Truslow
RESOURCE CONSULTING

FB
environmental

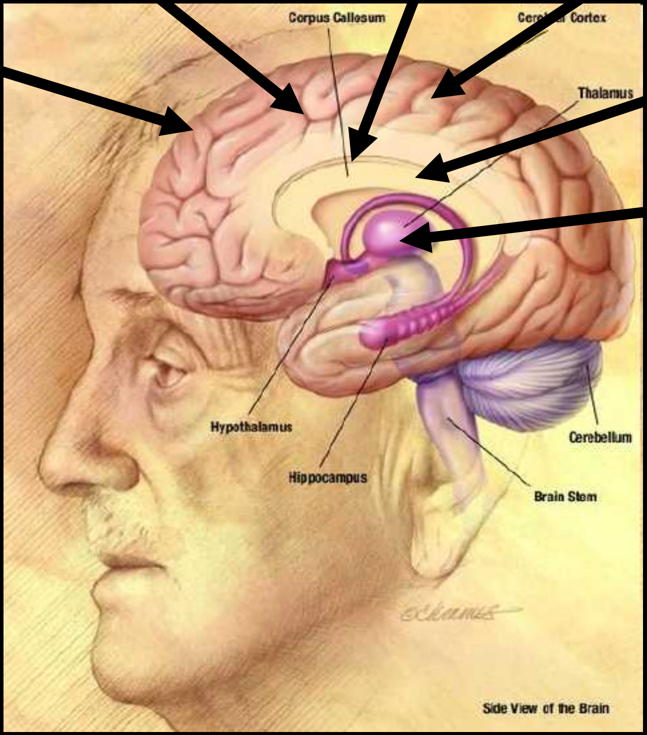
Life's a Ditch
Stormwater Utility Monitoring

2010 Monitoring for the Long Creek Watershed Management District

Overview of Long Creek Watershed Management District

- Precedent-setting stormwater permit program founded on EPA's Residual Designation Authority
- General vs. Individual Permit
- District is quasi-municipal
- Managed by Cumberland Co. Soil & Water Conservation Dist.

FBE Role is Monitoring



Storm Samples

Chloride Concentrations

Stage and Discharge

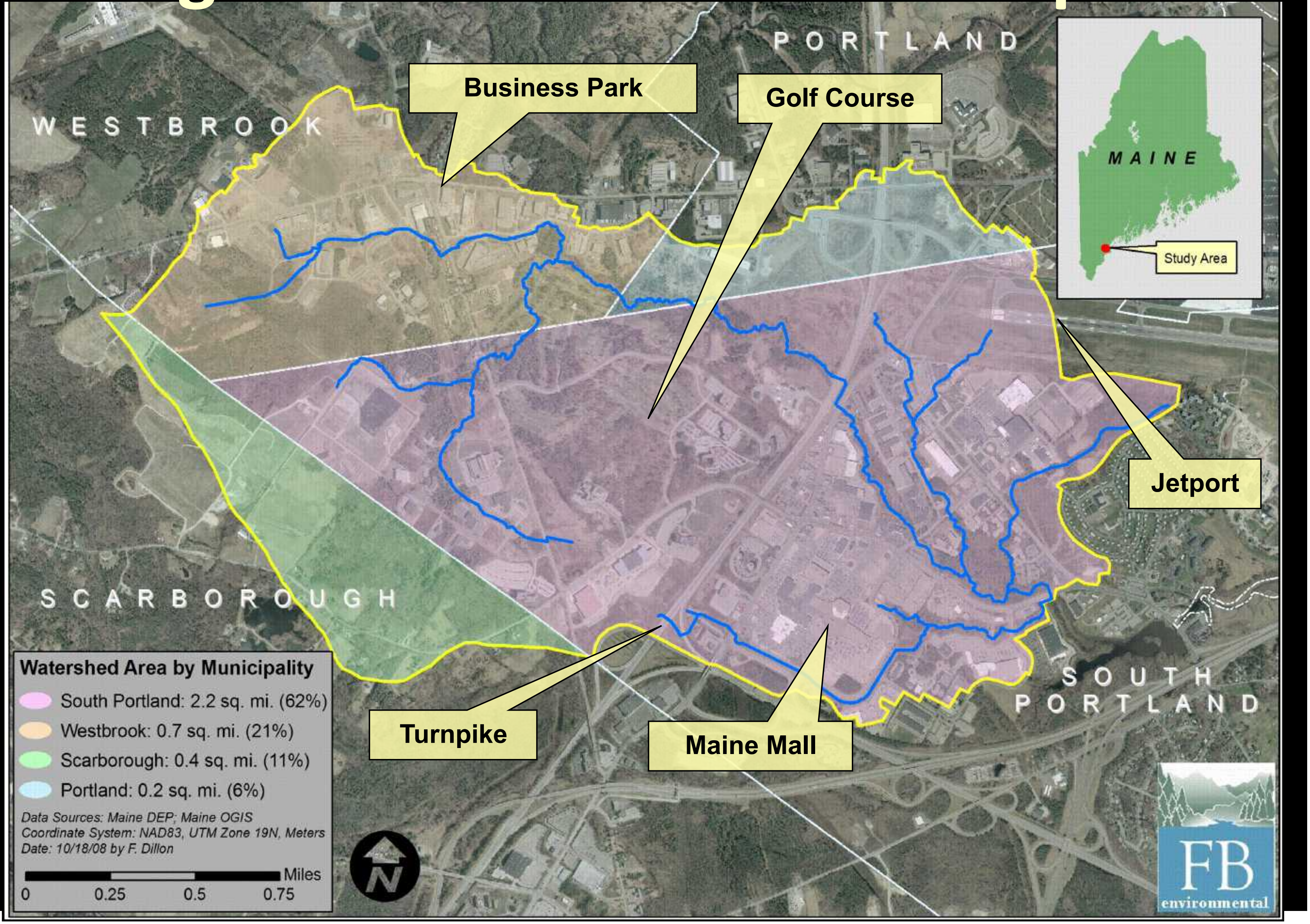
Dissolved Oxygen

State Water Quality Criteria

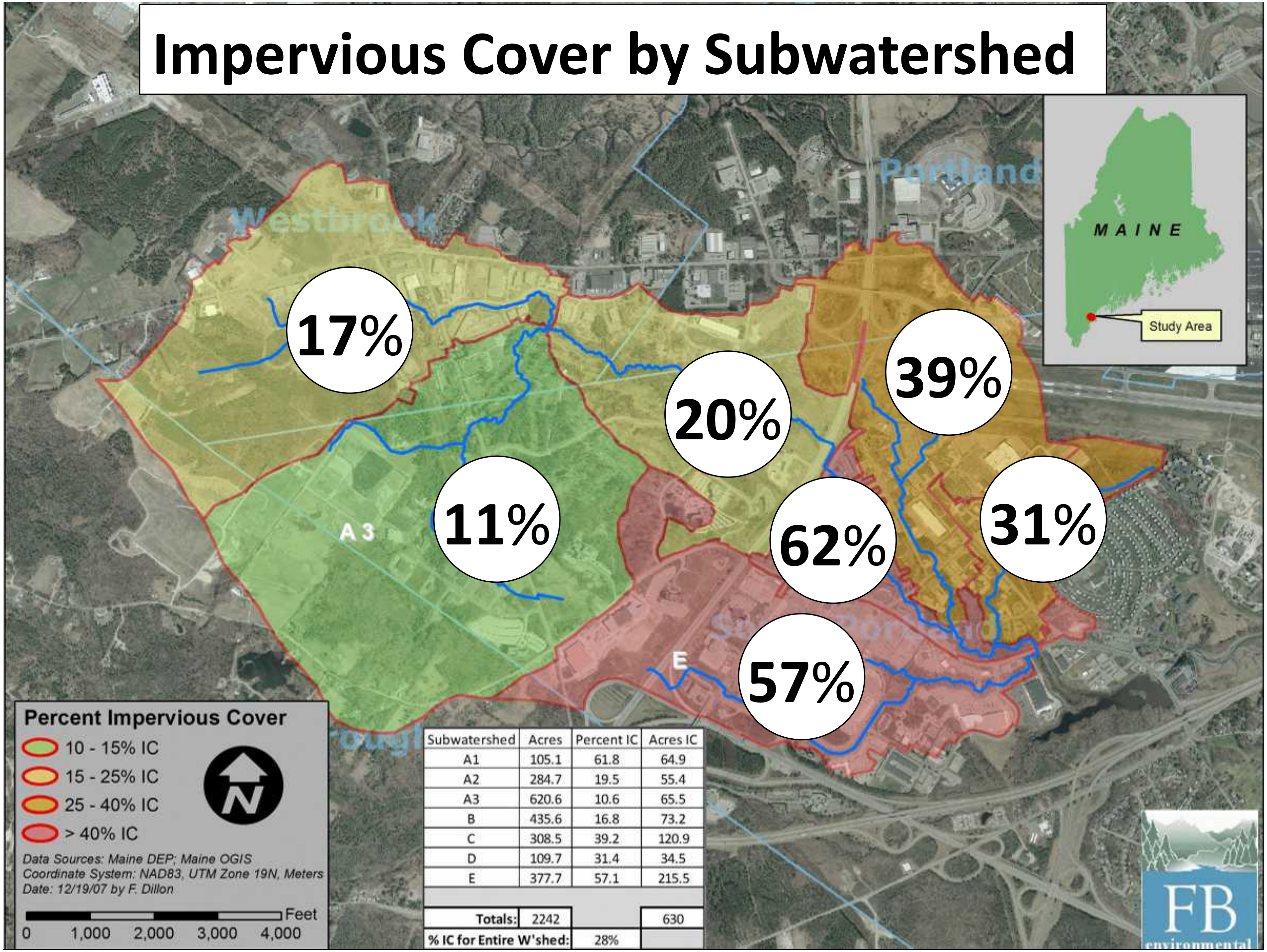
BMP Capital Investment

Long Creek Stakeholder

Long Creek Watershed ~3.5 sq. mi.



Impervious Cover by Subwatershed



Percent Impervious Cover

- 🟩 10 - 15% IC
- 🟨 15 - 25% IC
- 🟧 25 - 40% IC
- 🟥 > 40% IC

Data Sources: Maine DEP; Maine OGIS
Coordinate System: NAD83, UTM Zone 19N, Meters
Date: 12/19/07 by F. Dillon

Subwatershed	Acres	Percent IC	Acres IC
A1	105.1	61.8	64.9
A2	284.7	19.5	55.4
A3	620.6	10.6	65.5
B	435.6	16.8	73.2
C	308.5	39.2	120.9
D	109.7	31.4	34.5
E	377.7	57.1	215.5
Totals:	2242		630
% IC for Entire W'shed:		28%	

Upstream Aerial Photo

Image courtesy of USGS © 2010 DigitalGl
Pictometry Bird's Eye © 2
Pictometry Bird's Eye © 2

Downstream Aerial Photo

Image courtesy of USGS © 2010 DigitalGlobe © 2011 Microsoft Co

Pictometry Bird's Eye © 2010 MDA Geospatial Ser

Pictometry Bird's Eye © 2010 Pictometry Internatio


LC2 (downstream)


LC4 (tributary)

LC5 (mid-watershed)


LC6 (upstream)

Monitoring Plan Components

- **Dissolved Oxygen**
- **Nutrients** – TP and OP
- **Toxics** – Metals, Hydrocarbons, Chloride
- **Hydrology**
  - **Stage** (continuous)
  - **Discharge**
  - **Stage-Discharge curve**
- **Weather**

Monitoring Plan Components

- Other components will happen later:
    - Biomonitoring
    - Fish Sampling
    - Hydrological Modeling

How much did it co$t?

