



# Where Does it Hurt? Ecological Needs of the Poudre

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Civil and Environmental Engineering  
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State  
University

# Outline

Address three questions:

- How does the river work (ecologically)?
    - River integrity
    - Hydro-ecology 101
  - What kind of river do we have today, and what might we be most concerned about in the future (ecologically)?
  - What can we do?
- Take home messages and a question for you

# Geographic Focus

- Canyon mouth to Greeley
  - integrates the 1000+ square miles upstream
  - hardest working segment of the river
  - most vulnerable segment of the river
  - a focal point of the relationship between people and the river

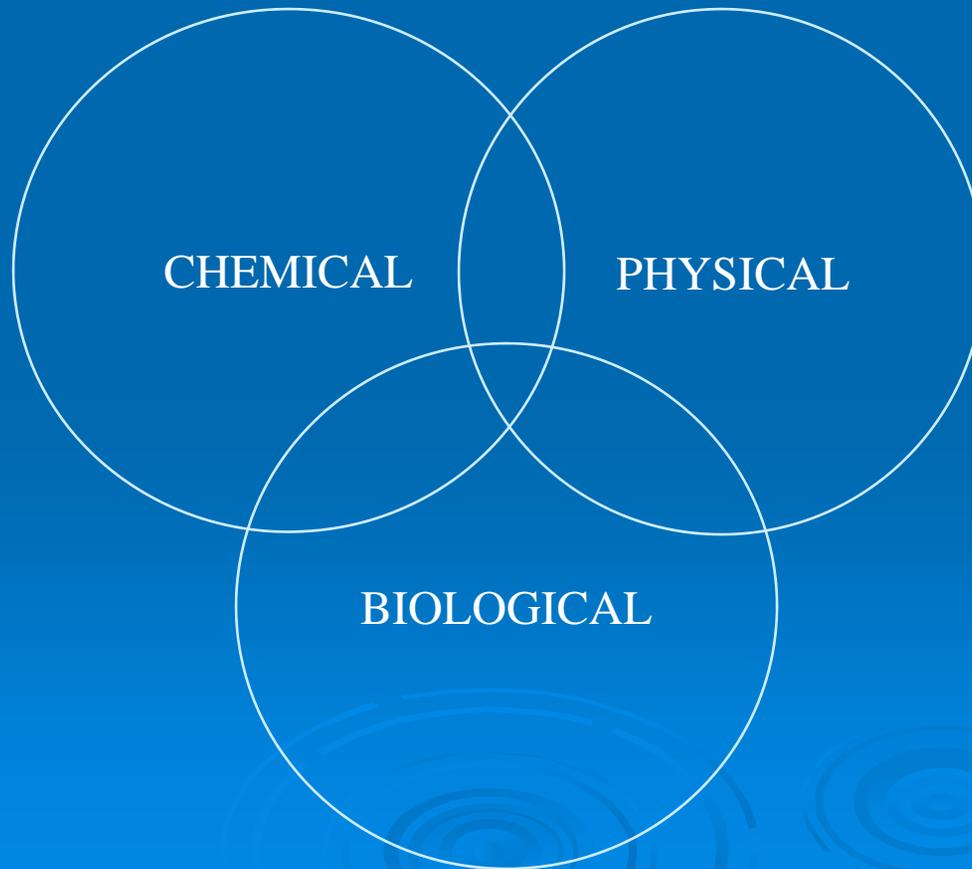


How does the river work  
(ecologically)?

What is river integrity?



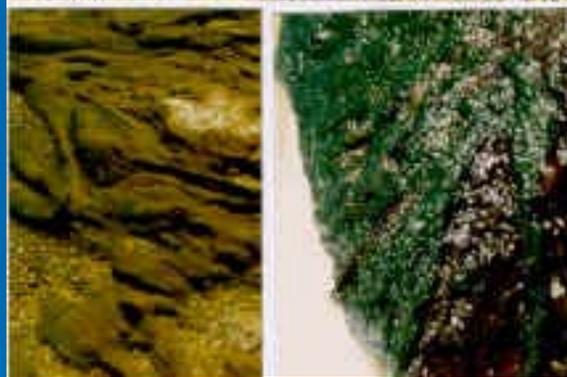
“To restore and maintain the  
chemical, physical, and biological  
integrity of the Nation’s waters”







NABS ([www.benthos.org](http://www.benthos.org))



# River Flow Patterns

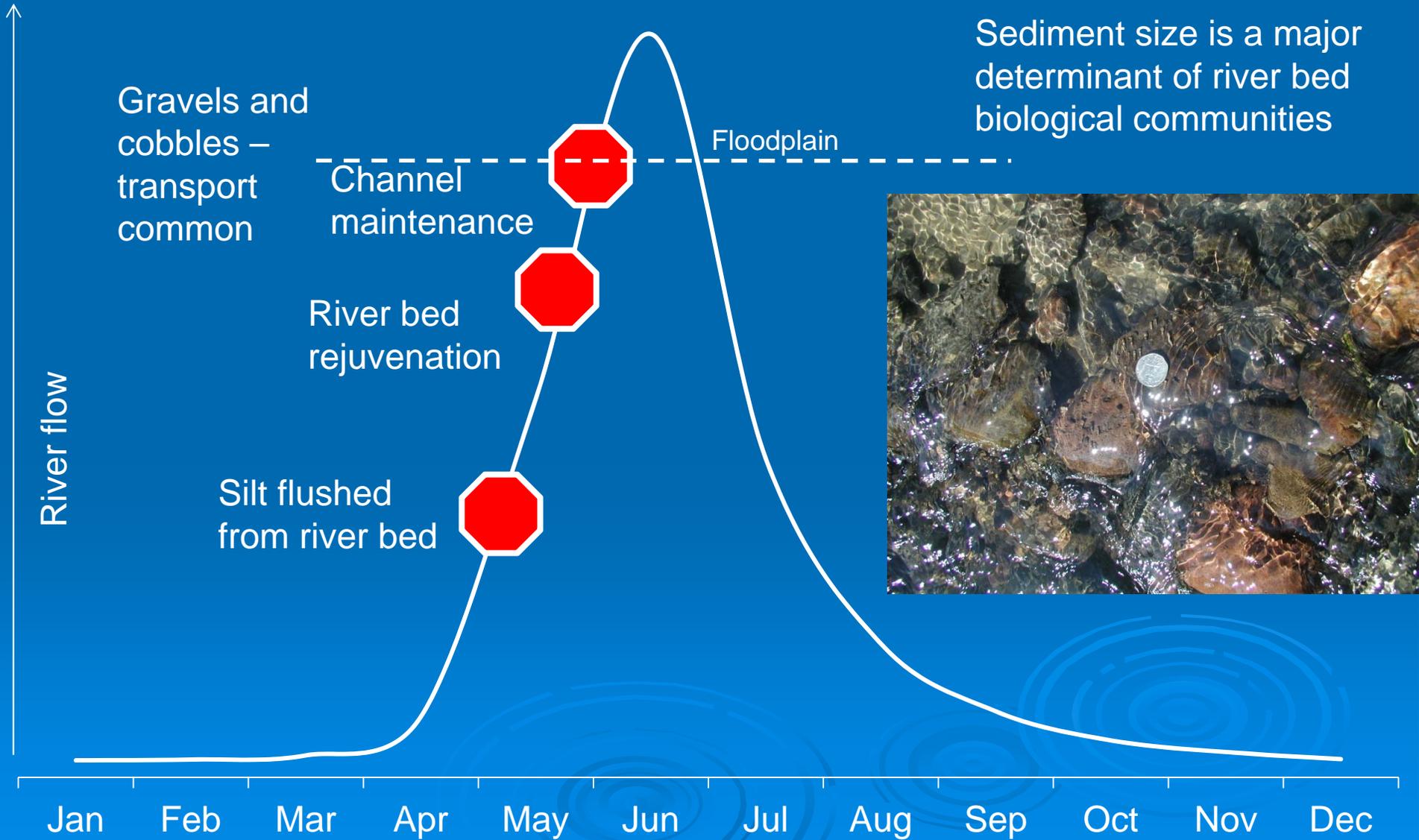
- The “conductor” or master variable of the river ecosystem
  - 5 key characteristics:
    - Magnitude
    - Frequency
    - Duration
    - Timing
    - Rate of Change
- 

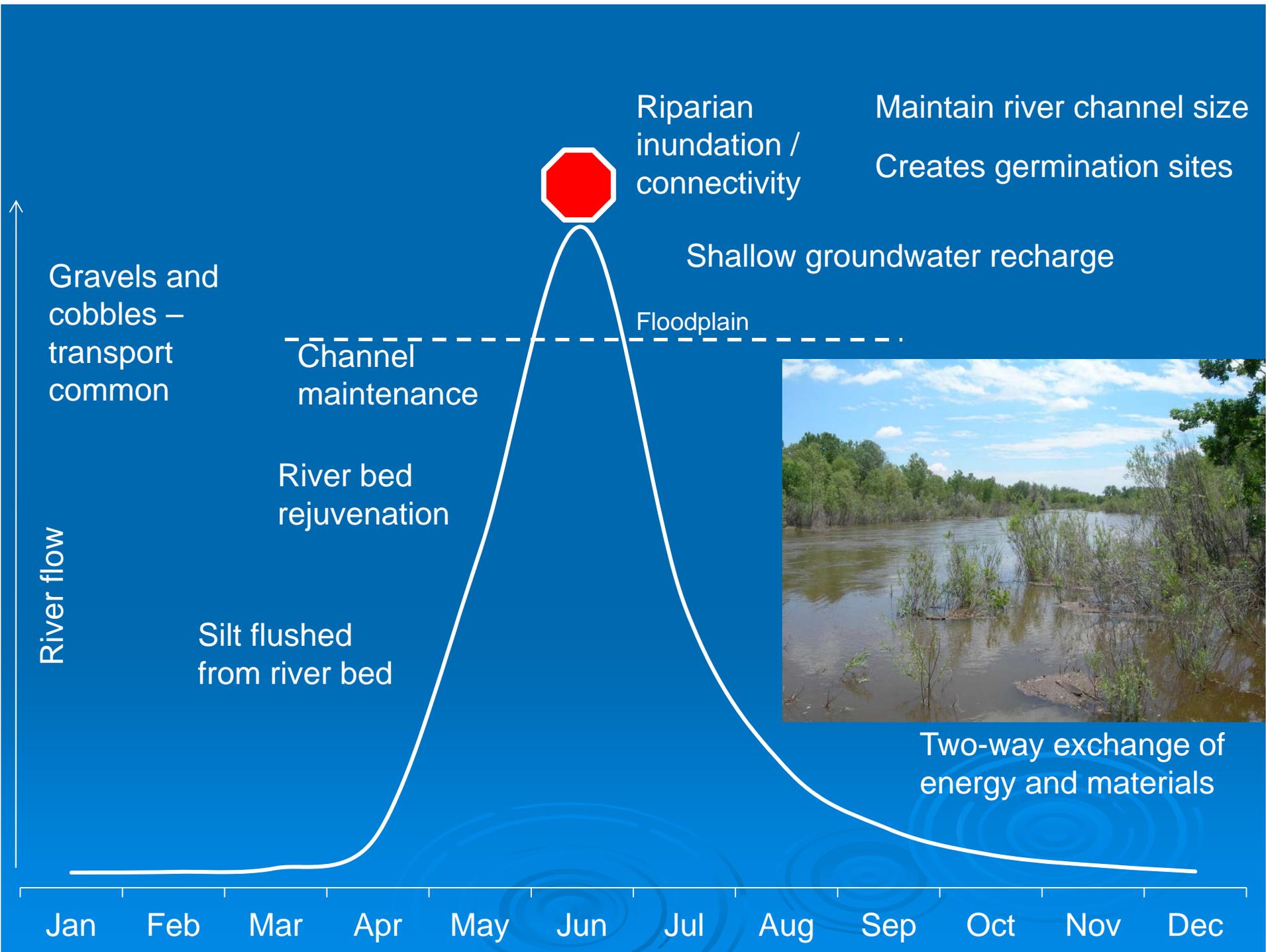
# A Brief Tour of a Poudre River Hydrograph



Maintain river channel size

Sediment size is a major determinant of river bed biological communities





Gravels and cobbles – transport common

River flow

Silt flushed from river bed

River bed rejuvenation

Channel maintenance



Riparian inundation / connectivity

Shallow groundwater recharge

Floodplain

Maintain river channel size  
Creates germination sites



Two-way exchange of energy and materials

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



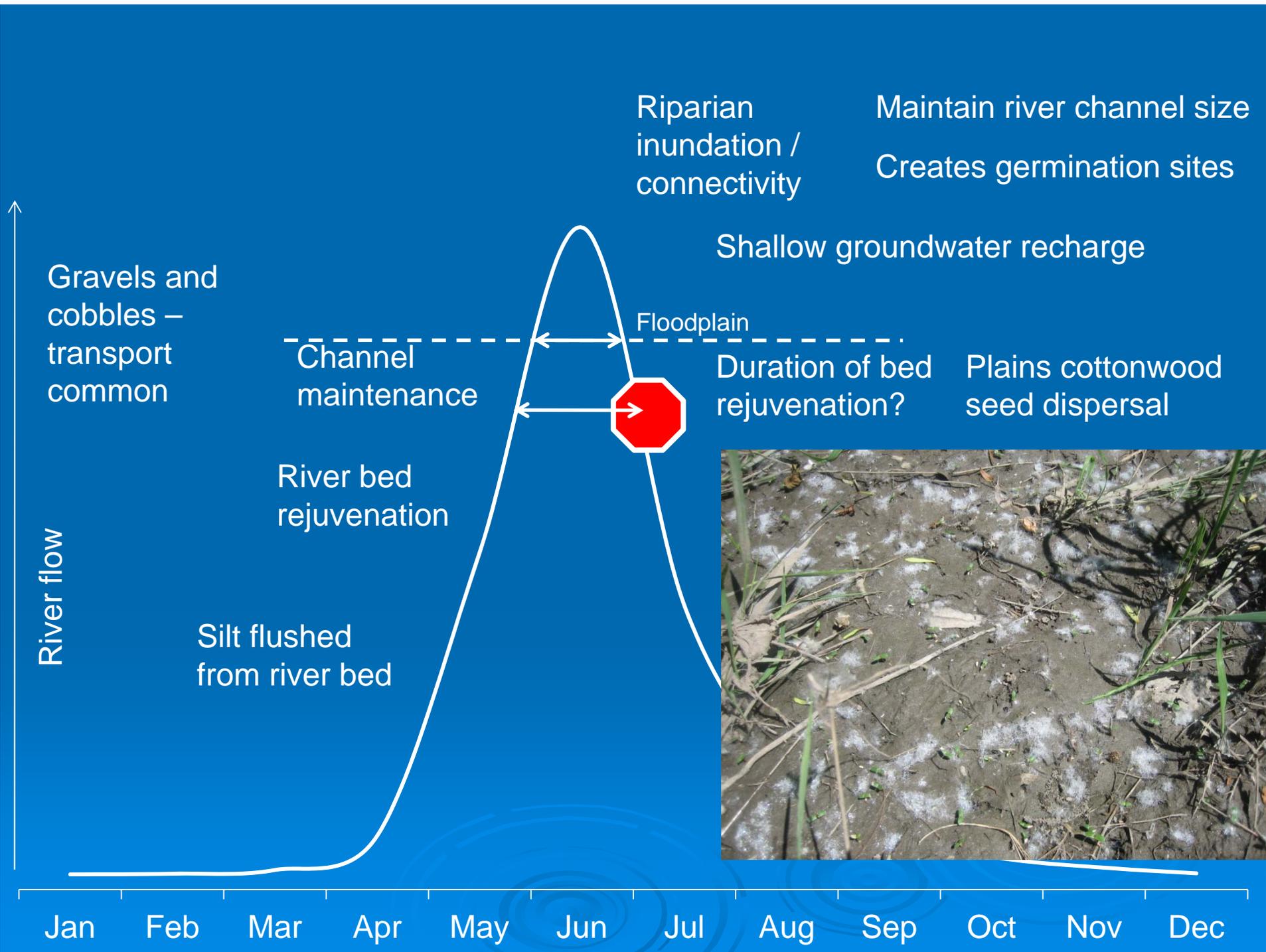
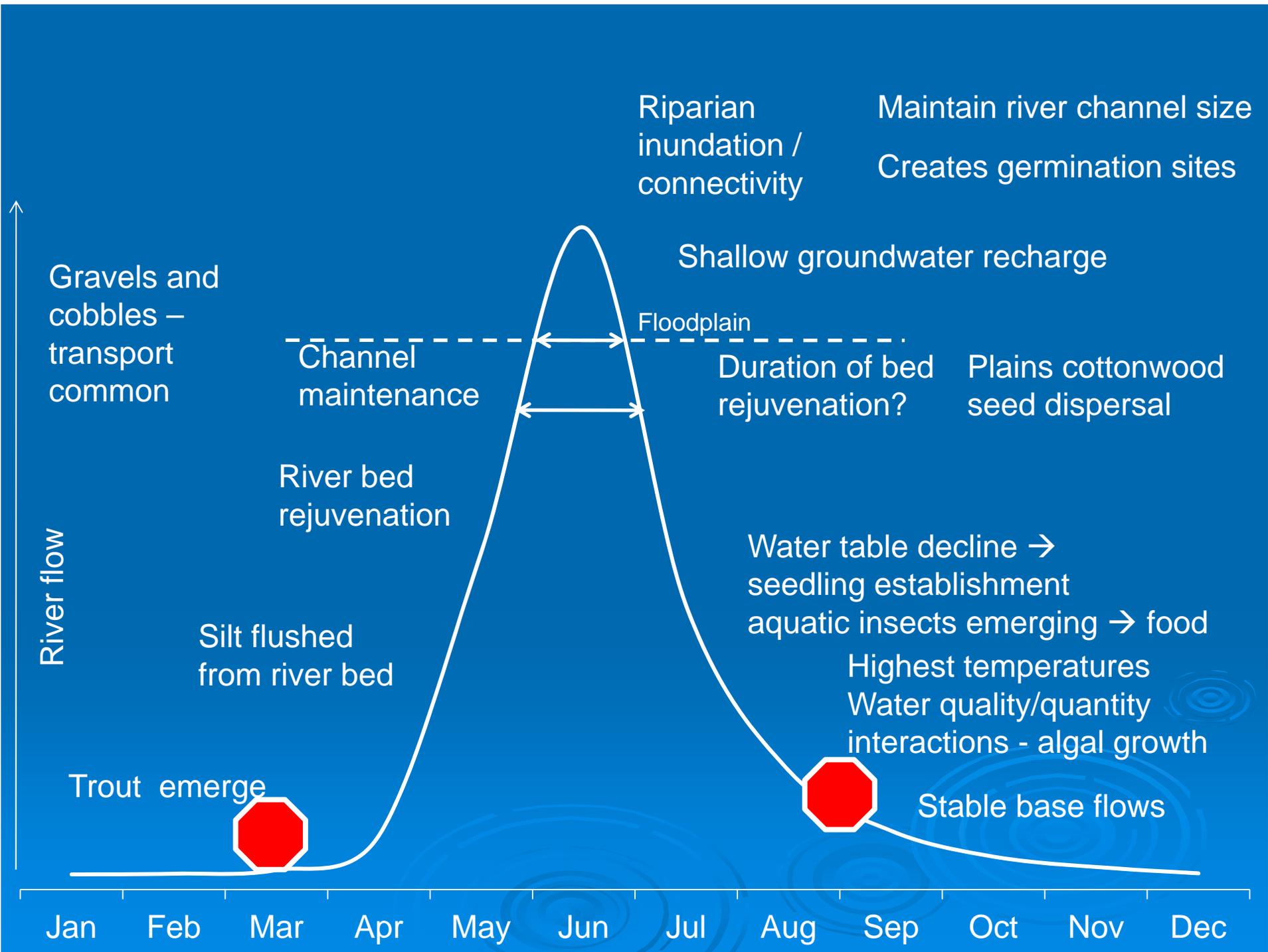






