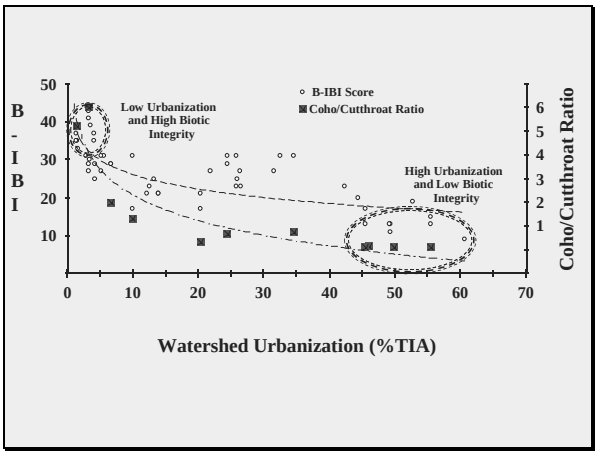
- **Difficult/Can't meet WQ Standards**
  - **Bacteria**
  - **Solids/Turbidity (if fine soils)**
  - **Temperature**
  - **Toxicants**
    - **Organics - insecticides/herbicides, PAH's, phthalates**
    - **Metals – dissolved copper, zinc?**

Impacts of Urbanization

- Shift in Watershed Hydrology
- Increased Pollutant loading
- Degradation of riparian buffers
- Stream Habitat Degradation
  - Loss of Habitat Complexity & Quality
  - Migration Barriers (culverts, dams, etc.)

Two Key Drivers

- **Extent of Effective Impervious Area**
- **Amount of Undisturbed Natural Vegetation and Soils**



Forest Cover & Stream Conditions

- **Unstable Stream Channels Predicted:**
  - **4% Effective Impervious Area (1 home/5 acres) with < 45% mature forest cover**
- **Stable Stream Channels Predicted:**
  - **4% Effective Impervious Area with > 70% mature forest cover**
  - **More forest cover may be necessary for soils with higher infiltration rates than till soils**

Land Use Management

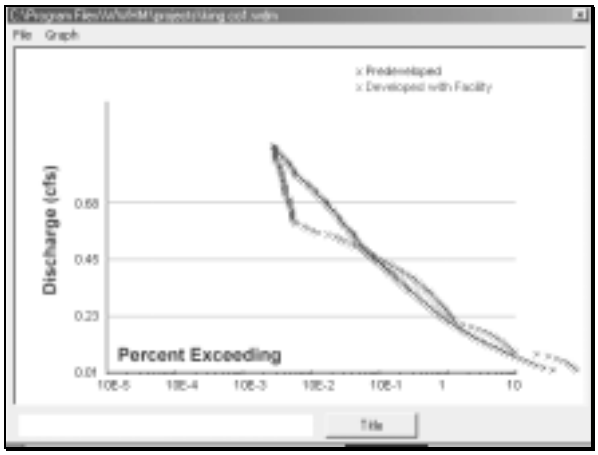
- **Disconnect pollutants and runoff from surface waters**
- **SW Manual should not drive land use**
  - Manual has a project level focus
  - Short of restricting site disturbance, what can be done to minimize impacts & protect resources
- **Growth Management Act**
  - Critical Areas Ordinances
  - Comprehensive Plans
  - Site Development Standards
    - LID = Standard Operating Procedure

Need Both Tools

- **Land Use Management**
  - **Primary tool to protect natural resources**
  - **Preserve vegetative & soil cover**
  - **Low Impact Development (LID) will reduce cost of stormwater management**
- **Stormwater Manual**
  - **To manage remaining surface runoff until Zero Impact Development**
  - **To encourage use of LID**

Manual & Land Use

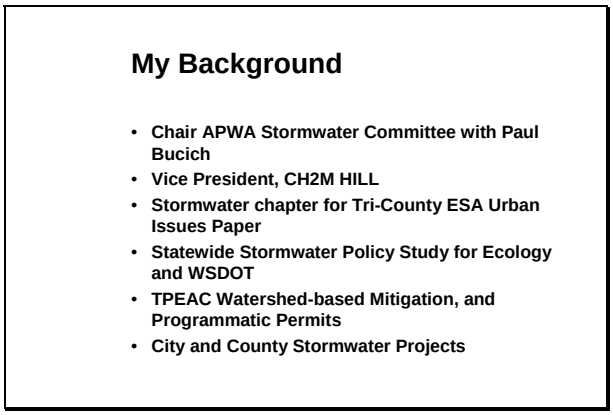
- **Post Construction Soil Quality & Depth BMP**
- **Protected Native Areas not modeled**
- **Credits for LID Techniques**
  - **Balance risk**

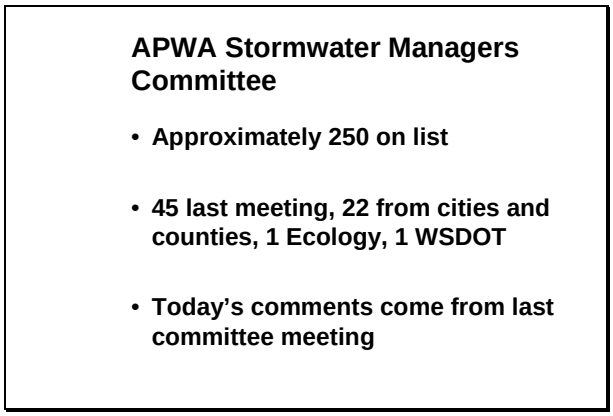


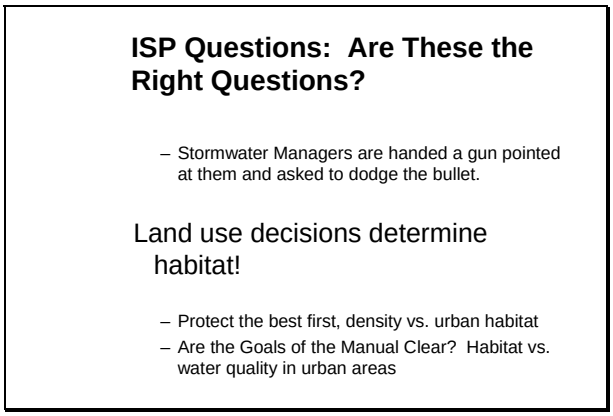
Invited Respondents

Bill Derry, Hydrologist, American Public Works Association (APWA) Stormwater Committee

Summary: Mr. Derry outlined responses to the three questions as discussed by the APWA Stormwater Committee. He noted that the best available science was used in the manual and that practices contained therein are consistent with that science, but he questioned applicability and reasonableness of judgments made where science was weak or absent. He recommended studies on best management practices (BMP) performance in urban areas. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.







Is the Manual Based on the Best Available Science Esp. Flow Control and Treatment Standard?

- **Yes but, in some cases, judgements were made in the absence of available science (best professional judgement)**

  - *committee consensus statement*

Are the Practices Reasonable and Consistent with Science?

- **Yes but, in some cases, judgements were made in the absence of available science (best professional judgement)**

  - *committee consensus statement*

What Scientific Studies Would You Recommend?

- **BMP (all) performance in field, especially in sequences**
- **What is achievable in urban areas for water quality, quantity and habitat?**
  - Is forested condition appropriate in urban areas?

Based on Best Available Science Cont.

- **Marginal knowledge of BMP performance:**
  - individual
  - in sequence
- **Not clear:**
  - are treatment BMPs always needed, e.g. low volume roads
  - basis for decision to go from “basic” to enhanced treatment

Based on Best Available Science Cont.

- **Is it necessary to match flow volumes and durations for large storms?**
- **Science from large rivers, is it applicable to urban streams?**
- **Extended precipitation records not used**

Based on Best Available Science Cont.

- **Water quality storm selection not well documented. What annual volume is treated?**
- **Manual assumes maintenance, no safety factor**
- **Doesn’t consider or compensate for cumulative impacts, margin of error**
  - <thresholds
  - <perfect enforcement

Are Practices Reasonable and Consistent with Science Cont.

- **Soil BMPs are not applicable for all sites**
- **Bigger ponds not necessarily the answer**
- **Land use not challenged, not the intent but critical issue**

What Additional Science is Needed Cont.?

- **Are there seasonal differences in significance of pollutants?**
- **More soil BMP research, what works, why, variations**
- **Landscape level approach to various receiving water conditions, what factors are limiting in each?**
- **LID-whole systems design concepts**

Summary: Is the Manual Based on the Best Available Science Esp. Flow Control and Treatment Standard?

- **Yes but, in some cases, judgements were made in the absence of available science (best professional judgement)**

• *committee consensus statement*

Are the Practices Reasonable and Consistent with Science?

- **Yes but, in some cases, judgements were made in the absence of available science (best professional judgement)**

• *committee consensus statement*

What Scientific Studies Would You Recommend?

- **BMP (all) performance in field, especially in sequences**
- **What is achievable in urban areas for water quality, quantity and habitat?**
  - Is forested condition appropriate in urban areas?

Q: What performance research do you recommend?

A: Recommend research on BMP performance in the field relative to water quality in urban areas (flow as well as habitat). In addition, the presumed pre-existing conditions are forested. As development occurs in an urban area, it is modeled as though it were forest. The concern is the presumed baseline.

Q: Is your concern about the applicability of the science/data to small streams?
A: Channel sizing storm flow data are from larger, forested streams.

Q: Do the members of the Stormwater Committee feel that 40 years of data isn't enough?
A: There is no consensus. It's an issue the Committee has identified.

Q: Following up on questions that would give more information on larger streams – isn't most of the design done for low volume events?
A: What do we really gain by spending a lot of money to treat an event that only happens every 20 years or less? From a habitat perspective, does a 20-year event really make a difference?

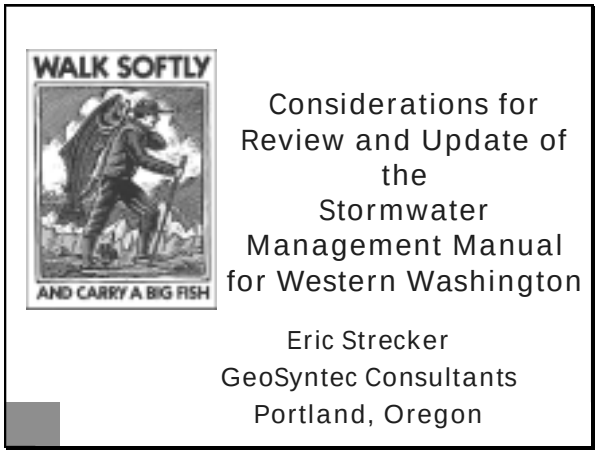
Q: Do you have a sense of how much of the data in your presentation were regional vs. national?
A: Not sure, better question for other members of the Committee. His impression is that where data were available, they were used.

