MASTER WATER STEWARD

Community Leadership for Clean Water

SESSION 2
HYDROLOGY 101

A Partnership of

MINNEHAHA CREEK WATERSHED DISTRICT

FRESHWATER SOCIETY

Sponsored by

CLEAN WATER LAND & LEGACY AMENDMENT

Learning Objectives

- Understand how rainfall, runoff, and the movement of water are **described, calculated, and measured**.
- Understand the factors that influence **how water moves**.
- Understand how water **shapes the land** and our water resources.
- Understand how precipitation patterns are **changing** and how that may impact our water resources.

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What is Hydrology?

The science of the properties, distribution, and circulation
of the waters of the Earth

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Why Do We Study Hydrology?

Because water shapes the land …

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Why Do We Study Hydrology?

Because water shapes the land …

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Why Do We Study Hydrology?

Because water influences where we live

St. Anthony Falls, 1867 Minnesota Historical Society

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Why Do We Study Hydrology?

Because flowing water picks up and conveys all kinds of stuff

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Why Do We Study Hydrology?

Because it's the only water we'll ever have

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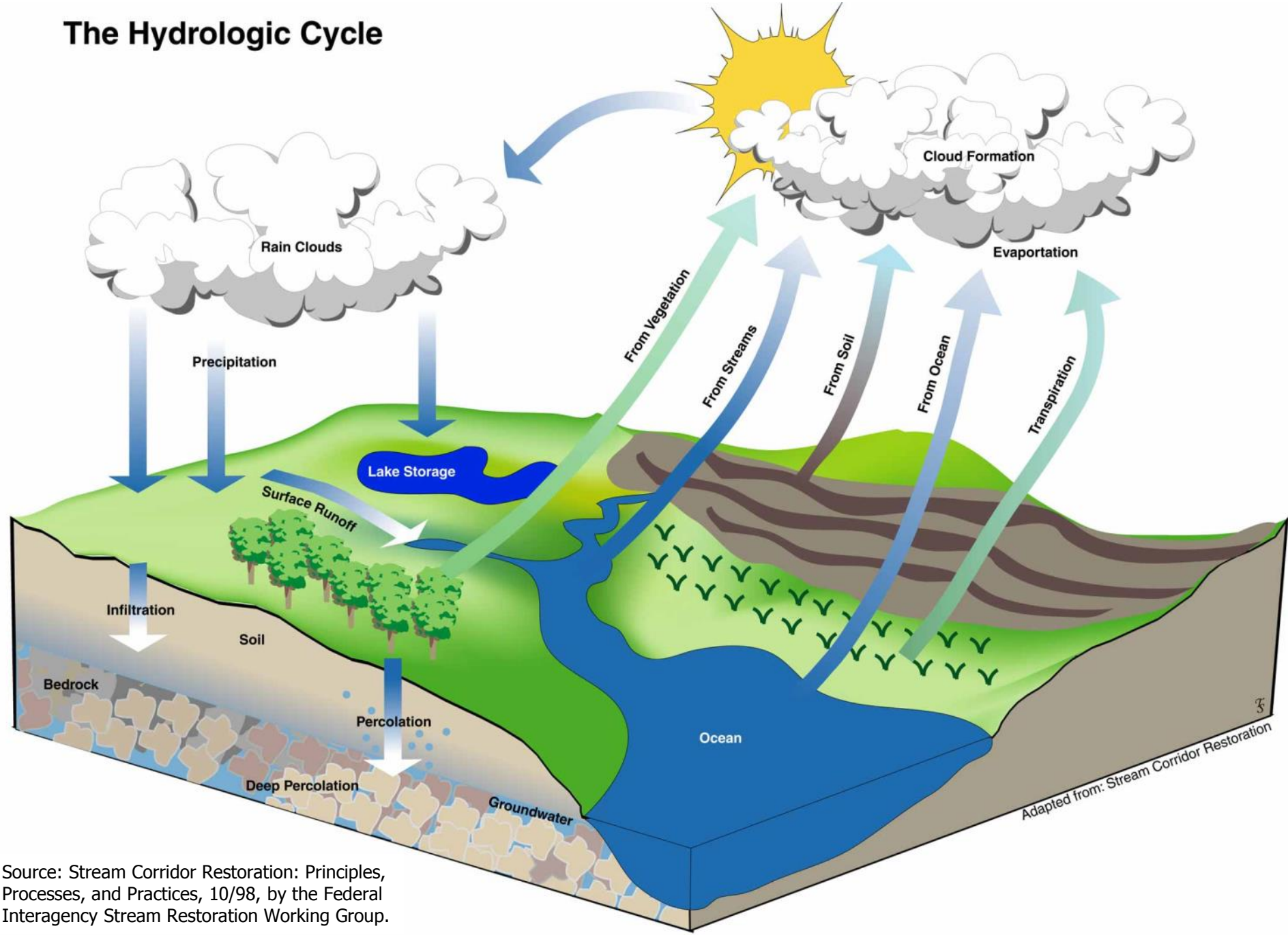

Source: Stream Corridor Restoration: Principles, Processes, and Practices, 10/98, by the Federal Interagency Stream Restoration Working Group.

Hydrology 101

- What is a watershed?
- How do we measure water?
- What influences how water moves?
- How does water impact the land?
- Are precipitation patterns changing?

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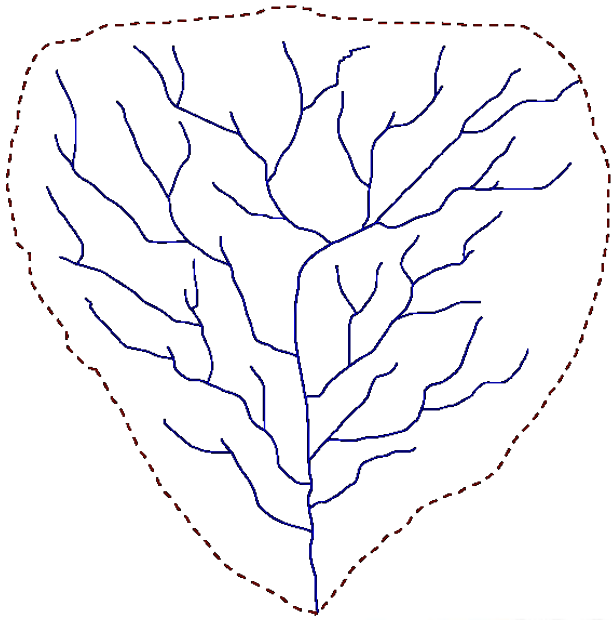
What is a watershed?

An area of land that drains to a water resource



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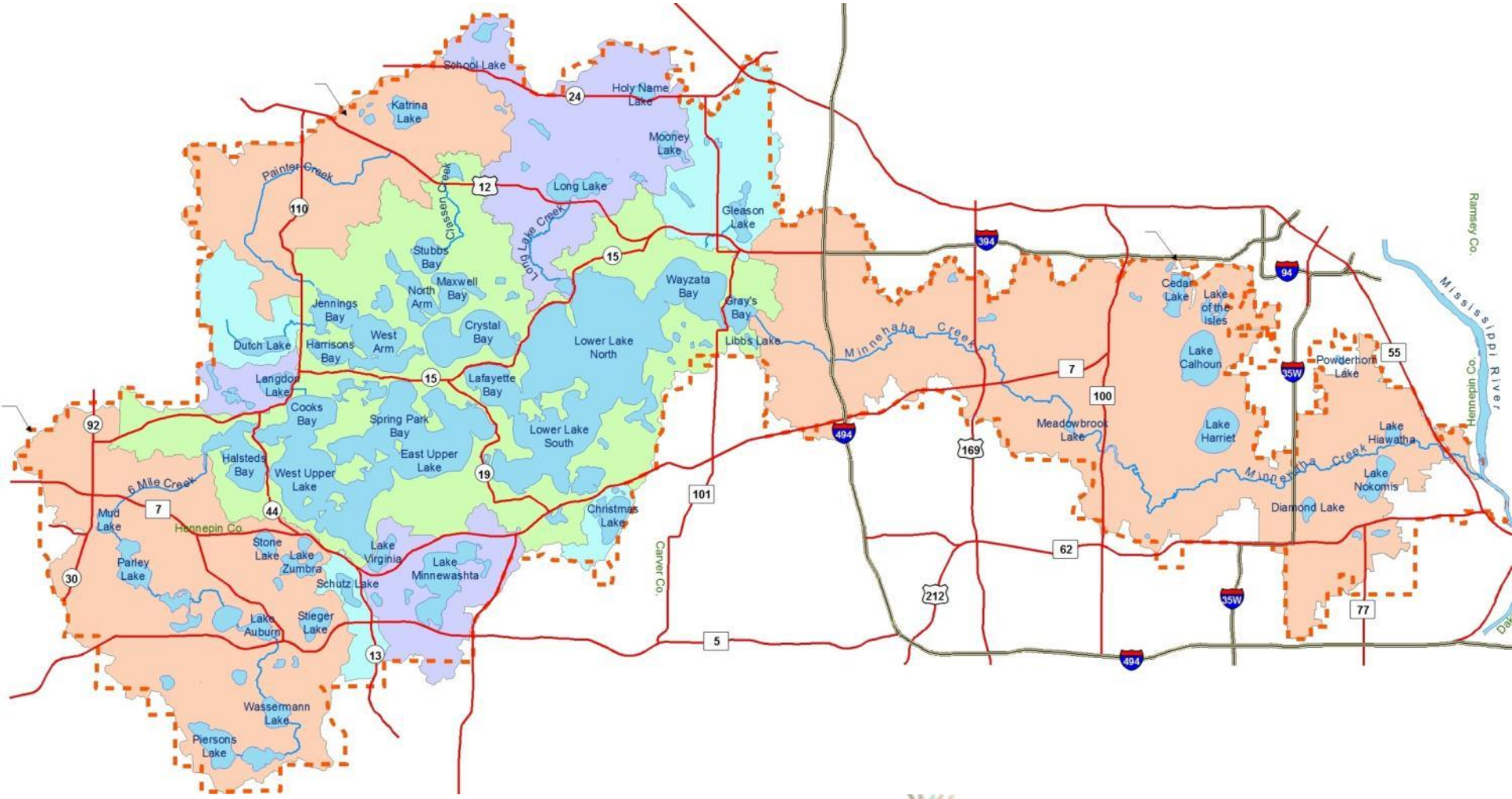
Minnehaha Creek Subwatersheds



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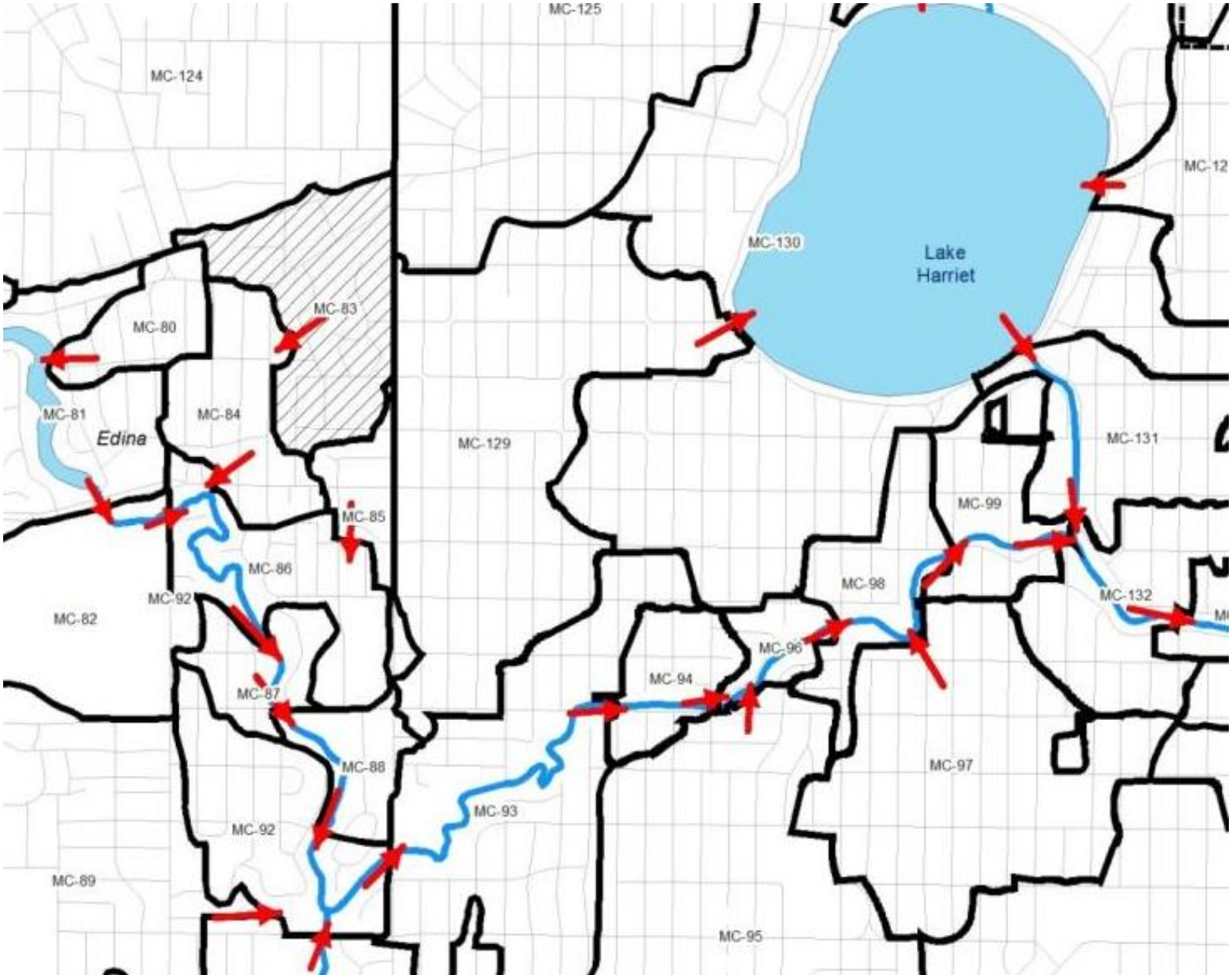
Catchments