Photo courtesy of  
David Merritt USFS





## Brown trout

Late summer / fall temps  
Fall spawning

Spring emergence



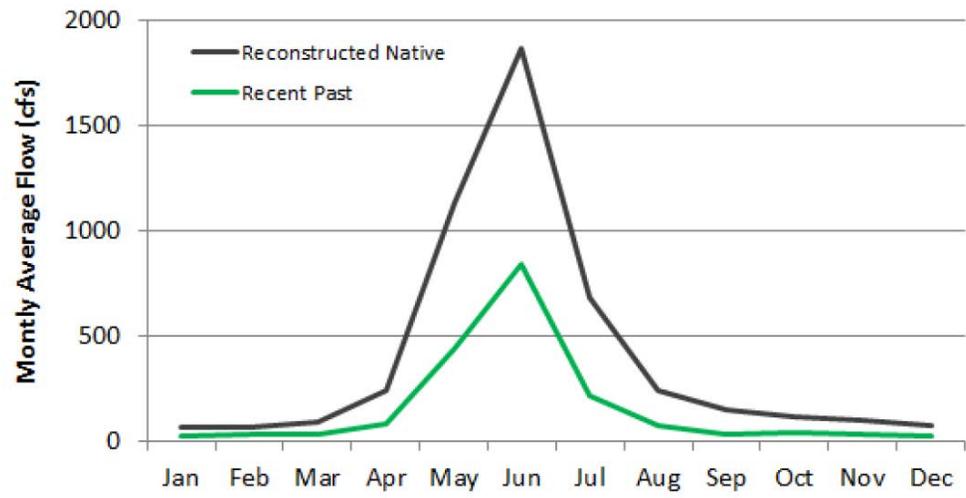
Photo Credit: Dave (Gio) Giordano

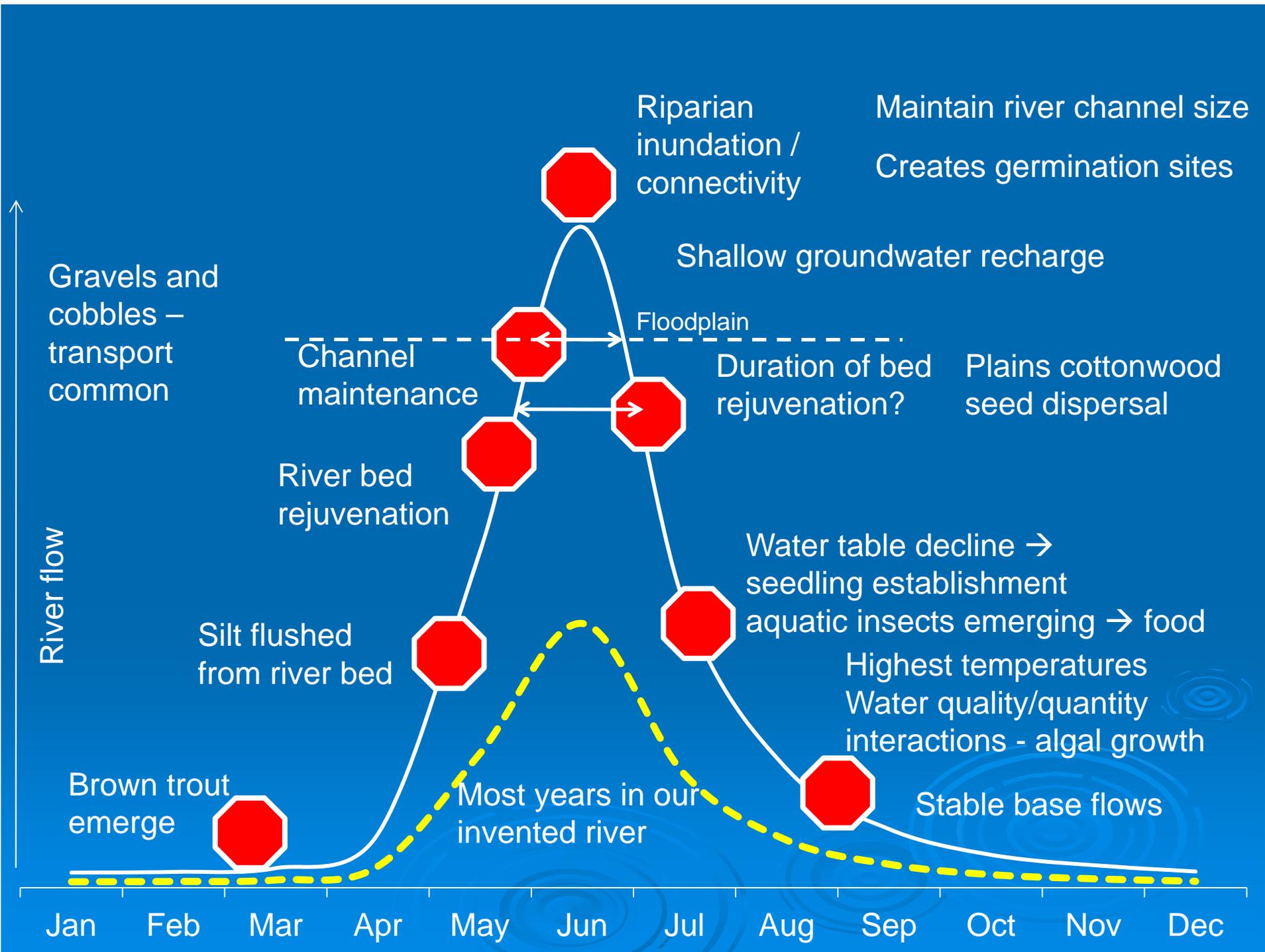
What kind of river do we have today (ecologically)?

What might we be most concerned about?









# Some Key Concerns

- Degraded water quality
    - River bed clogged with sediment
    - More filamentous algae
  - Maintain fisheries (trout and native)
  - Maintain flood conveyance
  - Maintain recreation and aesthetic appeal
  - Maintain valued biota
- 
- The bottom right corner of the slide features a decorative graphic of several concentric, light blue circles, resembling ripples on water, set against the dark blue background.

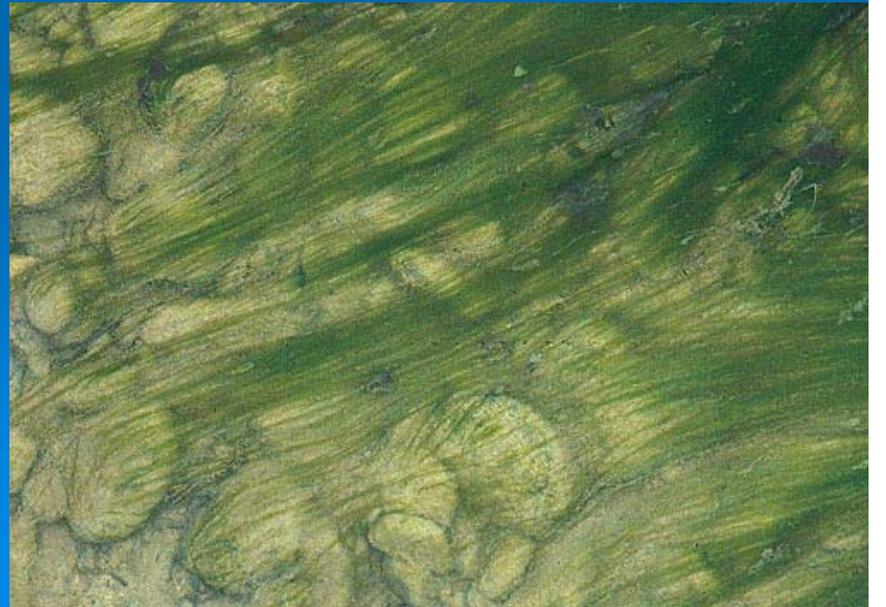
# Reduced Summer Low Flows

- Loads of N and P result in higher concentrations in less water / less scour
- Higher temperatures
- Water quality / quantity interactions

MORE PRODUCTION OF ALGAE

WITH SHIFTS TO FILAMENTOUS FORMS

– reduced aesthetic appeal for fishing and recreation, also food web effects



# Summer / Fall Base Flows



Stable base flows

Temperatures cool enough  
to maintain trout

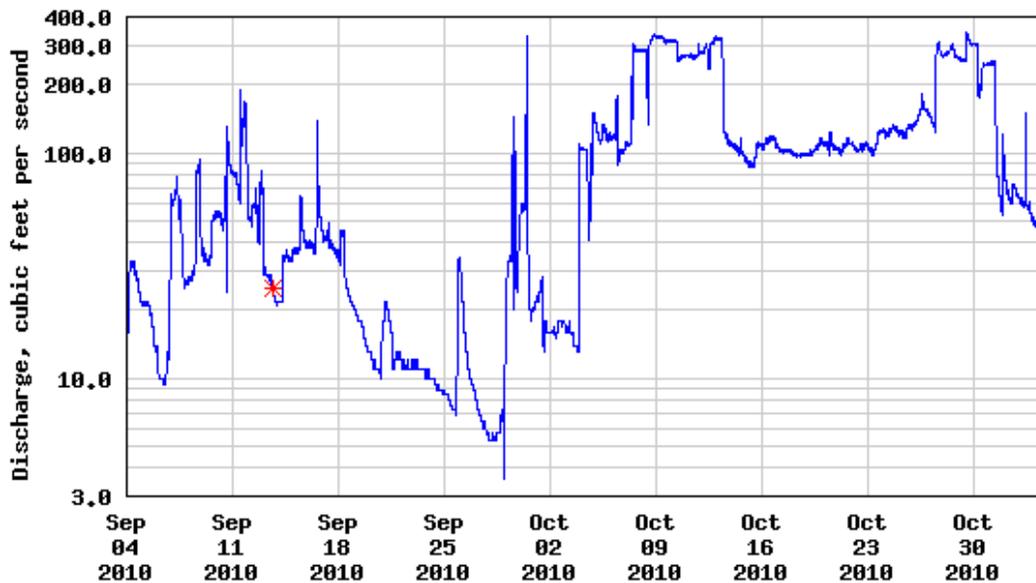
Jul

Aug

Sep



### USGS 06752260 CACHE LA POUVRE RIVER AT FORT COLLINS, CO



----- Provisional Data Subject to Revision -----

— Discharge

\* Measured discharge

Unstable base flows

Too warm for trout survival

Jul

Aug

Sep

# What if very low flows extend into winter?



Spring emergence or frozen?

# Flood Conveyance





Looking upstream  
from Shields Ave. in  
Fort Collins - 2004

Same location 2010







Fort Collins 1904



1999

# Valued biota



# Plains cottonwood



# Trout and Native Fish Habitat



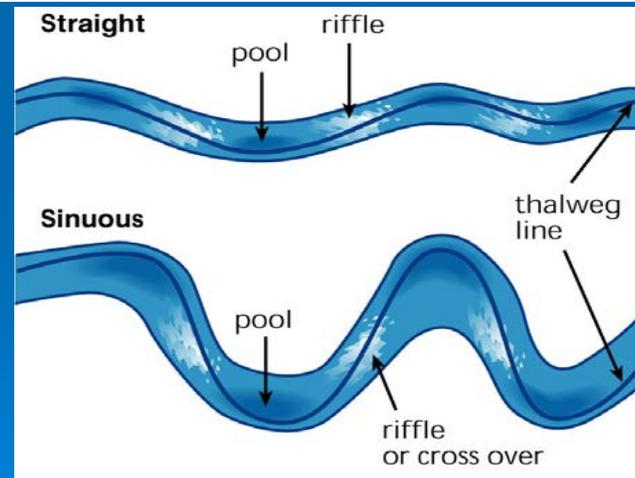
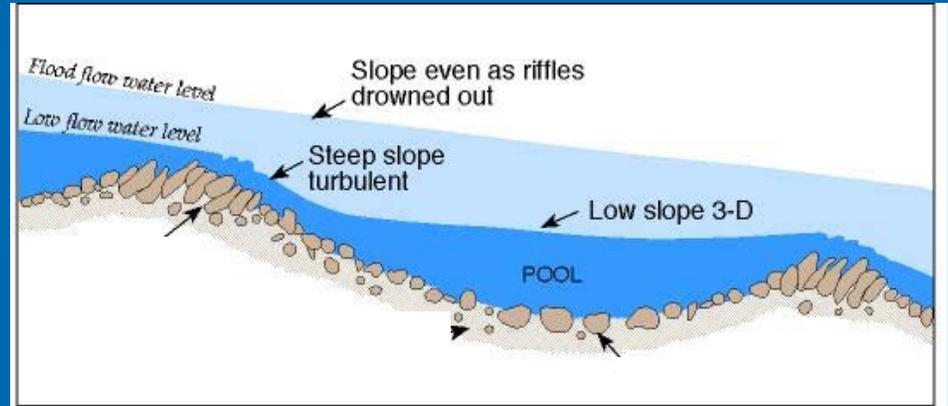


Photo Courtesy of Greg Wilkerson

Cinderella's castle - Disneyland

A meandering river...

But does it have diverse habitat for fishes?



Many combinations of depth, flow velocity, and gravel sizes?

What can we do?



# What can we do?

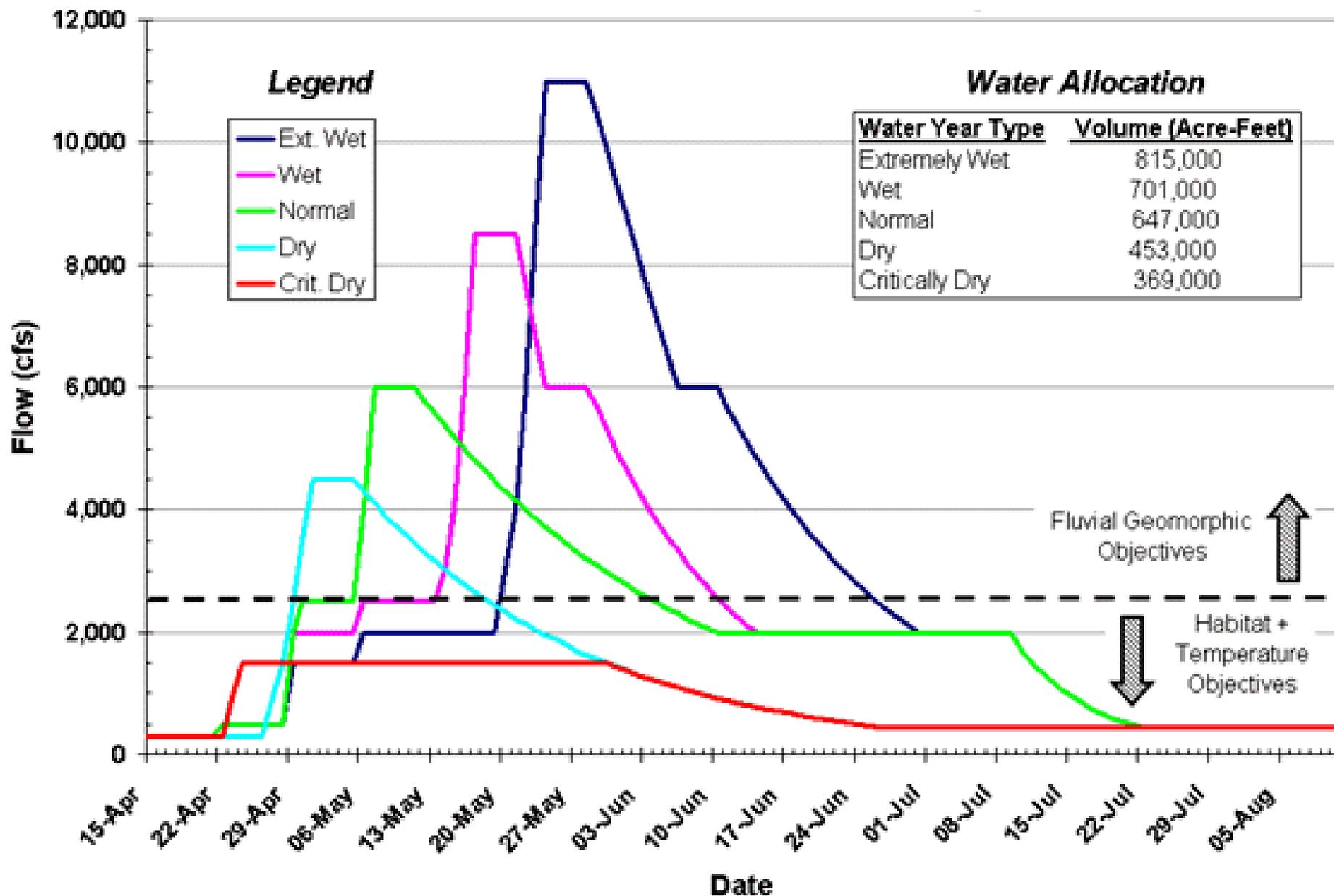
- Work towards environmental flows that conserve river amenities and functions
  - Some aspects easier than others
  - Engineers need numbers
  - Reduce waste and inefficiency
  - Cooperation, conservation, reuse
- “Pearls on a String” / “Room for the River”
- Economic valuation of ecosystem services