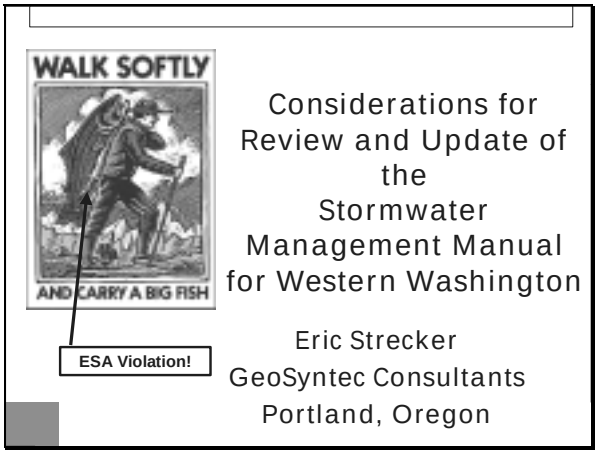
Q: To what extent are your cities cooperating and providing data?
A: Before the permit era, data flowed more freely.

Q: To what extent are the runoff data a limitation, as opposed to the precipitation data?
A: If we are designing facilities, we want to be able to "right-size" them.

Eric Strecker, GeoSyntec Consultants, Inc.

Summary: Mr. Strecker questioned the emphasis placed on flow control, and posed the question as to what can be done to prevent runoff in the first place. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.





Questions to Speakers

1. To what extent was the applicable scientific literatures used in the development of the manual, with special attention to the development of the flow control standard and the treatment standard?
2. Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?
3. What scientific studies would you recommend to address the most important gaps in knowledge associated

Manual is Comprehensive

- ü Obvious that an incredible amount of work and thought went into the manual
- ü Stormwater impacts and management is definitely not fully understood as a science; therefore there will be many opinions/conjectures on what is "best."
- ü There are emerging studies and findings that are revealing useful information
- ü Need to make good subjective decisions and then adapt as we learn

Big Picture Questions

- Is it better to concentrate development or spread it out? Some "Low Impact Development" techniques can encourage sprawl. (e.g., percent impervious caps, cluster development, etc.)
- Western Washington Manual is "designed" to reduce impacts with the "best attempts." How much are they reduced? Is a site-by-site approach the most effective or cost-effective for all cases?
  - How much watershed planning is taking place? Is more emphasis needed on the need for watershed planning?

Flow Control

- Is ½ of the peak flow of the "two-year" storm protective of streams in all cases (manual developed on basis of gravel embedded streams)?
- For streams that are passed the development levels that cause physical impacts, are there better approaches to consider?
  - Santa Clara Valley program is evaluating various stream and watershed conditions to determine where on-site measures will likely provide cost-effective results vs. regional approaches vs. instream stabilization and habitat repair

Is ½ of peak flow of the two-year storm protective of streams in all cases?

- How many watershed are there where there are primarily new development areas that "on-site" controls will protect? vs. they may just reduce the increase in problems?
- Are there other approaches that could lead to better solutions? (e.g., at what point would it make sense for a developer to put an equivalent amount of $ into the creek which could address existing and new development?)

Inspection and Maintenance

- Are facilities carefully inspected to assure that weir(s) are constructed and operating correctly?
- Maintenance of multiple facilities?
- Future infrastructure problems?

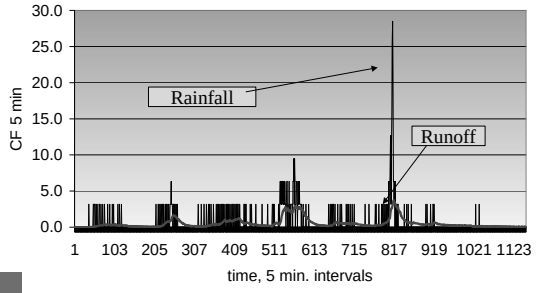
Emphasis on Flow Control vs. Hydrological Source Control

- Emphasis in methods appears to be on flow control vs. hydrology control measures
- More emphasis on managing stormwater through evapotranspiration is needed. (e.g., the sponge)
- Are appropriate Lower Impact Development techniques adequately accounted for in model? (to encourage their use)?

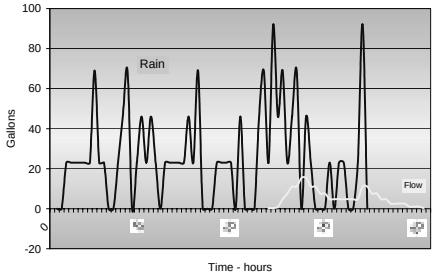
Hamilton Apartments Ecoroof

Ecoroof Monitoring

Hamilton Apartments Ecoroof, westside flows
Storm event Jan. 5 - 8, 2002 (2.8")



Hamilton Ecoroof westside rainfall and runoff
June 28-29, 2002 storm event 0.73"



- Total catchment 3,692 sf, ecoroof 2,690 sf, * impervious surfaces 527 sf, pavers on sand base 475 sf
- *If the 239 gallons of rainfall from the impervious surfaces is removed then no runoff would have occurred

Recommendations

- ü Emphasize hydrological source control
  - EcoRoofs, "planter boxes" (mulched planters); soil retention, canopy enhancements, etc. "Manage the sponge"
  - Helps tremendously with water quality also
- ü Consider where flow controls would be cost-effective vs. instream stabilization and habitat measures
- ü Consider MaCrae's work

Treatment Standard

- ü Percent removals are not supportable as standards or as a description of BMP performance

www.bmpdatabase.org

The National Stormwater Best Management Practices Database Project

Urban Water Resources Research Council

Principal Investigators
Ben Urbonas, P.E.
Jonathan Jones, P.E.
Eric Strecker, P.E.

Examples of Inconsistencies In BMP Monitoring Studies

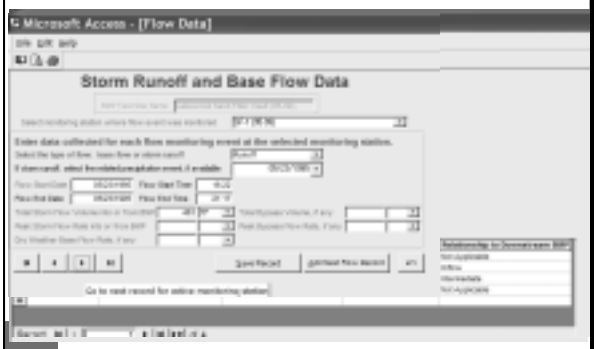
- Constituents
- Sample collection techniques
- Sampling approaches
- Data reporting
- Effectiveness estimation
- Statistical validation of results

Estimated BMP Pollutant Removal Performances in BMP Manuals (Cont.)

	TSS	TP	COD	PB	CU	ZN
Stormwater Ponds						
Wet Pond	80	45	40	75	NA	60
Dry Extended Detention	45	25	20	50	NA	20
Wet Extended Detention	80	65	NA	40	NA	20
Stormwater Marsh						
Vaults/Tanks	60	30	NA	30	NA	30
Infiltration						
Infiltration Trenches/Dry Wells	75	60	65	65	NA	65
Infiltration Basins	75	60	65	65	NA	65
Porous Pavements	90	65	80	100	NA	100
Filtration						
Sand FIlter	85	55	55	82	53	76
Vegetated Swale	83	29	NA	63-72	63-72	63-72

Source: City of Portland, OR, Stormwater Quality Facilities: A Design Guidance Handbook

BMP Performance Information



Distribution of Current Studies (2/5/03)

BMP TOTALS BY CATEGORY

BMP CATEGORY	NUMBER OF BMPS
Structural	
Biofilter (Grass Swales)	32
Detention Basin	24
Hydrodynamic Device	16
Media Filter	30
Percolation Trench/Well	1
Porous Pavement	5
Retention Pond	33
Wetland Basin	15
Wetland Channel	14
Total	**170**
Non-Structural	
Maintenance Practice	28
Total	**28**
Grand Total	**198**

BMP TOTALS BY STATE/COUNTRY

STATE	NUMBER OF BMPS
Domestic	
AL	13
CA	**41**
CO	4
FL	24
GA	2
IL	5
MD	4
MI	5
MN	7
NC	6
NJ	3
OH	1
OR	3
TX	19
VA	29
WA	20
WI	10
International	
Sweden	1
Canada	1

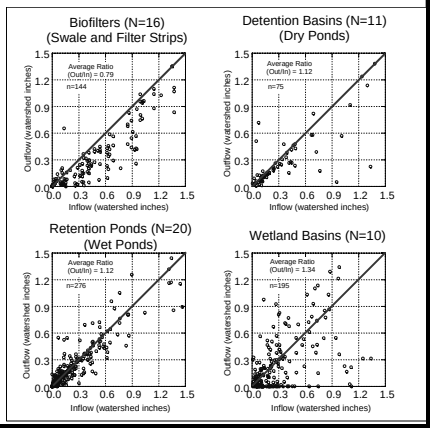
Table 1: Number of Statistical Summaries that are Available from the ASCE/EPA Database Analysis by BMP Type and Parameter

Parameter	Biofilter Grass Strip	Biofilter Grass Swale	Detention Underground Vault, Tank or Pipe(s)	Detention Basin (Dry) Concrete or Lined Tank/Basin With Open Surface	Detention Basin (Dry) Surface Grass-Lined Basin That Empties Out After A Storm	Filter Geotextile Fabric Membrane (Vertical)	Filter Other Media	Filter Peat Mixed With Sand	Filter Sand
Cadmium, Dissolved	1	6	1		3		1	3	4
Cadmium, Total	1	7	1	1	5		2	3	4
Copper, Dissolved	3	8	1	1	4	6	1	3	6
Copper, Total	3	11	1	2	9	6	3	3	6
Lead, Dissolved	3	8	1	1	4	6	1	3	6
Lead, Total	5	12	1	2	9	6	3	3	6
Nitrate + Nitrite, Dissolved					1				
Nitrate + Nitrite, Total		2	1		1			1	
Nitrate Nitrogen, Dissolved			1		1			1	
Nitrate Nitrogen, Total	5	10		2	5	6	2	2	6
Nitrogen, Kjeldahl, Total	5	7		1	6	6	1	2	6
Nitrogen, Total		4			4				
Nitrogen, Total Organic					1				
Oil and Grease		2			4		2		1
Phosphate, Ortho	2	8	1		9	1	1	3	5
Phosphorous, Dissolved					1				
Phosphorous, Suspended					1				
Phosphorous, Total	5	13		2	8	6	3	2	6
Phosphorous, Total					3				
Residue, Total			1					1	
Solids, Total		2							