MC-125
MC-124
MC-12
MC-130
Lake
Harriet
MC-83
MC-80
MC-81
Edina
MC-84
MC-129
MC-131
MC-99
MC-85
MC-86
MC-98
MC-92
MC-132
MC-82
MC-96
MC-94
MC-87
MC-88
MC-97
MC-93
MC-92
MC-89
MC-95

Measuring Water

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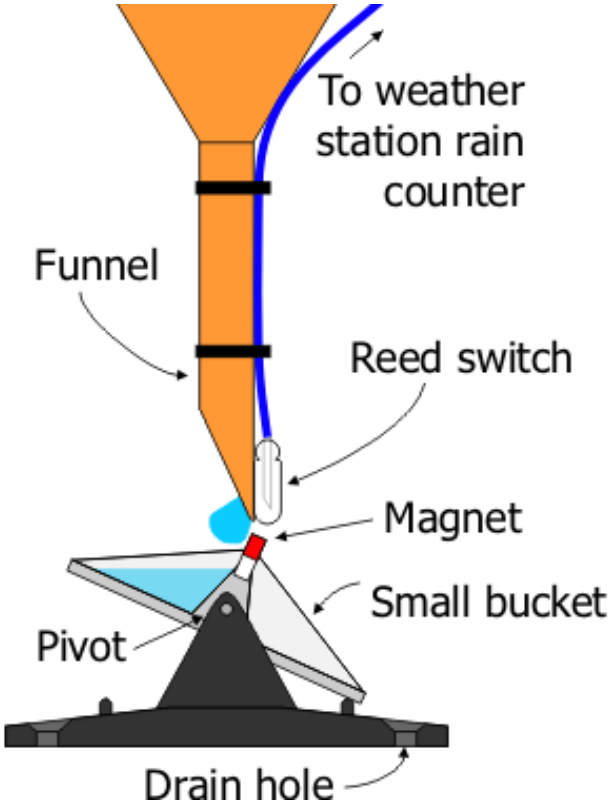
Measuring precipitation

www.gardenscape.ca

NOAA Rain Gauge



Tipping bucket

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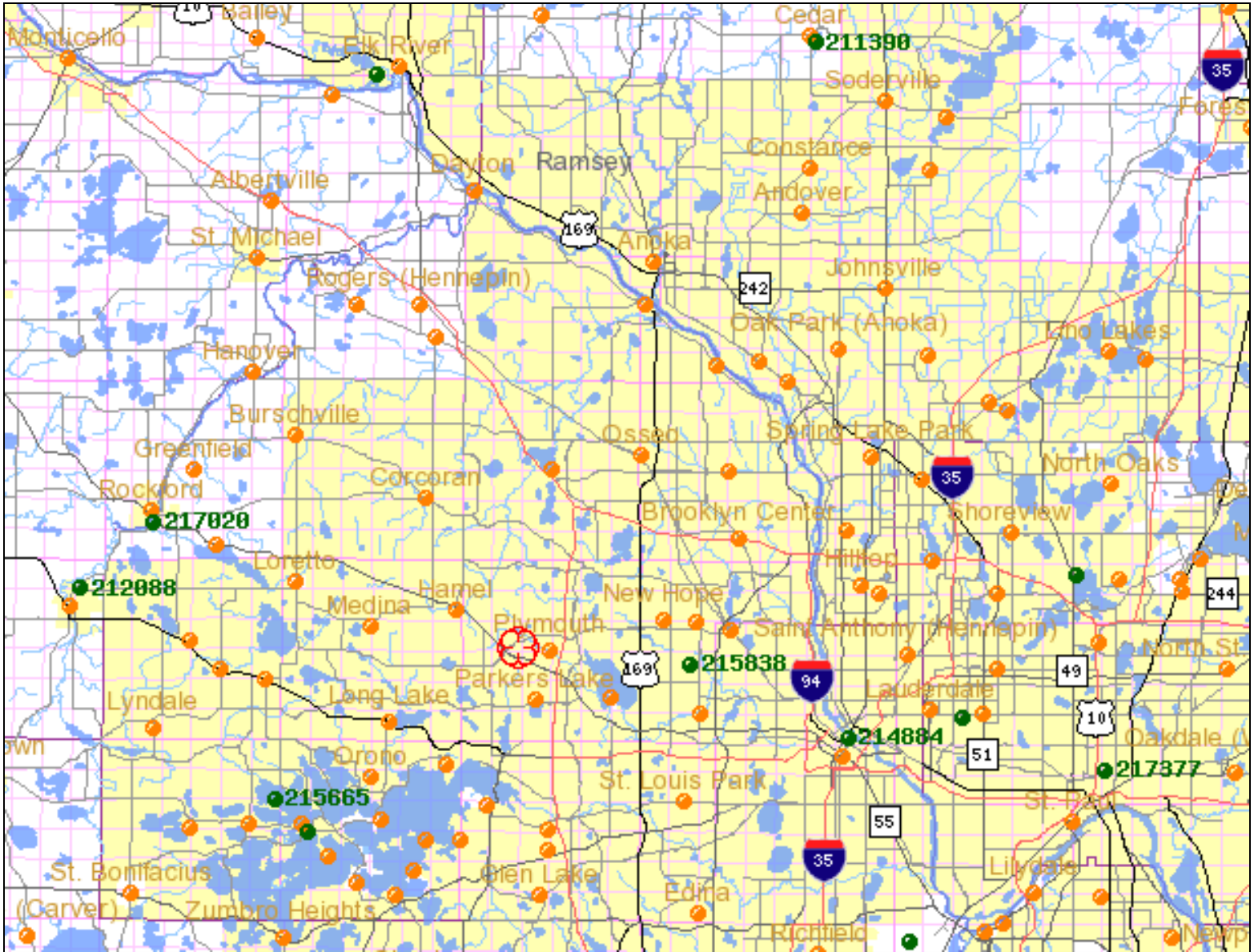
http://climate.umn.edu/climatology.htm



National Climate Network

NOAA US Climate Reference Network Site

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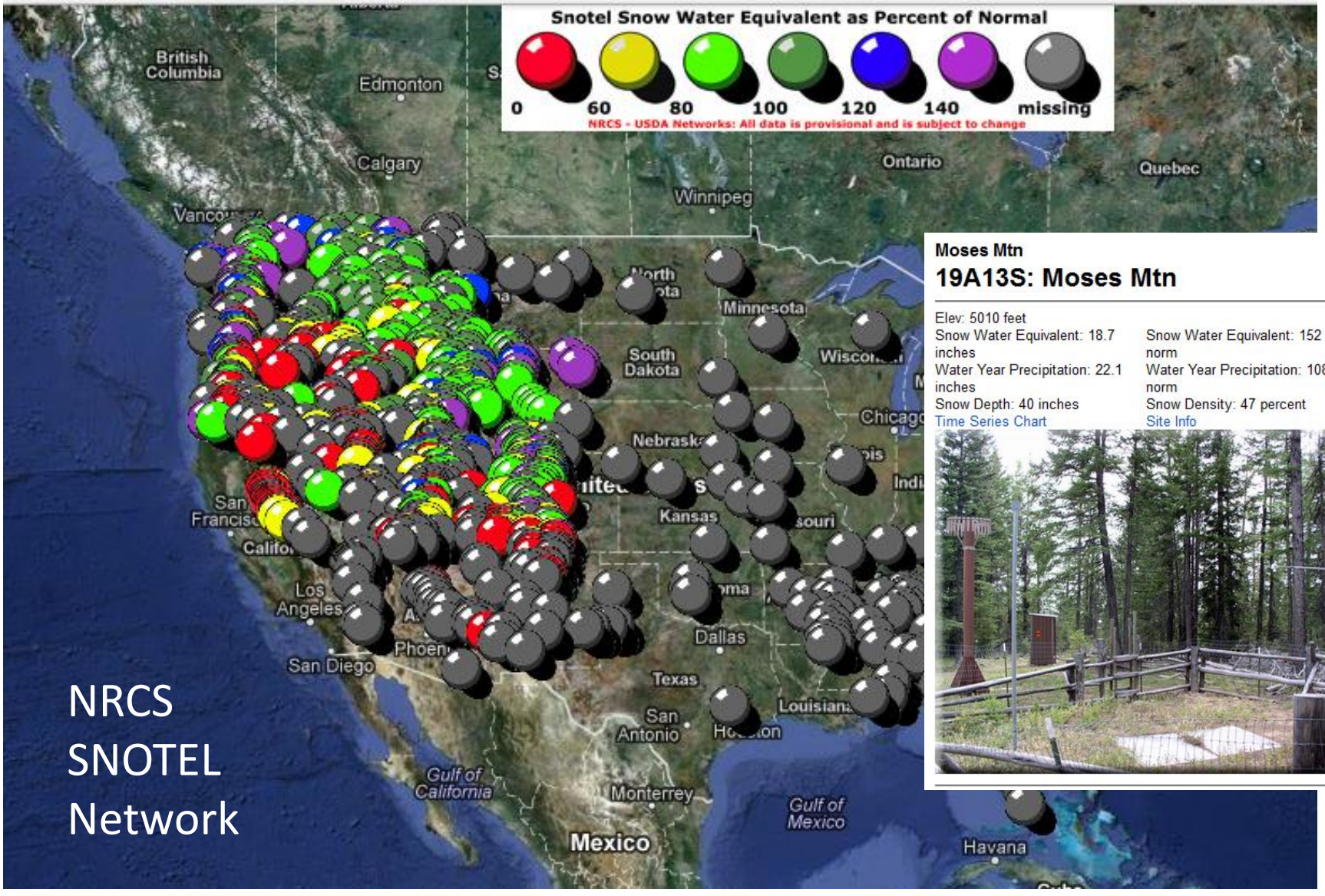
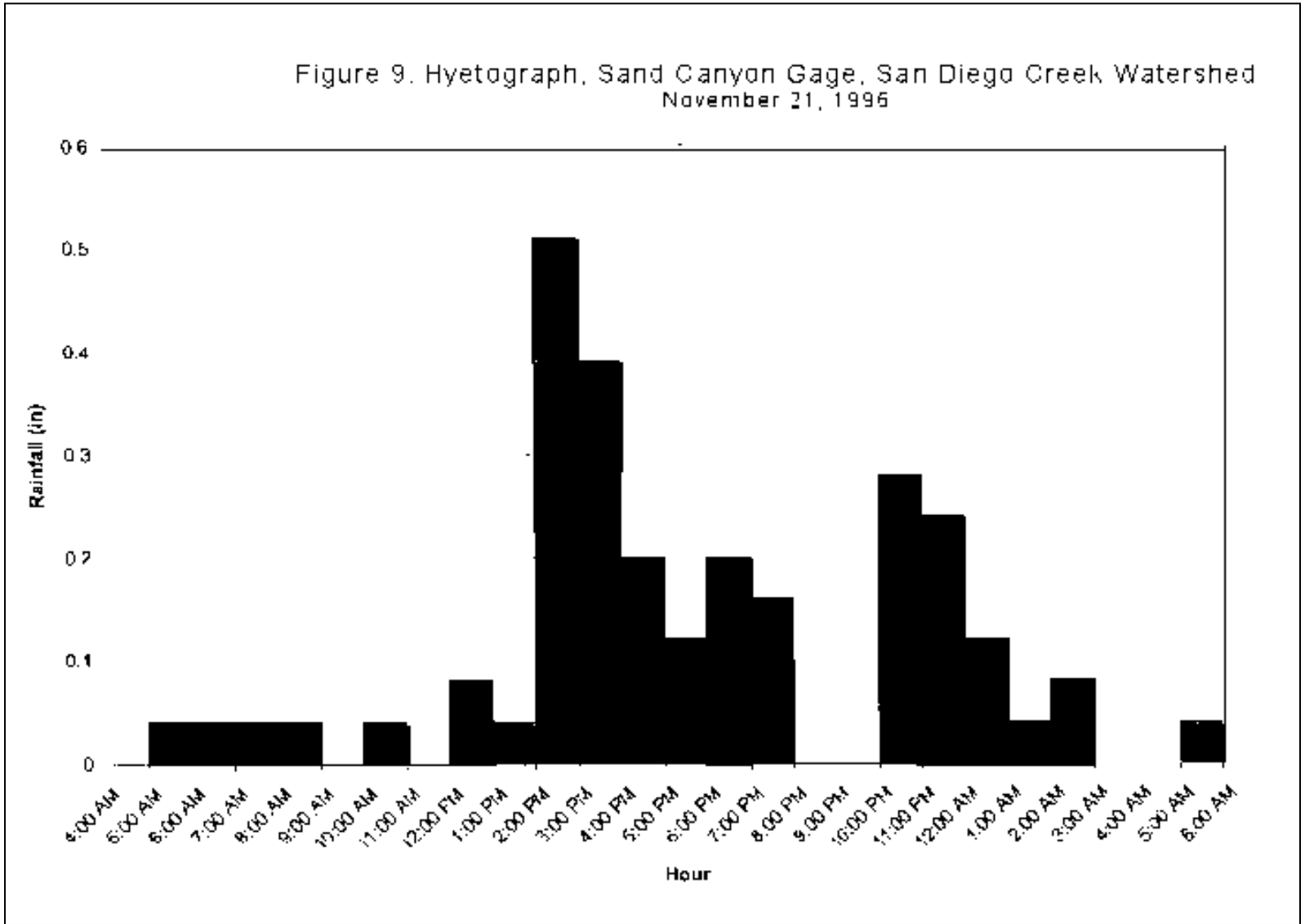
Measuring snowpack