# Environmental Flows

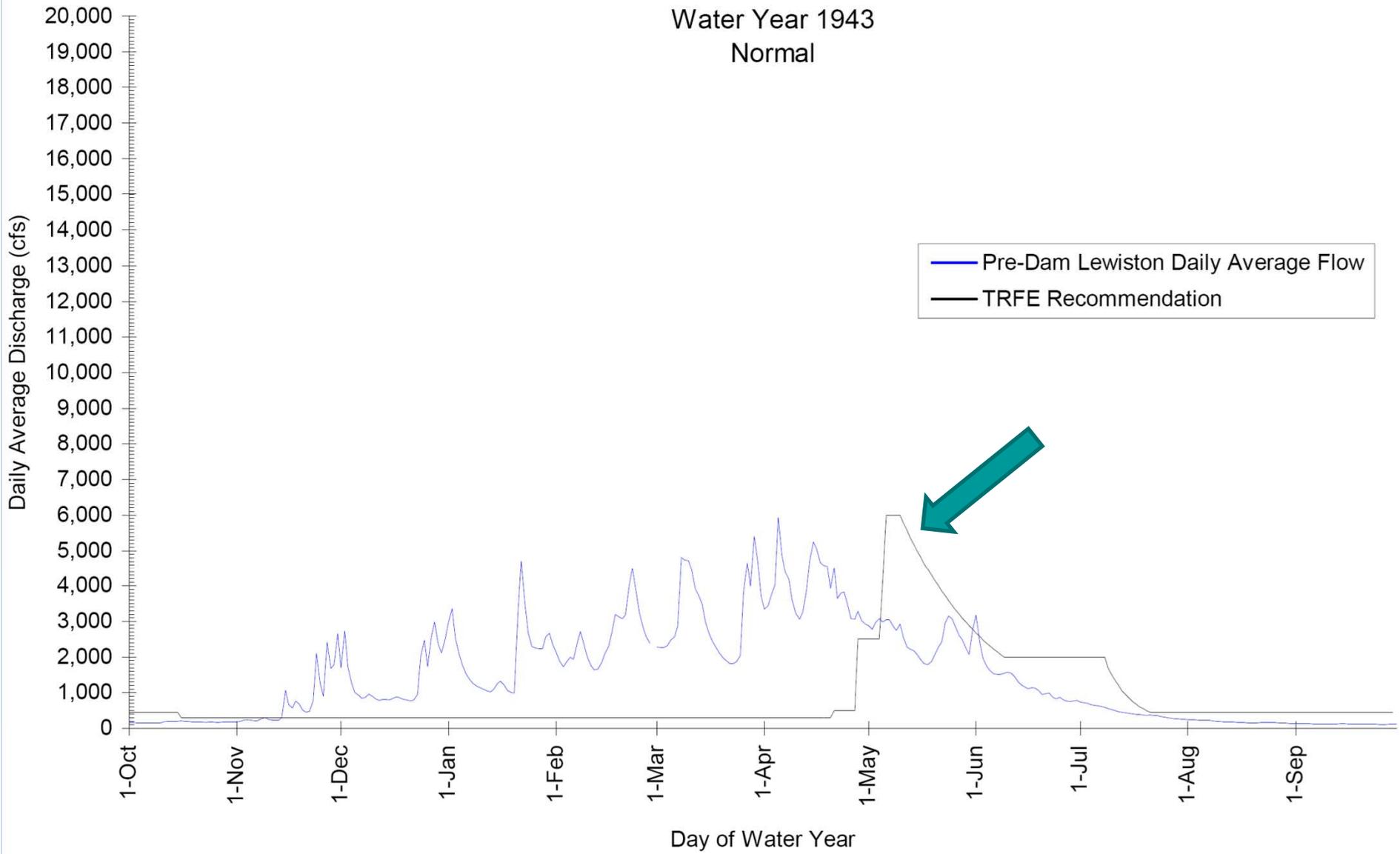
Amount of the original flow regime of a river that should continue to flow down it and onto its floodplains to maintain specified, valued features of the ecosystem such as:

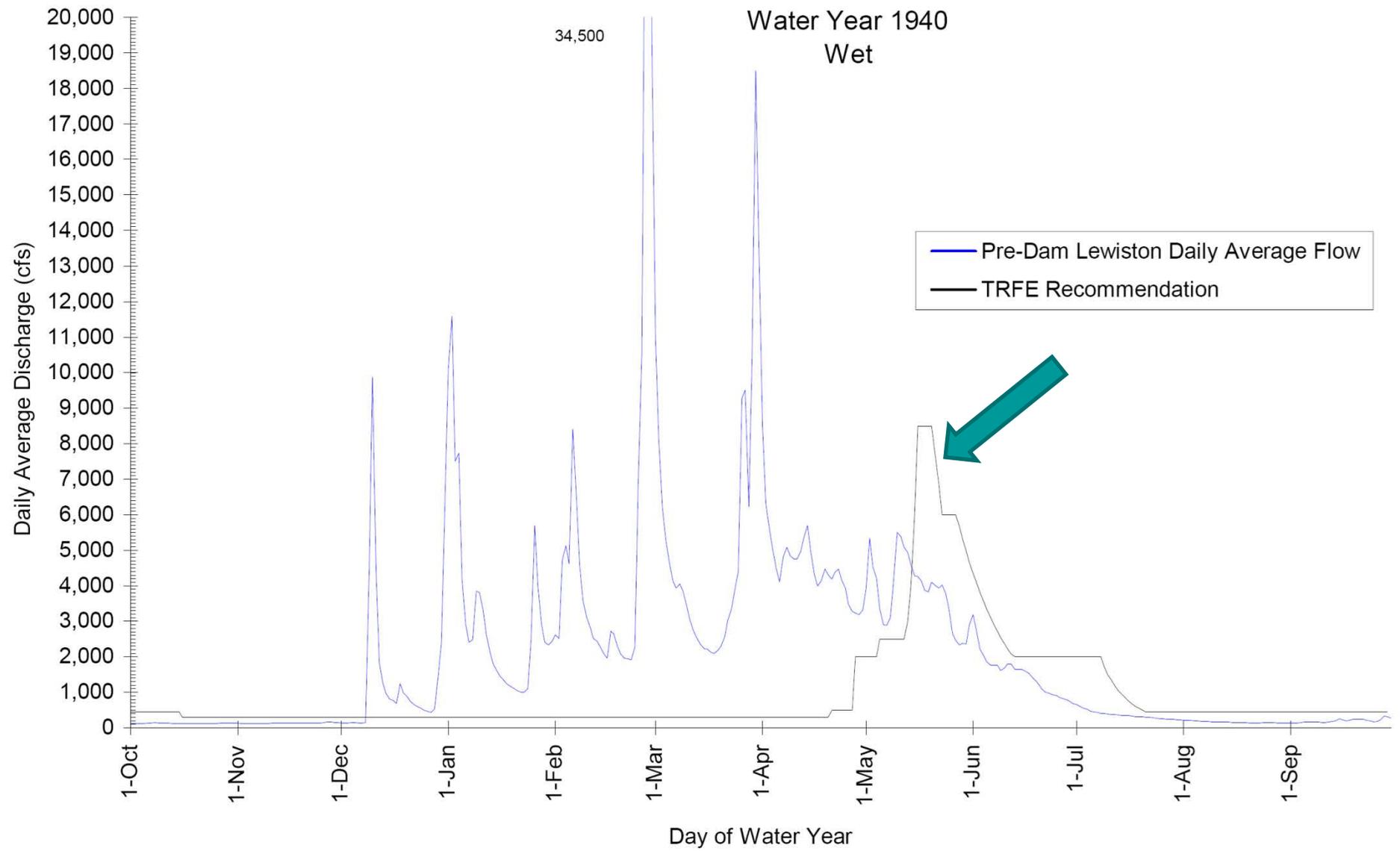
- recreation and aesthetics
  - channel form and capacity
  - habitat quantity, quality, complexity
  - fish and wildlife
  - life history patterns – spawning and recruitment
  - longitudinal continuity
  - riparian vegetation
- 

# ROD Recommended Flow Releases from Lewiston Dam to the Trinity River

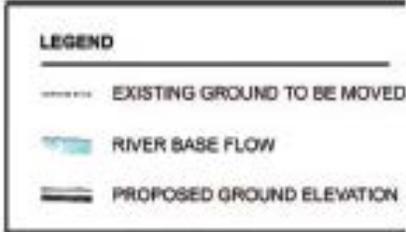


# Water Year 1943 Normal









# Urban River Parkways

*An Essential Tool for Public Health*

Richard J. Jackson, MD, MPH - UCLA Fielding School of Public Health

Tyler D. Watson, MPH - UCLA Fielding School of Public Health

Andrew Tsiu, MPH - UCLA Fielding School of Public Health

Bianca Shulaker, MURP - USC Department of Urban Planning

Stephanie Hopp, MPH - Johns Hopkins School of Public Health

Mladen Popovic - UC Santa Barbara

July 2014



Center for  
Occupational &  
Environmental  
Health UCLA

Every dollar spent  
results in \$3 direct  
medical benefit

# Restoration?

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.



# A Spectrum of Poudre River Futures

Water quality



Trout fishery



Siltation / filamentous algae



Flood conveyance



Valued biota – e.g., native fishes, plains cottonwood, birds



Recreation and aesthetic appeal



Large ditch

Functioning river

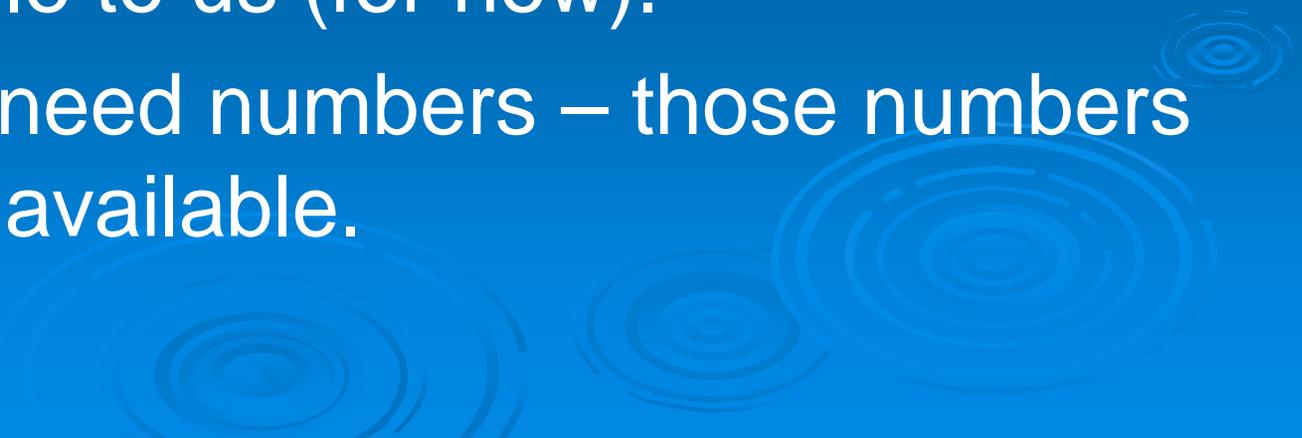
More Risk

Less Risk

# Take Home Messages

- The Poudre River is not going back to pre-development conditions – irreversible change has occurred – now an invented river ecosystem
- Restoration is not returning the river to an undeveloped historical condition. It is assisting and sustaining the recovery of an ecosystem that has been damaged.

# Take Home Messages

- The current trend of deteriorating river integrity and amenities can be reversed with environmental flows and sound long-term stewardship that balances human demands with ecosystem needs.
  - A wide range of alternative river futures is still available to us (for now).
  - Engineers need numbers – those numbers are mostly available.
- 

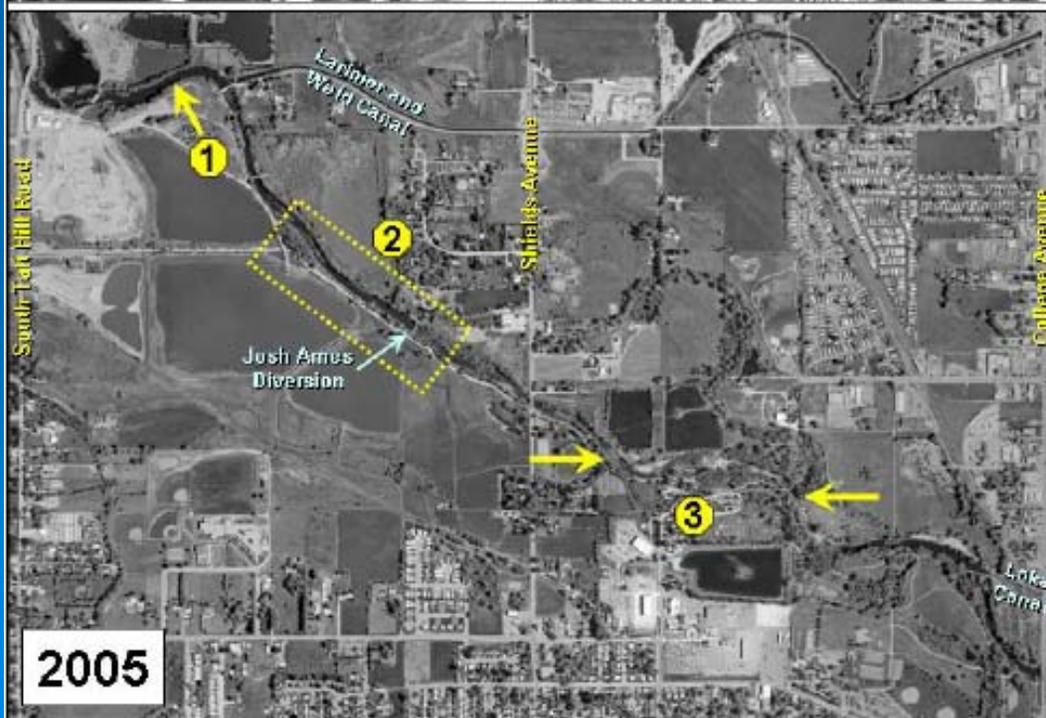
# Take Home Messages

- Focus on river services / amenities that we value the most:
  - Clean water
  - Trout and native fishes
  - Valued flora and fauna
  - Flood conveyance
  - Recreation and aesthetic appeal...
- Healthy farms and cities are compatible with sustaining these river amenities
- WE MUST HAVE A VISION!

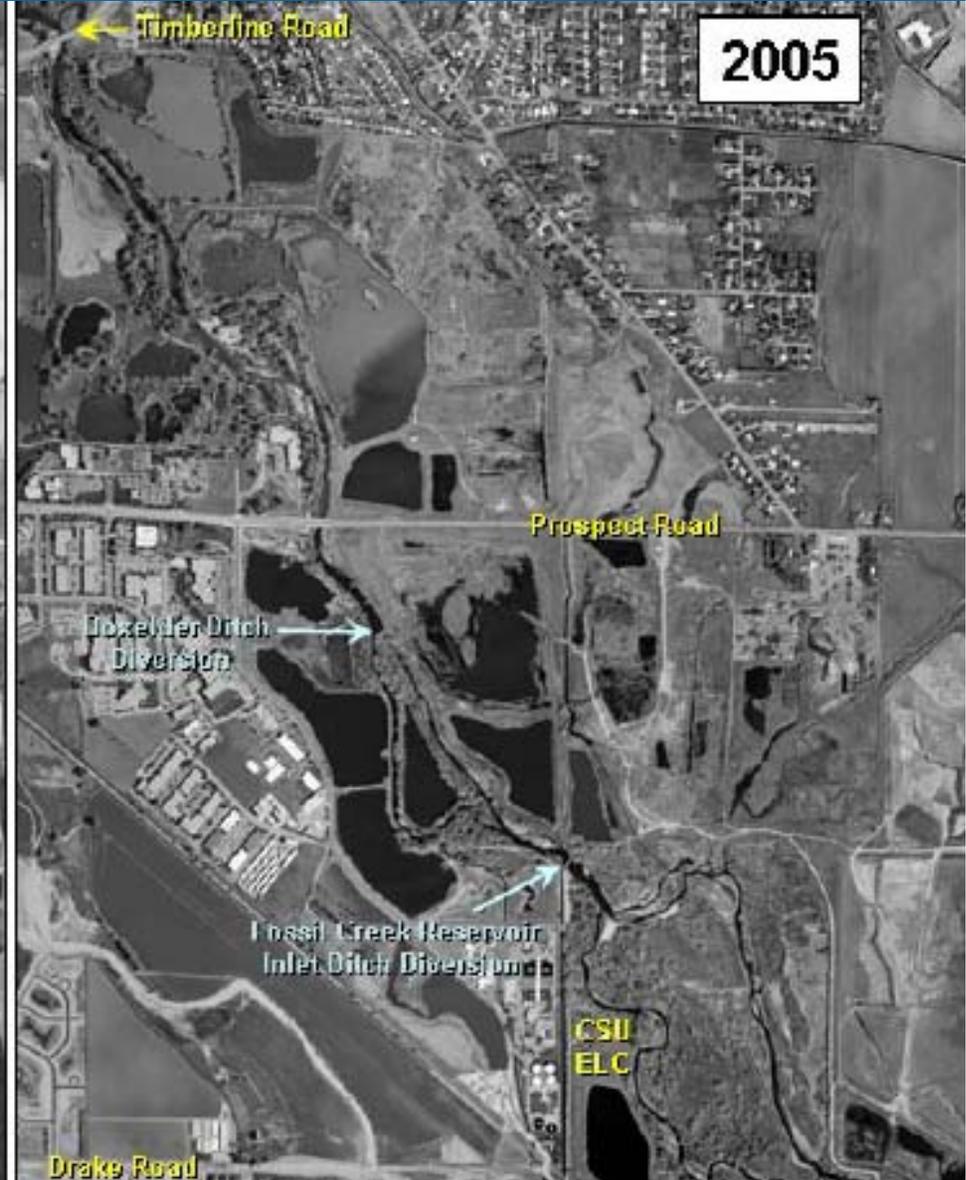
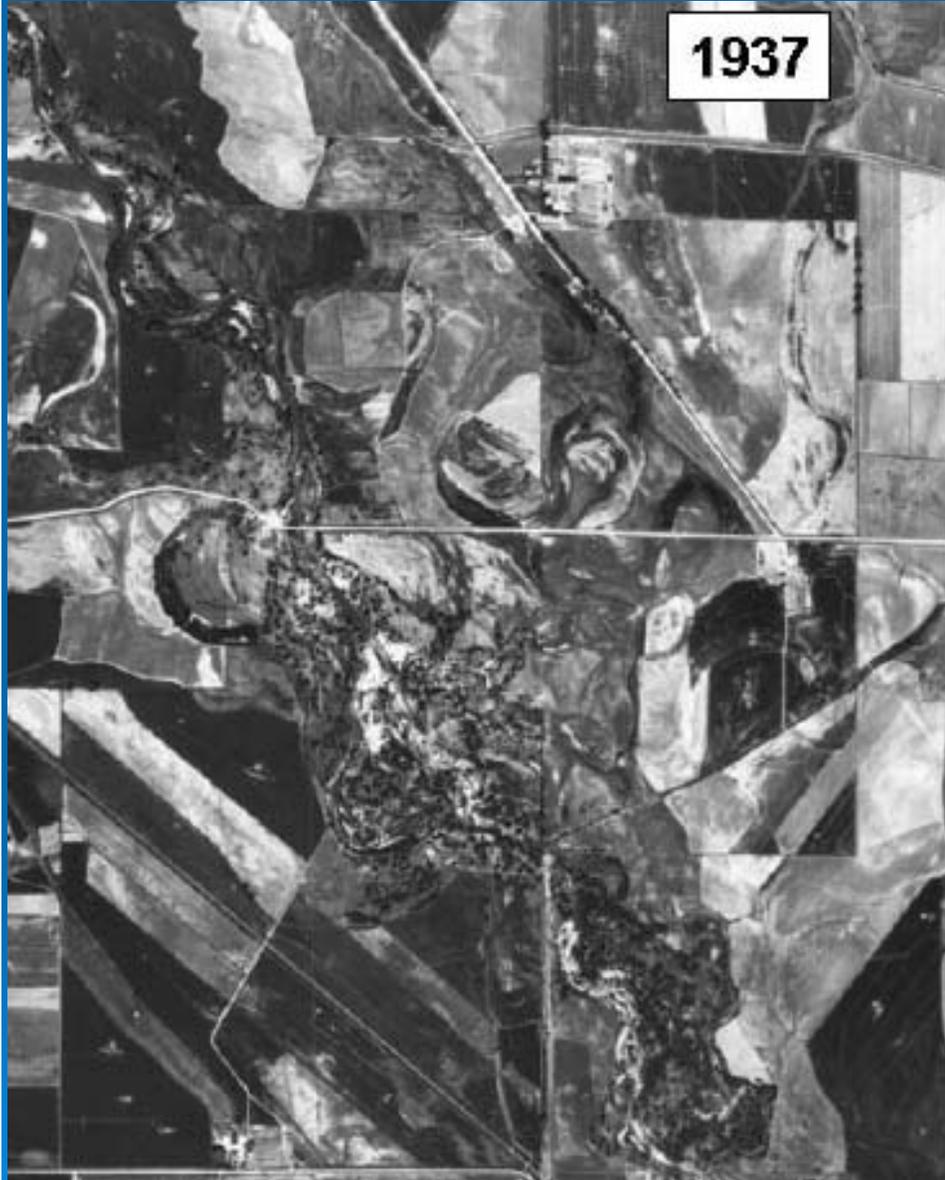
# Planning a future for the river

What's your vision?