Annual fee $3000 per impervious acre per year

Initial Breakdown

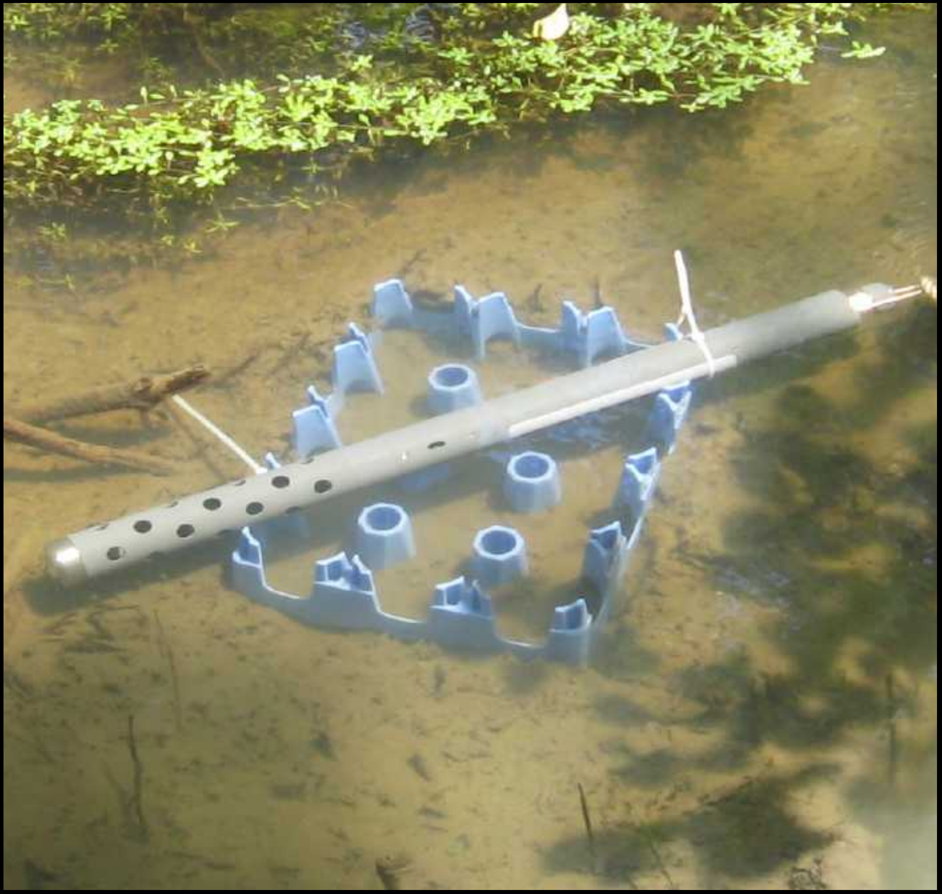
- **$1200 – Construction & Maintenance**
- **$900 – Pollution Prevention & Good Housekeeping**
- **$720 – Administration**
- **$180 – Monitoring**

About 6% of fee to monitoring in 1st year,

…or about $142,000.

Continuous Water Quality

- **YSI 600-OMS Data Sondes**
  - ○ **Optical Dissolved Oxygen Probe**
  - ○ **Onboard Temp / Conductivity**



Grab Samples

- **4 Base Flow**
- **4 Storm Rising Stage** – timed manually
- **Nutrients, Metals, Salt, Hydrocarbons**
  - **Phosphorus** & **Orthophosphorus**
  - **Chloride**
  - **Metals** – Ca Cu Ni Pb Zn
  - **PAH** – *EPA 8270C method*

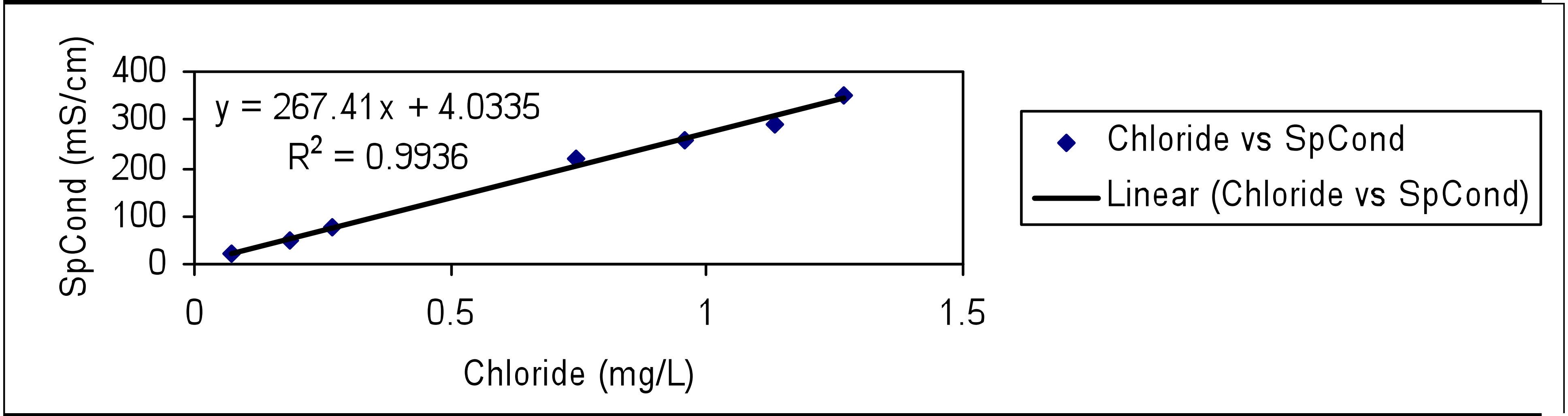
Water Quality Results

- **Nickel & Copper below CMC & CCC in ME Ch. 584**
- **Lead often above CCC in ME Ch. 584**
- **PAH's were not detectable (?!)**
- **Low dissolved oxygen, esp. upper watershed**
- **TP often high** (>0.1 mg/L)
- **And the big one…**


MOR
SALT

Chloride and Specific Conductivity

- **Chloride grab samples taken 8 times,**
- **Specific conductivity** – sondes (n=17,000)



Results: Cl Criteria

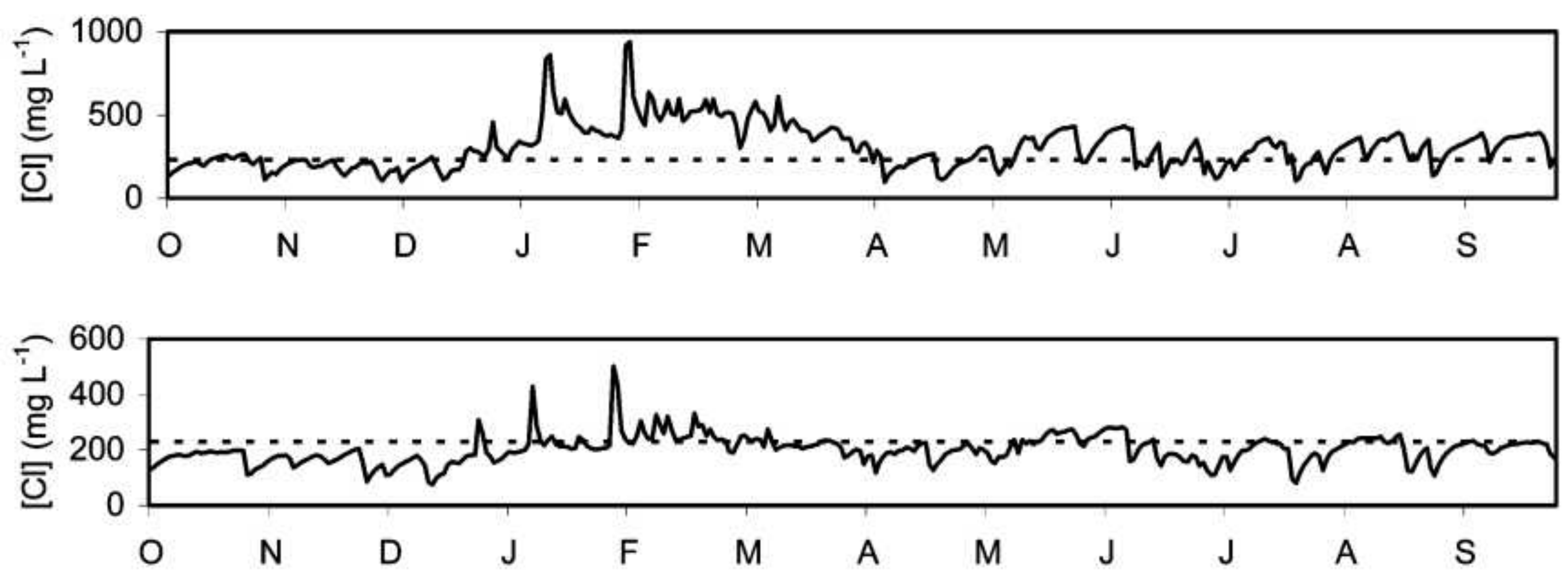
"The USEPA-recommended chronic criterion for aquatic life is a

4-day average chloride concentration of 230 mg/L with an occurrence interval of once every 3 years,

and the recommended acute criterion concentration for chloride is 860 mg/L (U.S. Environmental Protection Agency, 1988). The acute criterion relates to a 1-hour average concentration with a recurrence interval of less than once every 3 years. Other concerns regarding salt inputs include the effects of cation- exchange reactions on the quality of water (Granato and others, 1995)."