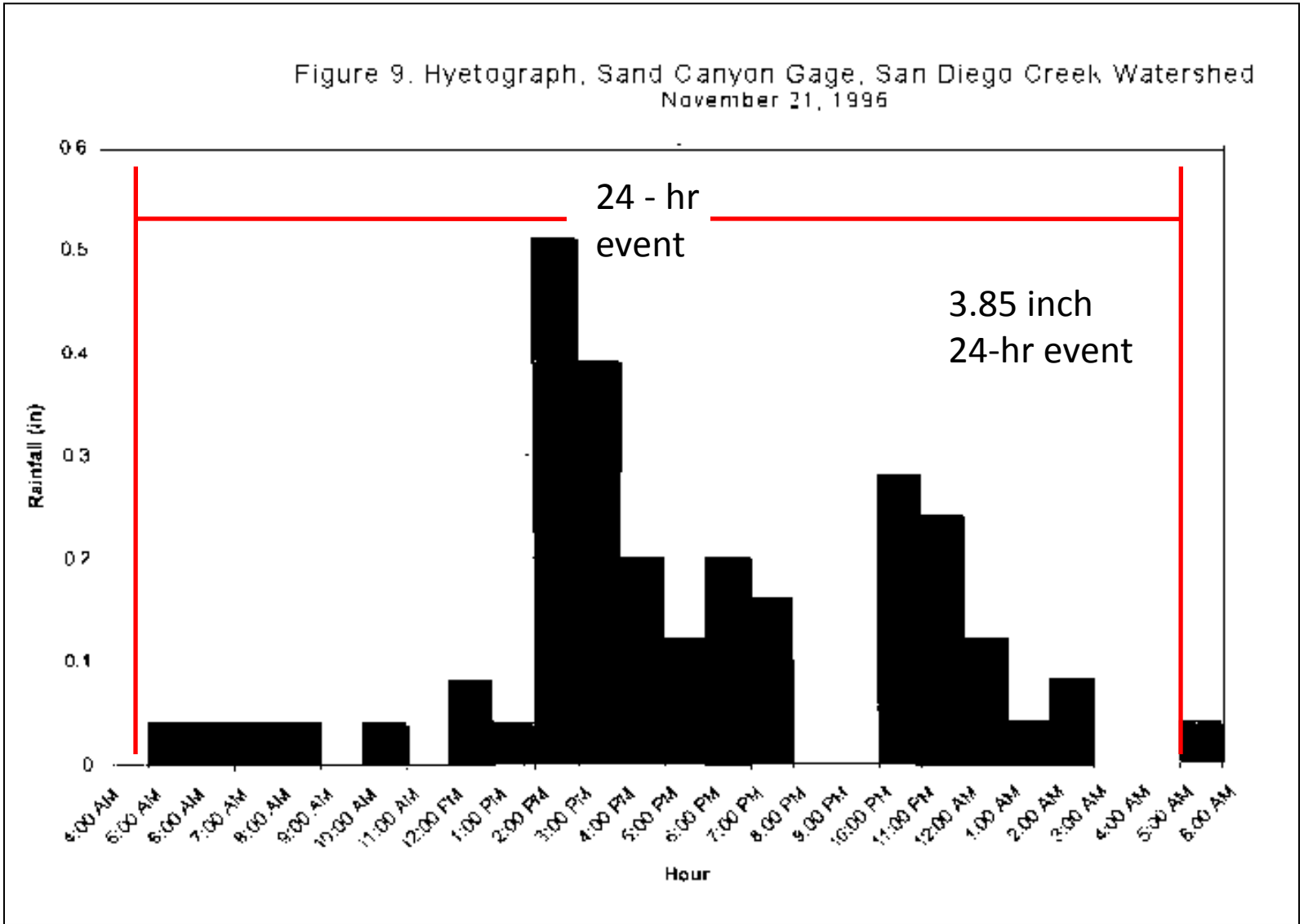


NRCS SNOTEL Network

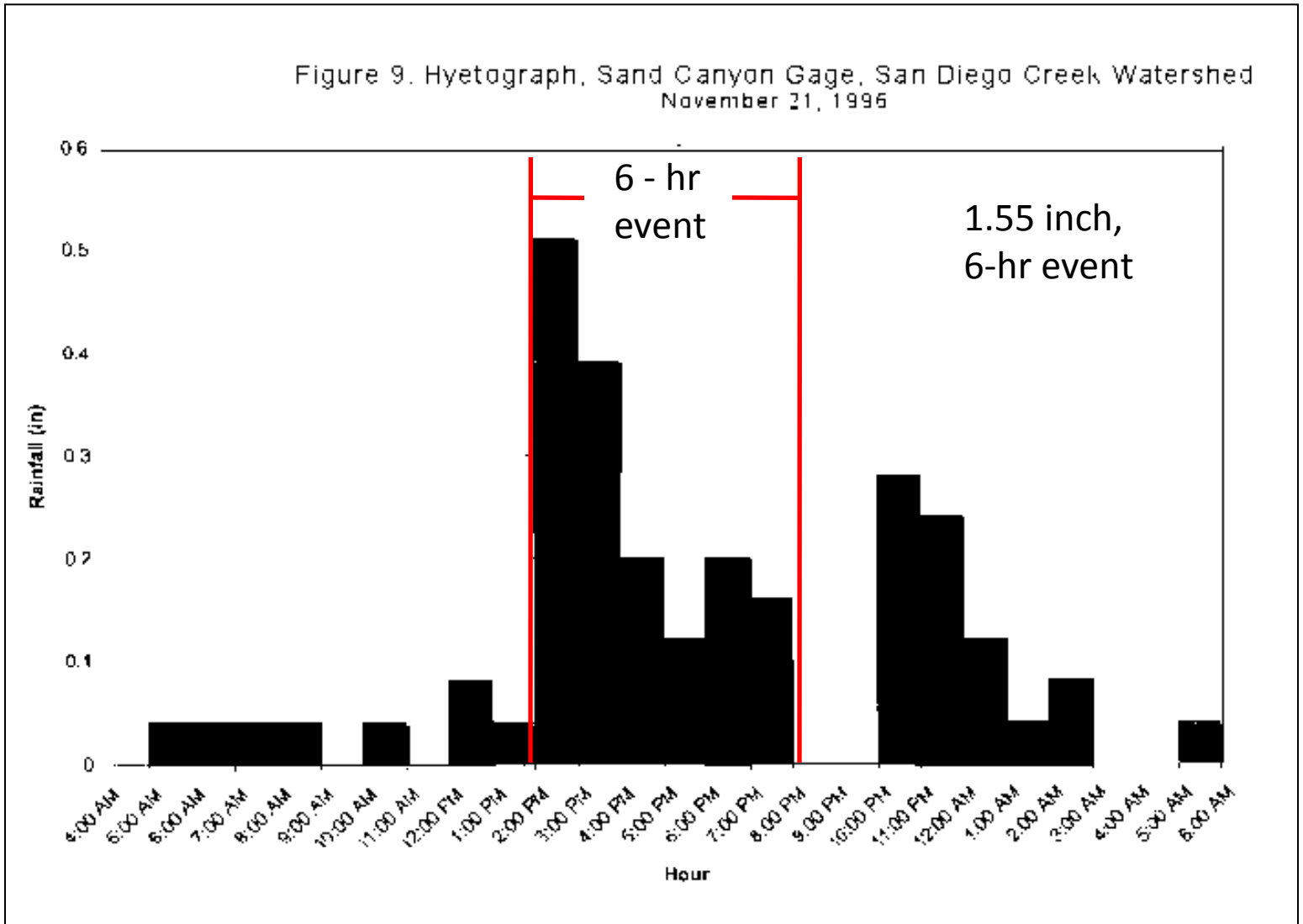
An event **hyetograph** shows the distribution of precipitation over time



An event **hyetograph** shows the distribution of precipitation over time



An event **hyetograph** shows the distribution of precipitation over time



Quick Quiz

List the three things we need to know about a rainfall event

Source: UCLA Library Digital Archives

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What rainfall events are we most interested in?

- *Return period* = 1/probability
- An event that has a 1% chance of occurring is a 1/.01 = 100 year return event
- An event that has a 50% chance of occurring is a 1/.50 = 2 year return event

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What rainfall events are we interested in?

Return Frequency	24-hour	12-hour	6-hour	3-hour	2-hour	1-hour	30-min	15-min
2-year (50% chance)	2.9	2.5	2.2	1.9	1.7	1.4	1.1	0.7
10-year (10% chance)	4.3	4.0	3.5	3.0	2.7	2.1	1.6	1.1
100-year (1% chance)	7.4	7.0	6.4	5.4	4.7	3.7	2.6	1.8

Source: NOAA Atlas 14 Volume 8
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=mn

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Other events of interest

- 1” event
- “Water Quality Event” = 1.25-1.3”

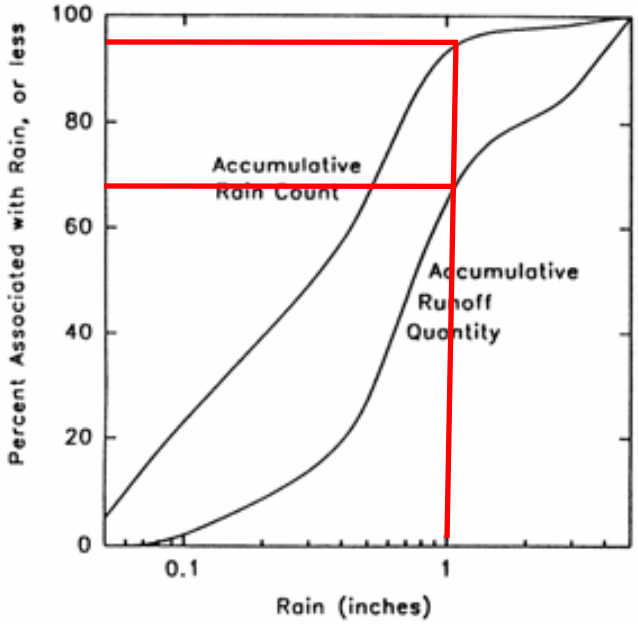


Figure 3. Milwaukee rainfall and runoff probability distributions.

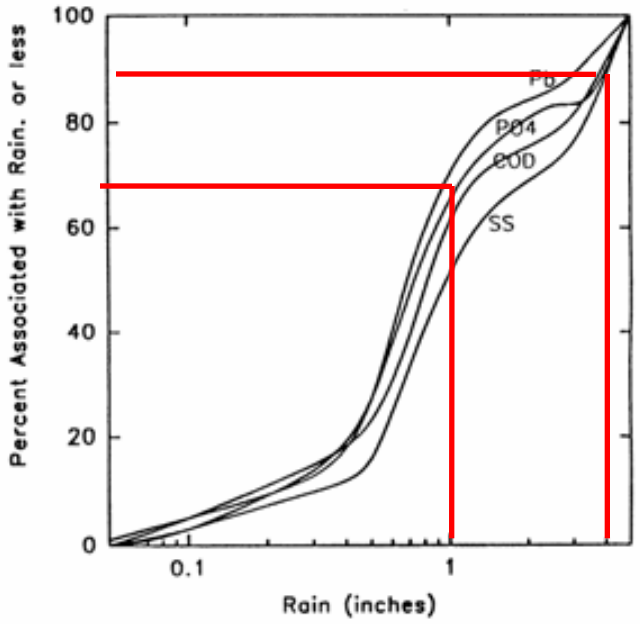
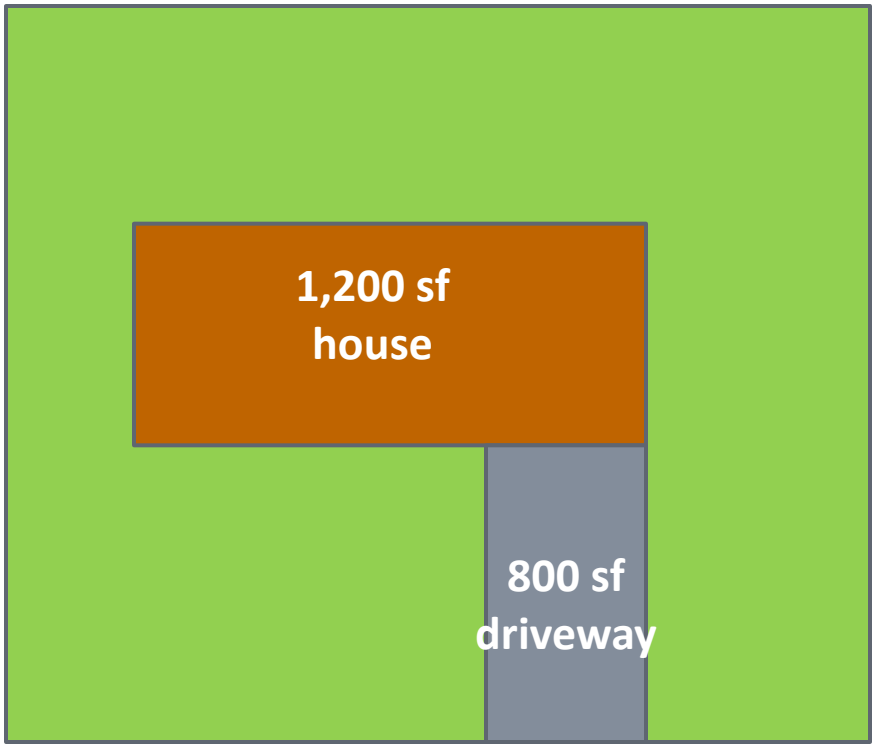


Figure 4. Milwaukee pollutant mass probability distributions.