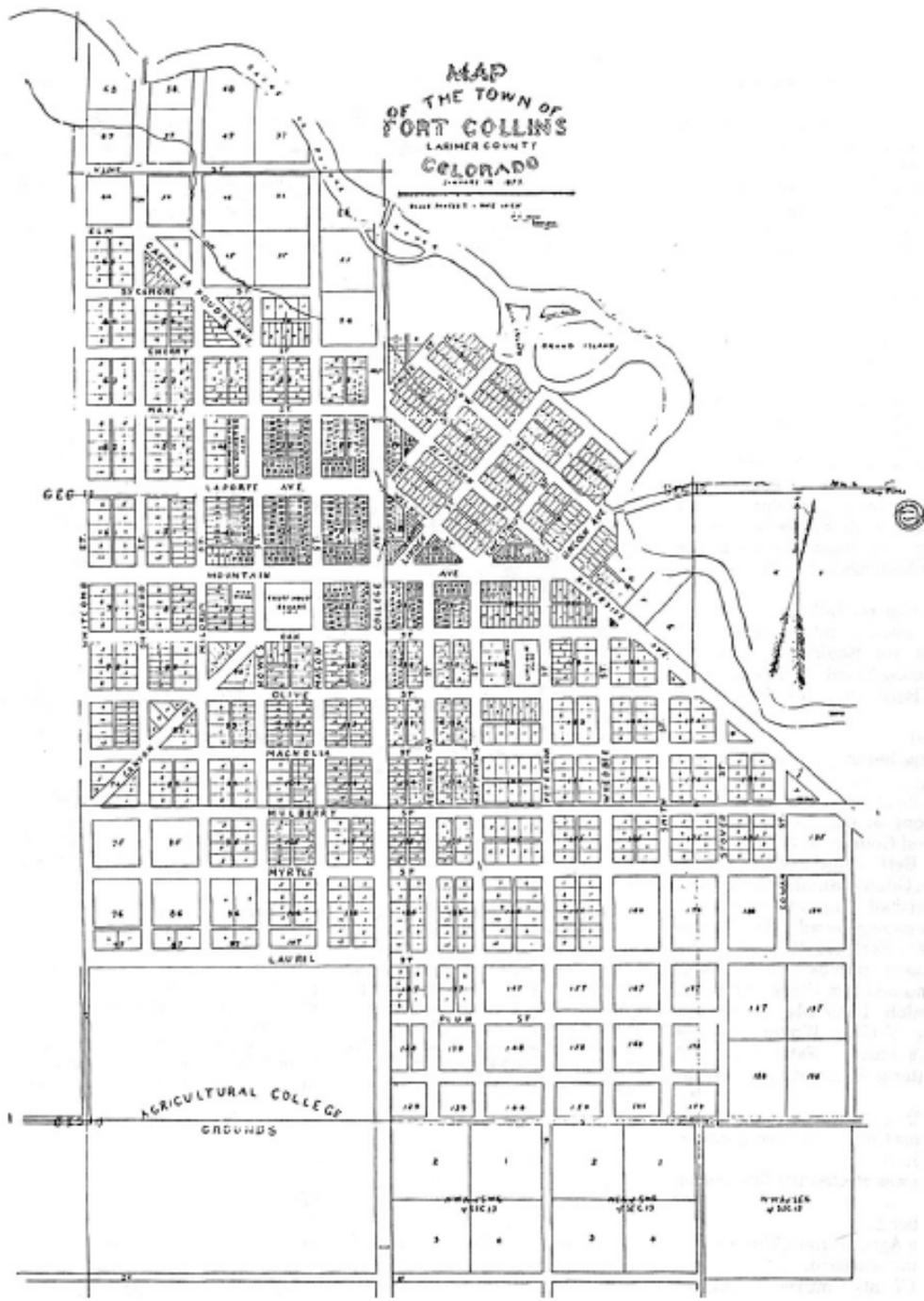


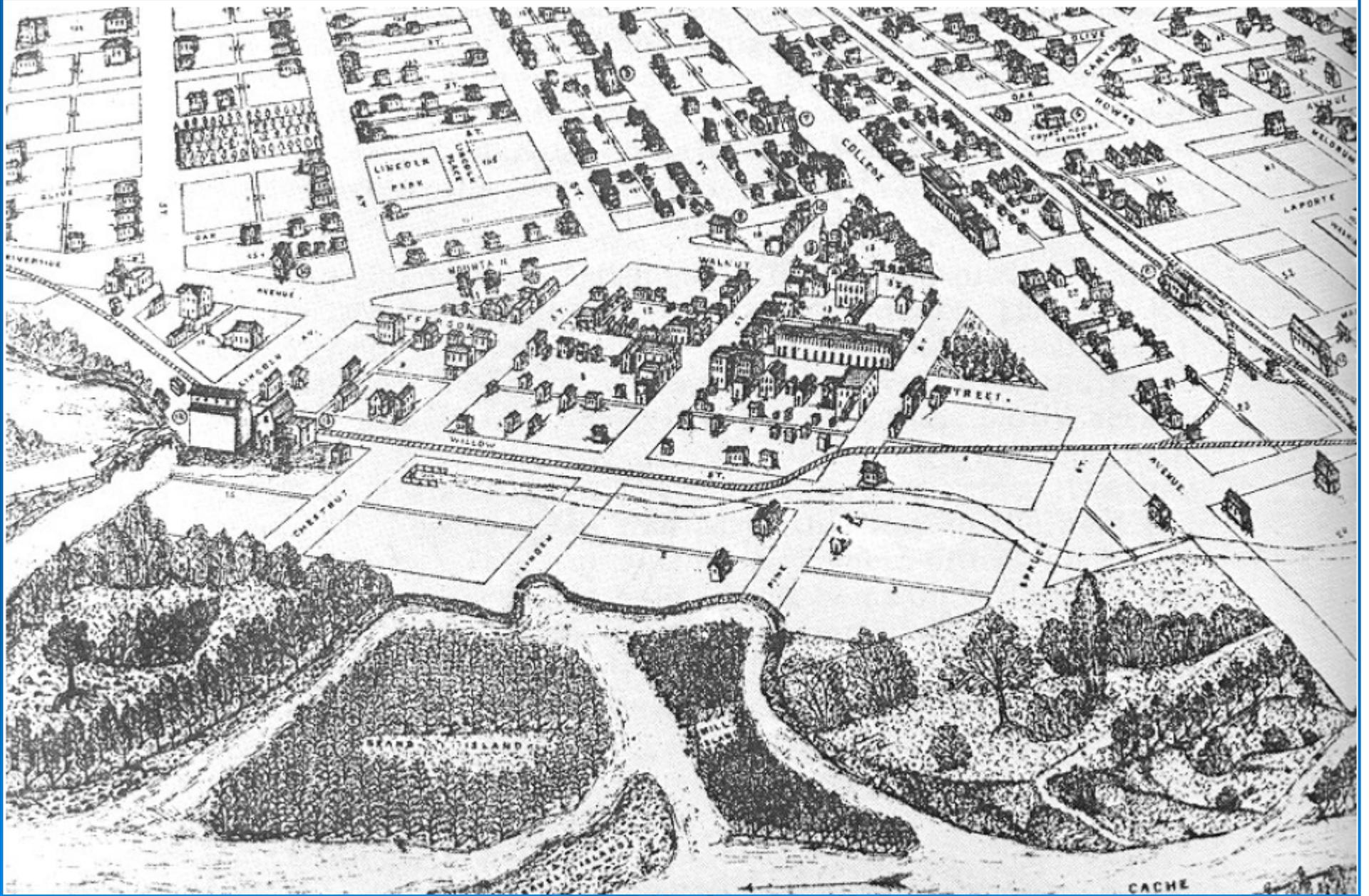




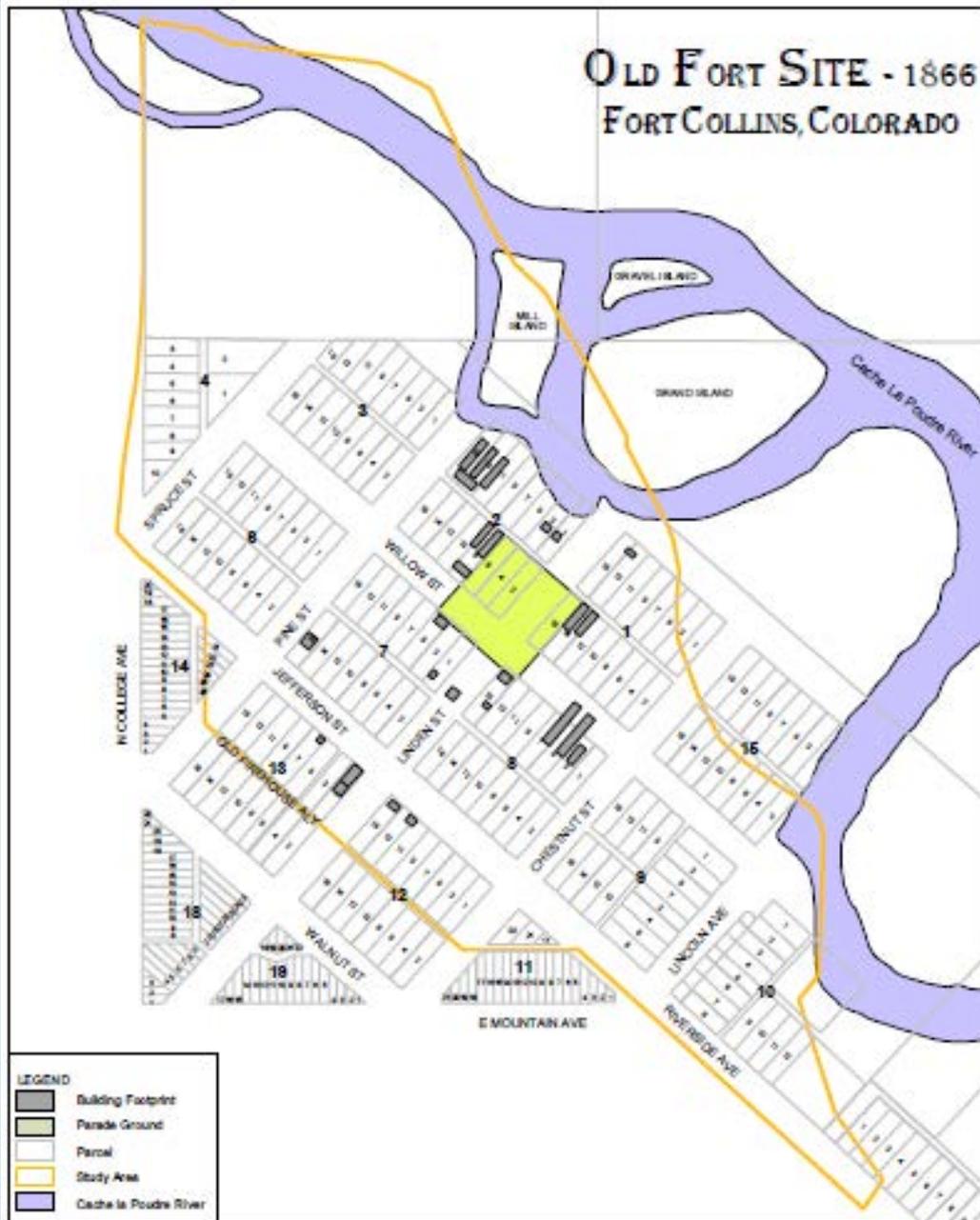








# OLD FORT SITE - 1866 FORT COLLINS, COLORADO



**LEGEND**

-  Building Footprint
-  Parade Ground
-  Parcel
-  Study Area
-  Cache La Poudre River

Map File Reference:  
340 E. Mountain Ave.  
Fort Collins, CO 80504  
LOCAL: 970.221.3800  
FAX: 970.221.3803  
MyPhone: 970.221.3800

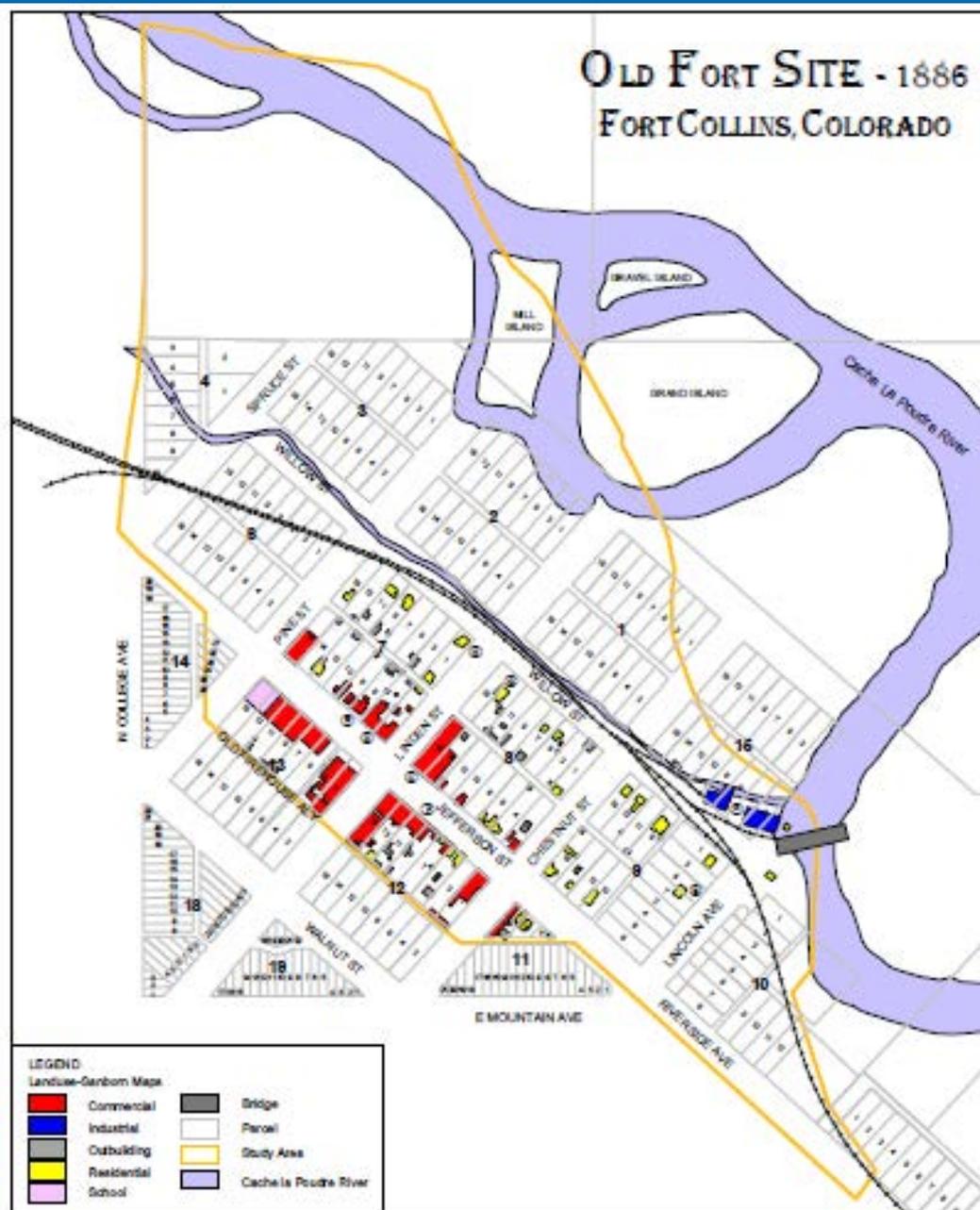
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**Data Sources:**  
Planning Programs, John P. Gray  
Parcel Data: 1994 City of Fort Collins Map  
City of Fort Collins, City of Fort Collins, Colorado



**Geographic Coordinate System:**  
Colorado North Zone  
Datum: NAD 83  
Scale: 1:1,000  
1 inch represents 270 Feet

# OLD FORT SITE - 1886 FORT COLLINS, COLORADO



**LEGEND**  
Landuse-Garborn Maps

<span style="display:inline-block; width:15px; height:15px; background-color:red; border:1px solid black;"></span> Commercial	<span style="display:inline-block; width:15px; height:15px; background-color:gray; border:1px solid black;"></span> Bridge
<span style="display:inline-block; width:15px; height:15px; background-color:blue; border:1px solid black;"></span> Industrial	<span style="display:inline-block; width:15px; height:15px; border:1px solid black;"></span> Parcel
<span style="display:inline-block; width:15px; height:15px; background-color:lightgray; border:1px solid black;"></span> Outbuilding	<span style="display:inline-block; width:15px; height:15px; border:2px solid yellow;"></span> Study Area
<span style="display:inline-block; width:15px; height:15px; background-color:yellow; border:1px solid black;"></span> Residential	<span style="display:inline-block; width:15px; height:15px; background-color:purple; border:1px solid black;"></span> Cache la Poudre River
<span style="display:inline-block; width:15px; height:15px; background-color:lightblue; border:1px solid black;"></span> School	