Chloride in Groundwater and Surface Water in Areas Underlain by the Glacial Aquifer System, Northern United States
http://pubs.usgs.gov/sir/2009/5086/

Cl in NH Seacoast Streams



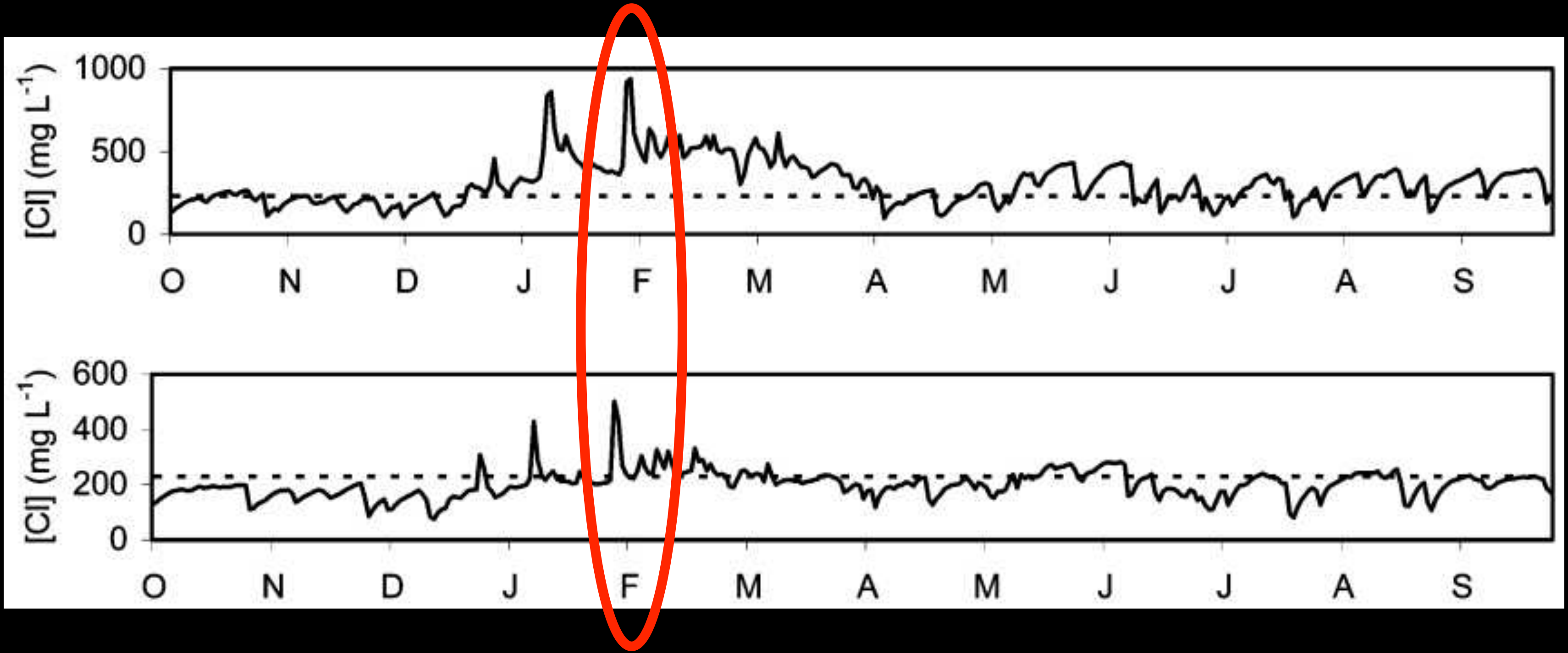
Hodgson Brook, Portsmouth, NH (upper graph) 2008-2009

Cain's Brook, Seabrook, NH (lower graph) 2008-2009

From Trowbridge *et al.*, 2010

February peak

Cl in NH Impaired Streams



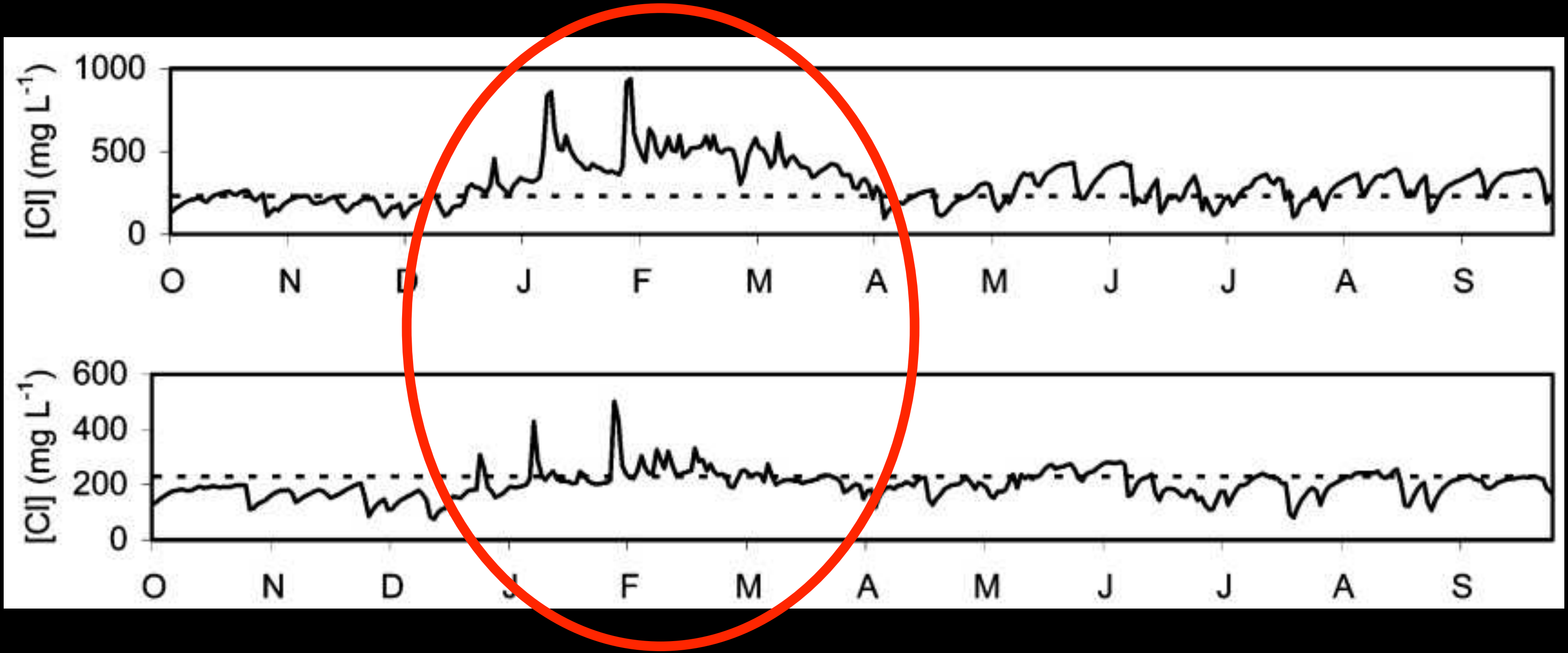
Hodgson Brook, Portsmouth, NH (upper graph) 2008-2009

Cain's Brook, Seabrook, NH (lower graph) 2008-2009

From Trowbridge et al., 2010

Winter bulge

Cl in NH Impaired Streams



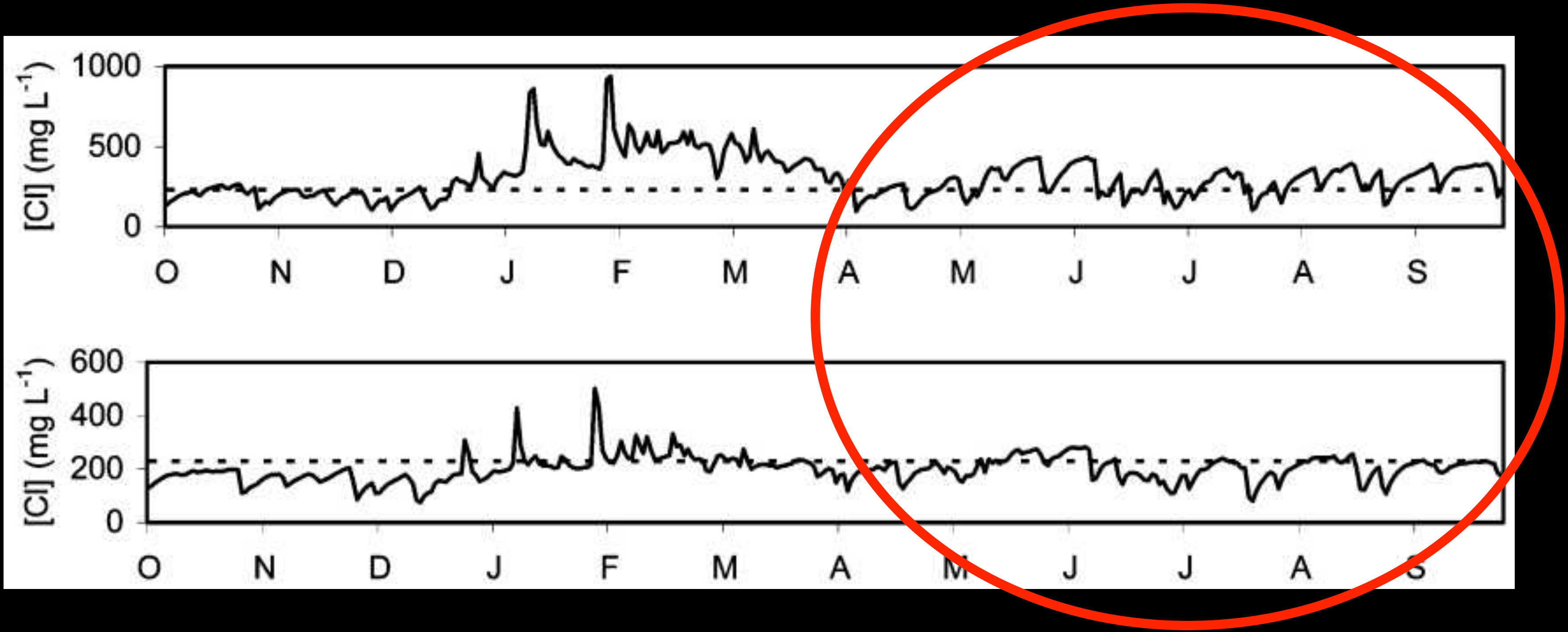
Hodgson Brook, Portsmouth, NH (upper graph) 2008-2009

Cain's Brook, Seabrook, NH (lower graph) 2008-2009

From Trowbridge et al., 2010

Spring & Summer exceedances

Cl in NH Impaired Streams

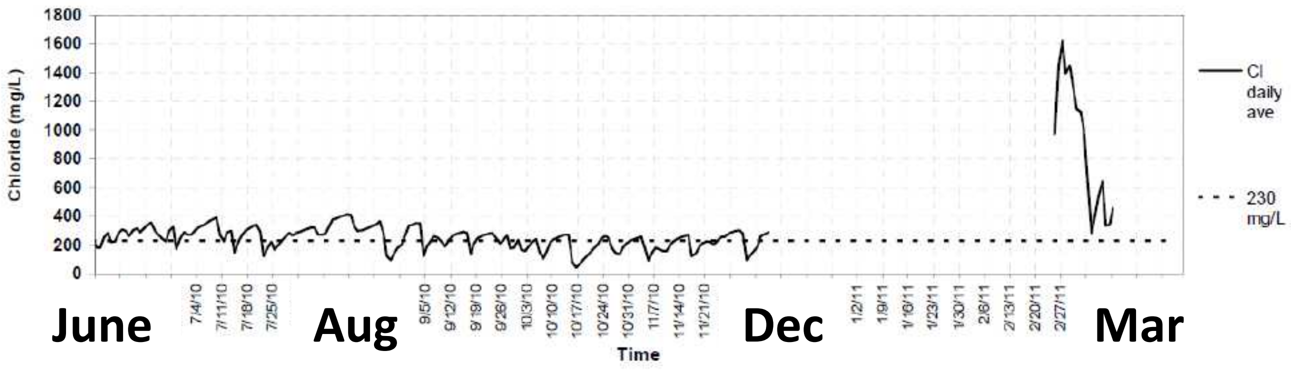


Hodgson Brook, Portsmouth, NH (upper graph) 2008-2009

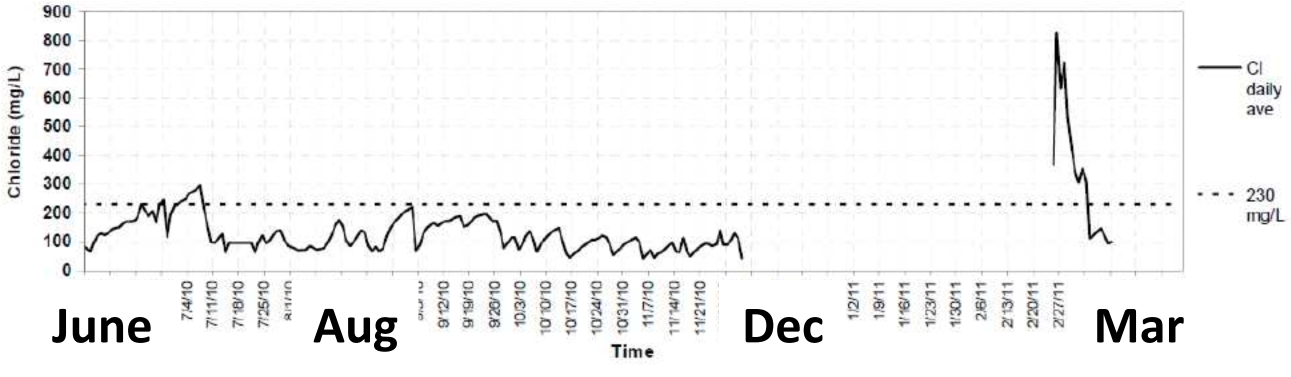
Cain's Brook, Seabrook, NH (lower graph) 2008-2009