Recommended Measures of Performance

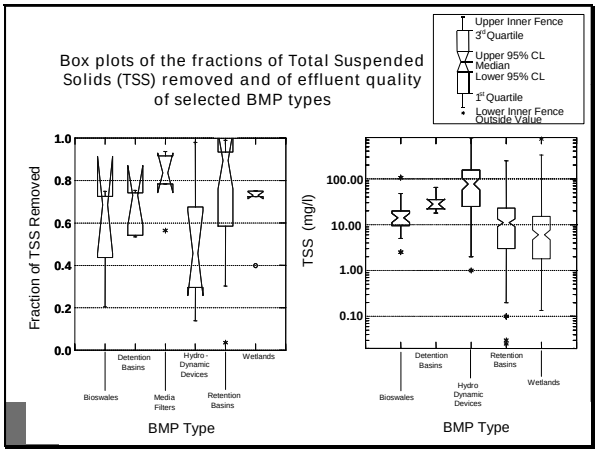
- ü How much stormwater runoff is prevented? ("hydrological source control")
- ü How much of the runoff that occurs is treated by the BMP or not ("hydraulic performance")?
- ü *How is the runoff flows managed?*
- ü Of the runoff treated, what is the effluent quality? ("concentration characteristics achieved" in runoff)

Runoff Volume Control

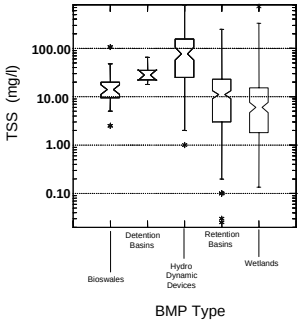


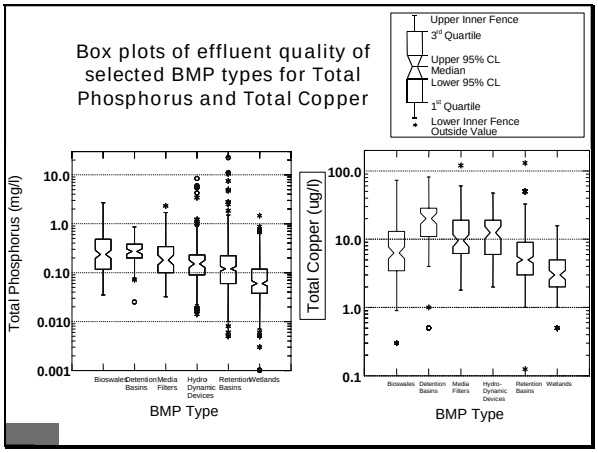
Runoff Volume Control

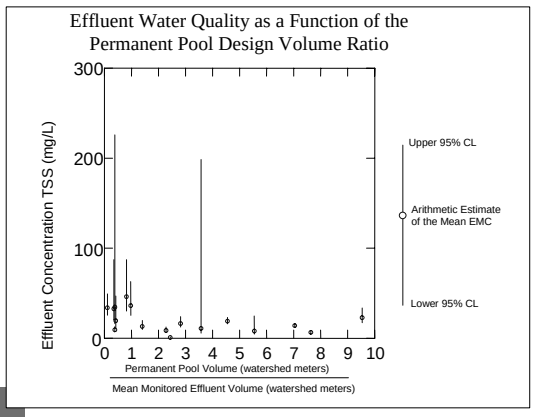
BMP Type	Mean Monitored Outflow/Mean Monitored Inflow for Events Where Inflow is Greater Than or Equal to 0.2 Watershed Inches
Detention Basins	0.70
Biofilters	0.62
Media Filters	1.00
Hydrodynamic Devices	1.00
Wetland Basins	0.95
Retention Ponds	0.93
Wetland Channels	1.00

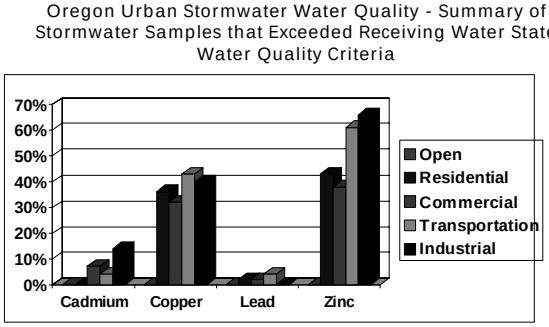


Not All BMPs are Equal







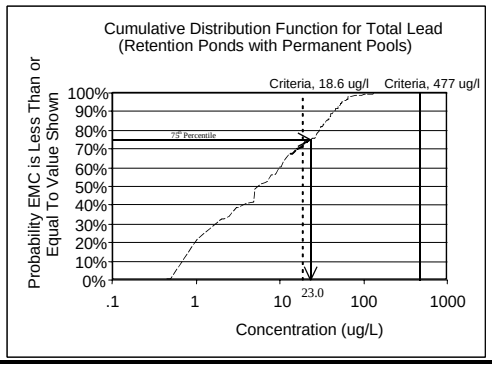


Based upon Oregon NPDES Stormwater Monitoring Data Compiled by ACWA. Developed areas: 27 to 67 storm events; Open space: 9 storm events

Dissolved Metals

- ü Limited data on dissolved metal effluent, but some
- ü Initial indication is the some BMPs are effective in controlling dissolved metals concentrations
- ü Some BMP also appear to increase hardness –standards exceedances are reduced

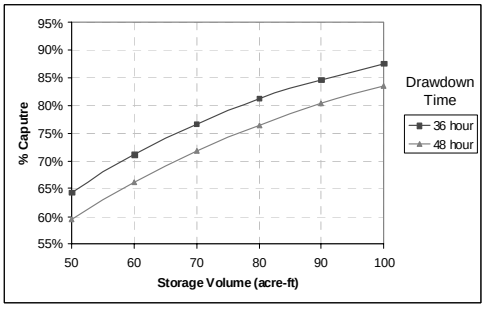
Other Measures of Performance



Oil and Grease

- ü Most studies show oil and grease levels at or below treatment "guidelines" in manual (10 to 15 mg/l) (FHWA, 1990 Highway runoff)
- ü What value is pre-treatment providing?
- ü Is it wise to encourage concentration of flows to do this treatment when bioswales/overland flow BMPs likely would provide more robust treatment for oil and grease?

"Capture Efficiency" –
SWMM Modeling Results (factoring in hydraulics of BMPs into how much runoff is treated)



Other Ideas

- ü Dry Ponds – reconsider as effluent data is pretty good; value in reducing runoff
- ü Mosquitoes – Obvious potential problem with wet pool BMPs (both above and below ground)
- ü Sand Filters?
- ü Roofs – Runoff is not clean (Pitt; Schueler). Consider addressing exposed building materials (e.g., no copper roofs)
- ü Temperature Increases with BMPs (wet ponds vs. dry ponds vs. wetlands)

3. What scientific studies would you recommend to address the most important gaps in knowledge associated with the issues?

- ü Performance of a study to evaluate under what conditions flow and/or hydrological source controls are cost-effective as compared to other regional approaches
- ü Performance of a probablistic evaluation of development scenarios and resulting downstream discharge comparisons to water quality standards
- ü Performance of an evaluation of treatment sizing and operating characteristics vs. treatment level achieved (if not completed already)

3. What scientific studies would you recommend to address the most important gaps in knowledge associated with the issues?

- ü More use of National BMP Database and other efforts to evaluate BMP performance
- ü Evaluation of lower impact development techniques and their potential role in reducing impacts for both stream degradation and water quality

3. What scientific studies would you recommend to address the most important gaps in knowledge associated with the issues?

- ü Consideration of dry weather flows and their potential impacts and BMPs to address impacts

"Urban Slobber"

Q: To what extent is your information regional in nature?
A: All the studies in the database described are field tests; 20 (of 178) are in Washington.

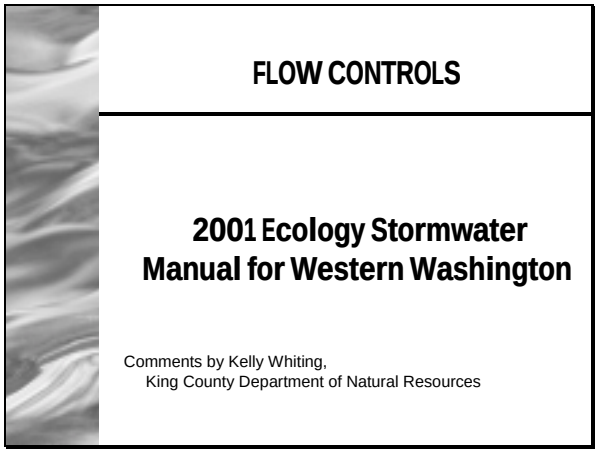
Q: In terms of the BMP database, when there are 15 - 20 practices you have variability within each one as well as between them. How should it be explained to engineers so they can chose?
A: There are no silver bullets. My advice is to look for things that meet needs based on studies. Regarding sequential treatments – it's hard to know how to do to math. Percent removal standards don't encourage source control.

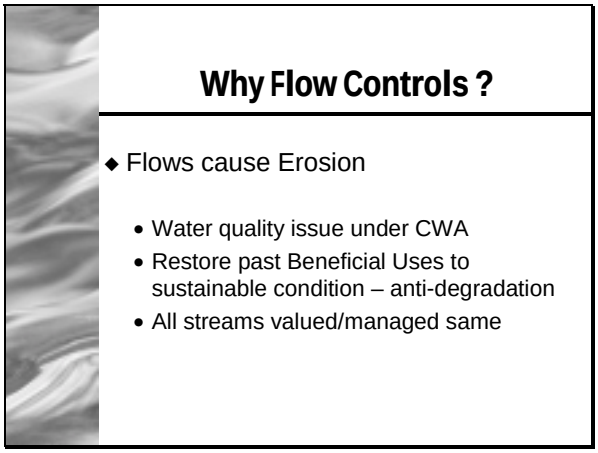
Q: Explanation for better Total Suspended Solids (TSS) than phosphorus control?
A: Perhaps because we are studying based on particle counts, so it is a function of data gathering. Maybe more studies are done on TSS and that distorts information.