Calculating Runoff

Area x Rainfall Depth = Volume



2,000 sf x 1” x 1 ft/12” =

166.67 cubic feet

1 cf = 7.5 gallons

166.67 * 7.5 =

1,250 gallons

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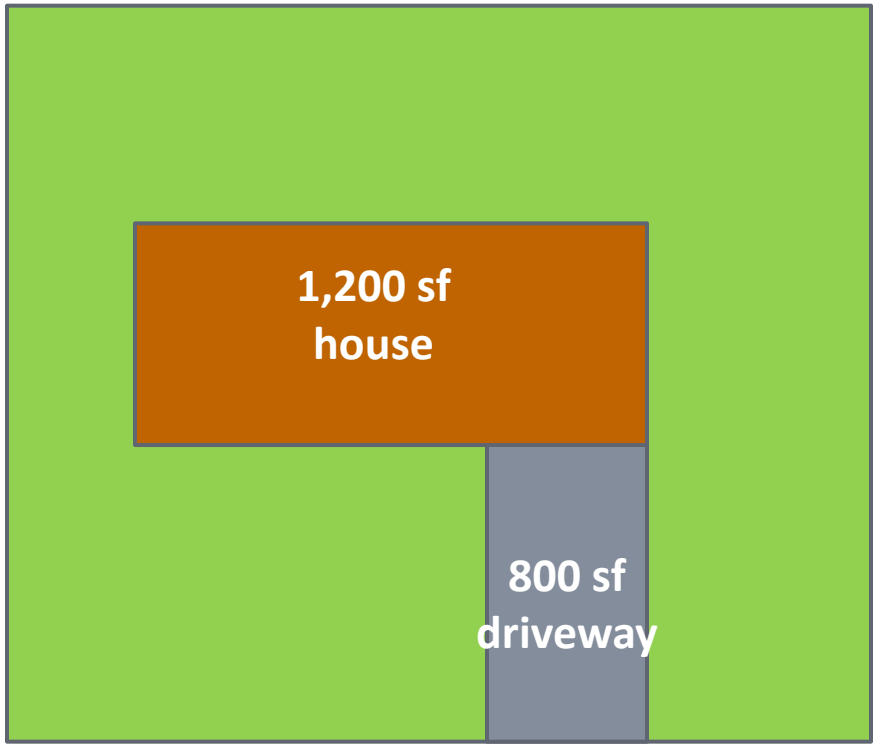
Calculating Runoff

Area x Rainfall Depth = Volume



2,000 sf x 7.4” x 1 ft/12” =

1,233.3 cubic feet

1 cf = 7.5 gallons

1233.3 * 7.5 =

9,250 gallons

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Terminology Test

1. Transpiration
2. Infiltration
3. Hyetograph
4. Tipping bucket
5. 100 year event
6. Watershed
7. Hydrology
8. Runoff
9. Lakeshed
10. Return period

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What influences how water moves

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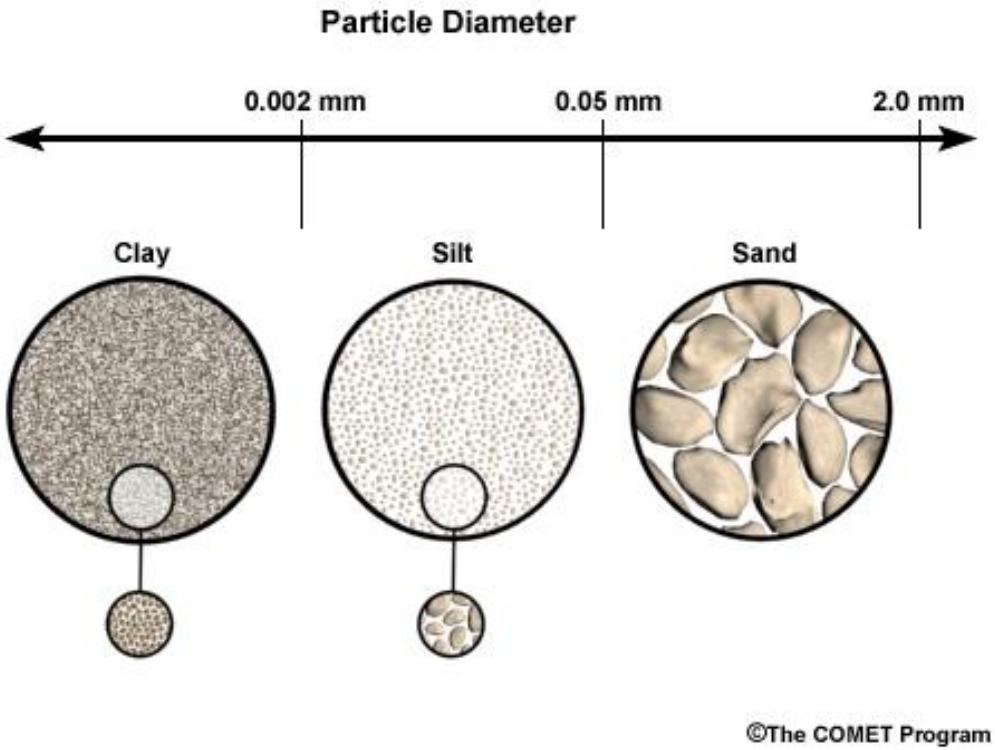
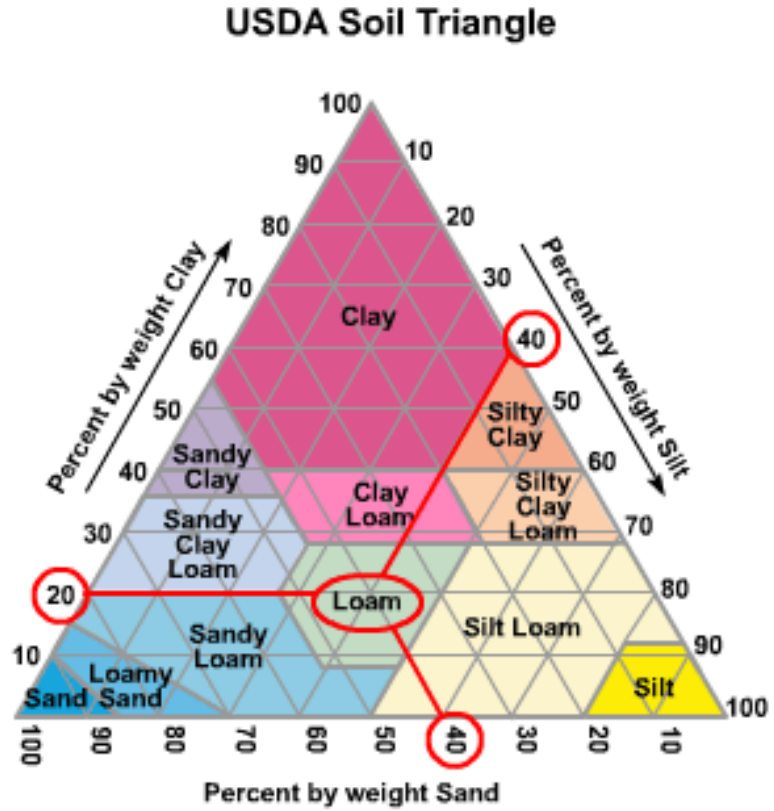
Soil Type





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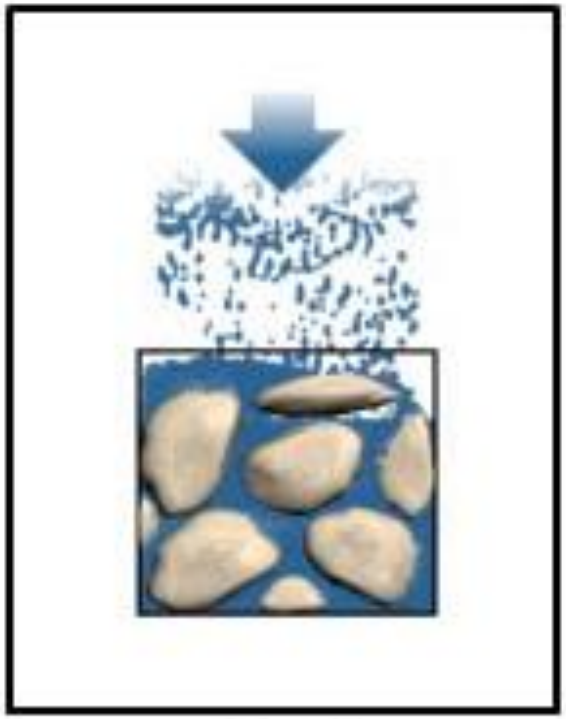
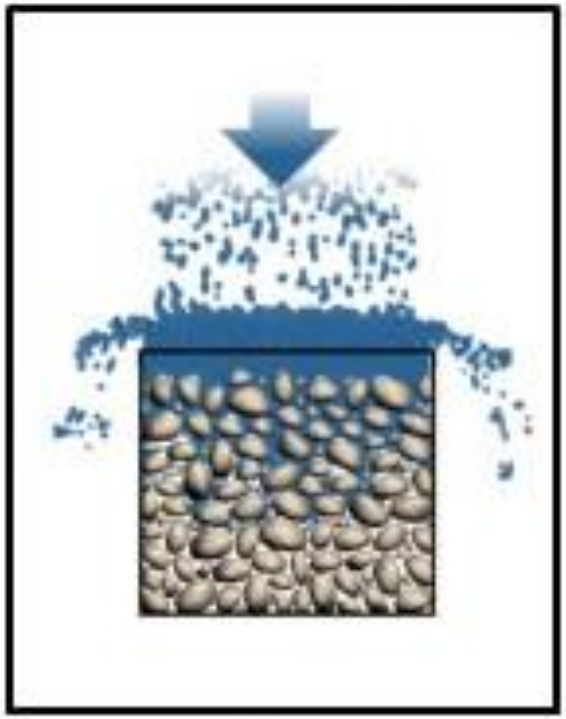
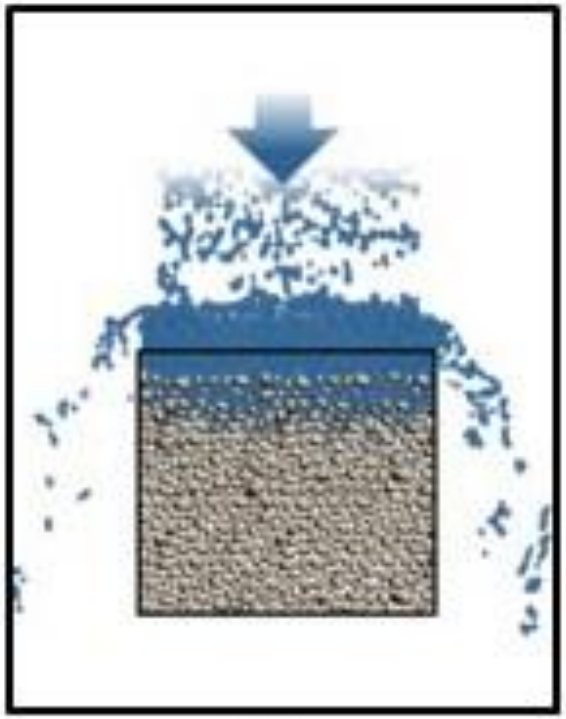
Infiltration Variations by Soil Texture