From Trowbridge et al., 2010

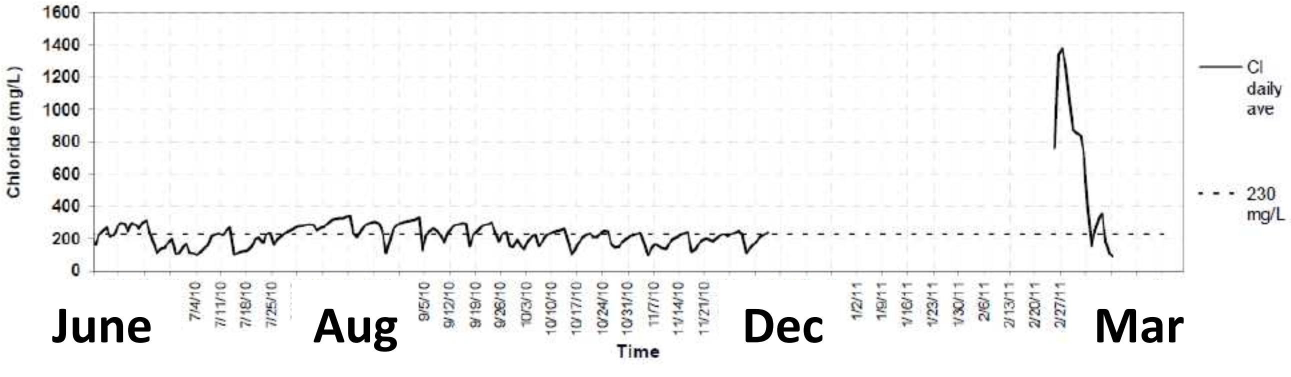
Long Creek Site 1: Chloride (daily average)



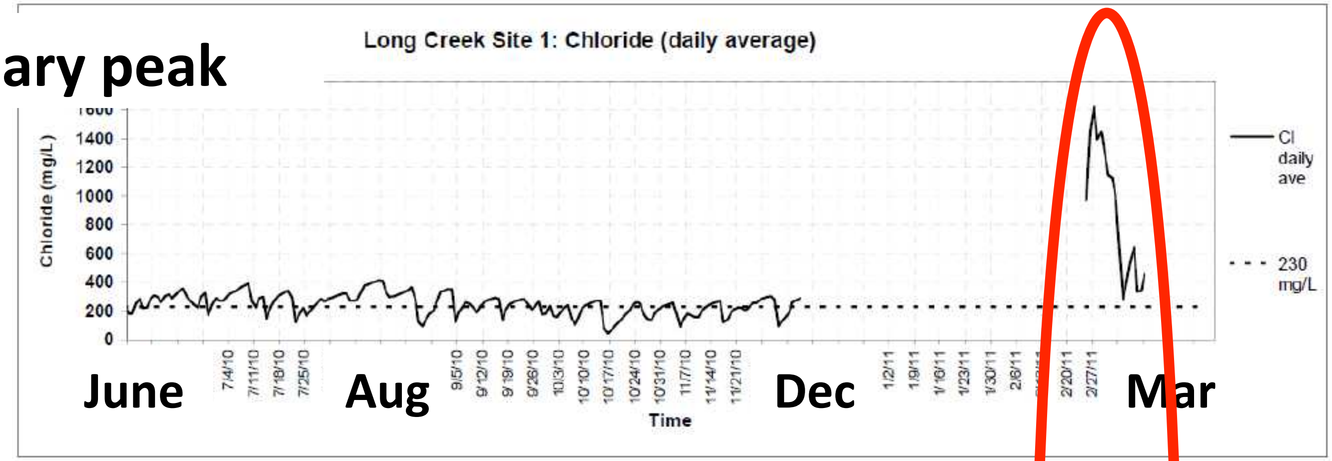
Long Creek Site 2: Chloride (daily average)



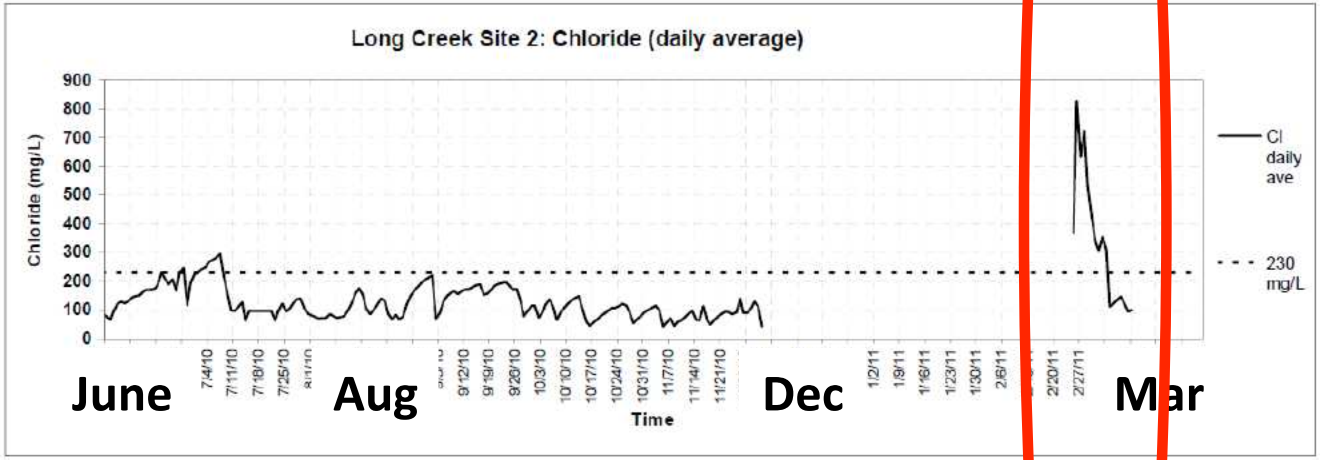
Long Creek Site 3: Chloride (daily average)



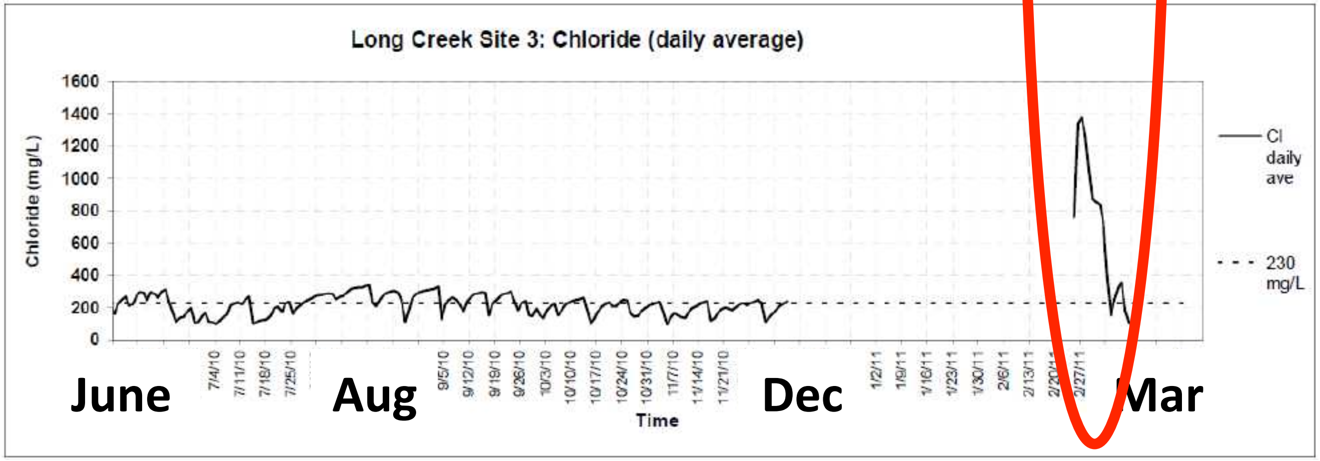
February peak



Long Creek Site 1: Chloride (daily average)

