

Evaluation Monitoring for Stormwater Runoff Water Quality Impact Assessment and Management

G. Fred Lee, PhD, PE, DEE Anne Jones-Lee, PhD
G. Fred Lee & Associates,
El Macero, CA

Problems with Conventional Stormwater Runoff Water Quality Monitoring in Defining Pollution and Pollutants

Need for, and Characteristics of, Evaluation Monitoring

Upper Newport Bay Tributary Toxicity Studies

Presented at Society of Environmental Toxicology & Chemistry 18th Annual Meeting, San Francisco, CA, November (1997)



Orange County Area Highway Stormwater Runoff Chemical Characteristics Caltrans District 8 & 12 (1994)

Parameter	Detection Units	Chapman Ave (I-5, PM34.7)	Walnut Ave (SR-55, PM14.2)
Total Suspended Solids	mg/l	85	100
Total Dissolved Solids	mg/l	12	12
Chemical Oxygen Demand	mg/l	42	24
Oil and Grease	mg/l	5.3	2.5
Fecal Coliform	ml	< 2/100	50/100
pH	unit	7.0	9.1
Total Residual Chlorine	mg/l	0.45	< 0.20
Nitrate	mg/l	0.43	0.37
Nitrite	mg/l	0.051	0.042
Ammonia	mg/l	1.3	0.9
Total Kjeldahl Nitrogen	mg/l	0.89	1.4
Total Phosphorus	µg/l	120	130

Dissolved Phosphorus	µg/	130	120
Sodium	µg/	3000	1600
Cadmium	µg/	< 5	8
Copper	µg/	24	22
Lead	µg/	48	160
Chromium	µg/	< 10	< 10
Zinc	µg/	180	140
Iron	µg/	3400	3400
Nickel	µg/	< 32	< 32
Magnesium	µg/	1300	1300

Conventional Water Quality Monitoring - Management Approach "Compliance Monitoring"

- Monitor Concentrations of Selected Regulated Chemicals in Runoff Water
- Compare Monitoring Results to Accepted Discharge Limits and Ambient Water Quality Standards
- If "Excessive" Concentrations (Loads) Found in Discharge, Reduce Discharge of Chemical Constituents to Achieve Regulatory Compliance with Water Quality Standards

Focus of Conventional Approach Is Control of Chemicals in Discharge to Achieve Allowed Concentrations (Loads)

Conventional Chemical Approach Not Technically Valid for Stormwater Runoff - Leads to Over-Regulation and Waste of Funds and/or Under-Regulation of Unregulated Constituents

Purpose of Monitoring

Compliance Monitoring to Meet Discharge Conditions

Water Quality Problem Definition

Water Quality/Use-Impairment

Not a List of Chemical Concentrations Relative to Water Quality Standards

Must Focus Monitoring Resources on Chemical **Impacts**, Not Chemical Concentrations

Evaluation of the Impact of Potentially Toxic Chemicals

Given 20 µg/L of Cu in Discharge/Runoff with the Water Quality Standard of 15 µg/L:

What Can Be Said about the Water Quality/Use-Impairment of the Receiving Waters Due to the Cu in the Discharge/Runoff?

Nothing

Need Site-Specific Evaluations of Possible Cu Impacts on Water Quality

Same Type of Problem Exists with Respect to Evaluating the Water Quality Significance of a Cu Exceedance of a Water Quality Standard in Ambient Waters

What Can Be Said about the Water Quality Impacts of Cu in a Waterbody at 20 µg/L When the Standard Is 15 µg/L?

Potential Water Quality Impact Due to Cu Toxicity

Impact Cannot Be Assessed Based on Chemical Measurements

Must Use Biological Effects-Based Approaches i.e., Toxicity Measurements to Determine if the Cu Is Toxic

Evaluation of the Impact of Potentially Bioaccumulatable Chemicals

Given Hg at 30 ng/L in a Waterbody with a Hg Bioaccumulation-Based Standard of 12 ng/L:

What Can Be Said about the Amount of Bioaccumulation of Hg in Fish?