Sand



Silt



Clay

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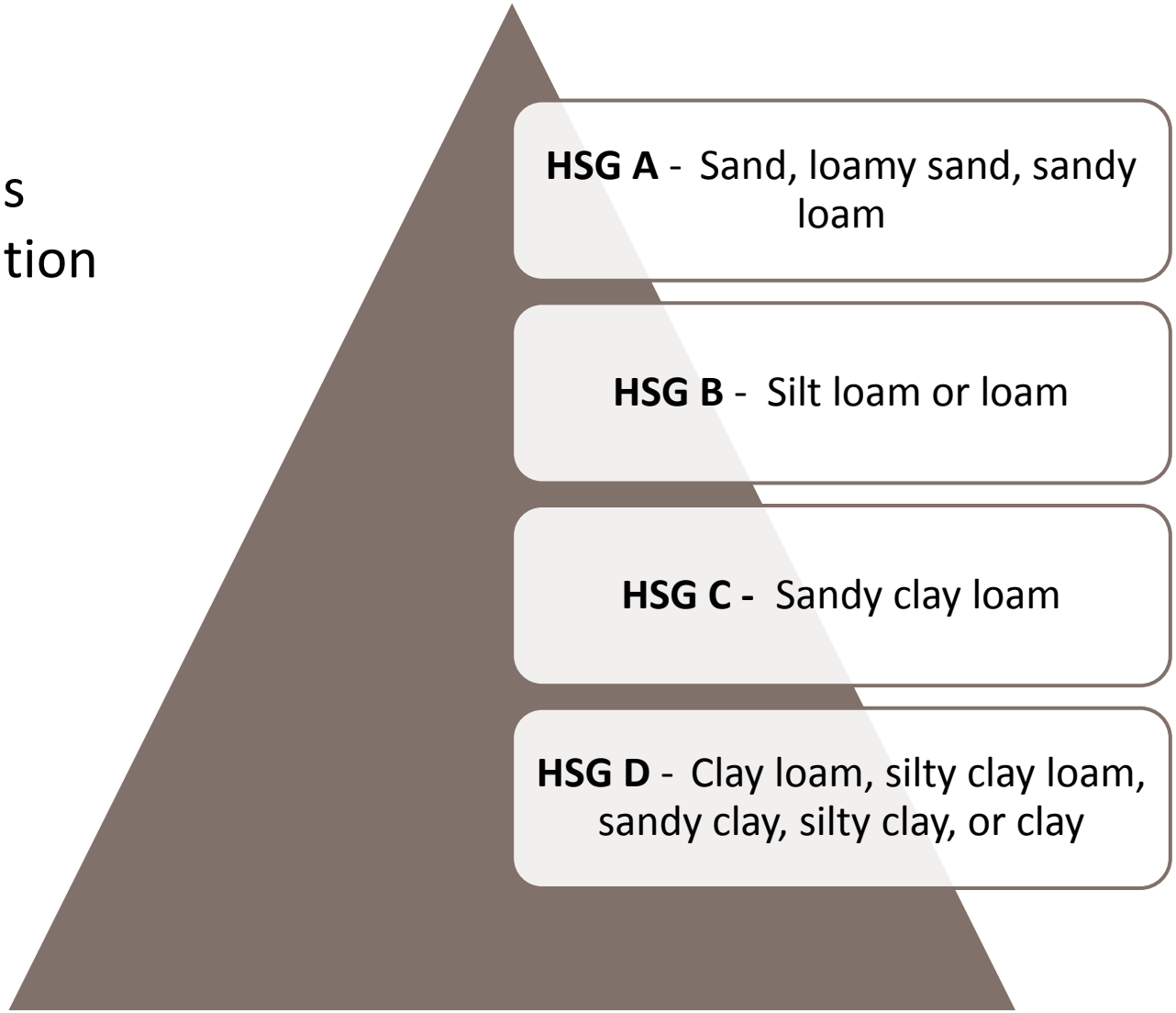
Hydrologic Soil Group

Natural Resources Conservation Service (NRCS)



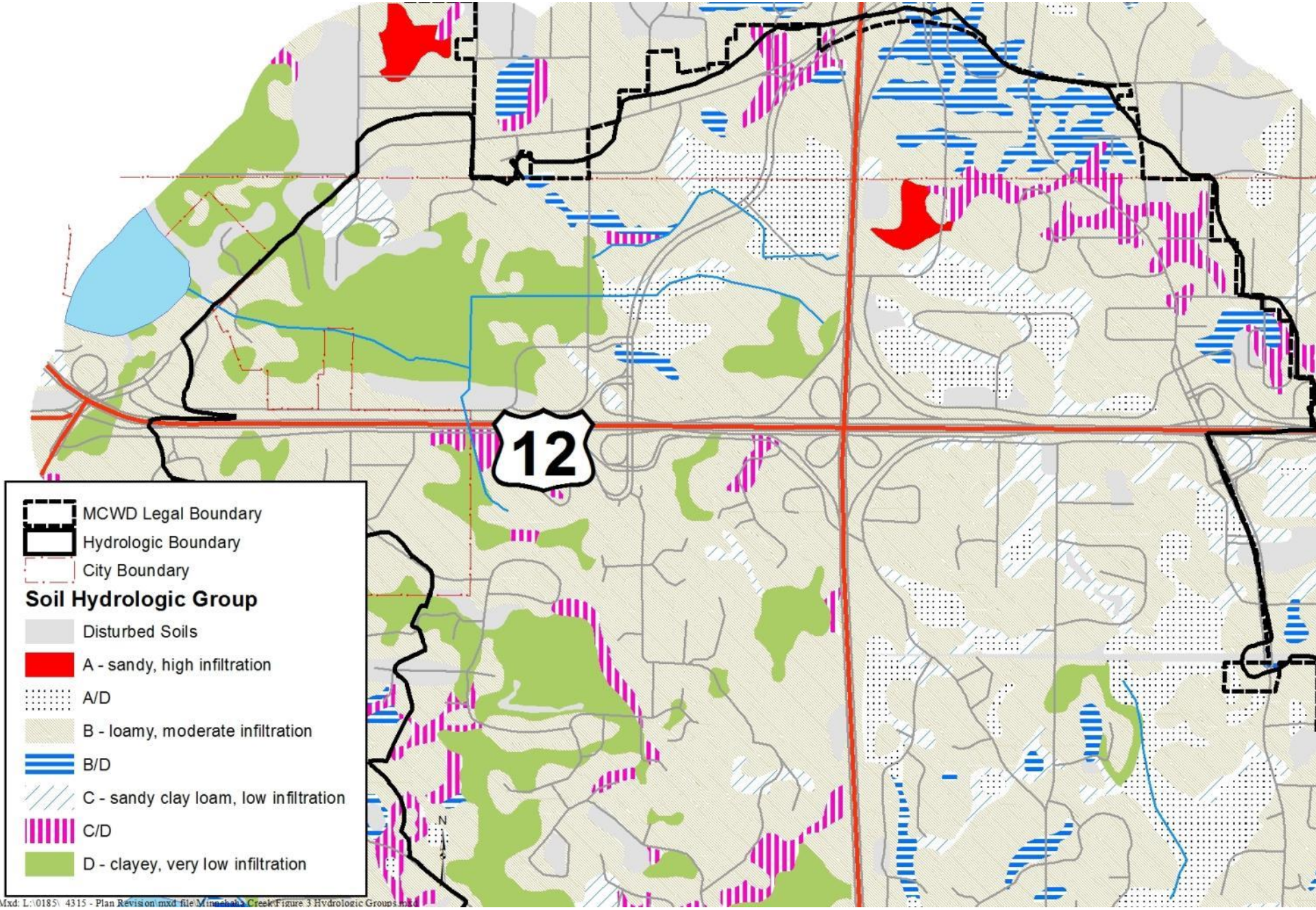
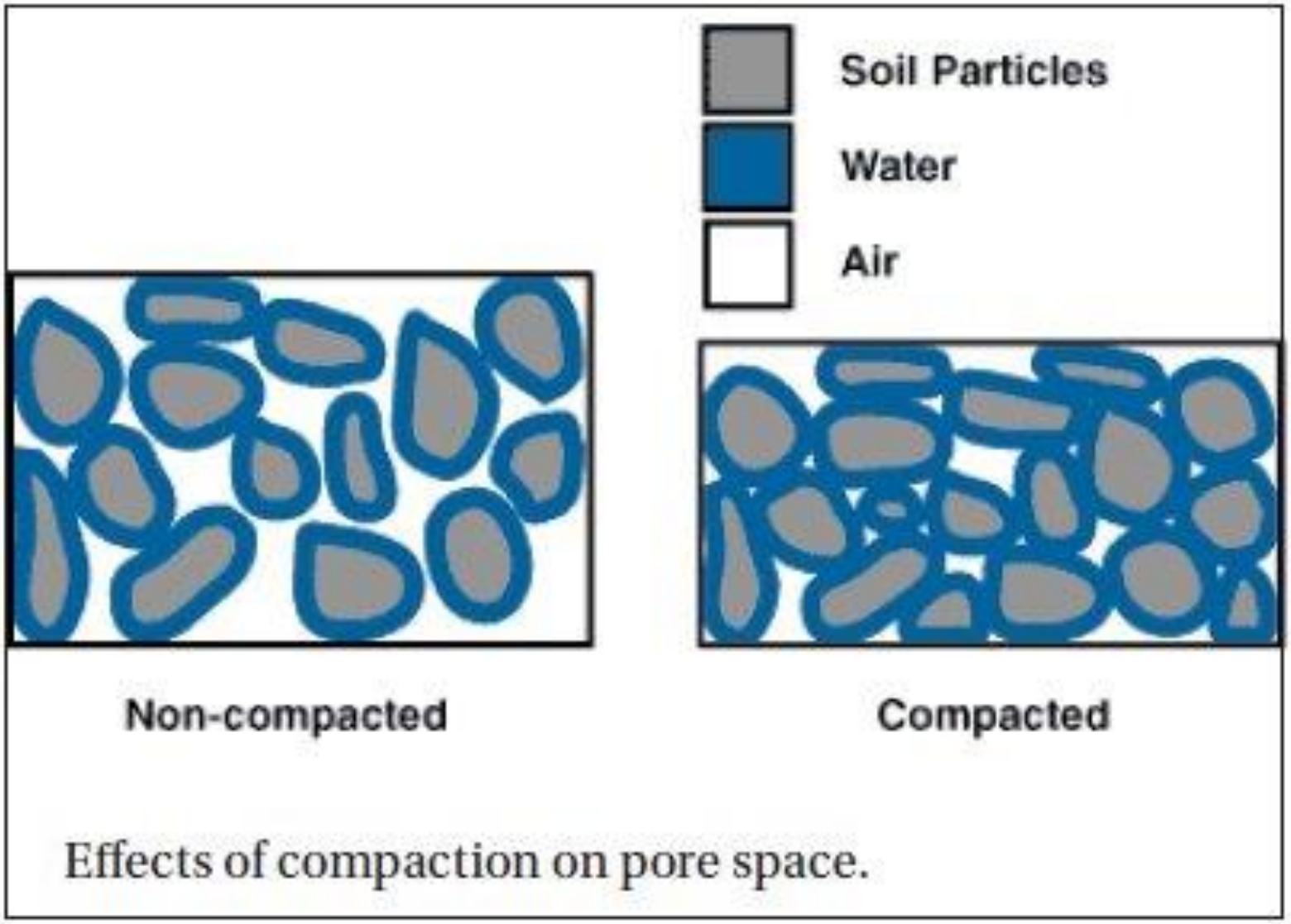

12
MCWD Legal Boundary
Hydrologic Boundary
City Boundary
Soil Hydrologic Group
Disturbed Soils
A - sandy, high infiltration
A/D
B - loamy, moderate infiltration
B/D
C - sandy clay loam, low infiltration
C/D
D - clayey, very low infiltration
N
Mxd: L:\0185\ 4315 - Plan Revision mxd file \Minnehaha Creek\Figure 3 Hydrologic Groups.mxd