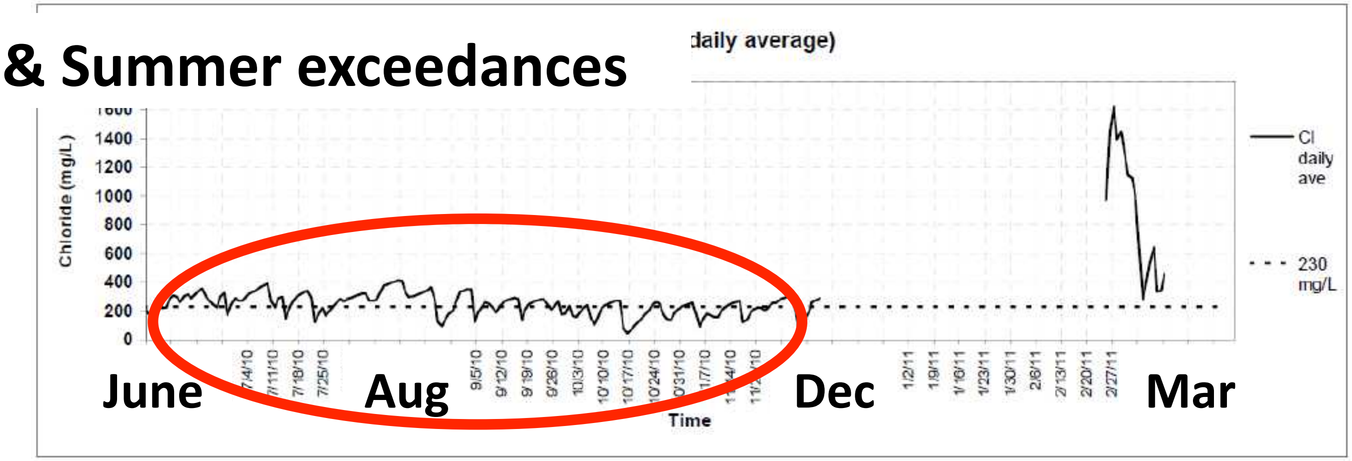


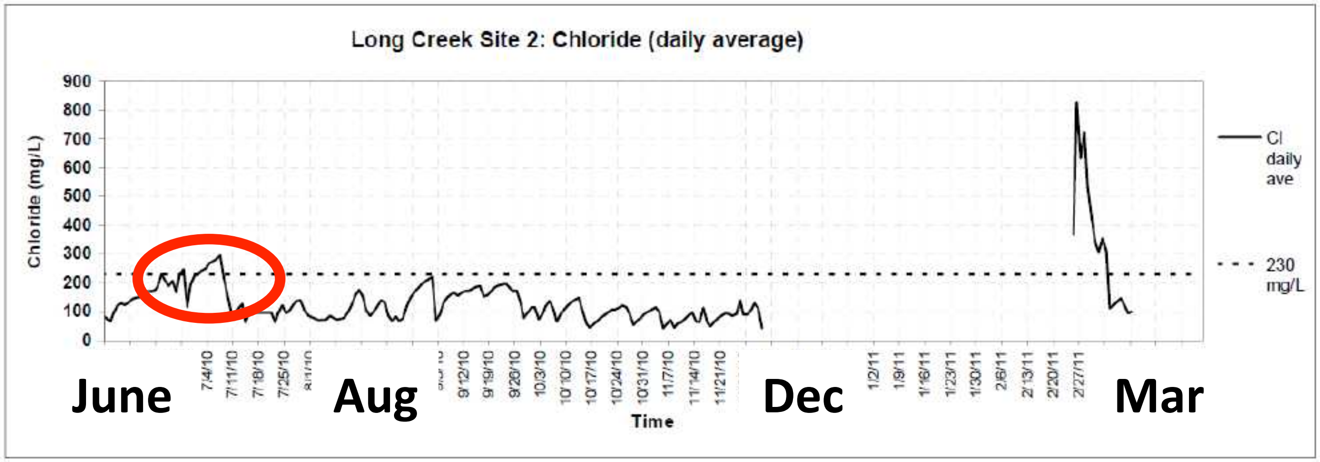
Long Creek Site 2: Chloride (daily average)

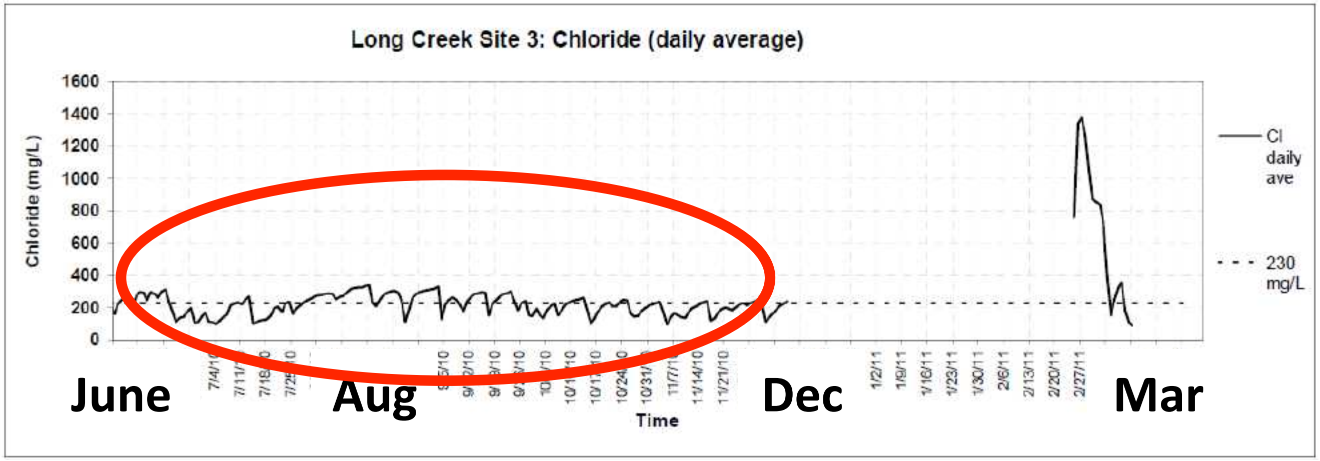


Long Creek Site 3: Chloride (daily average)

Spring & Summer exceedances







Solutions?

Pervious pavement,
which needs 75% less salt?

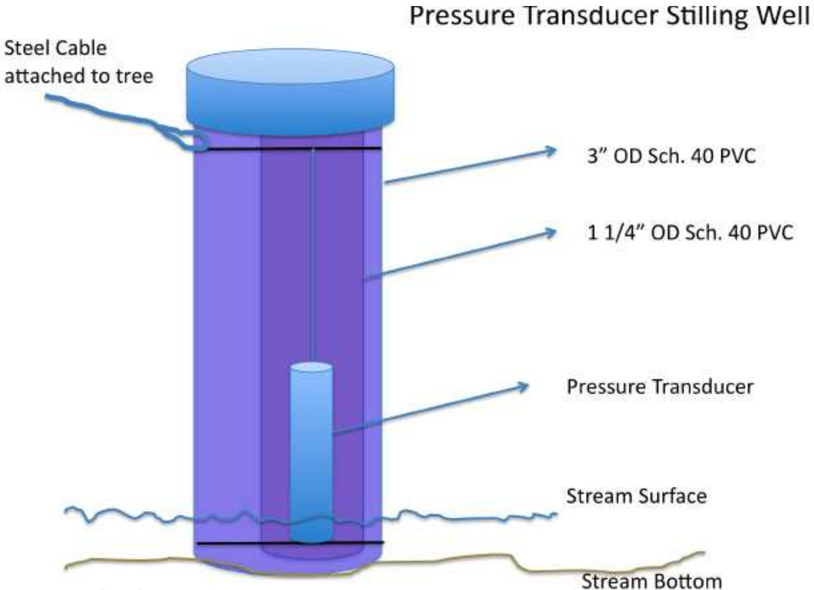
Results: Lessons Learned

- Chloride – Sp. Conductivity strongly correlated
- Manually timing storm samples successful
- We found impairments: Cl, Pb, DO
- TP/OP high (no impairment criteria yet)
- Hydrology…take it away Danna

Hydrologic Monitoring – Stage

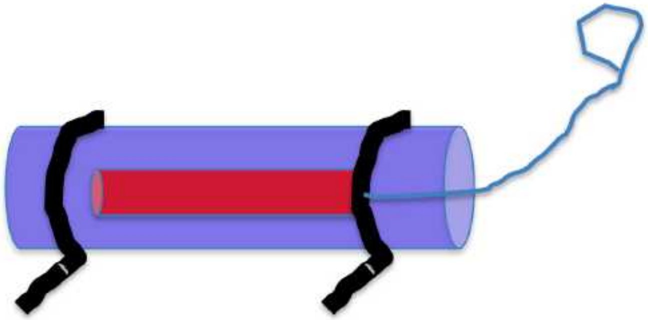
- **Pressure transducers** in stilling wells.
  (Hobo 13’ model)
- **15 minute** frequency
- Barometric pressure correction

Stream level and temperature measurement



LC1,2,3,5,6

Cable tie-off to ??



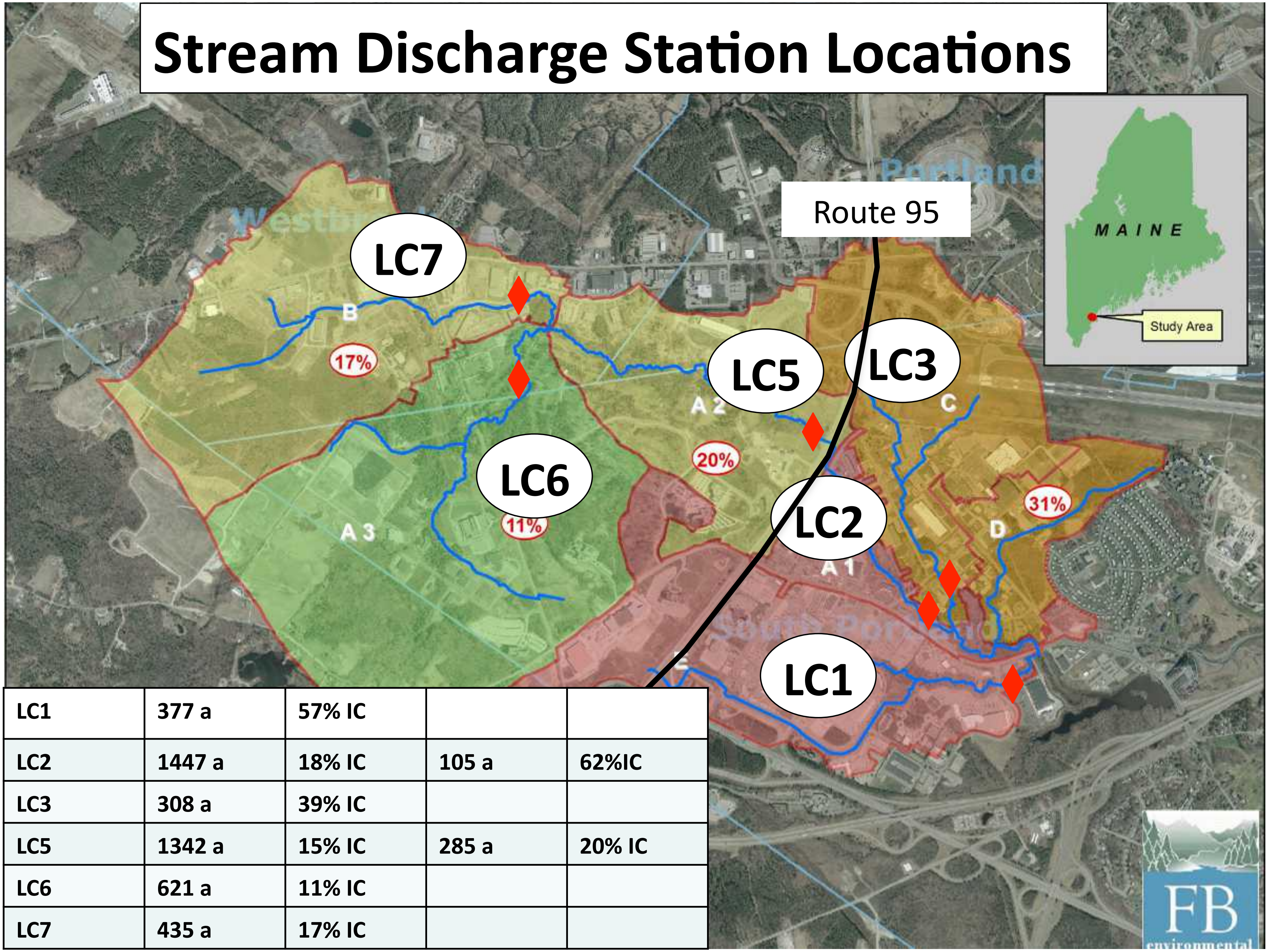
LC7

Brackets fastened to concrete

Hydrologic Monitoring – Discharge

- **Discharge** – measurements at 5 to 6 different stages. High flows most challenging.
- Stage-discharge relationship developed

Stream Discharge Station Locations



LC1	377 a	57% IC		
LC2	1447 a	18% IC	105 a	62%IC
LC3	308 a	39% IC		
LC5	1342 a	15% IC	285 a	20% IC
LC6	621 a	11% IC		
LC7	435 a	17% IC		

LC7 (spring 2010)

LC7 (Oct 15 2010)