Digital Division  
340 E. Mountain Ave.  
Fort Collins, CO 80526  
VOICE: 970.221.3600  
FAX: 970.221.8000  
http://www.audible.com

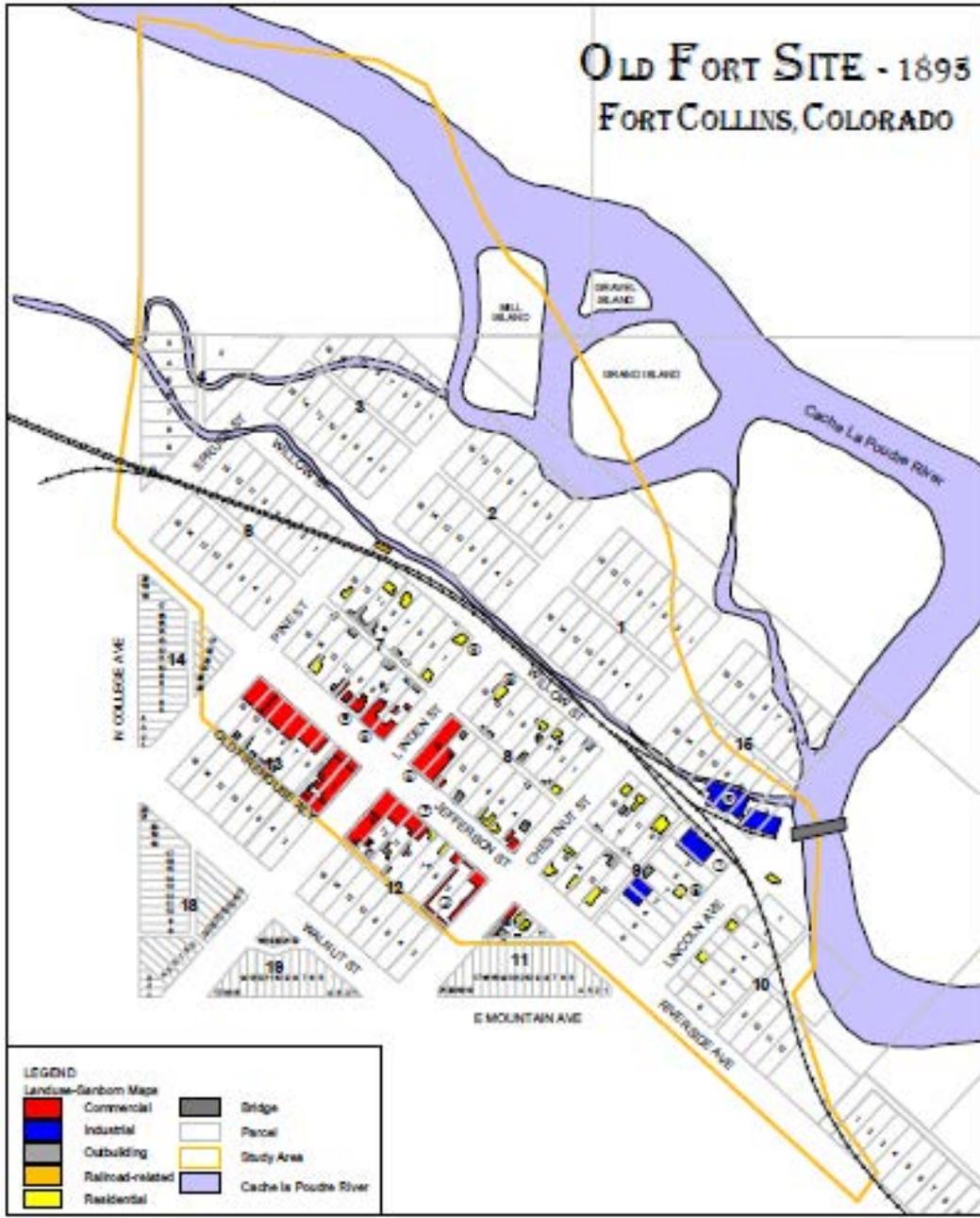
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**Data Sources:**  
Baldwin, Portlandia, 1884 Sanborn Map  
New Hope, 1888 V.C.C. 1884 Map  
Other Materials: City of Fort Collins, Colorado



**Relative Coordinate System**  
Colorado North Zone  
Datum: NAD 83  
Scale: 1:1,000  
1 inch represents 270 Feet

# OLD FORT SITE - 1893 FORT COLLINS, COLORADO



**LEGEND**

Commercial	Bridge
Industrial	Parcel
Outbuilding	Study Area
Railroad-related	Cache la Poudre River
Residential	

Salafet Collins  
345 E. Mountain Ave.  
Fort Collins, CO 80501  
VOICP: 970.221.3400  
FAC: 970.221.8000  
My.ArcView.esri.com

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**Data Sources:**  
 National Geographic, 1893 Sanborn Map  
 Parcel Data: GIS Data, GIS Data  
 City: Planning, City of Fort Collins, Colorado

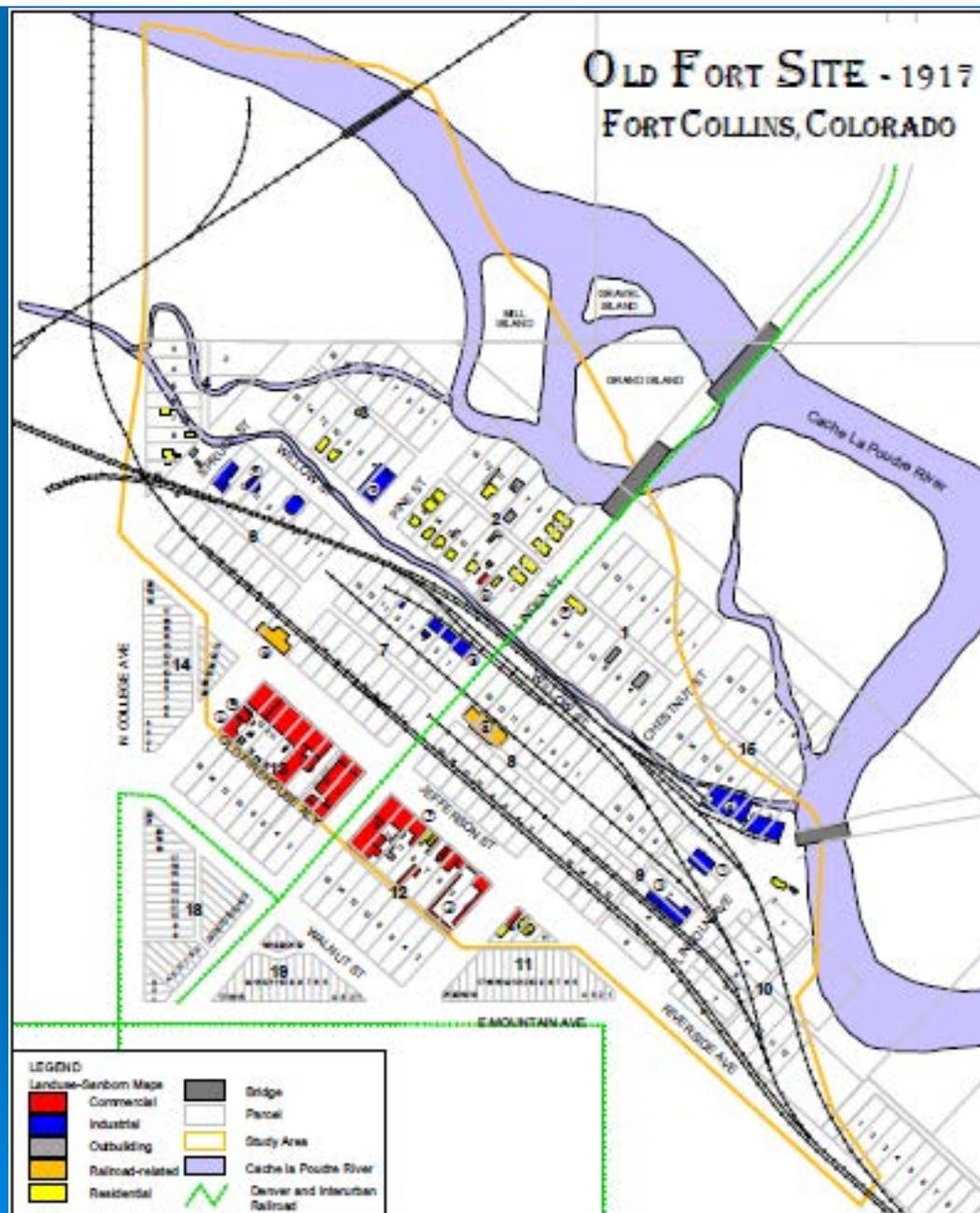


**MapScale Coordinate System:**  
 Colorado North Zone  
 Datum: NAD 83

Scale: 1:4,000  
 1 inch represents 270 Feet



# OLD FORT SITE - 1917 FORT COLLINS, COLORADO



**LEGEND**

Land Use - Garbom Maps	Bridge
Commercial	Parcel
Industrial	Study Area
Outbuilding	Cache La Poudre River
Railroad-related	Denver and Interoceanic Railroad
Residential	

**Radical Edition**  
 207 E. Shields Ave.  
 Fort Collins, CO 80502  
 VOICE: 970.221.3600  
 FAX: 970.221.3600  
 http://www.radical.com

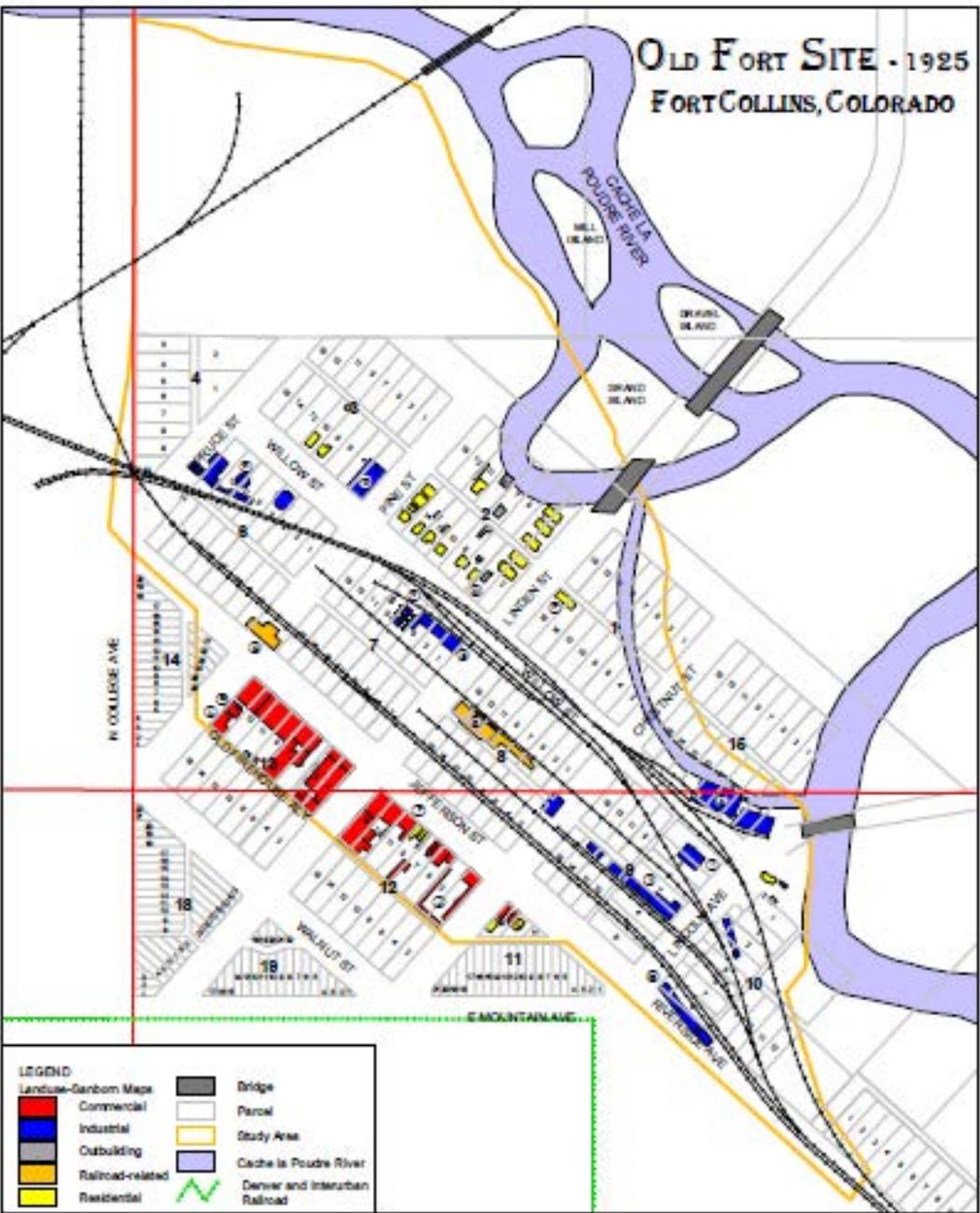
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**Data Source:**  
 Radco, Fort Collins, 1917 Radco Map  
 The City of Fort Collins, Colorado  
 City of Fort Collins, Colorado



**Universal Transverse Mercator System**  
 Colorado North Zone  
 Datum: NAD 83  
 Scale: 1:6,000  
 1 inch represents 375 Feet

# OLD FORT SITE - 1925 FORT COLLINS, COLORADO



**LEGEND**

Land Use-Carbon Maps	Bridge
Commercial	Parcel
Industrial	Study Area
Outbuilding	Cache la Poudre River
Railroad-related	Denver and Interurban Railroad
Residential	

Railroad Station  
207 E. Mountain Ave.  
Fort Collins, CO 80501  
VOICE: 970.221.3800  
FAX: 970.221.8000  
MyAvenue@fortcollins.com

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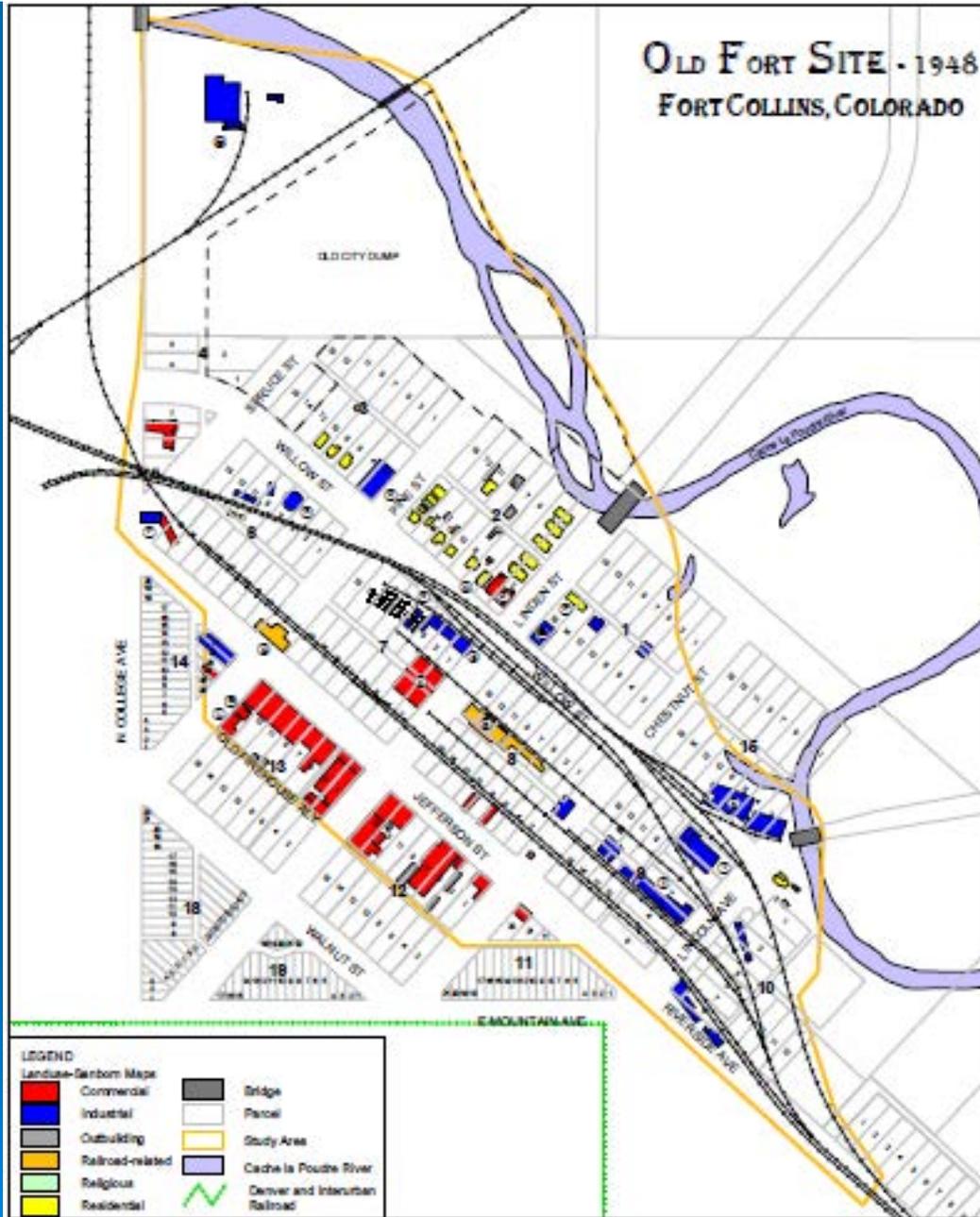
Data Sources:  
Nadine, Fort Collins, 1925 Sanborn Map  
City of Fort Collins, 2008 GIS, 2008 GIS  
City of Fort Collins, City of Fort Collins, Colorado

Reference Coordinate System  
Colorado North Zone  
Datum: NAD 83

Scale: 1:4,000  
1 inch represents 330 Feet

# OLD FORT SITE - 1948

## FORT COLLINS, COLORADO



Balluff, Robinson  
345 E. Mountain Ave.  
Fort Collins, CO 80504  
VOICE: 970.221.3400  
FAX: 970.221.8200  
http://www.balluff.com