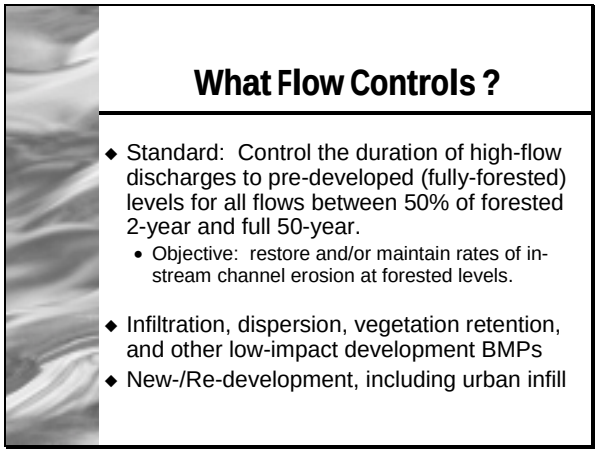
Q: How should improvement of different stream types be approached?
A: What Santa Clara is trying to do is recognize current condition and consider appropriate responses. Flow control on highly degraded streams is not a good use of funds. For example, if 70% of stream is developed, it may be better to stabilize the creek and focus on habitat work, not focus on flow control.

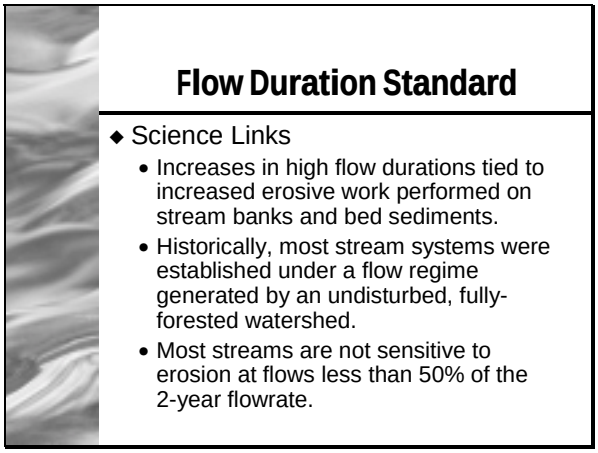
Kelly Whiting, King County, Department of Natural Resources

Summary: Mr. Whiting addressed his remarks toward the issues of applying standards based on a more natural landscape to urban watersheds. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.









Fully Forested Assumptions

- Maintain/Restore Forested Rates of Erosion in All Streams
  - Are forested retrofits a practical goal for all urban streams?
  - Some streams have stabilized under an altered flow regime.
  - Can local jurisdictions require mitigation of impacts not part of current permit?
  - Not explicitly related to biological goals.

Threshold of Movement

- Assumes all streams are subject to erosive work at flows as small as 50% of the 2-year forested flowrate.
  - Thought to be protective for most streams. (i.e., most streams actual threshold is at or above 50% 2-year)
  - Not explicitly related to biological goals.
  - There may be biological effects even with erosive work being maintained.

Urban Infill and Redevelopment

- Is it practical to require retrofits of highly urbanized streams?
  - Difficult to achieve urban GMA densities.
  - Restoration through redevelopment standards is costly and may not significantly benefit resources.
  - Limited resources (natural and financial) may be better served by larger picture management goals.

Stormwater Planning

- Ecology Manual allows subbasin scale CWA planning in setting area-specific stormwater requirements
  - Standards must provide equivalent or greater protection.
  - Alternate resource management goals not supported.
  - Existing planning (basin, ESA) likely not adequate as CWA level restoration of all streams not recommended.

Overview

- One size fits all standard may not be biologically (and financially) justifiable
  - Fully forested flow regime
  - Above 50% 2-year threshold
  - Erosion protection goal not explicitly tied to biological outcome
- How do low impact development techniques change flow control needs?

Normative Flows

- Which hydrologic attributes should be maintained at natural levels to support biological management goals?
  - Identify hydrologic conditions necessary to support ecological management goals other than streambank erosion.
  - Provide a methodology to determine the departure of a watershed's streamflows from sustainable flows.

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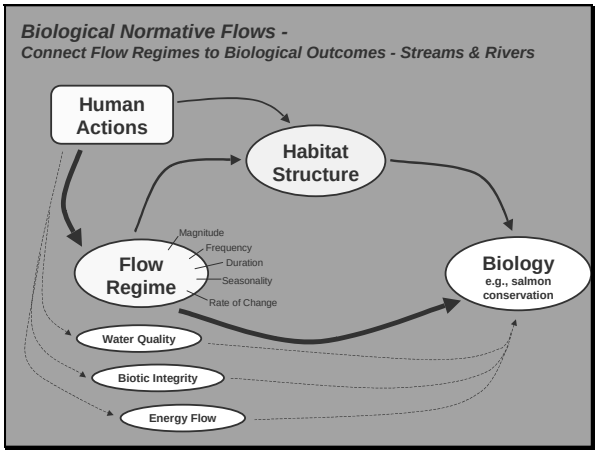


Low Impact Development

- Dispersion, Infiltration, and Vegetation Retention are normative approaches.
- Frequent storms handled well by LID BMPs, and likely to have strong biological connection.
- Is there need for conventional systems to protect against less-frequent, more-severe (e.g., >5-year storm) events?

Research Recommendations

- Hydrologic controls (and instream flows) based on biological outcomes and resource management goals.
- The use of low impact development techniques in conjunction with, or replacement for, conventional flow control and water quality treatment facilities.
- Guidelines for CWA related planning studies.

Q: 50% of 2-year storm equals what frequency? How defined?
A: About one year. Different bottom thresholds of movement were looked at. Lack of significant movement of channel bed sediments was found at 50% of 2-year storm.

Q: Expand on frequency and duration of smaller events.
A: The approach for the flow control standard is that if you are not causing erosion, the biology will be OK too. But, if we stack low flow processes up, there's a leap of faith that it will equate to "no adverse effects."

Q: You said this doesn't match basin planning?
A: Basin planning work in the 80s and 90s looked at habitat, but not from a perspective of non-degradation. So, those basin plans won't be viewed as adequate with regard to non-degradation standards here, although from a larger standpoint, planning with a system orientation is important.

Q: Are you implying that we need site-specific guidance for salmon in individual streams? Isn't there a connection between biology and flow duration? Do we have a sense of that, and how far off are we?

A: There is a strong connection between flow and biology so we are not far off as far as that goes, but it's about reasonable/best allocation of resources. He would question the benefit of dedicating resources to underground systems in urban areas.

Q: Practical goal of forested model, confused about goal vs. reality.
A: A plan that comes in has to meet that standard, but what if you are redeveloping one property in a highly degraded watershed? How reasonable is it to spend the money to meet that standard on only one project?

Q: Is there information on conveyance systems for less frequent storms, recovery period for streams?
A: From this perspective, infrequent storm events don't have as much impact.

Q: The Ecology manual is largely based on the King County Manual. Does King County have issues with how the manual has been expanded?
A: Benefit of last 10% is so low that it does not justify cost. Mostly want to concentrate development at the detriment of some urban areas.

Q: Are there data sources on conversion of forest to pasture, and impacts of low flows?
A: Yes; those sources and references can be provided.

Q: What other criteria besides stream bank erosion can be considered regarding flows?
A: We are trying to identify that, but don't have it now.

Q: Since baseline data are based on forested areas, do you have concerns about conversion to landscaped area? Is there data to support those concerns?
A: Much information is based on simulation work. Basin plans provide some estimation of hydrological response.

Q: What about the issue of a little bit of development in a big basin?
A: The King County Manual allows trading. LID techniques are more likely to work in less densely populated areas.

Q: Regarding the 100-foot buffer, why less controls?
A: It is based on best professional judgment as to what we thought we would get from dispersment.

Tom Holtz, SCA Engineering

Summary: Mr. Holtz addressed his comments primarily to Question #1, with some remarks directed on Questions #2 and #3. He addressed the issue of basing the manual on a "false definition of pre-development runoff," and the lack of science to support flow control assumptions. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.

SCIENCE AND STATE DRAINAGE STANDARDS

ISP - February 12, 2003

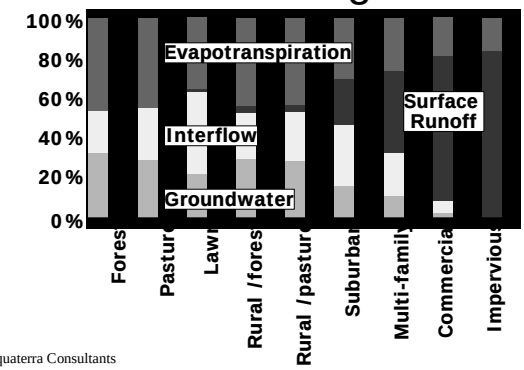
INCREMENTALISM

- 1950s, Flooding, The Rational Method
- 1970s, Channel Widening and Runoff
- 1980s, The SCS Method
- 1990s, Red Alert, Booth, Schueler, others

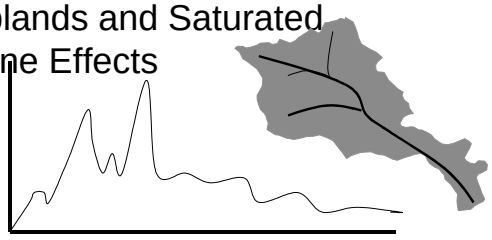
Paradigm Shift

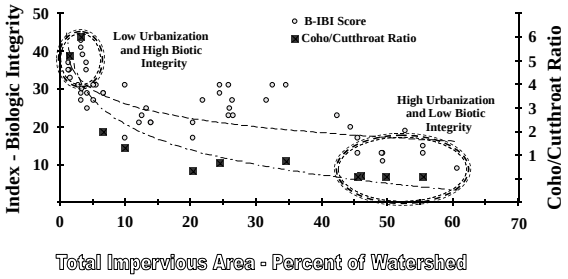
- 1998, The End of the Old Paradigm. Beyerlein, Karr, Horner, May