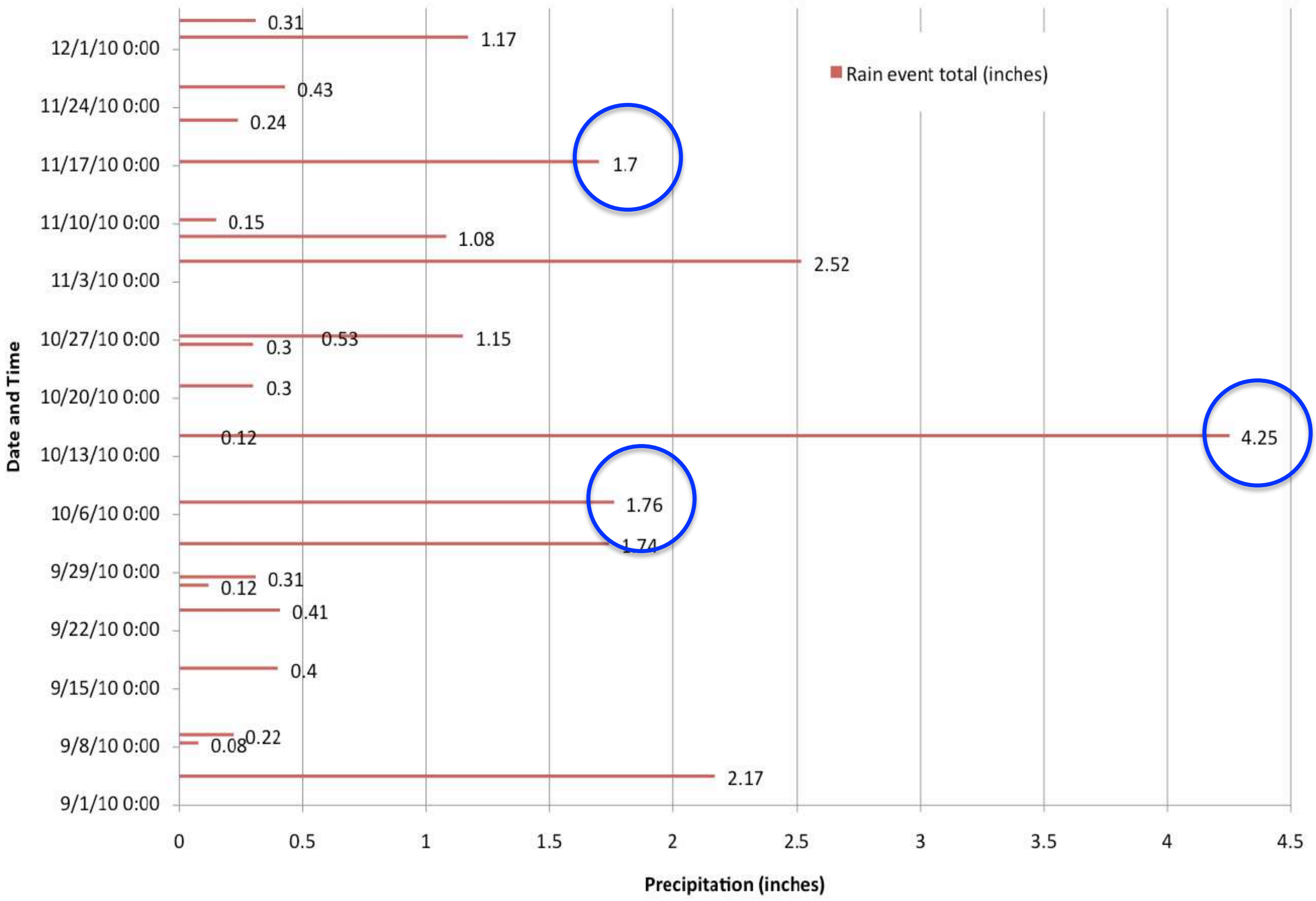

LC3 (Mar 14 2011)

LC3 (Oct 15 2010)

Response of Long Creek and tributaries to rainfall?

	Impervious Cover/ Land Cover	Rainfall Intensity/ Storm Total	Stream morphology/ Storm water infrastructure
Stream Discharge	X	X	X
Specific Conductance	X	X	?
Stream Temperature	X	X	?

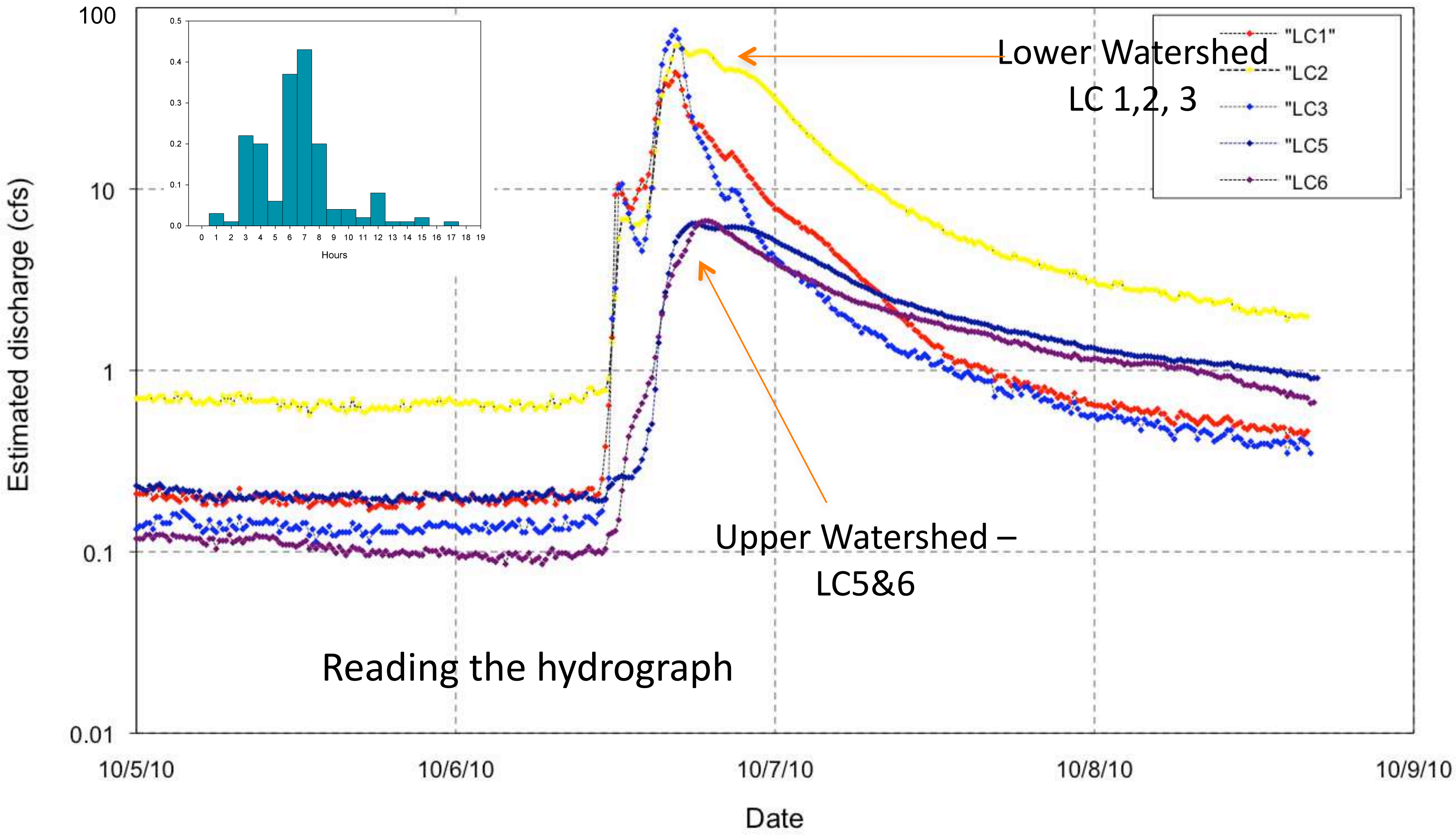
Three Fall 2010 Storms – Evaluating the Long Creek Response



Precipitation - Portland, ME Sept to Dec 2010

October 6&7, 2010 Storm Hydrograph

Storm date (s)	Total rainfall (inches)	Max intensity (in/hr)	Duration (hrs)	Estimated Peak Streamflow (cfs)
Oct 6 &7	**1.76**	**0.43**	**17**	**74 (LC3)**



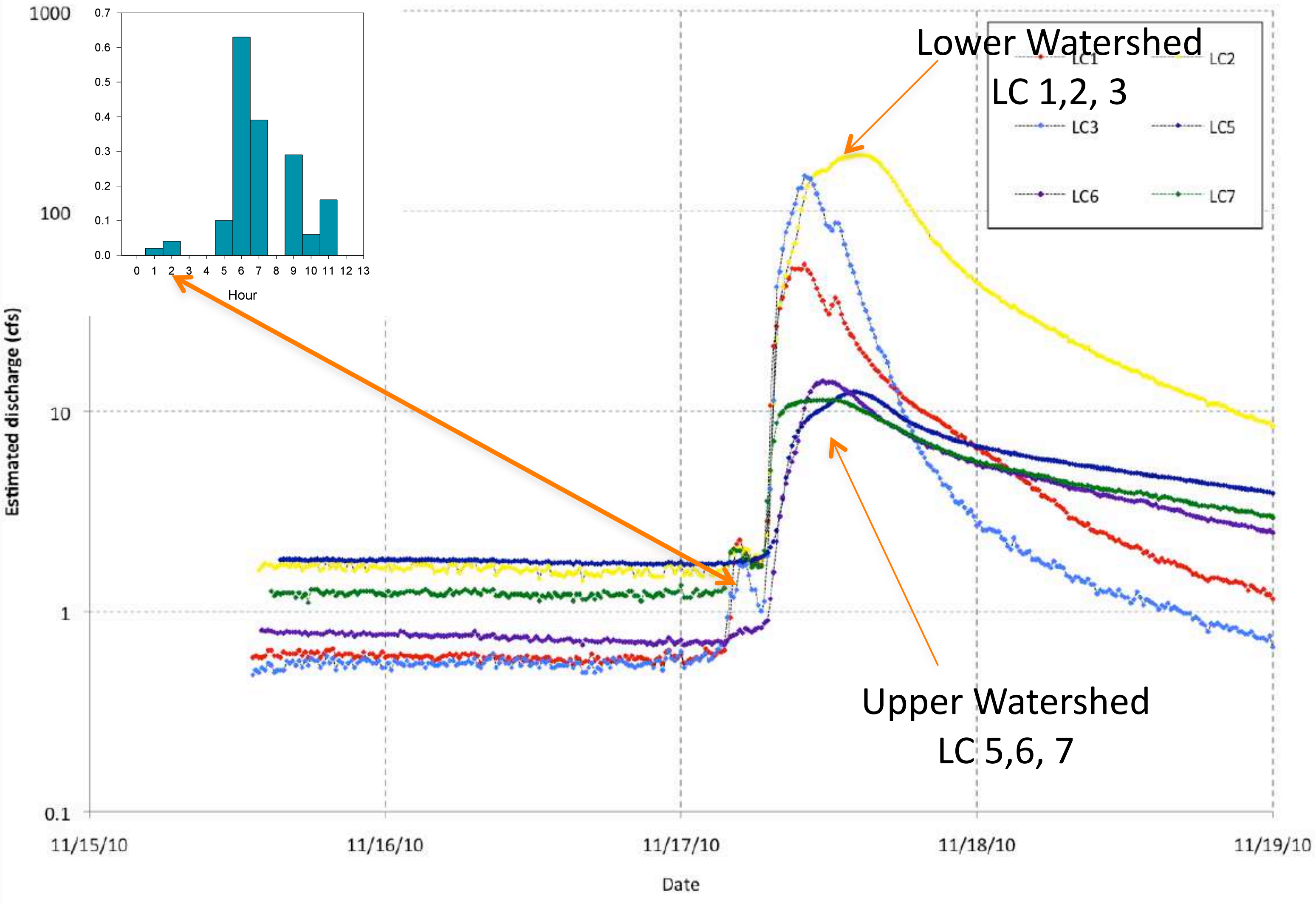
Lower Watershed
LC 1,2, 3

Upper Watershed –
LC5&6

Reading the hydrograph

November 17, 2010 Storm Hydrograph

Storm date (s)	Total rainfall (inches)	Max intensity (in/hr)	Duration (hrs)	Estimated Peak Streamflow (cfs)
Nov 17	**1.7**	**0.63**	**11**	**191 (LC2)**