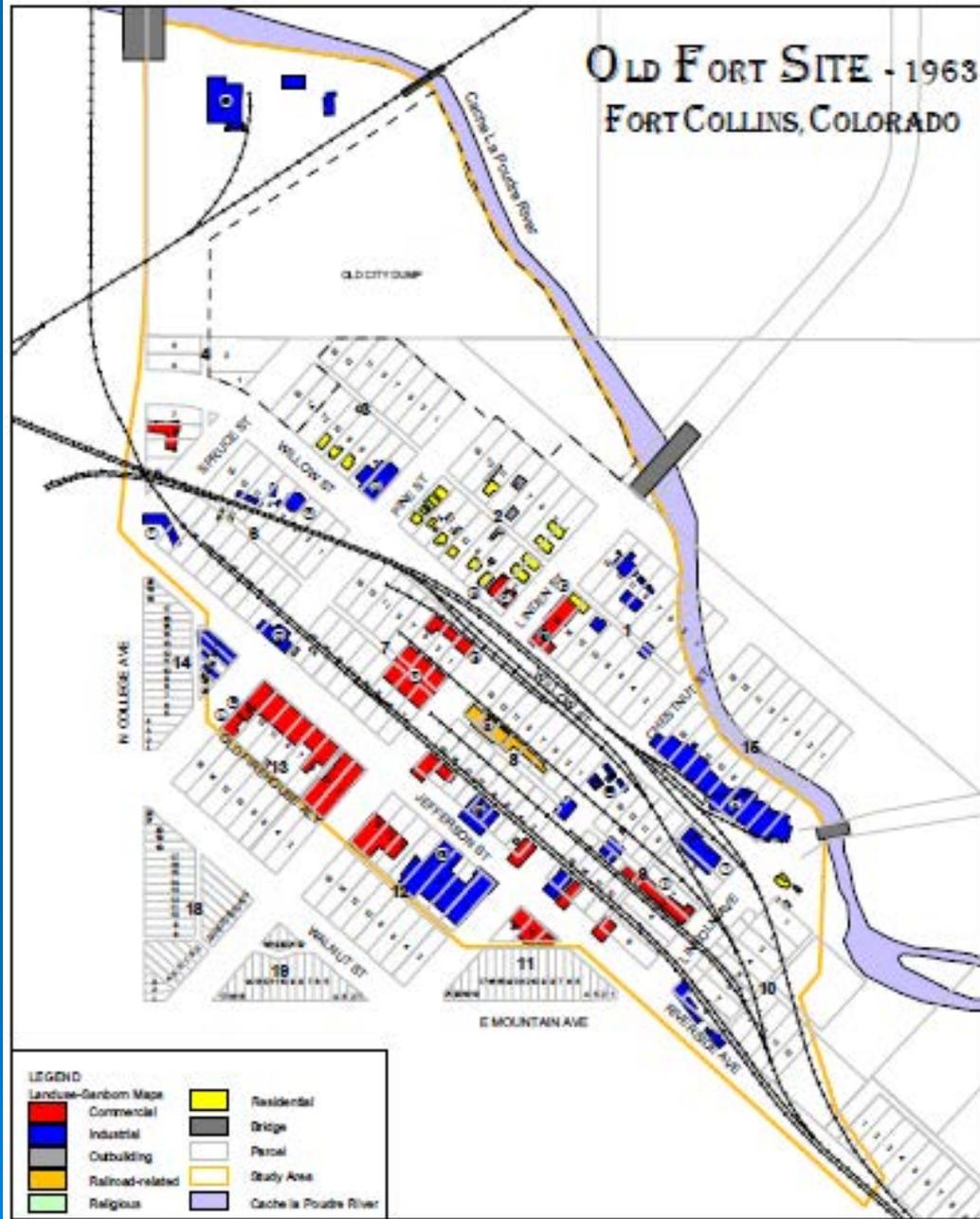
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Date Sources:  
Balluff, Fort Collins, 1985 Balluff Map  
Per all Plans, 1994 V.C. 108th City  
City of Fort Collins, City of Fort Collins, Colorado



Geographic Coordinate System  
Colorado North Zone  
Datum: NAD 83  
Scale: 1:4,000  
Title: 1948 Old Fort Site

# OLD FORT SITE - 1963 FORT COLLINS, COLORADO



**LEGEND**

Land Use - Commercial	Residential
Industrial	Bridge
Outbuilding	Parcel
Railroad-related	Study Area
Religious	Cache la Poudre River

Balluff Systems  
345 E. Mountain Ave.  
Fort Collins, CO 80504  
VOICED: 970.221.3800  
FAC: 970.221.9000  
My: [www.balluff.com](http://www.balluff.com)

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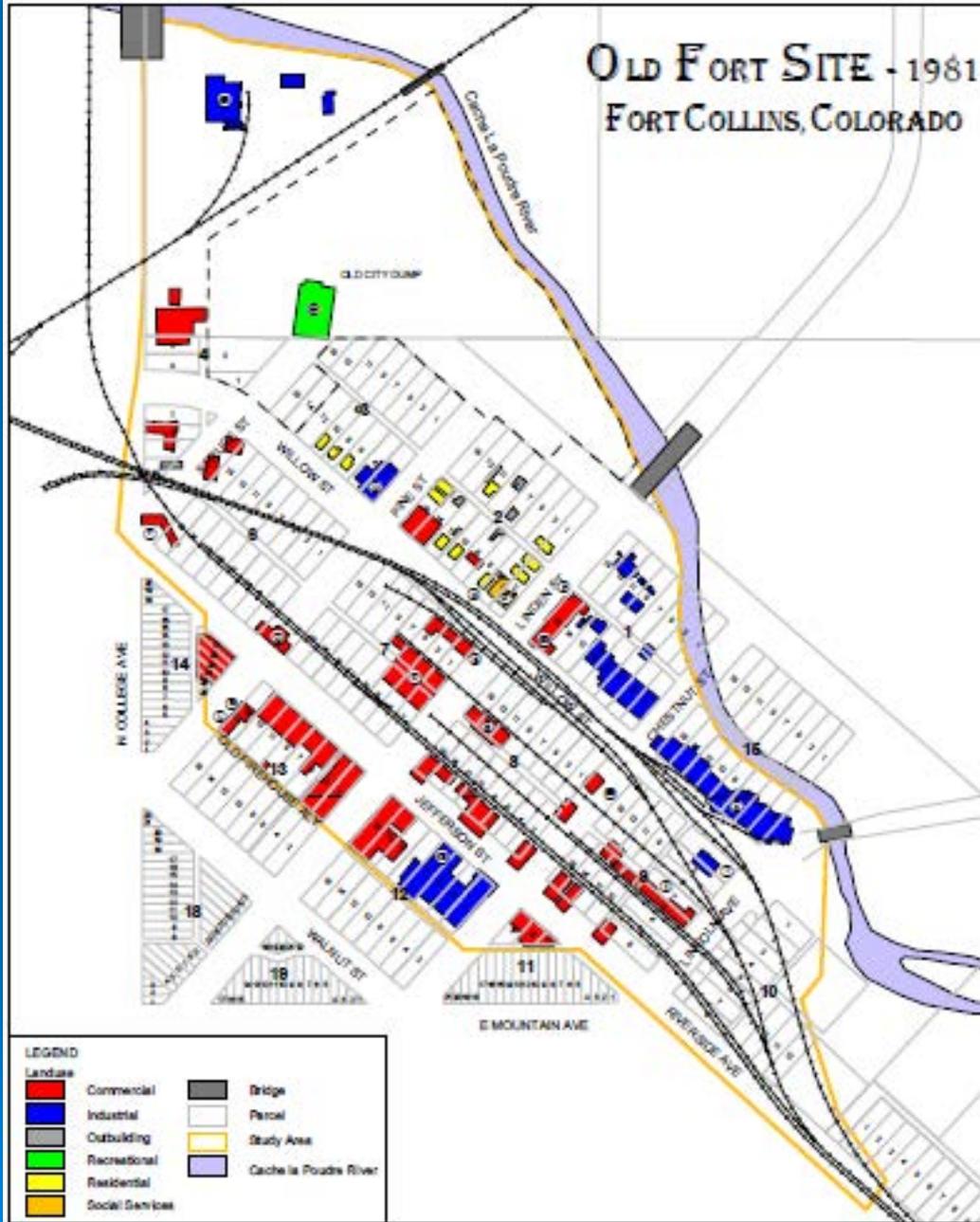
Date Revises:  
Building Footprints: 1983 Building Map  
Parcel Lines: 1984 V.C. 1984 City Map  
Other: Miscellaneous: City of Fort Collins, Colorado



Reference Coordinate System  
Colorado North Zone  
Datum: NAD 83  
Scale: 1:1,000  
1 inch represents 100 Feet



# OLD FORT SITE - 1981 FORT COLLINS, COLORADO



**LEGEND**

Landuse	
[Red Box]	Commercial
[Blue Box]	Industrial
[Grey Box]	Outbuilding
[Green Box]	Recreational
[Yellow Box]	Residential
[Orange Box]	Social Services
[Grey Box]	Bridge
[White Box]	Parcel
[Yellow Box]	Study Area
[Purple Box]	Cache la Poudre River

Technical Services  
 240 E. Mountain Ave.  
 Fort Collins, CO 80504  
 VOICE: 970-221-3800  
 FAX: 970-221-8200  
<http://www.esdinc.com>

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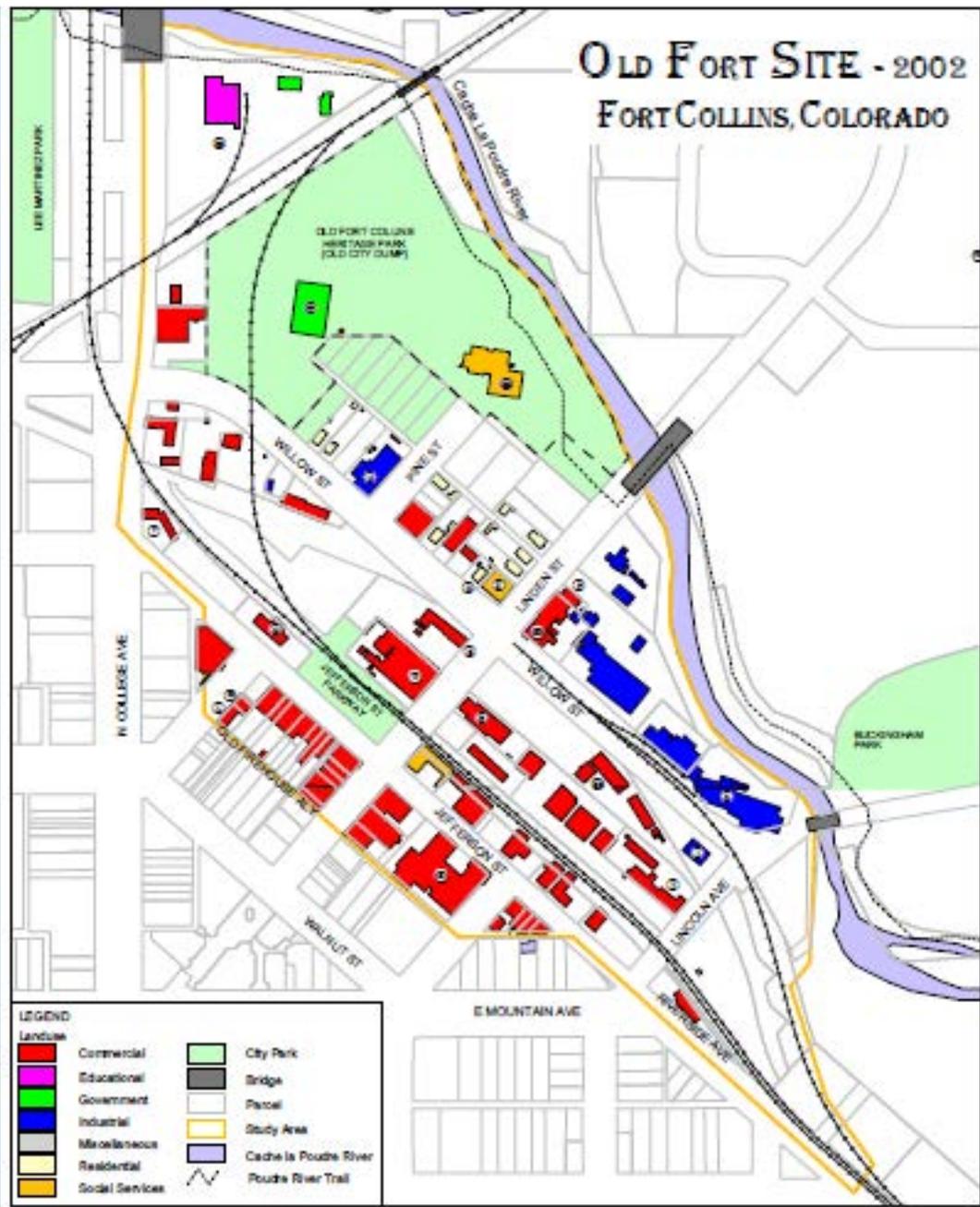
**Data Sources:**  
 Building Footprints: City of Fort Collins, Colorado  
 Parcel Data: 1984 V.C. Viala Map  
 Other Features: City of Fort Collins, Colorado



StatePlane Coordinate System  
 Colorado North Zone  
 Datum: NAD 83  
 Scale: 1:1,000  
 1 inch represents 275 Feet

# OLD FORT SITE - 2002

## FORT COLLINS, COLORADO



**LEGEND**

Land Use	
[Red Box]	Commercial
[Green Box]	City Park
[Magenta Box]	Educational
[Blue Box]	Industrial
[Light Green Box]	Government
[Yellow Box]	Miscellaneous
[Light Blue Box]	Residential
[Orange Box]	Social Services
[Grey Box]	Bridge
[White Box]	Parcel
[Yellow Outline Box]	Study Area
[Purple Line]	Cache la Poudre River
[Black Line]	Poudre River Trail

Staff: Paul H. Mendenhall  
 340 E. Mountain Ave.  
 Fort Collins, CO 80526  
 VOICE: 970.221.3600  
 FAX: 970.221.3620  
 http://www.cofort.com

This plan is for general planning purposes only and is subject to certain changes. City and County staff will do up to 10 minutes of site visit to see how the site actually looks. Because of the scale of this map, specific dimensions or other details may be necessary to determine the actual site.

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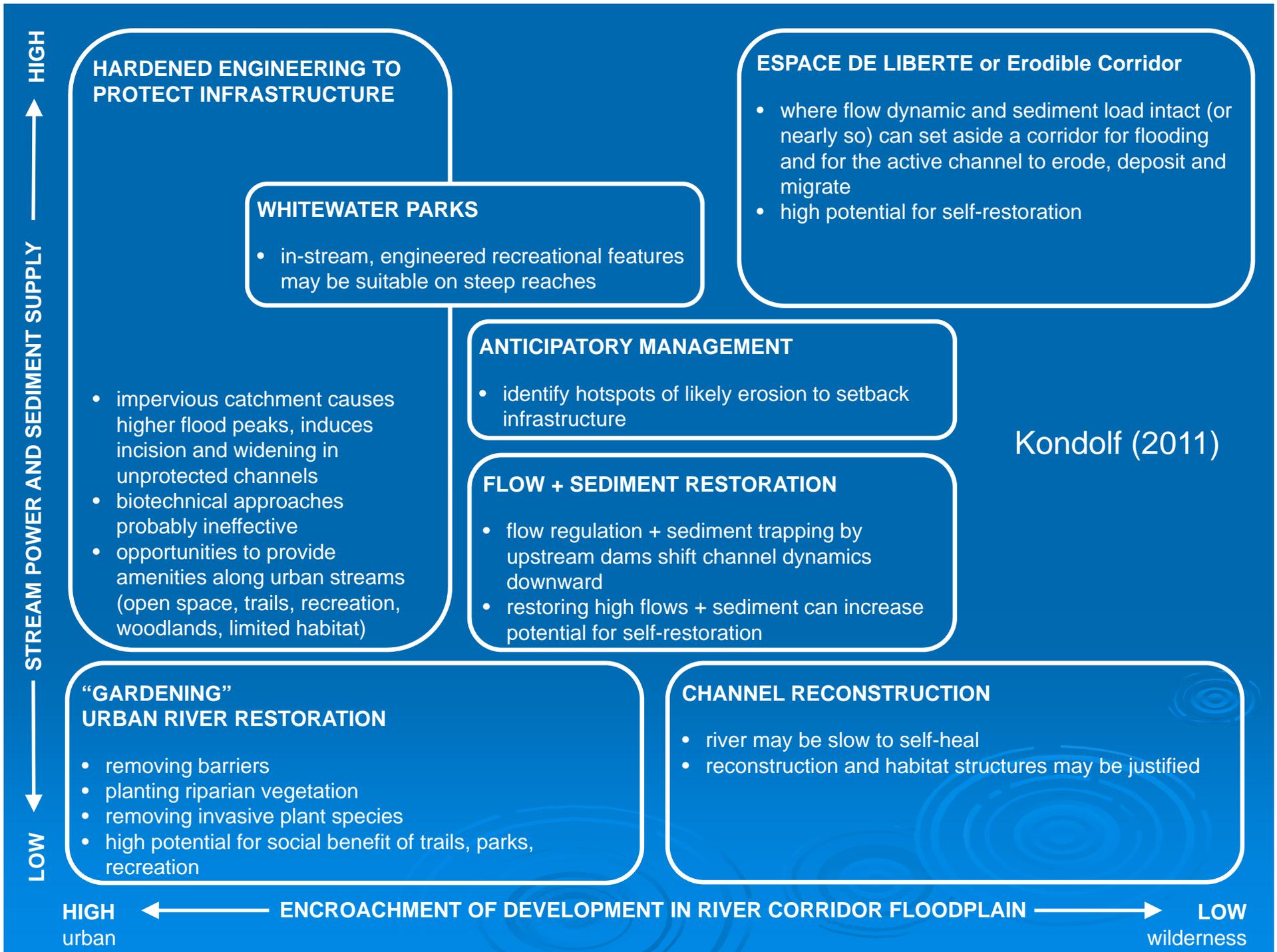
Date: 2002  
 Mapping: Paul H. Mendenhall, City of Fort Collins (PHM)  
 Photo: James J. 2002 A.C. 1000000000  
 Other: Paul H. Mendenhall, City of Fort Collins, Colorado