All That Can Be Said Is That Hg at 30 ng/L Could Bioaccumulate to Excessive Concentrations in Fish

Many Examples Where the Predicted Bioaccumulation Does Not Occur

Need Site-Specific Fish Tissue Analysis to Determine if Excessive Hg Bioaccumulation Is Occurring

US EPA Water Pollution Control Program for Toxicity and Bioaccumulation

Focused on Chemical Concentrations

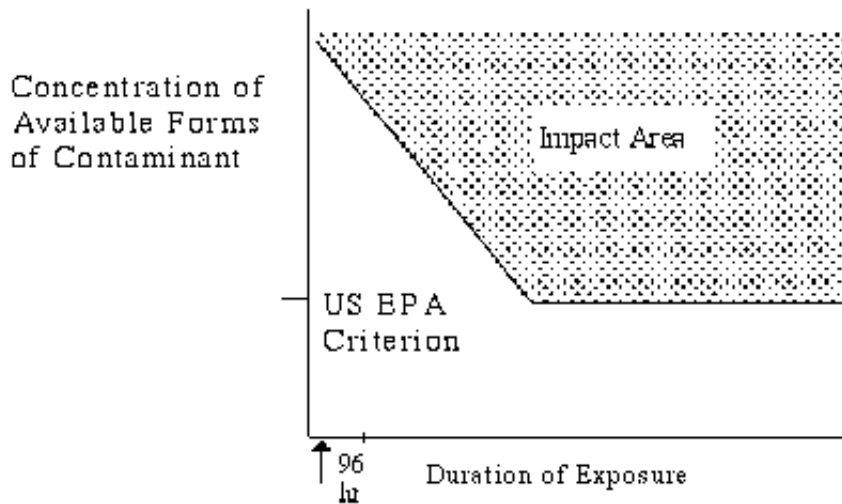
Water Pollution Control Program Should Be Focused on Chemical **Impacts**, Not Chemicals

Current Approach Bureaucratically Simple to Administer, but Often Technically Invalid

Tends to Over-Regulate Those Constituents for Which There Are Water Quality Criteria/Standards

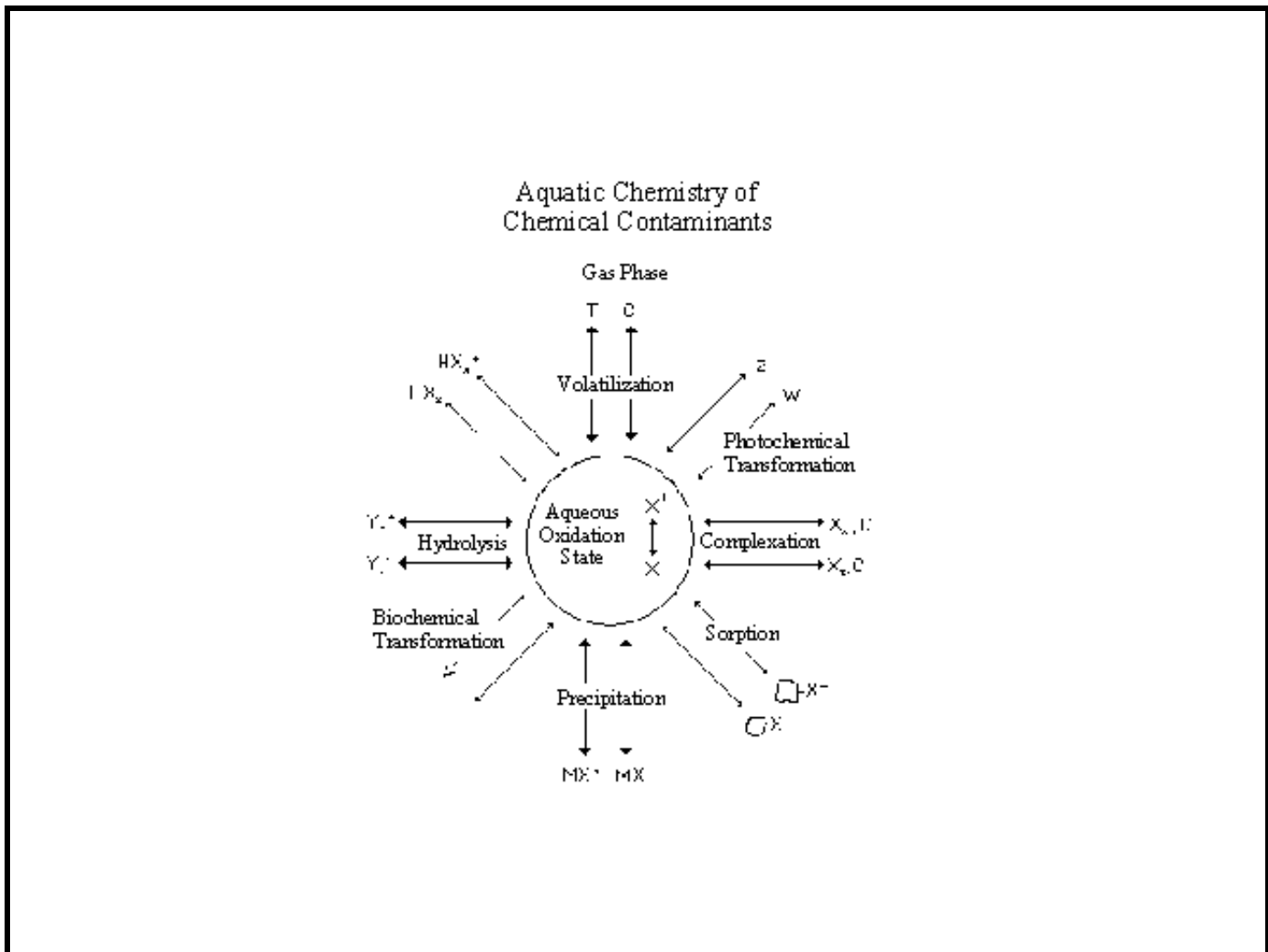
Does Not Address the Vast Arena of Unregulated or Under-Regulated Chemicals Such as the Organophosphate Pesticides