Where the water goes

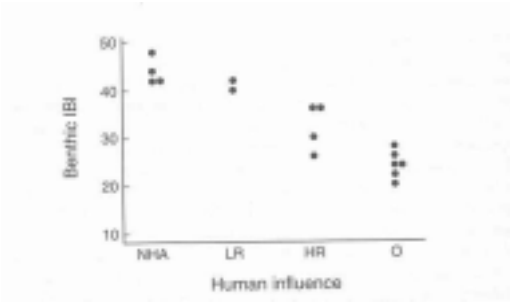


Basin Hydrologic of Forest is an Average of Uplands and Saturated Zone Effects

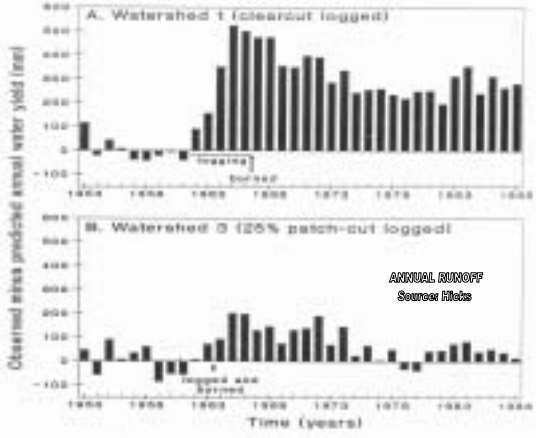




Influence of Recreation on Stream Health



Source: Karr, 1999



2001 - An Odd Decision

WWHM Functions As 3-Parameter Model

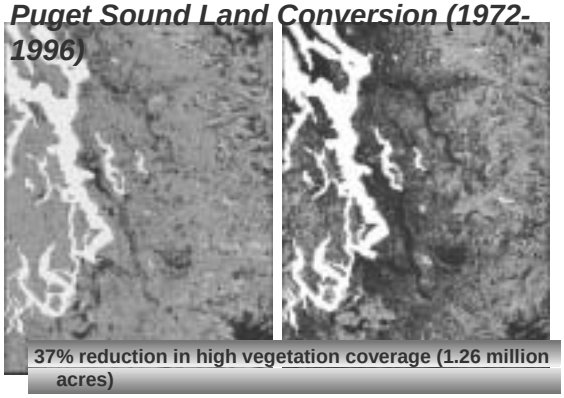
$$ET_{ad}+I_{ad} = ET_{pd}+I_{pd}$$

Replaces the Manual

Zero/Low Impact Ordinances in Washington

- Lacey
- Snohomish County
- Olympia
- Issaquah
- Tumwater (soon)
- Pierce County (soon)

Puget Sound Land Conversion (1972-1996)



37% reduction in high vegetation coverage (1.26 million acres)

Q: What do you recommend should be done to change the manual?

A: Give up the idea of pre-development flow. Measure evaporation/transpiration and infiltration. (handout provided to ISP). Four or five Washington jurisdictions have adopted zero/low impact ordinances (option not requirement). As long as we don't have universal zero flow standards in place, the manual is a staring point. Building storage to create less/zero runoff is more expensive.

Q: Why is Hydrologic Simulation Program-FORTRAN (HSPF) not a realistic model? Can't it show 100% stream flow as base flow, in the case of undisturbed conditions?

A: HSPF is a great model. For example, we can model what the impacts on an entire watershed will be from 1% activities. But that is not how people use it. They try to apply it to individual sites that do not actually generate any flow in the pre-development condition.

Q: So the HSPF model implies stream-flow where there was none?

A: Precisely, and if you say there was overland flow somewhere that there wasn't, then that gives you an easy out. The model has to be calibrated to stream flow.

Q: Can you cite the specific source of your reference attributed to Thomas Dunn?

A: It was a statement made at a conference but referred by Latham in his paper.

Kenneth Stone, Washington Department of Transportation (WSDOT)

Summary: Mr. Stone addressed his remarks to Question #2. He addressed the issue of some BMPs being of the wrong design for the intended purpose, and the need for different levels of treatment for different conditions. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.

WSDOT and Stormwater

A Presentation to the Independent Science Panel

Douglas B. MacDonald
Secretary

Paula Hammond
Chief of Staff

Kenneth M. Stone
Project Services Branch Manager
Environmental Affairs Office

February 12, 2003

Introduction

Who we are and what we do:

- Large developer in state
  - Highway and bridge construction as well as ferry, rail, and aviation facilities
- Government agency with environmental responsibilities
  - Must be accountable to taxpayers on how we spend resources in terms of cost effectiveness
- $3.6 billion spent over the last 5 years in construction/maintenance

Presentation Overview

1. Describe scientific shortcomings of the Stormwater Management Manual for Western Washington (Manual):
   - Basis for setting standards and thresholds
   - Manual's approach
2. Recommendations to rectify shortcomings

Scientific case lacking for enhanced metals treatment

- Dissolved metals removal methods are largely untested.
- Sand filters, the default method, are not effective in removing dissolved metals
- Parameter used to estimate toxicity does not address bioavailability of contaminants.

WSDOT Stormwater Research Facility

Scientific case lacking for enhanced metals treatment

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- Sand filters, the default method, are not effective in removing dissolved metals
- Parameter used to estimate toxicity does not address bioavailability of contaminants.

WSDOT Stormwater Research Facility

Thresholds in Manual are not always appropriate for highways

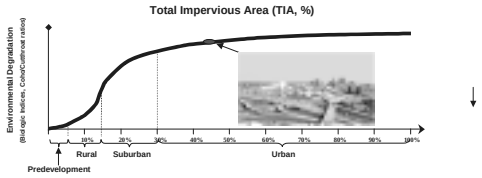
Example

SR 141, near Trout Lake, with average daily traffic (ADT) volume of 1,300 has the same requirements as Interstate 5 in Seattle with ADT of 200,000

Urbanized Environments

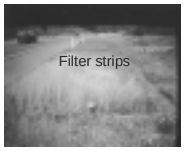
- Can't get "there" with BMPs:

- Flow control designed to mimic pre-development hydrology is ineffectual since stream geomorphology has already been altered.
- Research shows no measurable improvement in stream biota when BMPs have been implemented in watersheds with >25% total impervious area.



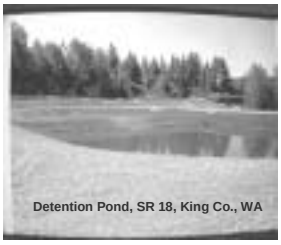
Manual lacks guidance for using LID/low-tech BMPs

- Ecology continuous flow model does not accommodate low-tech BMPs.
- Science suggests that these techniques may be the better response and more cost effective.



Unintended ecological consequences of flow control standards

- Large pond sizes – potentially creating higher temperatures and displacing valuable habitat.
- "Regulated stream gamble" – more prominent periods of higher flows vs. less peak flow erosive events.


Detention Pond, SR 18, King Co., WA

Basis for our Assessment of the Manual

1. Participated in developing Ecology's manual.
2. Referred data and peer reviewed research and journals.
3. In support of revising WSDOT's Highway Runoff Manual, analysis by interdisciplinary technical team and consultants made up of:
   - Designers
   - Hydrologists
   - Erosion control, water quality, & stormwater specialists
   - Landscape architects
   - Geotechnical and hydraulic engineers

Recommendation #1

Use the best available validated science (i.e., refereed data, peer reviewed research)

Recommendation #2

Stormwater treatment should focus on removing those pollutants that are limiting factors for fish

Recommendation #3

Provide guidance that is scientifically supported to ensure it meets intended objective(s).

Recommendation #4

Identify information gaps and set up a mechanism to pool funds to conduct research to close these gaps.

Recommendation #5

Continue looking outside to other professions and disciplines during your assessment of the Manual.

Q: You indicated unintended consequences of temperature increases from large ponds. Are you aware of any data from Washington on the subject?
A: No, not in western Washington, but it does exist from other parts of the country.

Q: Do you see the manual applying to existing roads, or just new roads? Have you thought about the costs of maintaining many small facilities?
A: We think small would be better.

Q: What is the scope you have included in linear transportation facilities"?
A: Roads. Pipelines mostly buried, don't apply.

Q: What about spill containment?
A: We are involved in spill control on floating bridges. Conventional BMPs on land are designed to contain spills and make allowances.

Q: What do you recommend should be done in the absence of more date?

A: Incorporate BMPs into transportation systems when they are cost effective environmentally. It doesn't make sense to mimic pre-development conditions. We want to continue treatment for stormwater, but are reluctant to use enhanced treatment.

Q: Do you know of data to support your skepticism about delayed high flows?
A: No.

Q: Does WSDOT have any data on a change in runoff from shifting from gravel to pavement or chipseal?
A: WSDOT does not have many gravel roads.

Q: What about road sanding for snow? What is the implication for water quality?
A: We have done research on de-icing chemicals, and we try to use the least damaging ones. Snowmelt would be considered run-off, however.

Q: Do you also use sand?
A: Yes.

Q: You noted studies that demonstrate that average daily traffic volume doesn't have an impact on water quality. Do you know of any data?
A: Yes. A paper from CalTrans is included in the notebook (handed out to ISP). Atmospheric deposition on roadway also contributes, and varies a lot from place to place.

Q: Since WSDOT-owned right-of-ways include land along roadways do you have more flexibility in controlling stormwater (than cities with urban streets)?
A: Yes, when a roadway is big enough to accommodate the size of BMPs. Where we have to buy a right-of-way it is sometimes too expensive or unavailable.

Doug Beyerlein, P.E., Aqua Terra Consultants

Summary: Mr. Beyerlein addressed concerns about the treatment of low flows in the manual. A copy of his presentation is found below, followed by brief notes from the question and answer period associated with his talk.

ISP Workshop Feb 2003

Doug Beyerlein, P.E.
AQUA TERRA Consultants
Everett, WA

Question 1: Was applicable science used?

Yes for high flows.
No for low flows.

AQUA TERRA Consultants

Flow control standard: High flows mitigated by controlling flow duration above ½ of the 2-year flow.

Western Washington Hydrology Model (WWHM)

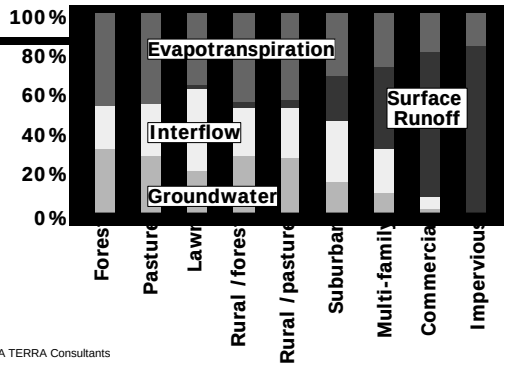
AQUA TERRA Consultants

Low flows decrease because lack of groundwater recharge.