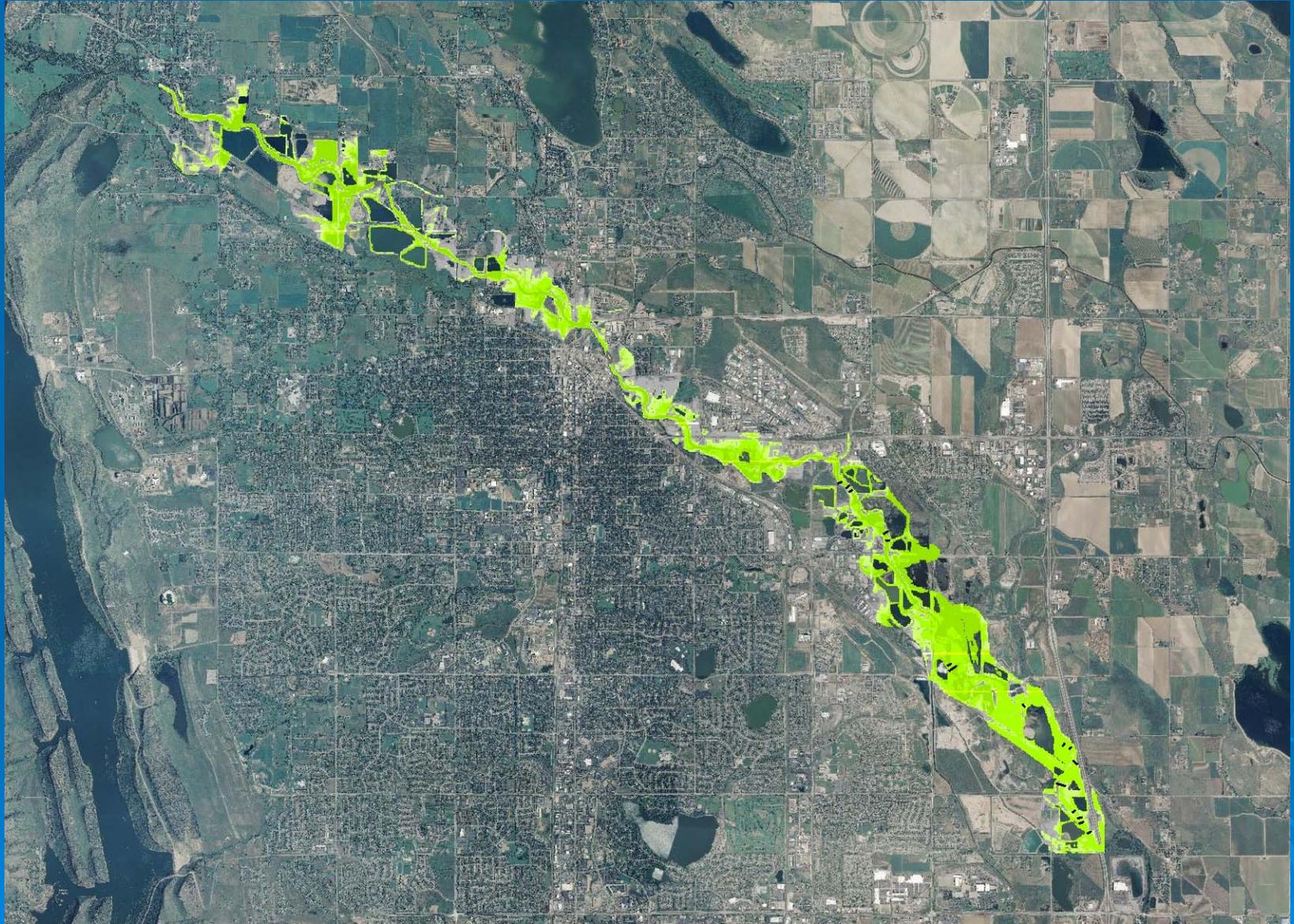


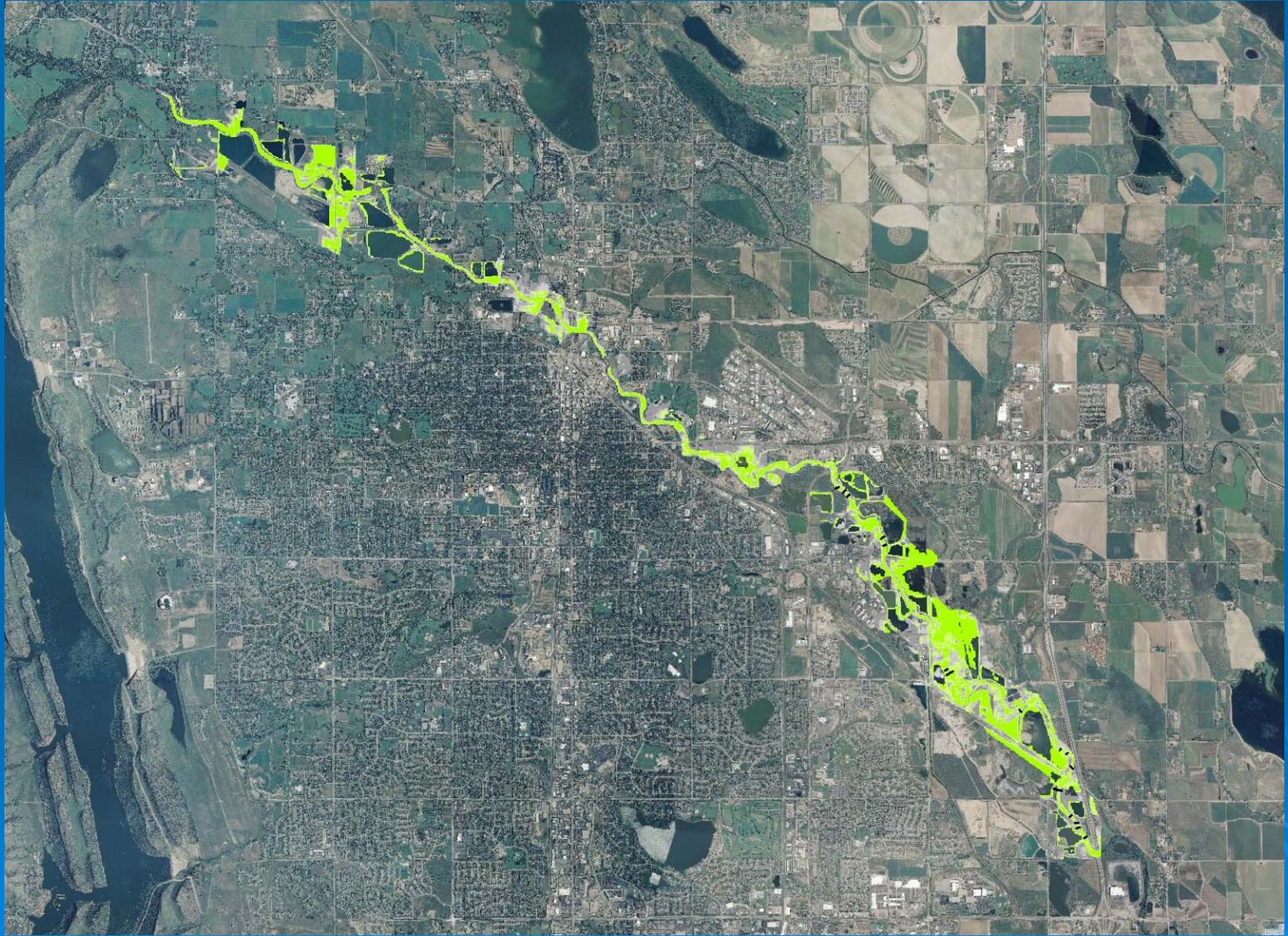
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 Datum: NAD 83

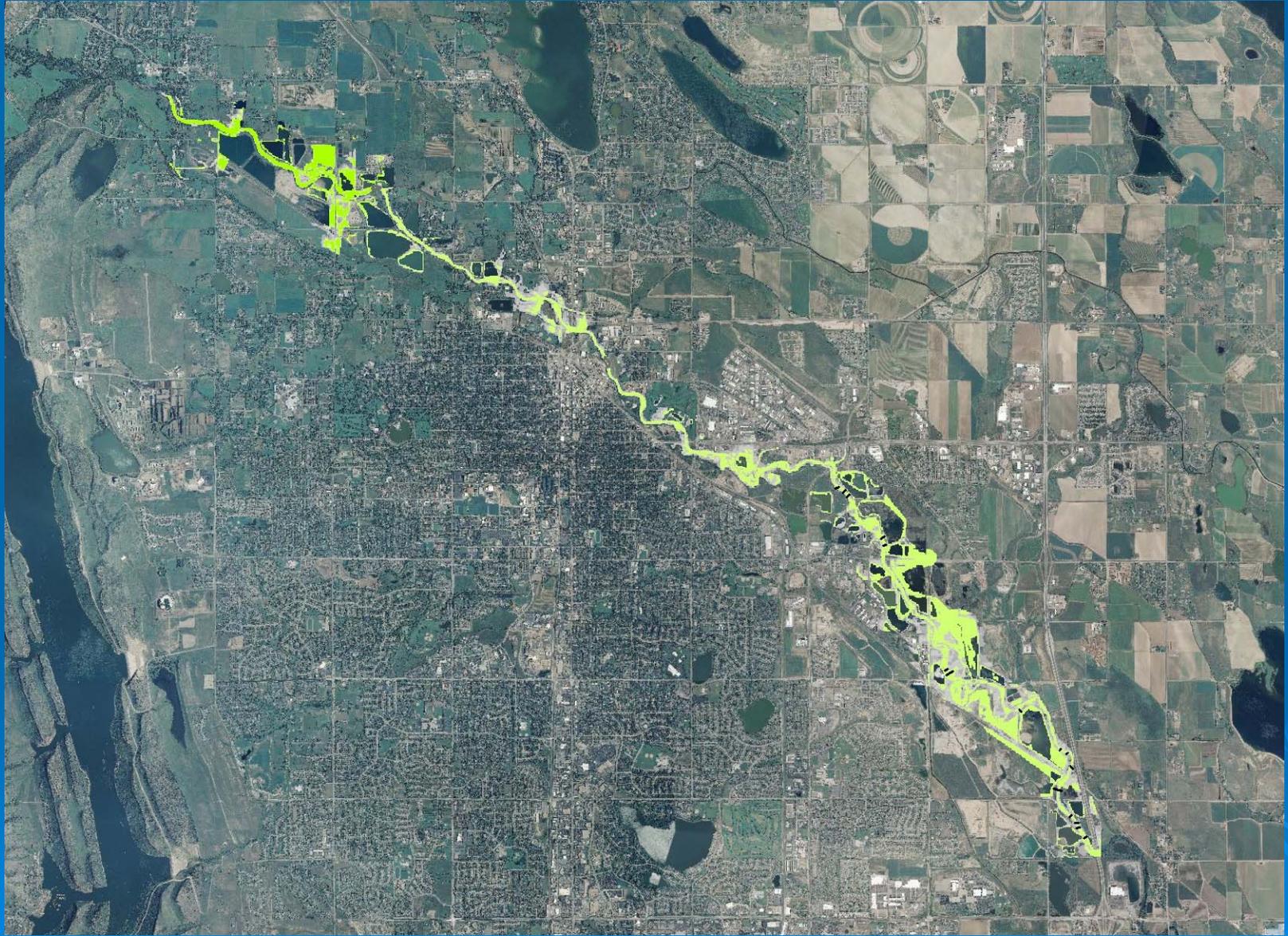
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 1 inch represents 200 Feet