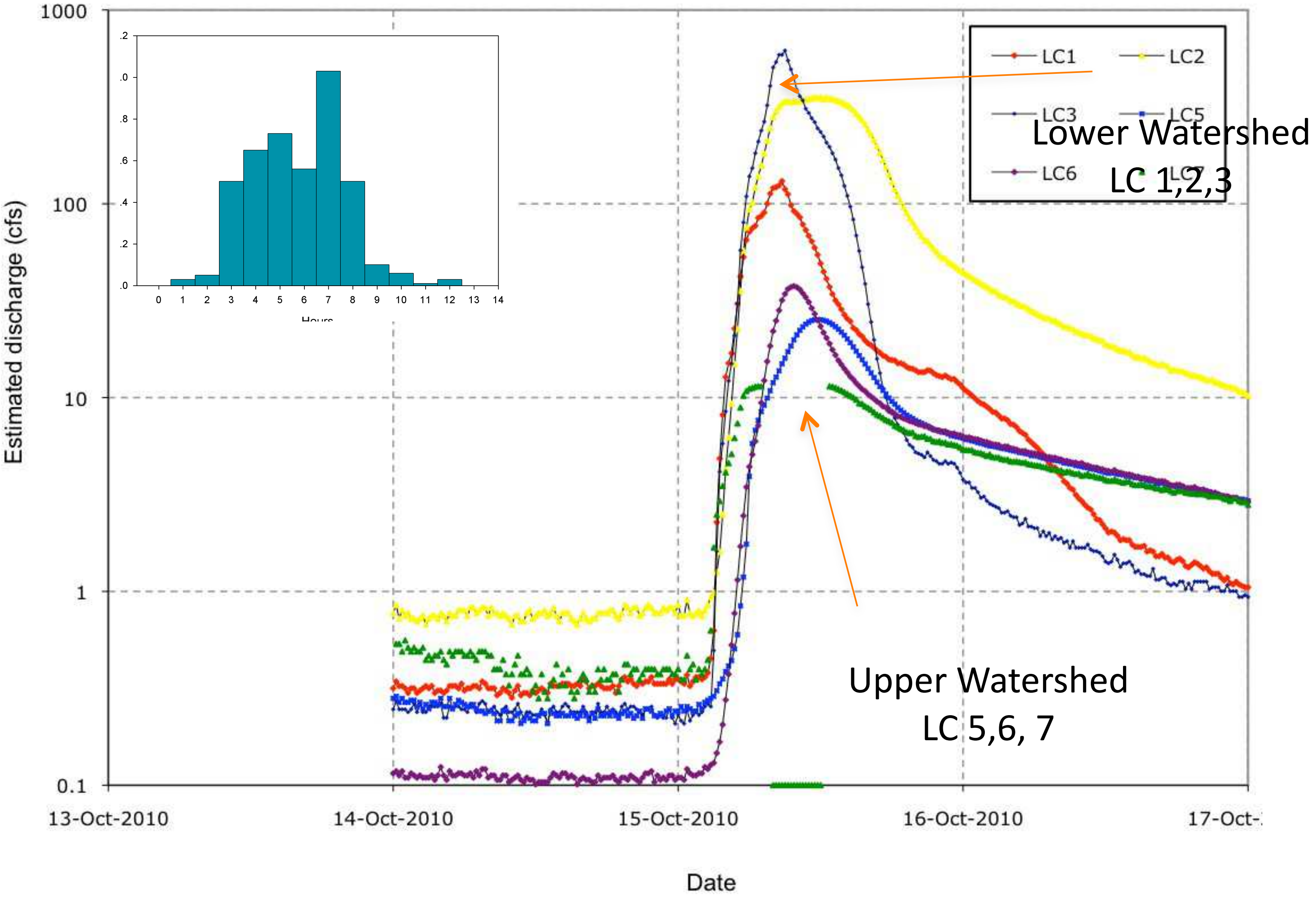
Lower Watershed
LC 1,2, 3

Upper Watershed
LC 5,6, 7

LC3 (Oct 15 2010)

October 15, 2010 Storm Hydrograph

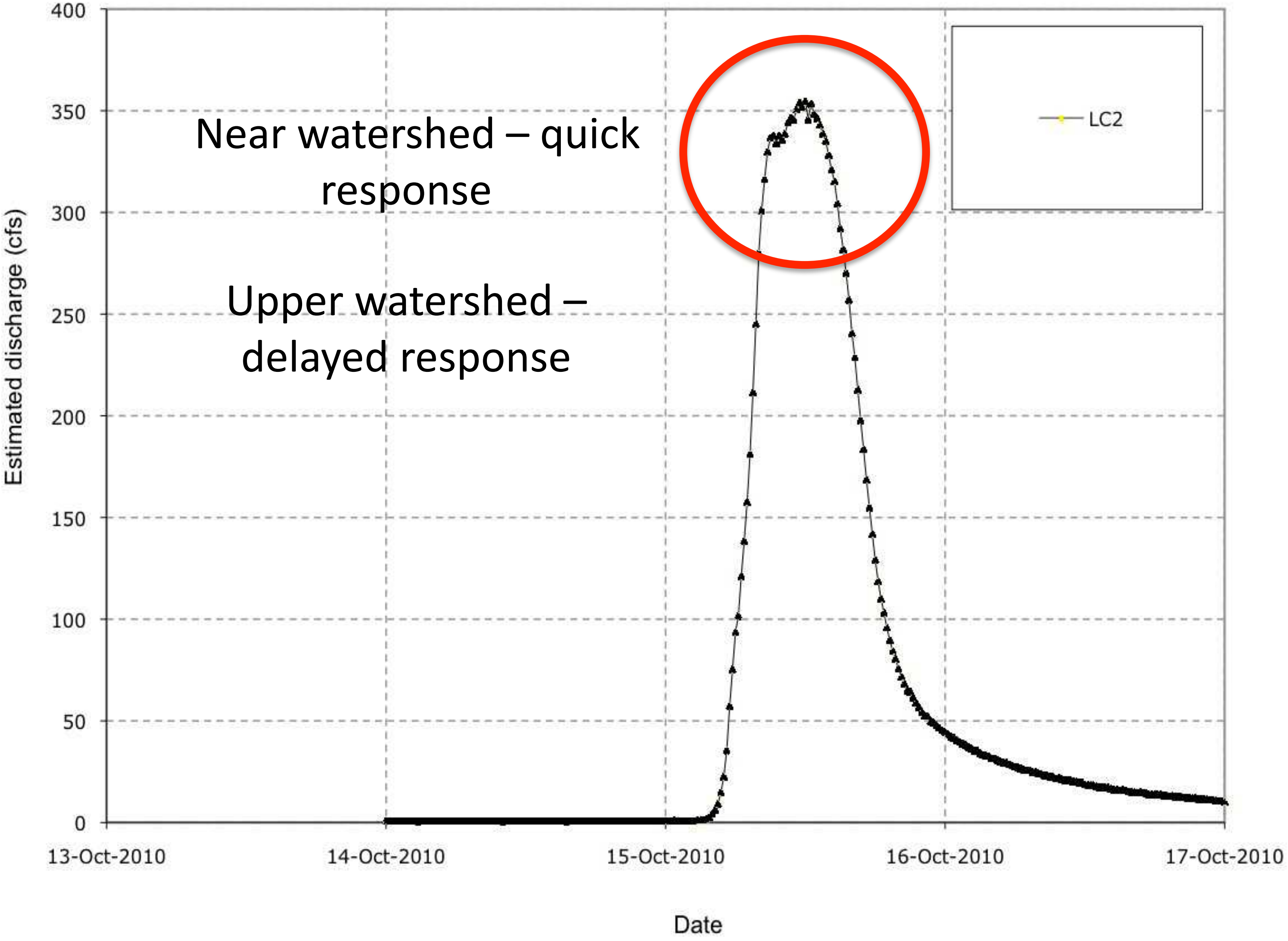
Storm date (s)	Total rainfall (inches)	Max intensity (in/hr)	Duration (hrs)	Estimated Peak Streamflow (cfs)
Oct 15	**4.25**	**0.87**	**12**	**600 (LC3)**