Groundwater provides over 90% of summer forest runoff; only 60% of suburban residential runoff.

AQUA TERRA Consultants

Where the water goes



AQUA TERRA Consultants

Question 2: Are the practices in the manual reasonable and consistent?

Yes and No.

AQUA TERRA Consultants

Practices are reasonable and consistent for erosive flows in Puget Sound watersheds.

Control flows above ½ of the 2-year flow.

AQUA TERRA Consultants

Less reasonable and consistent for summer low flows.

30% loss of summer low flows is not addressed.

AQUA TERRA Consultants

Less reasonable and consistent for watersheds outside of the Puget Sound region.

Few or no watershed studies outside of King, Snohomish, Pierce, and Thurston counties.

AQUA TERRA Consultants

Question 3: What scientific studies are recommended?

1. Evaluate the impacts of development on summer low flows.
2. Calibrate WWHM parameter values for watersheds outside of the Puget Sound region.

AQUA TERRA Consultants

In summary...

- The flow control standard for high flows is not the whole answer.
- Maintain summer low flows by infiltrating to groundwater.
- Need additional hydrologic studies in western Washington.

AQUA TERRA Consultants

Q: I have recently observed in another part of the country that there are increased flows in summer because of imported water (i.e., lawn watering). Are you aware of local studies of actual summer flows? Are we sure we are reducing flows in the summer?

A: There is the potential to augment, but in western Washington some creeks dry up every summer, so although there are not specific studies there is anecdotal information. If augmentation is occurring it is not making it into the stream channel.

Q: Is the chart in your presentation annual or seasonal?

A: Annual.

Q: On same chart, pastures have more interflow than forests. This seems contradictory to the manual.

A: The graph is based on results from a computer model. A lot of the impact is in how soils are changed, from forest to pasture to lawn. Pasture increases surface run-off, which occurs more quickly – the stream channel is not used to it, and so shows impact. I can't address why Ecology made the choices they did in the manual. Increase in surface runoff from pasture is five times that of forest, which is still small.

Q: Why do lawns have more interflow than forests?

A: Because there is less to groundwater, because of the compaction of soils.

Q: If we increase infiltration, need we worry about bank stability?

A: Varies by site.

III. ATTENDEE COMMENTS

Oral

Briefly summarized below are comments from each attendee who made oral statements at the workshop.

Rick Dinicola, U.S. Geological Survey, Tacoma

Dr. Dinicola offered the following comments, with emphasis on Question #2:

- He performed some of the original watershed modeling for HSPF.
- Regarding Question 2, "Is the manual consistent with available science?" There are some reasons why HSPF went the way it did. A lot of detention pools were going in at the time. Designing a pond based on a specific event seemed unreasonable. We tried to model for cumulative impact of multiple ponds and multiple storms. Although now applied on a site-specific basis, the model was designed on a cumulative basis. Single event models did not realistically simulate runoff conditions in western Washington, especially for development conditions. Generalized parameters were tested through regional calibration – using 21 gauging stations. The model was calibrated using mixes of land use and soil types. The method resulted in parameters that try to do what this manual does - give good overview of a region.
- Forested conditions – Before clearing and grading, shallow subsurface flow was the primary runoff. The forest model is less about trees and more about soil condition. We saw major change in hydrographs based on soil condition. We had most area in basins. It was runoff from impacted areas that we had the most confidence in.
- Other research projects have done better. Specific data exist for some sites, but the hydrology in the manual is good for general use.
- Three summary points in conclusion:
    - Glad to see work has been incorporated in the run-off model.
    - There's just not a lot of empirical science out there.
    - Ecology did a good job. There are well ahead of the curve in including good hydrology.

Q: In the calibration, what original work was used?
A: Twenty-one gauges, in several watersheds in King and Snohomish Counties.

Q: How well do your parameters encompass all of western Washington?
A: I have not tested that. The data relate to glacially derived soils in the Puget Sound area.

Q: So if you get south into different soils – would the information still be applicable?
A: I don't know.

James Albrecht

Mr. Albrecht offered the following comments regarding Question #2:

- The need for maintaining in-stream flow regime should be emphasized. Not just peak flow, but the whole regime throughout the year. This is critical to salmon at all the different life stages.
- (Reference made to article by Derek Booth). In order to maintain flow regime, you would need to have the same storage capabilities as pre-development condition – ground water.

- 303 list – storm runoff equals 20% increase from 1950s. The situation is worse in lower part of the Deschutes River, in the Olympia area. He is concerned about significant loss through storms.
- Last year the legislature passed law providing for aquifer recharge so as not to waste winter runoff. Subject to additional loss of flow from warmer winters. Note decrease in glaciers, and snow-pack. Need to think of whole watershed as an infiltration device, not just basins –everything.

Nancy Malmgren, citizen volunteer, CWCAP

(Note: Ms. Malmgren submitted a written response form at the workshop with clarifying comments. Those comments have been integrated into the notes of her oral remarks below, and are also attached later in this appendix.)

Ms. Malmgren offered the following comments regarding Question #2:

- I share concerns about impervious surface/ground water recharge. Pipers Creek has a real problem in the south section.
- I know that there are concerns about cost/value of urban creeks. But with growth, soon all will be urbanized. I am concerned about the impact on large rivers that are critical to salmon.
- I strongly support the work Ecology has done with manual. A careful stewardship job has been done. Congratulations to Ed O'Brien and staff.
- Flow characteristics – are both an aesthetic and biological challenge for maintaining integrity in urban creeks. Flow control is necessary to assure it doesn't impact low flow conditions, and that groundwater is protected.

Ms. Malmgren offered the following comments regarding Question #3:

- West Nile Virus – public health concerns should be examined. Detention ponds may need to be retrofit to assure no threat to public health.
- Flow control studies are needed to assure low flow conditions are not impacted. Examine effects on groundwater.
- There needs to be studies on "non-attainable" water quality standards. It is really important to think about linkage between CWA, TMDLs and 303 listing. Will somebody please find something other than Reed Canary grass for fecal coliform?
- Need studies to develop biofiltration strategy for bacteria, E Coli, fecal coliform, etc.

Ken Ludwa, Parametrix

Mr. Ludwa offered the following comments regarding Question #2:

- The approach to water quality treatment could be more robust.
- The questions I am posing often are posed to consultants in the federal nexus/ESA reviews. It would be great to have a more prescriptive approach.
- More data are needed on sub-lethal impacts on fish.
- More research and standards are needed on:
    - Synergy or antagonism between constituents and stormwater, and toxicity levels of chemicals in combination.
    - Effects of BMP's on organic compounds, very little research available.
    - Temperature effects of extended detention times.

Q: Do you know of any studies regarding combined toxicity?
A: There was a newspaper article in Seattle Post-Intelligence last Thursday.

Q: What organic compounds?
A: Hydrocarbons, pesticides, herbicides.

Linda Logan, Parametrix

Ms. Logan offered the following comments regarding Question #2:

- Knowing we are moving toward compliance with numeric water quality standards, urge panel to consider applicability of numbers developed for continuous discharge being applied to stormwater events.
- Acute standards (for fish health) are usually 24 to 48 hours, which is not the case with most runoff. Stormwater varies in magnitude and duration. The perspective of continuous discharge doesn't account for short shot in receiving stream.
- Testing situations use pristine water instead of the conditions we would typically see in the field, especially for metals.
- Focus the criteria on the receiving stream, not at the end of the pipe.

Mike Kent, British Columbia Department of Transportation, Chief Engineer

- We developed a stormwater drainage manual in 1990. We build roads around hatcheries and so included lots of BMPs. We have stringent construction control, and we feel pretty successful. Lots of ponds were eventually turned into wetlands, and we are just now getting data on those, via a thesis project conducted by George Onwumere ("A evaluation of highway stormwater runoff quality in the G.V.R.D.," 2000, Ph.D. dissertation, Department of Civil Engineering, University of British Columbia, Vancouver).
- Research was funded in 1998 on high traffic arterials that speak to the correlation between traffic volumes and runoff. Highways are very linear, and cut across watersheds. Trying to accommodate BMPs in the right-of-way can be difficult.
- The thesis referenced above shows a simple system of grass swales took out most concentration of pollutants out of the water.
- Need to examine more highway studies. Consider that rural roads may need to be treated differently. There is quite a bit of data in the Vancouver, British Columbia area developed in conditions similar to western Washington.

Q: Chloride run-off from road salt – does it have an impact on trout or salmon?
A: No. Use of road salt in Vancouver is very limited. Sand is used, but it is highly treated, and collected at the end of each season. Agencies have management plans for use of materials such as these that have been identified as toxins.

Written Response Forms

The written responses below were submitted using an online template that prompted input on the three questions. The comments have not been edited.

Dale Rancour, West District Washington State Association of County Engineers

Please refer to (the following) form for Response to Key Questions. Generally, the only concerns I have with the stormwater manual are the thresholds to apply all minimum requirements to safety upgrades of existing rural roadways. As a professional, I am having problems seeing how the science of flow control and sometimes treatment apply to safety projects on rural roads. I believe that applying the manual can many times have more impacts in rural areas than it is meant to resolve.

The Washington Association of County Engineers meets twice a year (once for the entire state and again as western and eastern districts). We have had discussions on this issue before and I believe the group supports my comments. Since there is limited time to respond as a group, I will be sending copies of my comments to the engineers. Department of Ecology did make a presentation at our conference last year where similar comments were received. I am setting up an agenda for our April 3-4 Conference in Olympia if anyone is interested in making a presentation.

I believe my concerns are similar to those noted by the representatives from APWA, Washington State Department of Transportation, British Columbia Province of Transportation and to some extent those involved with Low Impact Developments.

I appreciated the workshop as a learning and exchange experience and am looking forward to helping out on your review of the manual. If you have any questions or comments, please feel free to call me at 360-786-5134 or e-mail rancoud@co.thurston.wa.us.