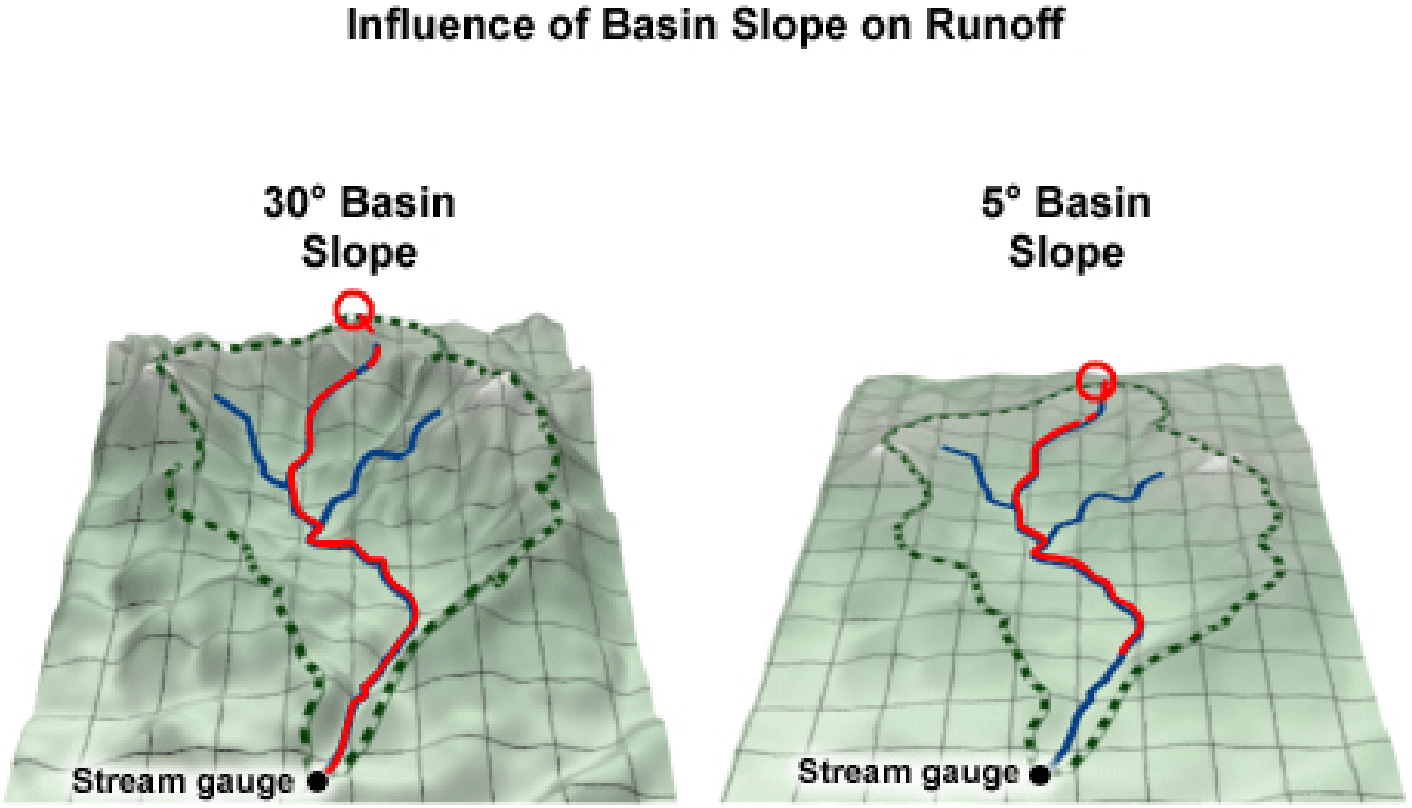
Table 12.INF.7 Design Infiltration Rates			
Hydrologic Soil Group	**Soil Textures***	**Corresponding Unified Soil Classification****	**Infiltration Rate [inches/hour]**
A	Gravel, sand, sandy gravel, silty gravel, loamy sand, sandy loam	**GW** – Well-graded gravel or well-graded gravel with sand **GP** – Poorly graded gravel or poorly graded gravel with sand	1.63
		GM – Silty gravel or silty gravel with sand **SW** – Well-graded sand or well-graded sand with gravel **SP** – Poorly graded sand or poorly graded sand with gravel	0.8
B	Loam, silt loam	**SM** – Silty sand or silty sand with gravel	0.6
		ML – Silt **OL** – Organic silt or organic silt with sand or gravel or gravelly organic silt	0.3
C	Sandy clay loam	**GC** – Clayey gravel or clayey gravel with sand **SC** – Clayey sand or clayey sand with gravel	0.2
D	Clay, clay loam, silty clay loam, sandy clay, silty clay	**CL** – Lean clay or lean clay with sand or gravel or gravelly lean clay **CH** – Fat clay or fat clay with sand or gravel or gravelly fat clay **OH** – Organic clay or organic clay with sand or gravel or gravelly organic clay **MH** – Elastic silt or elastic silt with sand or gravel	< 0.2

Compaction



Effects of compaction on pore space.

Slope and Roughness



Time of Concentration

Directly Connected Impervious Area

Quick Quiz

List the factors influencing runoff and how water moves

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Influence of Water on Land

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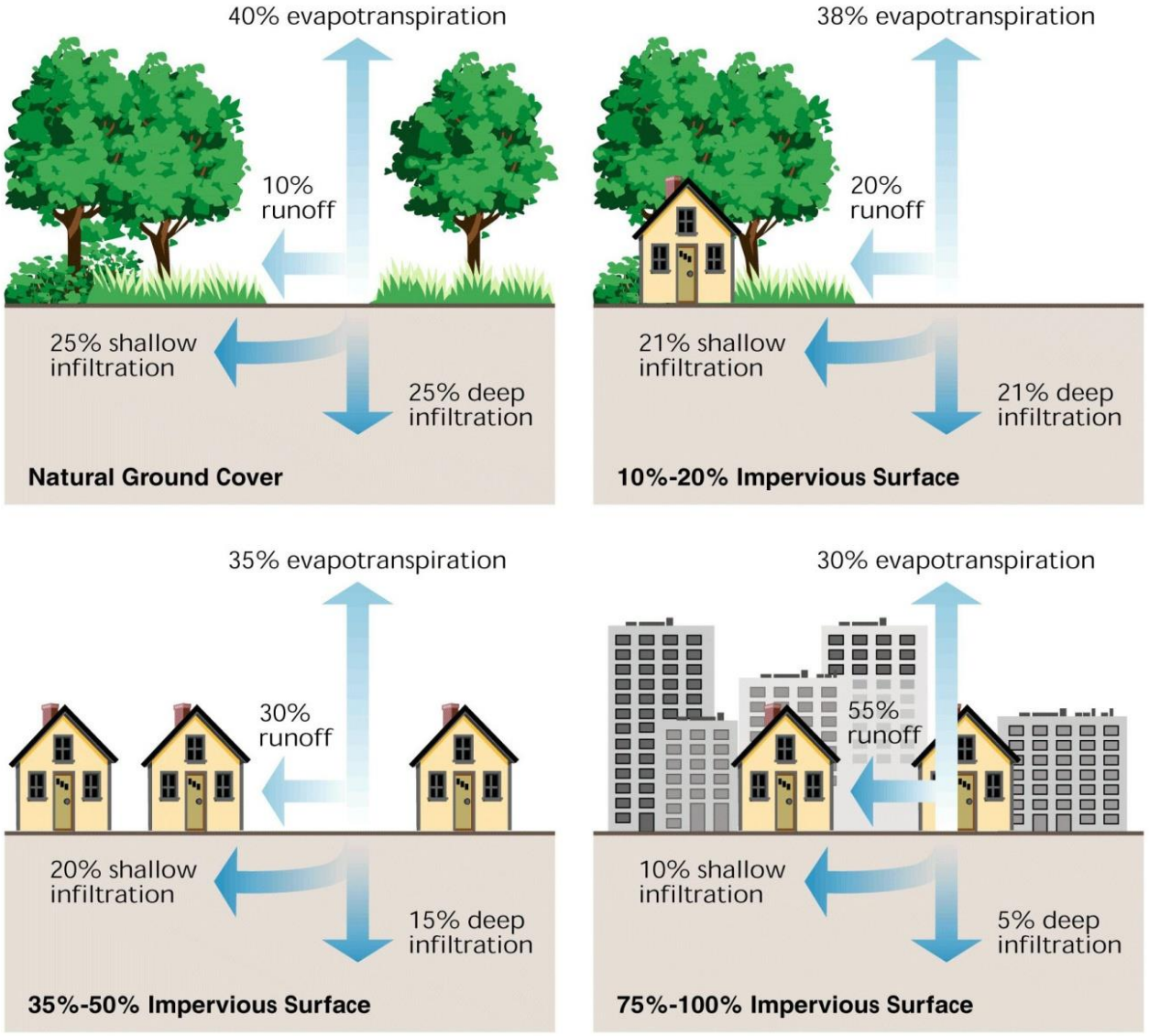
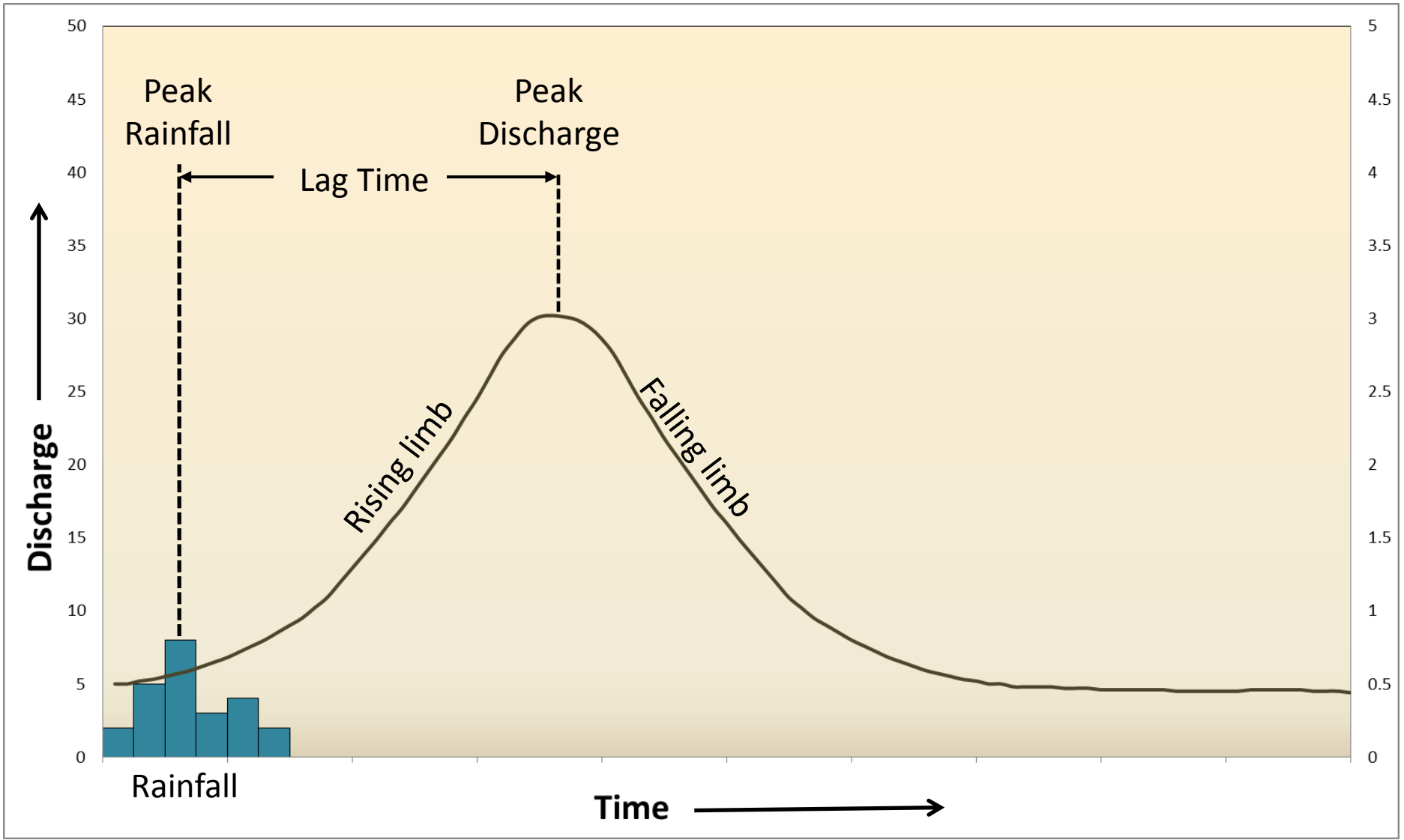
Development Changes Runoff

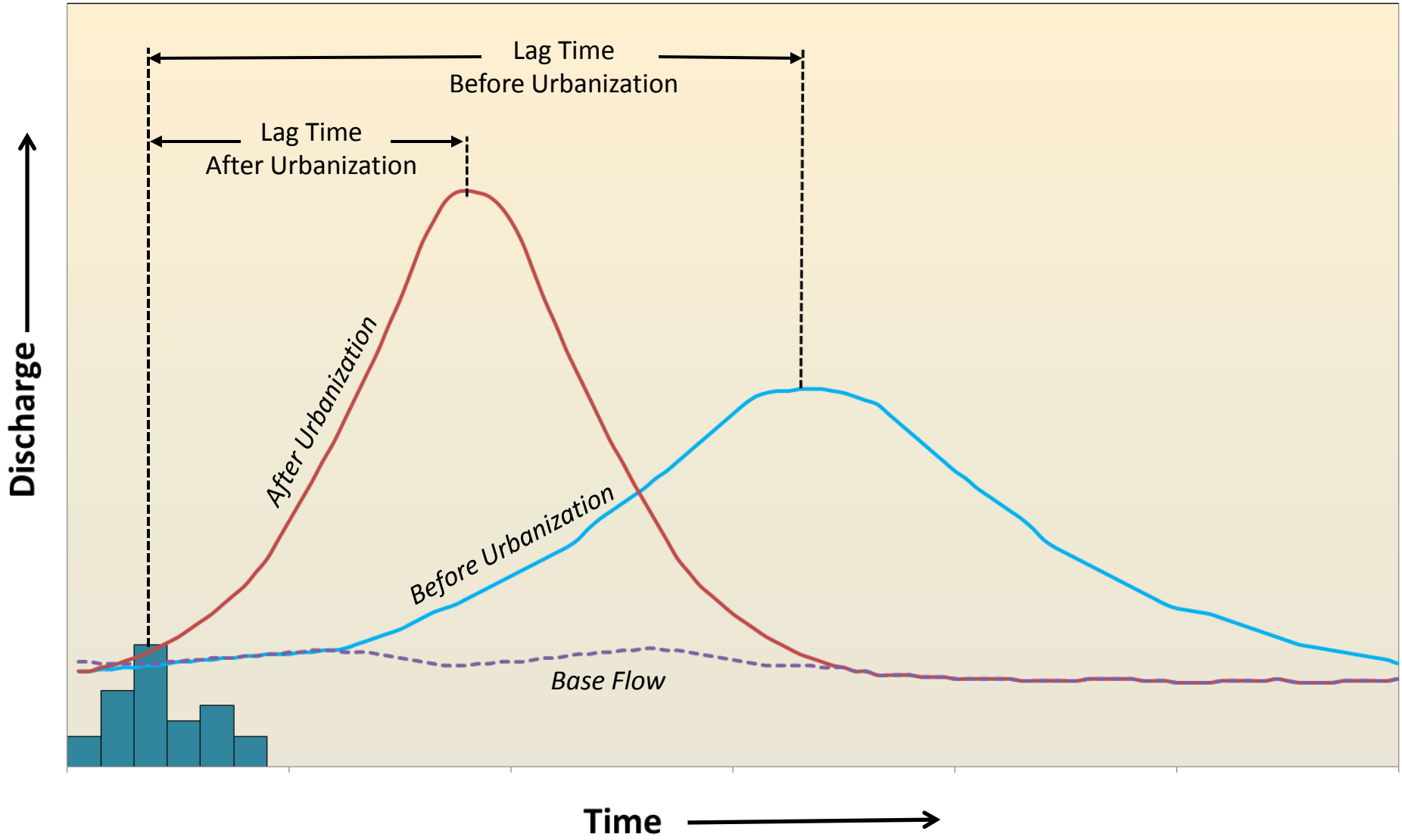


FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't).