Aquatic Toxicology



US EPA Criteria List 1-hr-Average Maxima and 4-day-Average Maxima

Not Valid for Assessing Potential Impacts of Urban Stormwater Drainage



**Factors That Must Be Evaluated
in Translating Stormwater Runoff Concentrations
of Potentially Toxic Chemicals
to Receiving Water Aquatic Life Impacts**

Runoff Waters

Concentration/Duration Profile of Potential Pollutants during Runoff Event

Analytical Chemistry of the Measurement Procedures Used

Forms of the Chemical Constituent That Are Measured in the Chemical Test Relative to the Forms That Are Adverse to Aquatic Life

Hydrologic Characteristics of the Runoff Event

Receiving Waters

Physical Factors

Currents, Tides, Mixing/Dispersion, Density Differences between Runoff and Ambient Waters

Transport/Advection

Temperature, Sunlight Penetration, etc.

Chemical Factors

Ambient Water Concentration of Toxic/Available Forms of Constituent

Aquatic Chemistry

Chemical Kinetics and Thermodynamics of Possible Chemical Transformations/Reactions

Other Chemicals in Receiving Waters

Biological Factors

Types of Organisms Present and Their Sensitivity to the Chemical of Concern

Locomotion, Diel Migration, Attraction/Avoidance to the Discharge

Concentration of Chemical/Duration of Exposure Relationship in the Ambient Waters for Potentially Impacted Organisms Relative to the Critical Concentration/Exposure Relationship for the Organisms Exposed

Importance of the Impacted Organisms to Water Quality and the Ecosystem/Ecosystem Health



Conclusions

Conventional Water Quality Monitoring Provides Limited Information on Water Quality Impacts of Stormwater Runoff-Associated Chemical Constituents

Should Shift Monitoring Resources from End-of-the-Pipe / End-of-the-Pavement, Periodic Monitoring of a Suite of Chemicals to Evaluation of Receiving-Water Chemical Impact

Focus on Event-Based Monitoring Such as during Runoff Events

Far More Reliable and Cost-Effective for Defining Pollution and Pollutants

Evaluation Monitoring Provides a Technically Valid Basis for Cost-Effective Pollution Control

Evaluation Monitoring Is a Readily Implementable Approach That Can:

Define the Real Water Quality/Use-Impairments in Receiving Waters for Stormwater Runoff

Determine the Water Quality Significance of the Use-Impairments

Determine the Source of the Constituents Responsible for the Use-Impairments

Provide a Technically Valid Basis for Formulating Cost-Effective Pollution Control Programs



Reference as: "Lee, G.F. and Jones-Lee, A., 'Evaluation Monitoring for Stormwater Runoff Water Quality Impact Assessment and Management,' Presented at Society of Environmental Toxicology & Chemistry 18th Annual Meeting, San Francisco, CA, November (1997)."