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   Most of the presenters and responders to the key questions and the Washington Independent Science Panel Stormwater Manual Review Workshop on February 12, 2003, based increased stormwater management particularly for flow control on studies showing increased stream degradation as a percentage of the impervious development of the contributory watershed. The studies tended to show that the streams would show some signs of degradation when the percent impervious of the tributary watershed is 4-10%. Land Cover Mapping of Thurston County, June 2001, calculates impervious area in basins. When this report is adjusted for basins and portion of basins in the rural area, the percentages on impervious area rarely are greater than one percent. Thurston County is in the process of projecting percent of impervious area based on zoning with results anticipated in 2003. The draft Stormwater Management Manual for Eastern Washington exempts projects for flow control that discharge to a lake, river or stream where the long-term, projected total impervious surface area in the contributing watershed for that water body is less than 4% of the total area based on current and probable future zoning requirements as determined through a basin analysis conducted by the local jurisdiction. This exemption should also be allowed in Western Washington and consideration should be given to simplify the analysis required of the local jurisdiction.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

Drainage facilities on rural roads and highways throughout the nation (as far as I have observed) don't try to collect stormwater. Their stormwater drainage facility's function is to keep the water from saturating the ground under the pavement and shoulders. Usually these facilities disperse the water to the adjacent property. When there are ditches along side of the roadway, they typically only exist where the adjacent land is higher and many times stop before there is any low spot in the road profile or any interception with a stream. This has always been allowed as long as the project isn't significantly concentrating runoff, diverting runoff or blocking natural drainage flows. The practices outlined in the manual for Roadway Dispersion Best Management Practice (BMPs) requires high percentages of forested or native vegetative cover, low percentages of impervious area in the road right-of-way and dispersion areas need to be protected through recorded easements (the only exception we have been told is where the road is through a national or state forest). These requirements are so high that they are generally viewed as unattainable. This leaves us with collecting and concentrating stormwater unless we can pre-treat (poorly defined in the manual) and infiltrate within the existing width of the road Right-of-way. In the rural area, particularly where the impervious is less than 4%, I would decrease or eliminate the flow control and treatment requirements.

The manual says that it encourages permeability and infiltration but the hydrologic models and formulas do not adequately account for this. There are limited BMPs developed or instructions as part of the manual around an open roadside ditch/swale system, which promotes infiltration. In reviewing a rural roadway shoulder-widening project in relative poor draining soils for stormwater treatment, I can observe no flow in the existing ditches or in the ditches of the adjacent previously widened project during storm events equal the requirements for treatment. The ditches for a rural road seem to meet some for the requirements of a number of BMPs, but do not meet the requirements of any one BMP. The grass slope away from the pavement into the ditch is too steep to meet the requirements of a biofiltration strip. This same grass slope into the ditch is over free draining gravels extended from under the pavement, but does not meet the requirements of a sand filter. The grass-lined slope of the ditch is too narrow or steep to meet the requirements of a biofiltration swale, the ditch is dispersed through 350 feet of native vegetation but the project does not meet the manual's requirements for dispersion. I believe the overall project surpasses any one of the manuals recognized BMPs. My recommendation would be to review treatment requirements for at least all two-lane shoulder widening projects with grass lined open ditch/swale systems.

The manual seems to have a number of thresholds that are not based on scientific information. Gravel surfaces and bituminous surface treatment (chip seal) are counted in the manual as impervious surfaces when modeling stormwater runoff but when upgraded to asphalt or concrete are considered as new impervious. One of the independent science panel members had asked a question that seemed to be related to this concept of gravel and bituminous surface treatments. Local jurisdictions have many miles of roadway gravel and bituminous surface treatments. The upgrades of these surfaces should not be considered as redevelopment.

In general, the manual seems to apply urban criteria and BMPs to rural situations without adequately reviewing the scientific need or methods plus the environmental consequence and impacts to adjacent property owners by applying the BMPs.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   The state needs to review the application of this manual beyond the Urban Growth Areas. Does the population or percent impervious, even with growth, support the application of the manual as written?

   There seemed to be debate at the workshop on how traffic volumes impacted treatment requirements. This needs to be resolved so the threshold can be reviewed for low or even relatively low traffic volumes of rural roadways.

   BMPs need to be developed to reflect the infiltration and treatment of roadside dispersion and ditch/swale stormwater drainage facilities.

   We need to develop new methods to promote and calculate infiltration. The Washington State Department of Transportation has done some investigation on compost, not only to amend disturbed soils but to also promote infiltration. If we can develop BMPs within the roadside slopes or ditches for flow control and treatment, we will eliminate our need to disturb more trees and native vegetation.

Bob Fuerstenberg, King County Department of Natural Resources and Planning

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   Although well based in hydrology and geomorphic information, little or no stream and river ecology information or theory was brought to bear on setting annual standards. Such information would likely emphasize climatic cycles, spatial differences, patch dynamics, stream respiration and habitat heterogeneity within channels as fundamental to maintaining the biological integrity goal of CWA.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   Most BMPs are a bit too faith-based, and generally reflect short-term removal efficiencies (almost and instantaneous efficiency) but do not address declines over subsequent events that may reduce efficiency greatly (the literature on filter strips in agricultural applications is instructive).

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   First: Paired comparisons between streams with current stormwater controls and without: (1) BIBI scores, (2) respiration, and (3) patch heterogeneity and turnover rates.

   Second: BMP performance over extended periods such as 5 – 15 years. Need a dedicated experimental station, or program aimed at developing and evaluating BMPs, etc. (in concert with the Center for Watersheds in Western Washington).

Nancy Malmgren, Director, Carkeek Watershed Community Action Project

Note: The following written input is to clarify verbal points made by Ms. Malmgren's at the workshop.

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   Should acknowledge that most of our creeks and rivers will have an urban element.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   Job <u>well</u> done by DoE on manual. Congratulations to Ed O'Brien and Staff

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   Public Health Concerns (people and salmon)

   West Nile Virus – Current detention pond retrofit, to assure no threat to public health.

   Flow control to assure it doesn't impact low flow conditions – Protection of ground water.

   Study to develop biofiltration strategy for bacteria, E Coli, FC, etc.

Bill Rozeboom, Northwest Hydraulic Consultants, Inc

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   My comment concerns flow control standards in previously developed basins. There is to my knowledge no data which shows that, in an already-urbanized basin (say > 20% impervious without effective flow control), there is measurable further stream degradation associated with the addition of small increments of additional impervious surface. The corollary is that there is no evidence of benefit to retrofitting a highly urbanized basin with detention control facilities influencing only a small portion of the total impervious fraction. Speculatively, the stream has reached some sort of new equilibrium by scouring to underlying hardpan soils or developing a pavement layer of coarser materials.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

I think that it is unreasonable for the manual to not distinguish between previously urbanized and relatively pristine basins in the setting of flow control targets and detention standards. It is not consistent with the scientific information. If there is no realistic chance to recover a basin to "forested" conditions because the basin is already highly altered and little area remains to be developed, then there is no basis for assuming that cumulative benefit or harm will come from incremental projects. In my opinion projects in urbanized areas should be subjected to less strict peak flow control standards than projects in relatively undeveloped basins. I think that the target land use in urbanized basins should be actual existing conditions rather than a hypothetical forested basin, and that the control standard should be simply to match or reduce 2-year through 50-year peak flows, and to not require duration matching at all.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   No response--no realistic (or simple) study comes to mind to address the issue raised: impacts and consequences of incremental flow impacts, and incremental flow reductions, in already urbanized basins.

Joel Rupley, Clark County ESA Program

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   As a non-scientist, I had hoped the workshop would focus on science that defines the relationship between water quality (including flows) and salmonids. The presenters, particularly in the afternoon, did not really emphasize fish issues. There is a considerable body of science that recognizes disturbance regimes within watersheds destroy, change and re-create habitat over time. Scientists are now trying to understand how anthropogenic disturbances affect the natural disturbance cycles. Work on resiliency is an example. I had hoped the scientists in the room would discuss habitat-forming processes in a more dynamic sense.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   The Western Washington Manual seems to focus on regulatory compliance rather than good outcomes for fish. In order to be effective for fish, the manual should encourage stormwater planning and actions on a watershed basis. These plans and actions should focus on preserving and strengthening dynamic habitat-forming processes within individual watersheds.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   As a non-scientist, I am not qualified to be specific or to discuss study protocols. However, it seems important to better understand the relationships between flows, pollutants and habitat-forming processes within watersheds.

Gary Minton, Resource Planning Associates, Inc.

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   My input reflects attendance at the workshop on Feb 12. Mr. O' Brien gave the impression that the TSS standard was based on National data. While I do not directly dispute this, the standard bears a striking resemblance to a graph that I developed in 1999 using then available PNW performance data. That curve includes a line called the Line of Comparative Performance. I prepared the graphs in the development of the 1999 APWA (Washington chapter) protocol for testing BMPs (precursor to the TAPE protocol). His standard follows almost exactly my line. My point is that the line is judgmental. I can provide these graphs if you wish. There is no reason why the committee can exercise its own judgment. Also of particular import are data recently compiled by the California Department of Transportation. Its value is that the various BMPs have been evaluated under similar climatic and stormwater quality conditions.

   Further, if the data points for the grass swales (whose performance is very inconsistent) are removed, the "standard" would clearly become more conservative. CalTrans data also shows the inconsistent performance of swales. Mr. Strecker noted that significant infiltration occurs in swales, suggesting that this should be factored into the consideration. This actually further strengthens my recommendation that the standard be made more stringent, supportable by the data. (but one could argue that the fact that the water infiltrates should be not given credit, as we do not know what level of further treatment occurs in the soil before the water reaches the receiving water body).

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   The requirement for a double treatment system for dissolved metals and phosphorus is totally without support, and could be counterproductive. With respect to the menu for metals, the menu was taken from the King County manual in which the treatment objective is total zinc, not dissolved. Many of the BMPs in the menu would not be expected to remove dissolved metals. There is certainly no assurance that the second system will provide any additional removal over the first. The double box system should be dropped. Instead, the menu should consist of those systems in which there is some evidence that a significant fraction of the dissolved metals are removed, specifically: wet ponds, wetlands, sand filters (they do removed dissolved metals), and approved proprietary systems. Furthermore, the concept of increasing a sand filter by 55% to increase P removal is silly. Consider the following. A normal sand filter treats 90% of the water. Assume that it removes 50% of the P, or a total of 45%. If you increase the filter by 55%, you now (according to hydrologic modeling) treat 95% of the water, which means you now have removed 47.5% of the P. We are going to significantly increase the cost just to get 2.5% of the P. Makes no sense.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   The Caltrans study includes dissolved metals data. The data is now available to support a percentage goal for dissolved metals.