A **hydrograph** shows the movement of water during and after precipitation



Impact of urbanization on streamflow



Undeveloped v. developed stream

Hydrological impacts of development on water resources

- Urban runoff and flashiness

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2 hours later…

Hydrological impacts of development on water resources

- Urban runoff and flashiness
- Decrease in stream baseflow

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Hydrological impacts of development on water resources

- Urban runoff and flashiness
- Decrease in stream baseflow
- Changes to wetlands
- Streambank instability
- Agricultural stream degradation

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Quick Quiz

How would you reduce the impacts of urbanization on our lakes, streams, and wetlands? What changes to the developed landscape would you recommend?

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Observed Climate Changes

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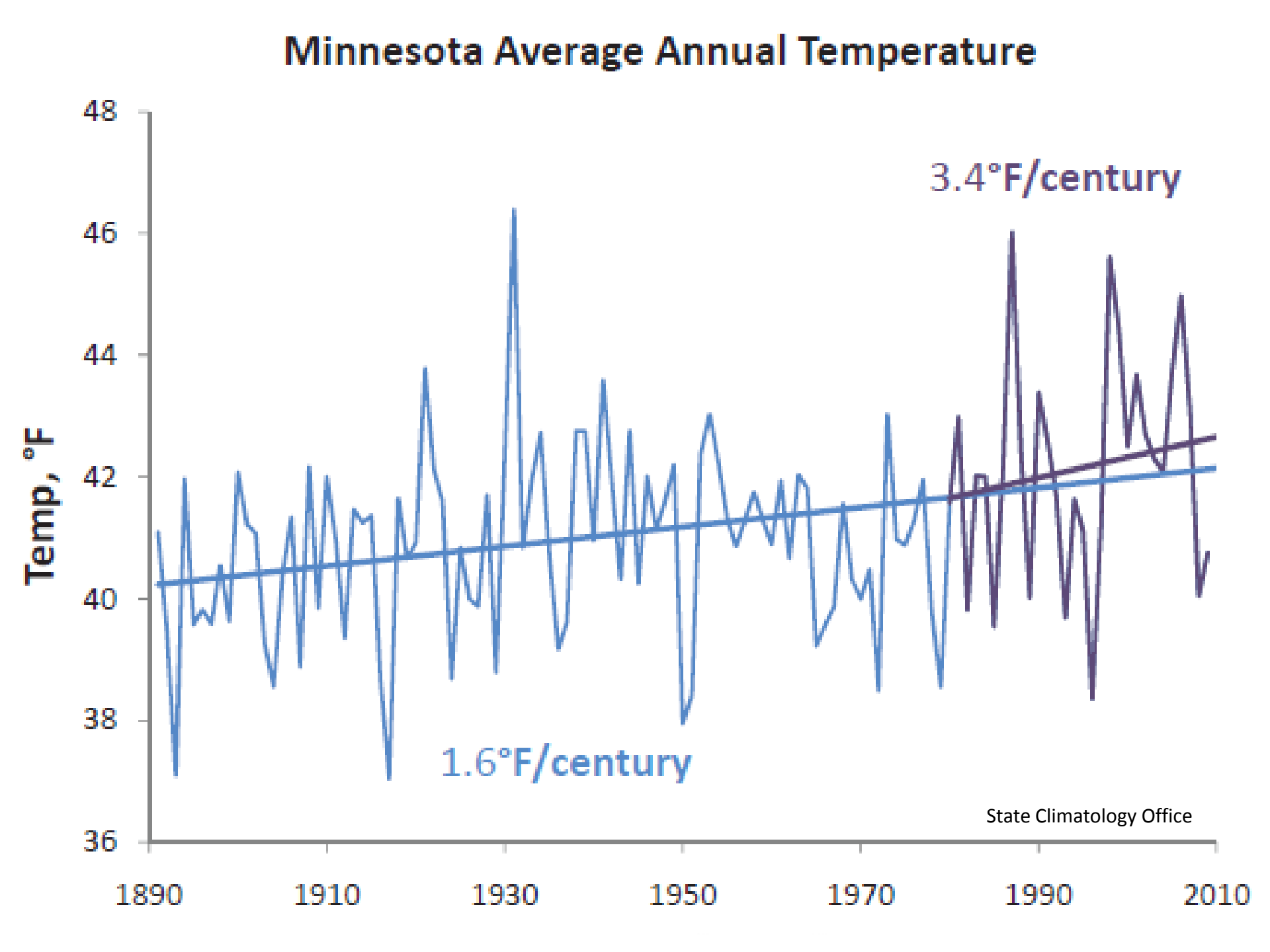
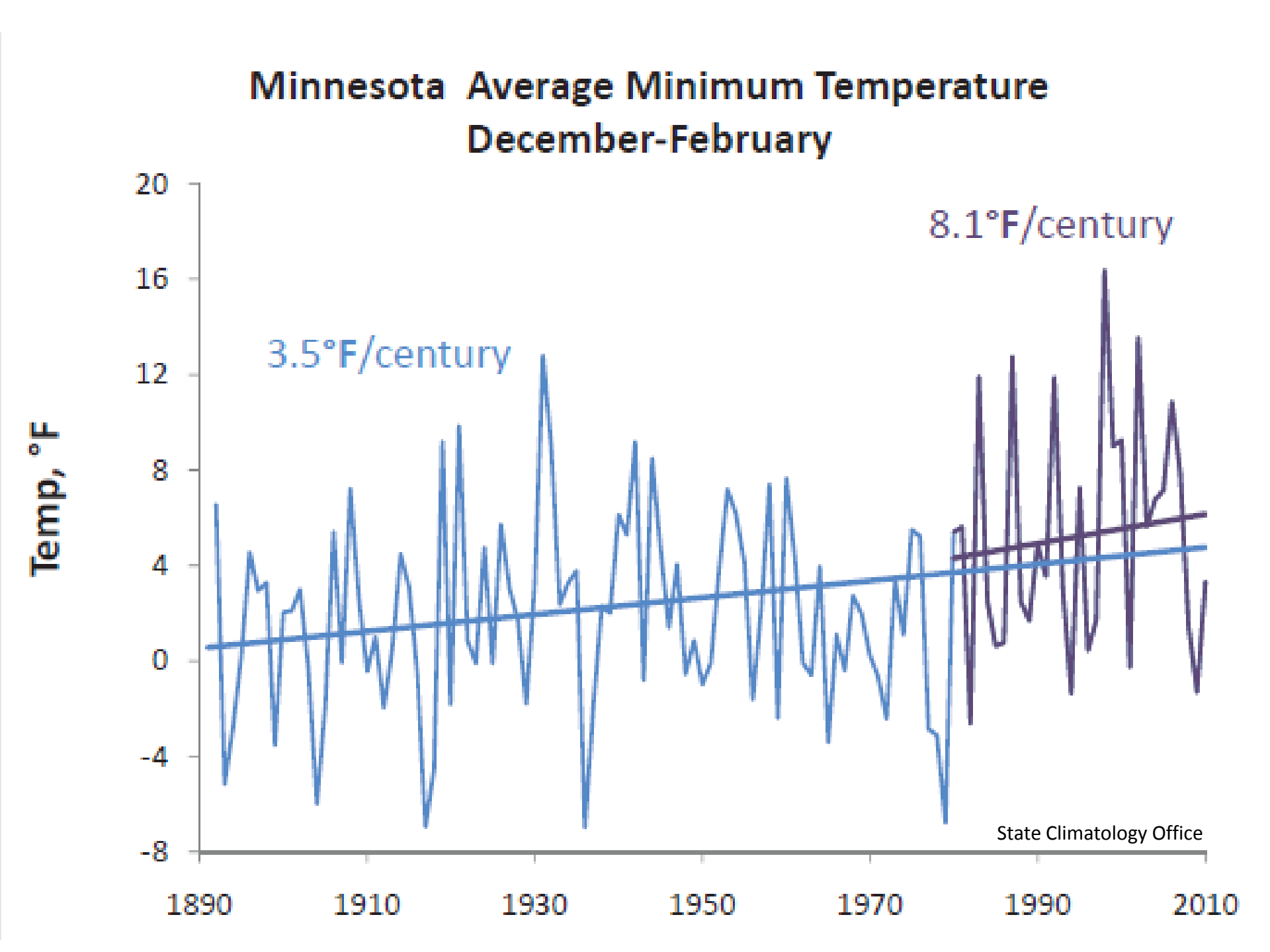
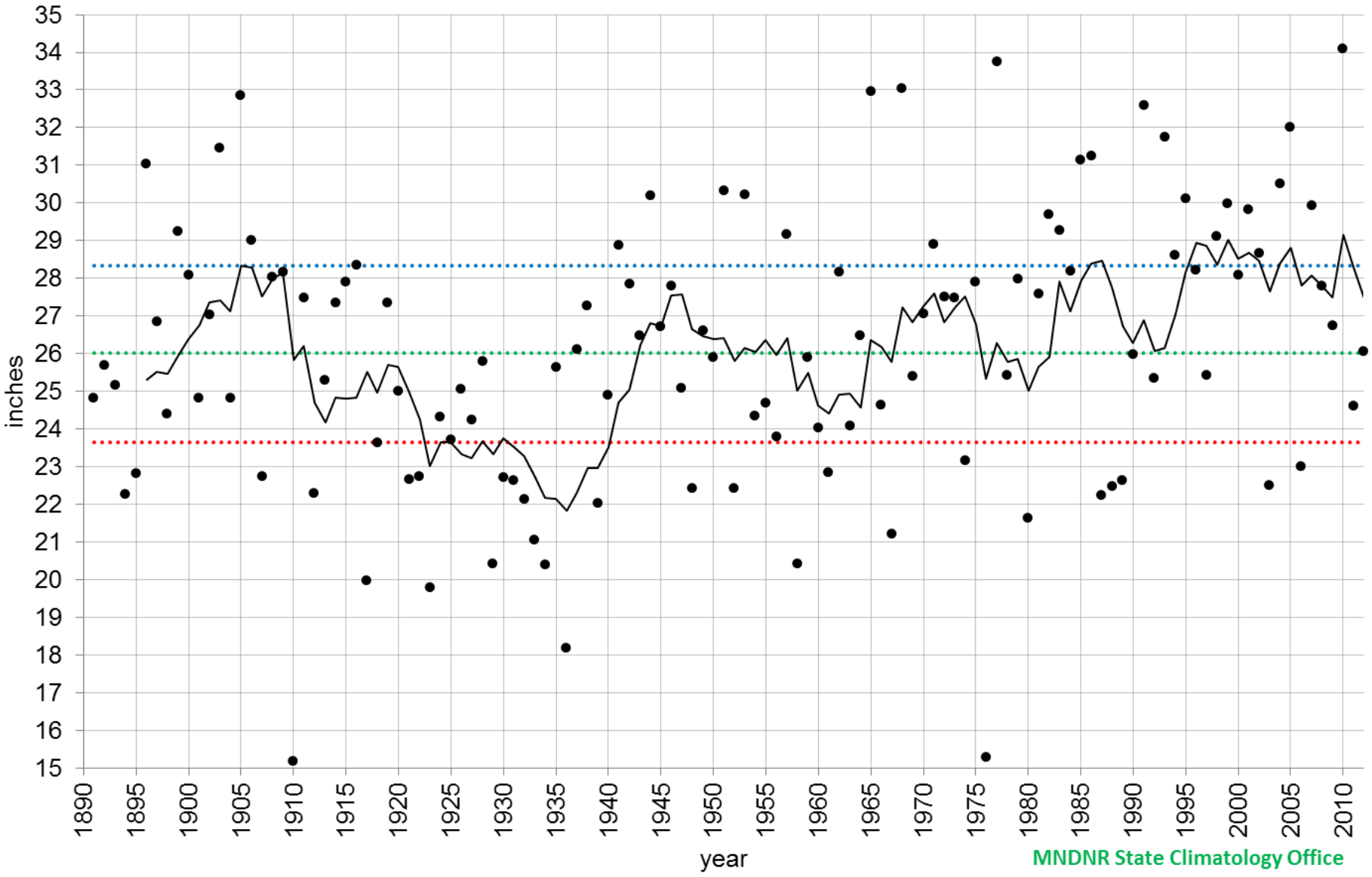
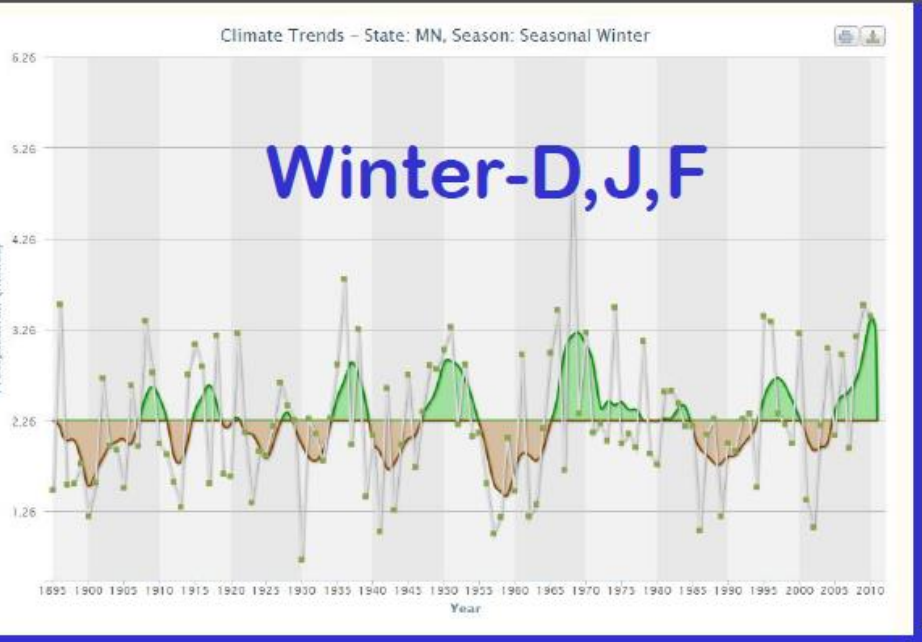
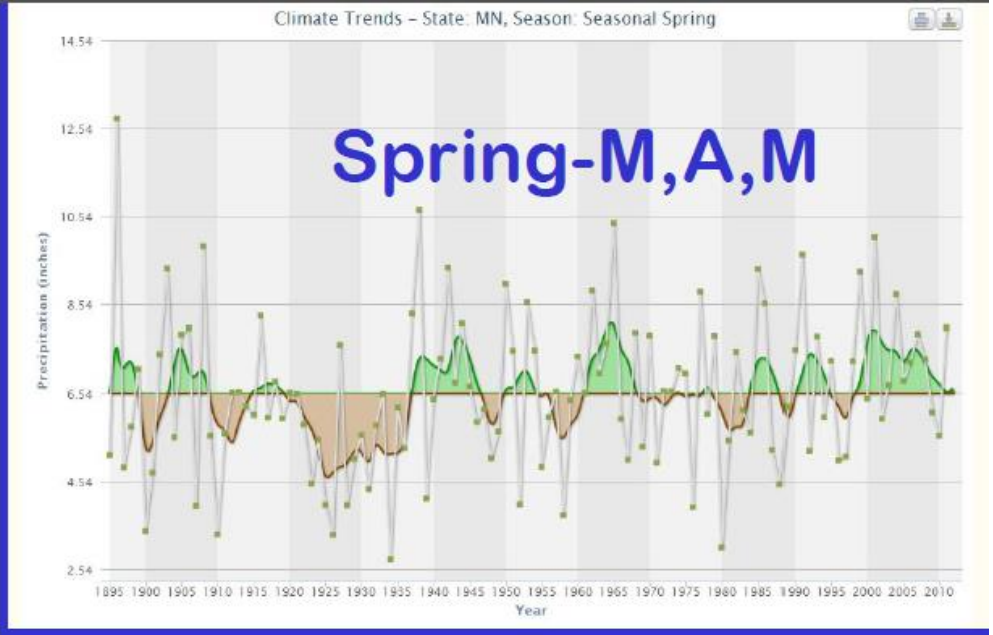