Lower Watershed
LC 1,2,3

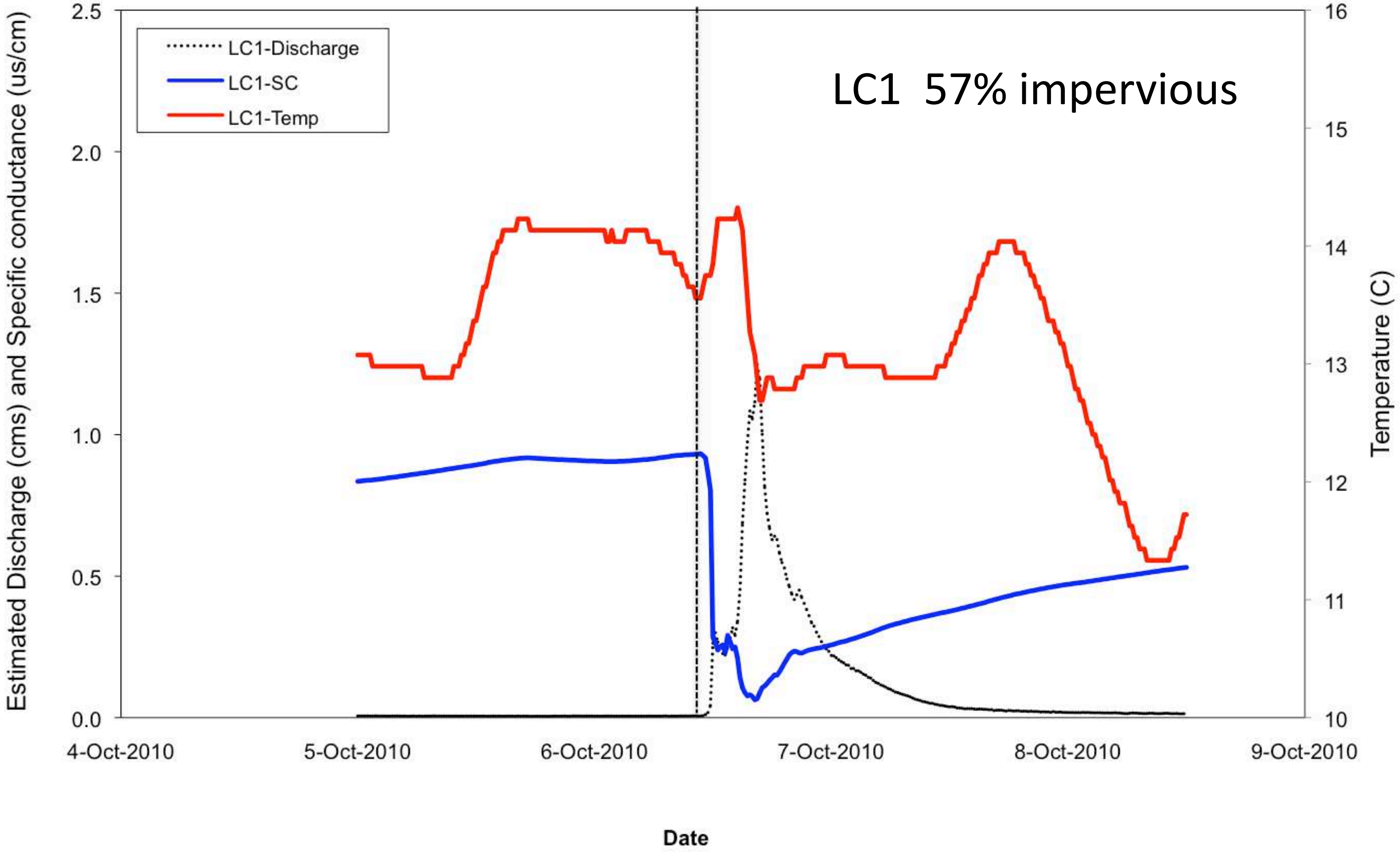
Upper Watershed
LC 5,6, 7

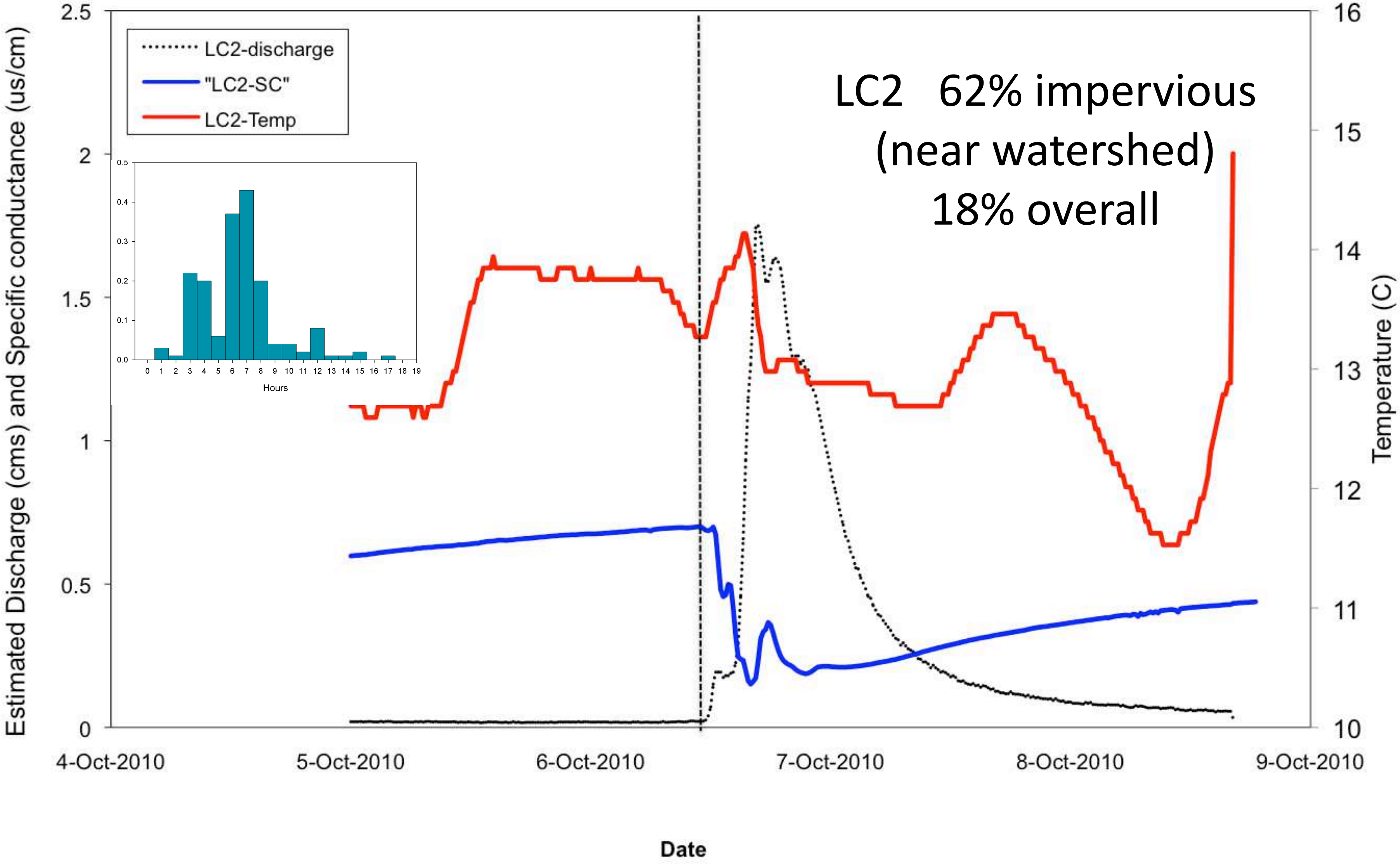
LC2 – October 15, 2010



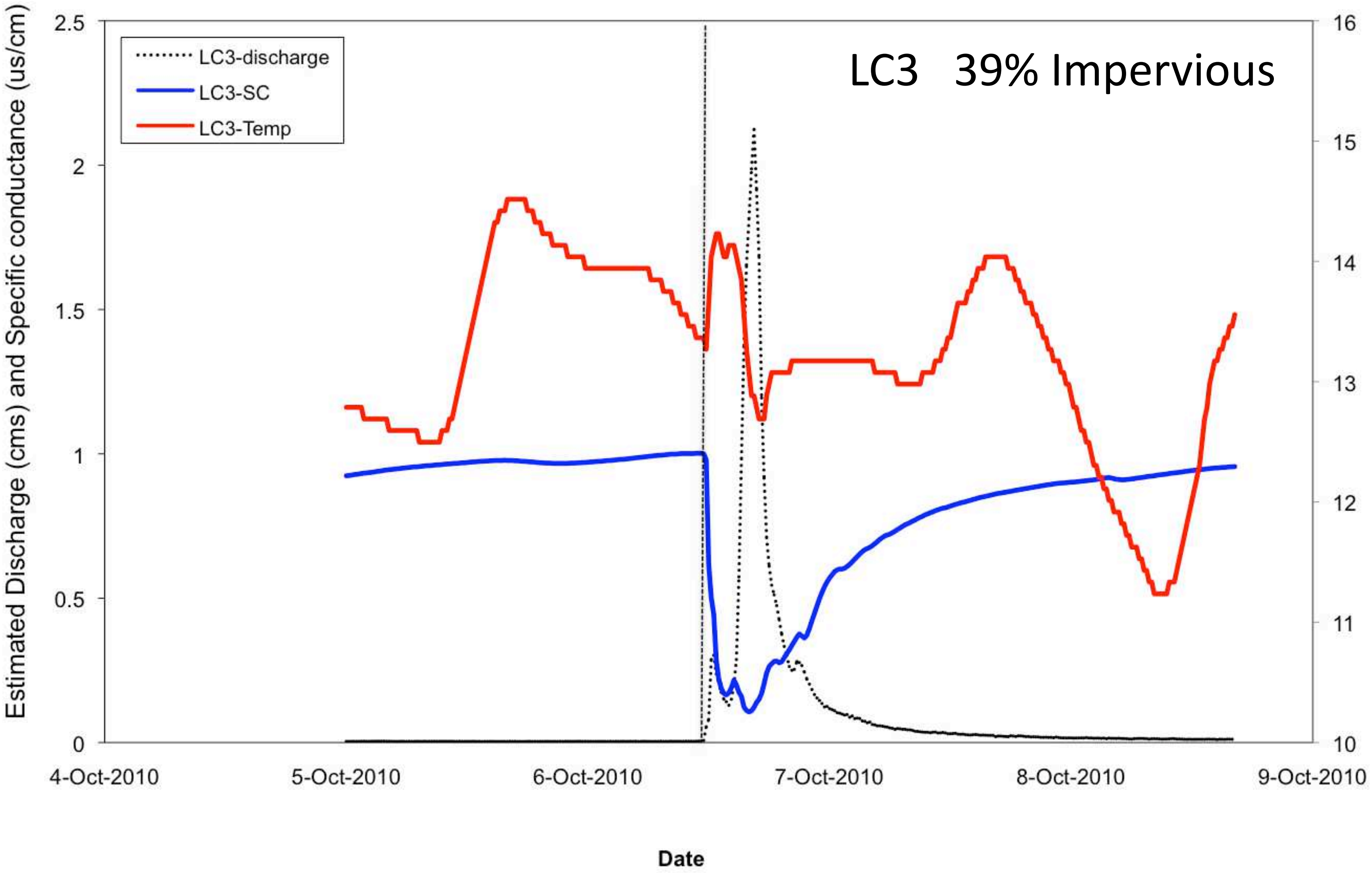
Near watershed – quick response

Upper watershed – delayed response


LC1 57% impervious
LC1-Discharge
LC1-SC
LC1-Temp
Estimated Discharge (cms) and Specific conductance (us/cm)
2.5
2.0
1.5
1.0
0.5
0.0
Temperature (C)
16
15
14
13
12
11
10
4-Oct-2010
5-Oct-2010
6-Oct-2010
7-Oct-2010
8-Oct-2010
9-Oct-2010
Date



LC2 62% impervious
(near watershed)
18% overall


LC3 39% Impervious
LC3-discharge
LC3-SC
LC3-Temp
Estimated Discharge (cms) and Specific conductance (us/cm)
2.5
2
1.5
1
0.5
0
Temperature (C)
16
15
14
13
12
11
10
4-Oct-2010
5-Oct-2010
6-Oct-2010
7-Oct-2010
8-Oct-2010
9-Oct-2010
Date

Preliminary Observations – Hydrologic Response

High discharge – most uncertainty

Downstream discharge order of magnitude greater than upstream

LC1, LC3, LC7 most reactive to precipitation – shortest response time

LC 2 – twin response –subwatershed inflow followed by watershed response

Riparian zone, wetlands even in high IC area effective in dampening hydrograph

Baseflow recession

- Temperature response precedes stream response.
- Good measure of first flush?
- Peak flow = lowest temperature

- SC dilution peak inverse of streamflow peak, LC2 double peaked

- LC3 fastest SC recovery
- less dilution = less baseflow?

How might infrastructure improvements be identified in hydrographs, water quality data?

- Lessen precipitation -- streamflow response (especially small precipitation events)
- Reduce peak flows
- Lengthen baseflow recession
- Moderated thermal response
- Lower SC values, lower annual – intra-watershed variation

Questions??