Bruce Wulkan, Puget Sound Action Team

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   I served on the Volume I advisory committee and helped develop policy on the minimum requirements, thresholds, redevelopment policy, etc. I believe that Ecology did in fact search out and use available and applicable scientific literature in developing the manual. If I were to suggest any additional information, it would concern the use of low impact development techniques, and would urge Ecology to incorporate such techniques into the manual, specifically retention of native vegetation, limiting of impervious surfaces, and specific BMPs, such as bioretention, permeable pavement, and green roofs.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   The practices outlined in the manual are reasonable and consistent with available and applicable scientific information. Again, if I were to urge Ecology to do more, it would be to better characterize and provide credits to certain low impact development techniques. The manual's runoff model offers a very modest and indiscriminate 15% credit for all permeable pavement - this is a very conservative credit. The model offers no credits for soil amendments, nor for green roofs, nor for bioretention.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   As outlined in the first two questions, I believe that scientific studies are warranted to develop performance designs and runoff credits for various low impact development BMPs, such as bioretention, green roofs, and soil amendments. Greater credit should be granted for permeable pavement. There should be greater discussion of the need to preserve native vegetation on site and to limit effective impervious surface area. We hope that some of this information will be gleaned from an upcoming monitoring project of a complete low impact development subdivision in Pierce County, Meadow on the Hylebos. WSU Cooperative Extension is leading the effort, with help from UW and others.

James C. Albrecht

1. *To what extent was the applicable literature used in development of the manual, with special attention to the development of the flow control standard, and the treatment standard? If you think other information is appropriate to use or has emerged since completion of the manual, please identify it and clarify why you think it should be included.*

   The Volume 1 References list is minimal in the extreme. Sorely lacking there as well as in the manual generally is any recognition of the need to maintain infiltration and ground water recharge that is critical to habitat and passage needs during inter-storm periods. Suggested additional sources, referenced by number below, are:

   1. Booth, Derek B. 1991. Urbanization and the Natural Drainage System - Impacts, Solutions, and Prognoses. Northwest Environmental Journal 7:93-118.
   2. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Team. USDAFS, USDIFWS, USDCNOAA, USDCNMFS, USDINPS, USDIBLM, USEPA, 1993.
   3. Florida Yards and Neighborhoods Handbook. A guide to environmentally friendly landscaping. University of Florida Bulletin 295.
   4. FUNDAMENTALS OF URBAN RUNOFF MANAGEMENT. August 1994. Richard R. Horner and others. Terrene Institute and EPA, Washington, D.C.
   5. PROTECTING WATER QUALITY IN URBAN AREAS. 1989. Minnesota Pollution Control Agency, Division of Water Quality.
   6. URBANIZATION AND WATER QUALITY. March 1994. Terrene Institute and EPA. Washington, D.C.

   The following is an amplification of the remarks I made during the first response period of the workshop:

   "Timing, magnitude, duration, and spatial distribution of peak and low flows must be sufficient to create and sustain riparian and aquatic system habitat and to retain patterns of sediment, nutrient, and wood routing."(p. V-19)

   "A second class of changes in hydrologic processes consists of those that control infiltration and the flow of surface and subsurface water. This class is dominated by the effects of forest roads. The relatively impermeable surfaces of roads cause surface runoff that bypasses longer, slower subsurface flow routes... The longevity of changes in hydrologic processes resulting from forest roads is as permanent as the road. Until a road is removed and natural drainage patterns are restored, the road will likely continue to affect the routing of water through watersheds." (p.V-20)

   As I stated then, the emphasis on peak storm flows to the total neglect of low and intermediate flows is a fatal flaw in the manual if there is to be hope of aquatic habitat protection and recovery. Inter-storm period flows are fed from the ground water reservoir, which in turn is recharged from infiltration. BMPs to preserve existing soil infiltration capacity and exploit it to preserve necessary groundwater recharge are not provided in the manual. Infiltration is suggested (not required) as a useful option for aiding in storm runoff reduction. It is not even suggested as a needed design and construction parameter.

   Forest Ecosystem Management (2) stresses the importance of instream flow regime for habitat:

"Timing, magnitude, duration, and spatial distribution of peak and low flows must be sufficient to create and sustain riparian and aquatic system habitat and to retain patterns of sediment, nutrient, and wood routing."(p. V-19)

Booth (1) noted:

" . . . the runoff conditions prior to development can be recovered only by providing a like amount of surface storage once the subsurface reservoirs are paved over." (pp.112-113)

Instead of providing surface storage the subsurface reservoirs must be accessed.

The 1998 (303d) list of water quality limited streams in Washington included 53 listed for low instream flows attributed to human causes. My own analysis comparing storm runoff from the upper Deschutes watershed (in Thurston and Lewis counties, logged over a period of 40 or more years), showed an increase of 4 inches per year in storm runoff from 1950-1959 to 1988-1997, a 20 percent increase and equal to water rights holdings in the local Water Resources Inventory Area.

Apart from habitat considerations, the loss of this water during winter surfeit, when a law to promote artificial recharge to save it has just been enacted, is ironic, to say the least. The MANUAL should incorporate preconstruction planning, construction, and permanent maintenance and retrofit BMPs to maintain and reestablish habitat and passage instream flows. The BMPs should be framed as a performance standard, specifying the risk of liability for nonperformance codified in RCW 90.03.500, " . . . increasing the surface water or storm water accumulation on or flow over real property, beyond that which naturally occurs on the real property, may cause severe damage to the real property and limit the gainful use or enjoyment of the real property, resulting in a tort, nuisance or taking." References 3 to 6, above, provide useful material.

2. *Are the practices outlined in the manual reasonable and consistent with the scientific information used to develop the manual? If not, what changes would you recommend and why?*

   Yes but much qualified by the above.

3. *What scientific studies would you recommend to address the most important gaps in knowledge associated with these issues?*

   How to get governments, developers, contractors and individuals to meet the need.

Table 1. Workshop Agenda and Attendee List

AGENDA

WASHINGTON INDEPENDENT SCIENCE PANEL
STORMWATER MANUAL REVIEW WORKSHOP

February 12, 2003

Radisson Hotel Seattle Airport
Seattle, Washington

8:00-9:00 Sign-in

9:00-9:10 Introduction (Ken Currens, Independent Science Panel Chair)

9:10-9:40 The science of stormwater: national and regional perspectives
(Tom Schueler, Center for Watershed Protection, Maryland)

9:40-10:00 Overview of the Stormwater Management Manual for Western Washington
(Ed O' Brien, Washington Department of Ecology)

10:00-10:15 BREAK

10:15-10:30 Review the three key questions and ground rules

10:30-3:45 Responses to key questions

- 10:30-11:00 Bill Derry (APWA Stormwater Committee)
- 11:00-11:30 Eric Strecker (GeoSyntec Consultants)
- 11:30-12:00 Kelly Whiting (King County)

12:00-12:30 BREAK - WORKING LUNCH

12:30-1:00 Attendee response to key questions

- 1:00-1:30 Tom Holz (SCA Engineering)
- 1:30-2:00 Ken Stone (Washington Department of Transportation)
- 2:00-2:30 Doug Beyerlein (Aqua Terra Consultants)
- 2:30-3:00 Sue Joerger (Puget Soundkeeper Alliance)

3:00-3:15 BREAK

3:15-3:45 Attendee response to key questions

3:45-4:00 Summary and next steps

4:00 ADJOURN

ISP Members in Attendance: Dr. Kenneth Currens, Chair; Dr. Dudley Reiser, Vice Chair; Dr. John McIntyre; Dr. Walter Megahan (Dr. Hiram Li was not in attendance)

ISP Adjunct Advisory Panel Members in Attendance: Dr. Wayne Huber, College of Engineering, Oregon State University; Dr. Rhett Jackson, Warner School of Forest Resources, University of Georgia; Dr. Lee MacDonald, Department of Earth Resources/College of Natural Resources, Colorado State University; Dr. Robert Pitt, Cudworth Professor of Urban Water Systems and Director of Environmental Engineering, The University of Alabama; Mr. Tom Schueler, Center for Watershed Protection, Endicott City, MD

ISP Staff in Attendance: Mr. Steve Leider, ISP Liaison, Governor's Salmon Recovery Office

Participants: Jim Albrecht; Riley Atkins, David Evans and Associates; Douglas Beyerlein, Aqua Terra Consultants; Mark Blosser, City of Olympia, Storm and Surface Water Utility; Paul Bucich, Federal Way Public Works Department; John Burk, City of Tacoma; Naomi Chechowitz, WSDOT; Tom Cleverdon, Fakkems and Kingma, Inc.; Curt Crawford, King County Stormwater Services; Erik Davido, Davido Consulting Group, Inc.; Bill Derry, CH2M Hill, APWA; Tom C. Dickson, Consultant; Richard Dinicola, US Geological Survey; Bob Duffner, Port of Seattle; Steve Foley, King County WLRD; Robert Fuerstenberg, King County DNRP; Thomas Holz, SCA Engineering; Thom Hooper, NOAA Fisheries; Rick Johnson, Department of Transportation; Charles Keller, Boeing; Michael Kent, Ministry of Transportation and Highways; Brent Kirk, City of Longview; DeeAnn Kirkpatrick, NOAA Fisheries; Bill Leif, Snohomish County Surface Water Management, Water Quality Services; Linda Logan, Parametrix, Inc.; Gino Lucchetti, King County Department of Natural Resources; Kenneth Ludwa, Parametrix, Inc.; Nancy Malmgren; Lorna Mauren, City of Tacoma; Krista Medelman, US EPA; Gary Minton, Resource Planning Associates; Bill Moore, Department of Ecology; Jim Muck, US Fish and Wildlife Service; Phil Noppe, City of Kent Public Works; Mel Oleson, Boeing; Dale Rancour, Thurston County Roads and Transportation Service; Kate Rhoads, King County; Joel Rupley, Clark County; Larry Schaffner, Department of Transportation; Dan Schultz, Kennedy/Jenks Consultants; Ken Stone, WSDOT; Christy Strand, City of Tacoma; Eric Strecker, GeoSyntec Consultants Inc.; Kelly Whiting, King County DNRP; Jane Zimmerman, City of Everett; Llyn Doremus, Nooksack Indian Tribe; Bruce Wulkan, Puget Sound Action Team; Bill Rozeboom, NW Hydraulic Consultants.