Minnesota Average Annual Temperature
Temp, °F
48
46
44
42
40
38
36
1890
1910
1930
1950
1970
1990
2010
3.4°F/century
1.6°F/century
State Climatology Office


Minnesota Average Minimum Temperature
December-February
Temp, °F
20
16
12
8
4
0
-4
-8
1890
1910
1930
1950
1970
1990
2010
3.5°F/century
8.1°F/century
State Climatology Office

Minnesota State-Averaged Annual Precipitation

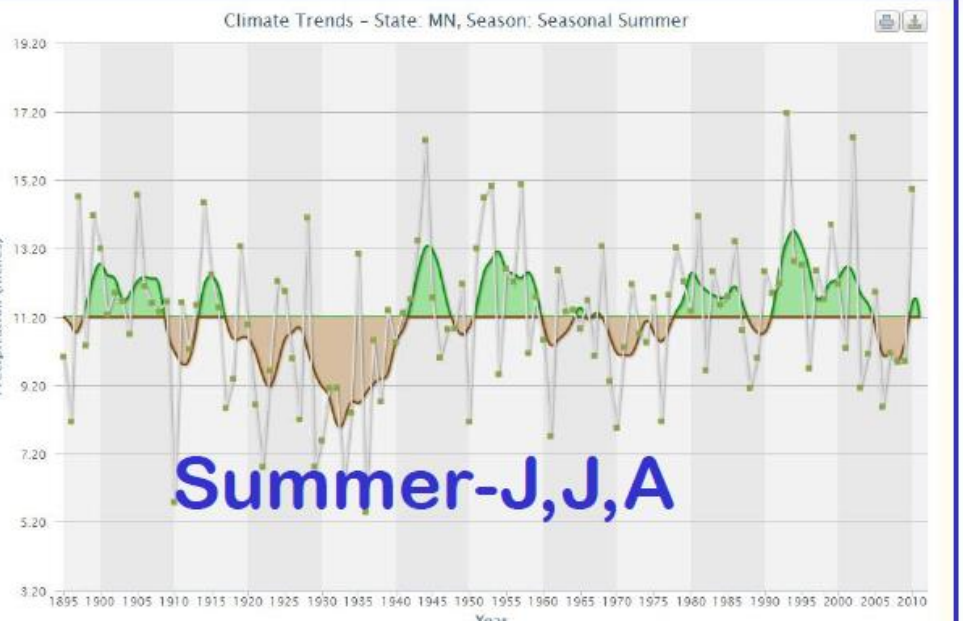


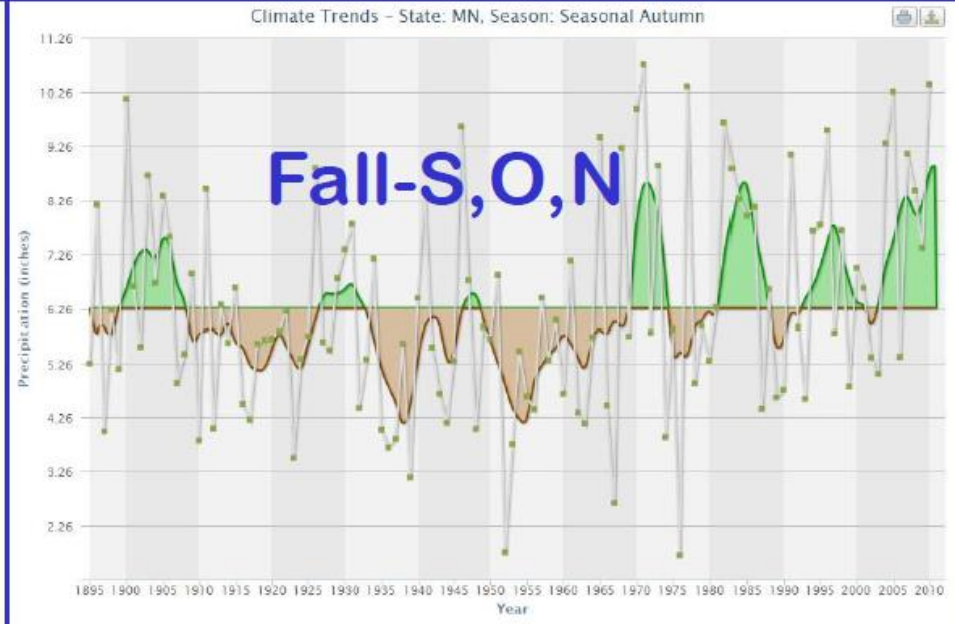




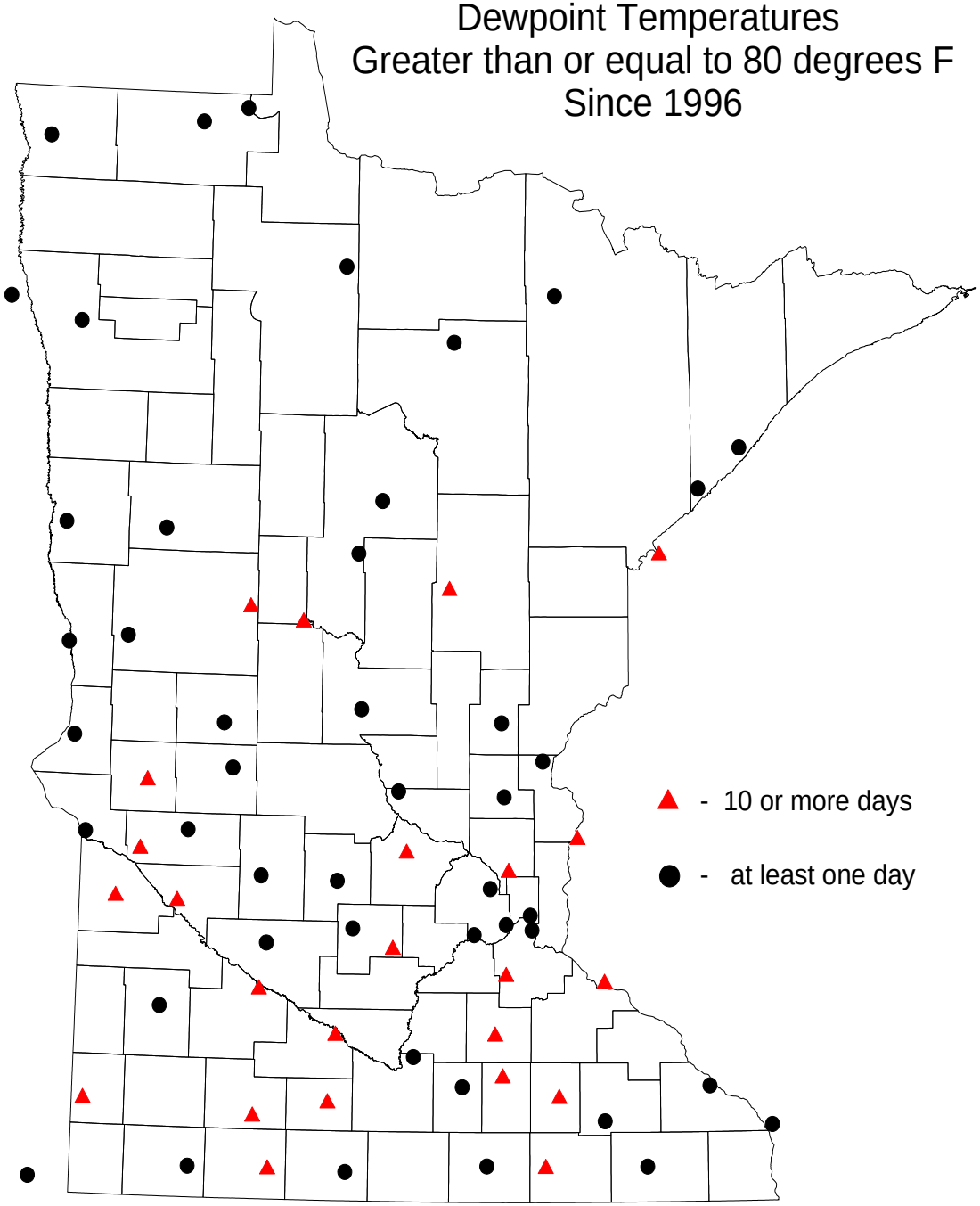
Seasonality in MN Precipitation Trends

Dr. Mark Seely





Dewpoint Temperatures
Greater than or equal to 80 degrees F
Since 1996



State Climatology Office - DNR Waters

Impacts of Change in Climate

- Warmer temperatures: more ET
- Some areas dryer, others get more rain
- Rain events more intense
- Warmer winters: less snow and snowpack
- Longer growing season: more irrigation withdrawals
- Increase in water temperature

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Writing Assignment

What could be done to minimize the impacts of changing climate on our water resources?

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Homework

Visit your county website's property map (in Hennepin County, (gis.hennepin.us/property/map) and zoom in on your property. Click Hybrid, then the "More…" button and select Parcel Annotation. Print this and trace or freehand sketch a diagram of your property showing the house, driveway, garage, and any other impervious areas such as outbuildings, patios or decks, alleys, etc. Label the dimensions and estimate the amount of impervious surface. Calculate the amount of runoff from a 1" event.

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Reflections and Final Thoughts

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