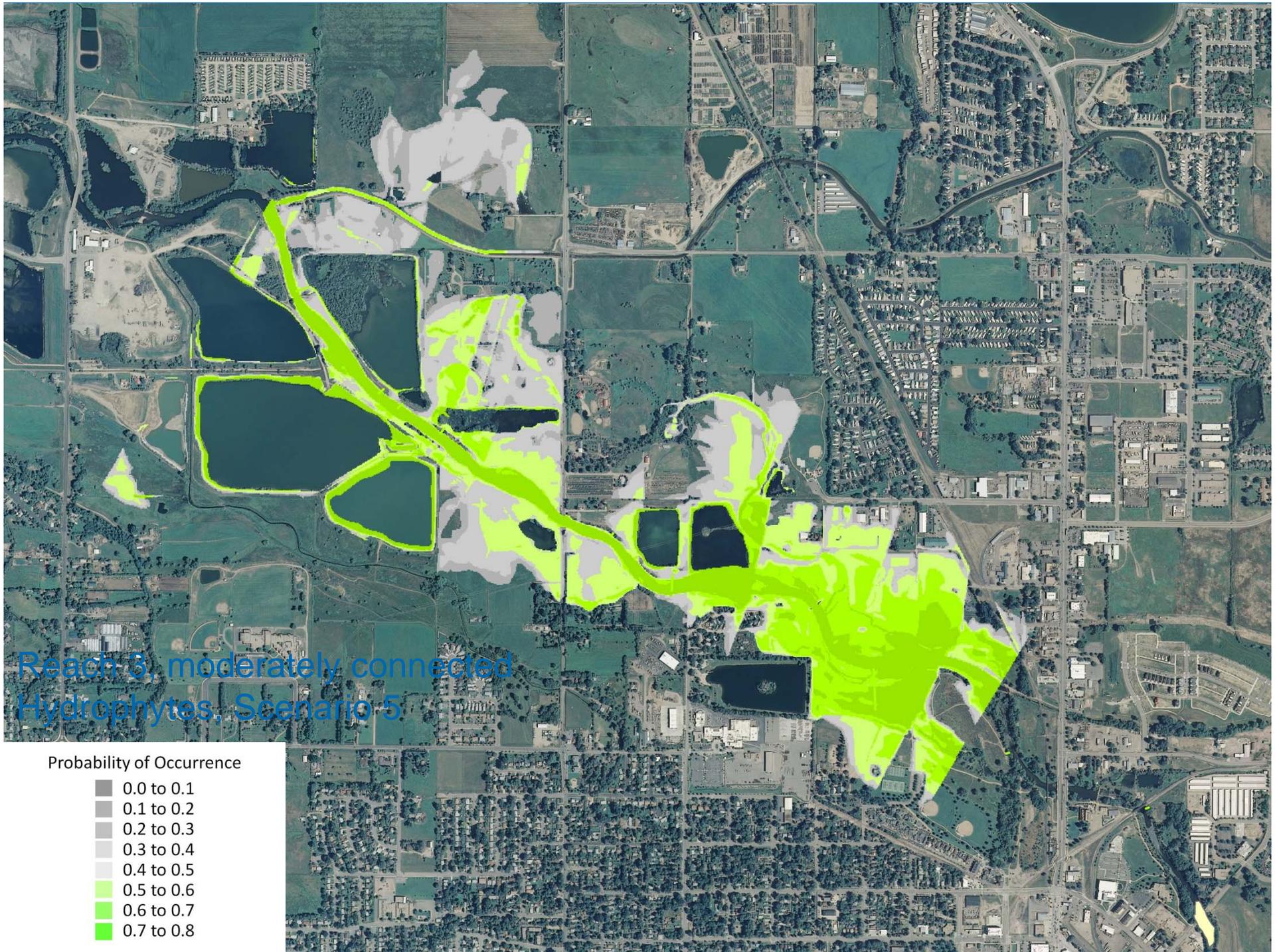


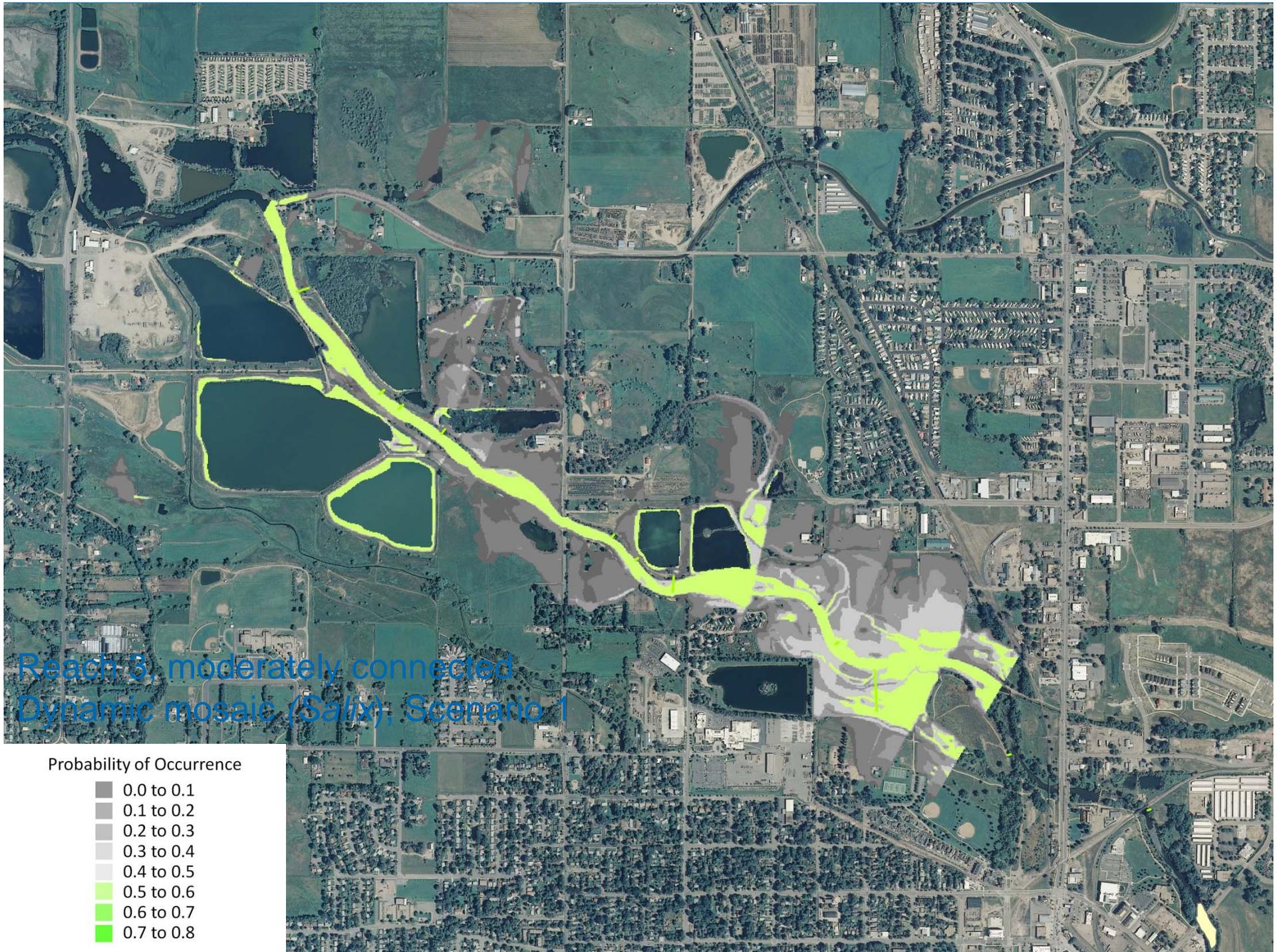


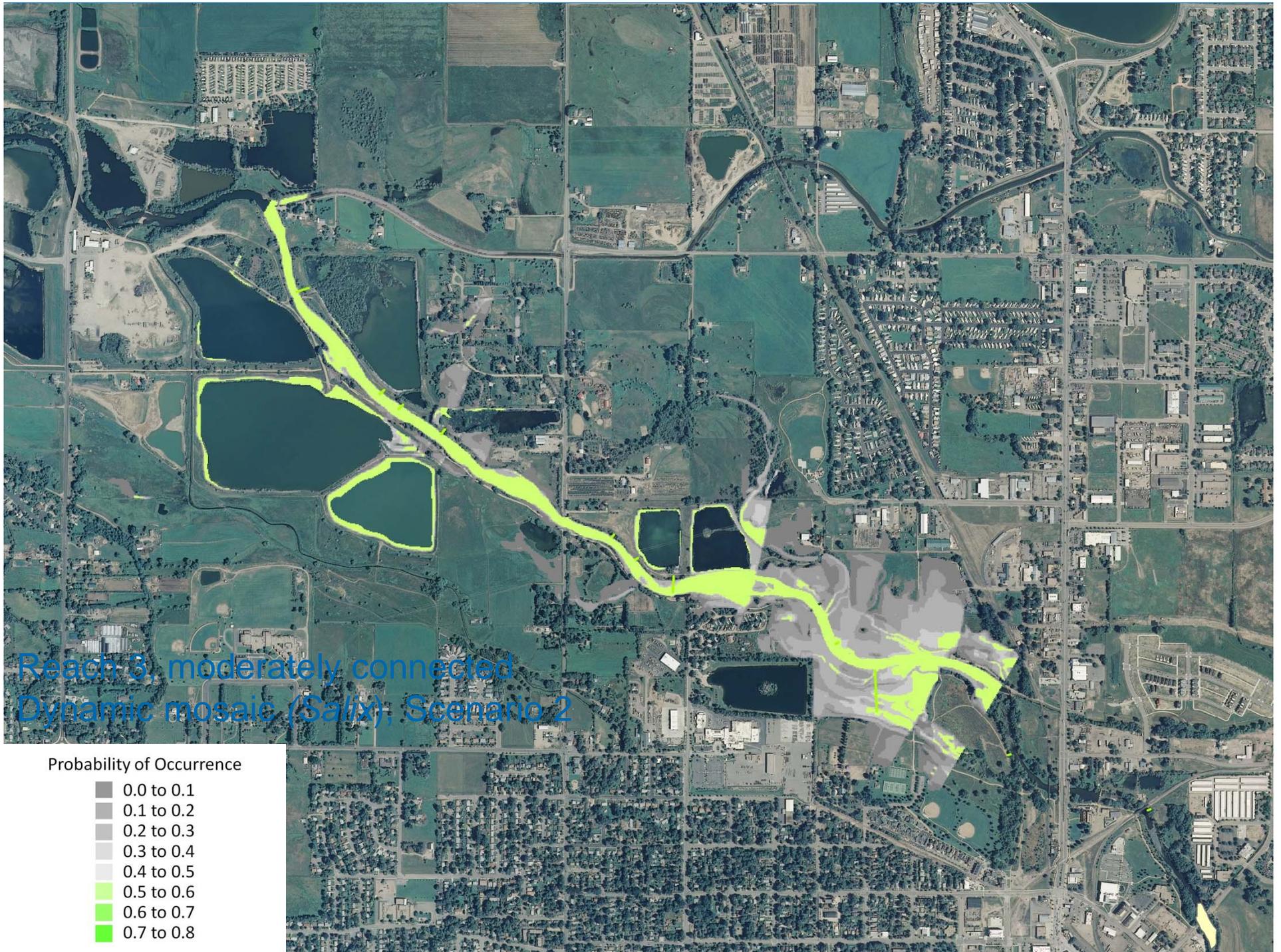




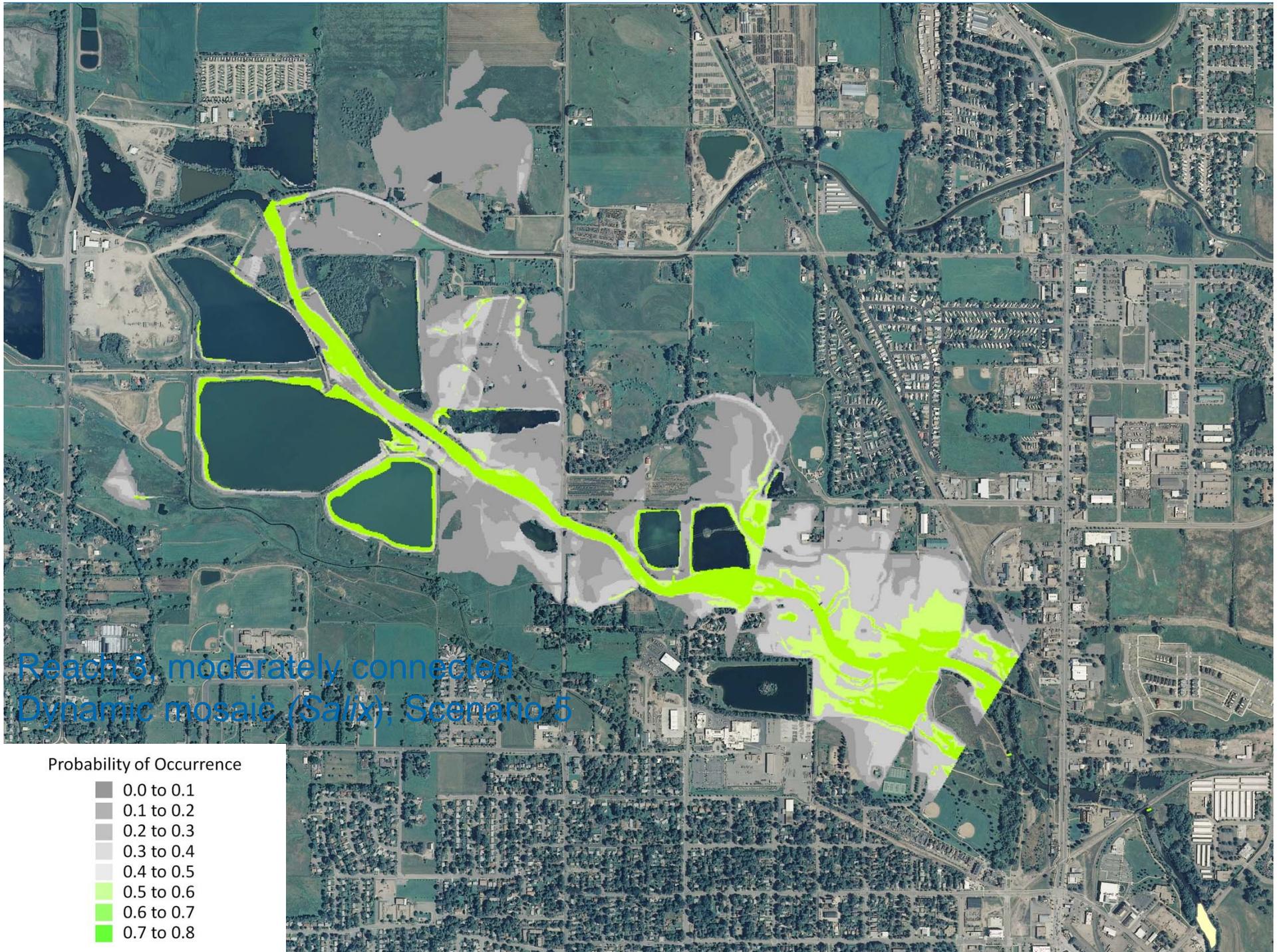


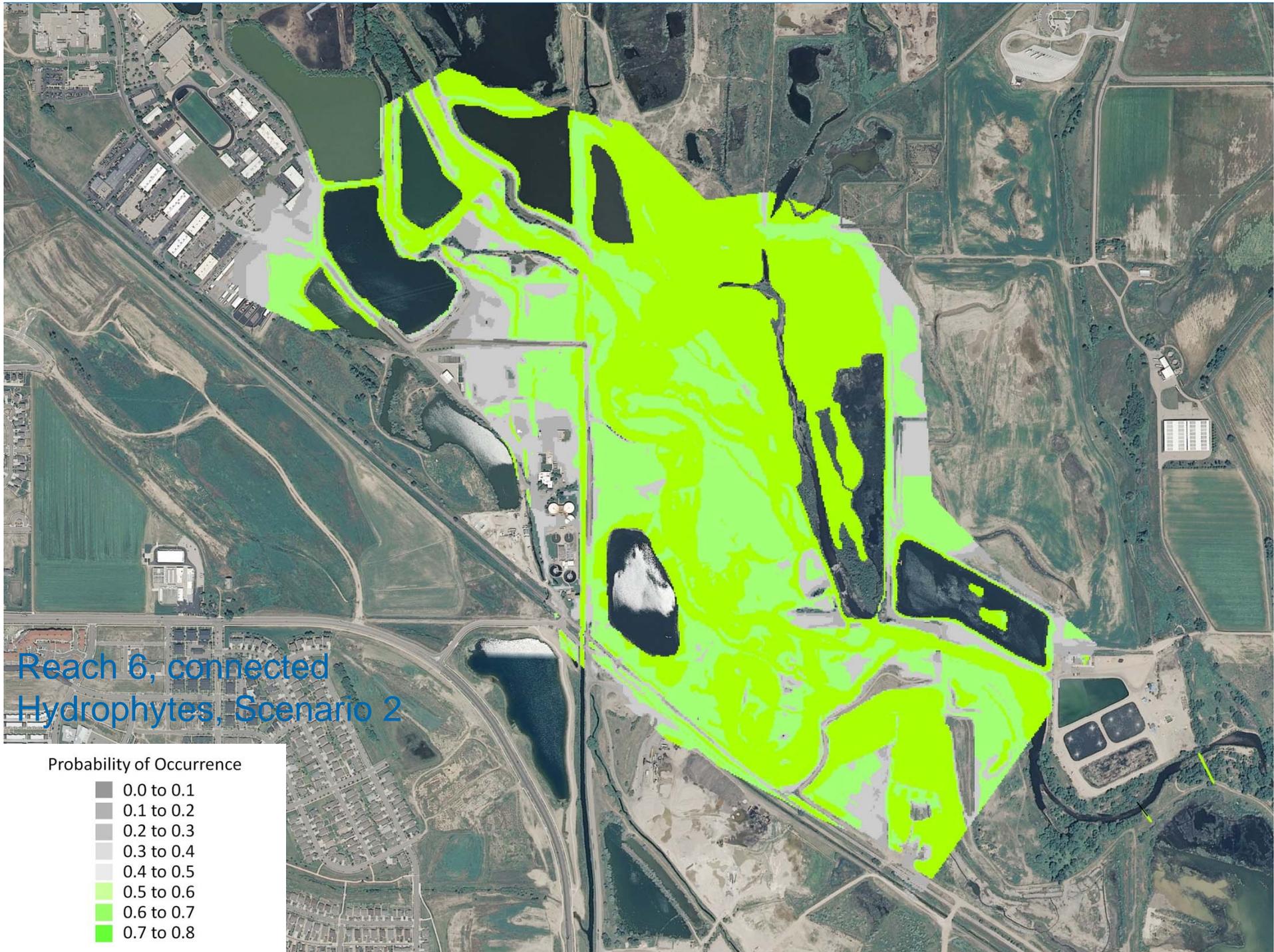


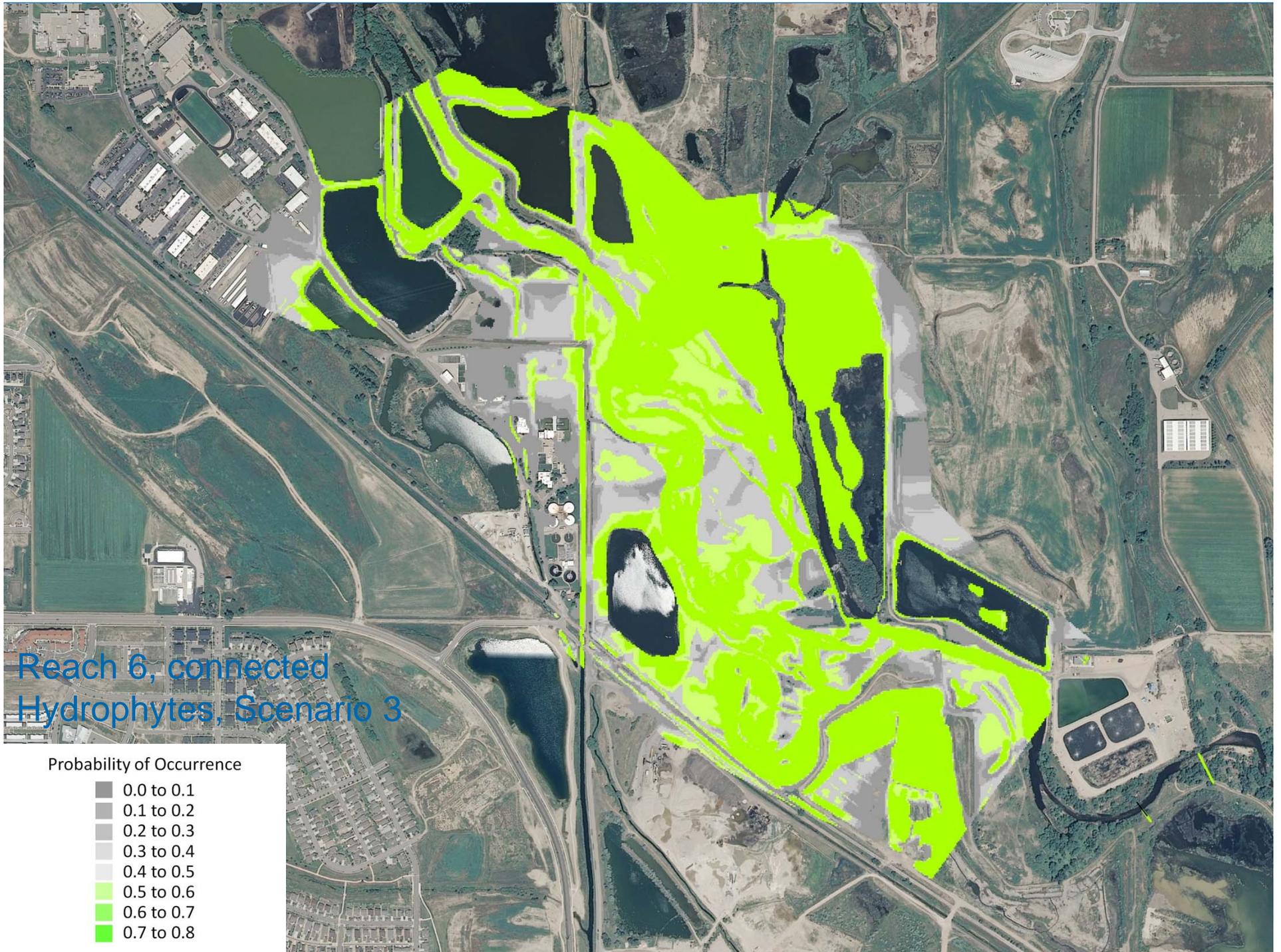


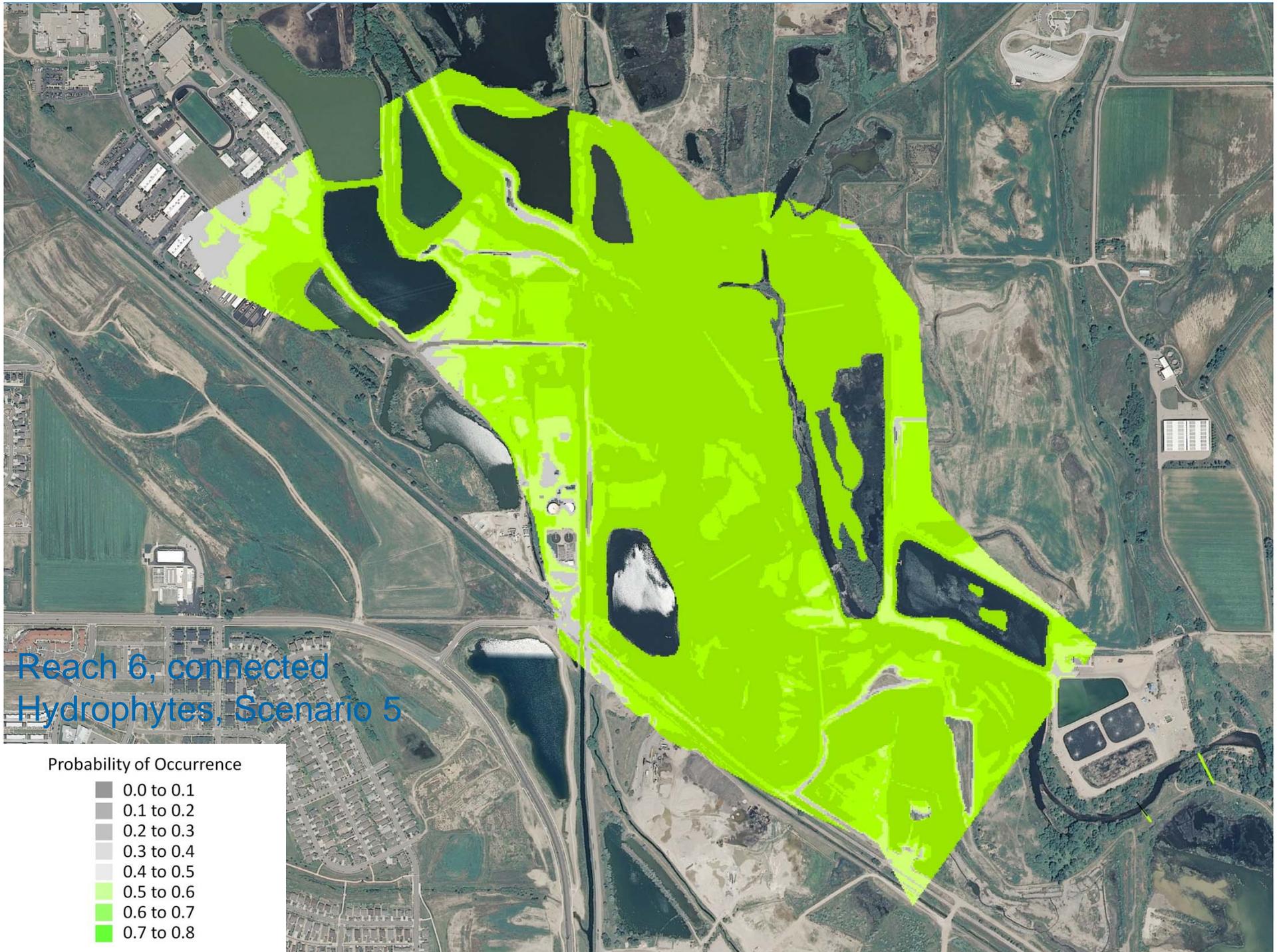


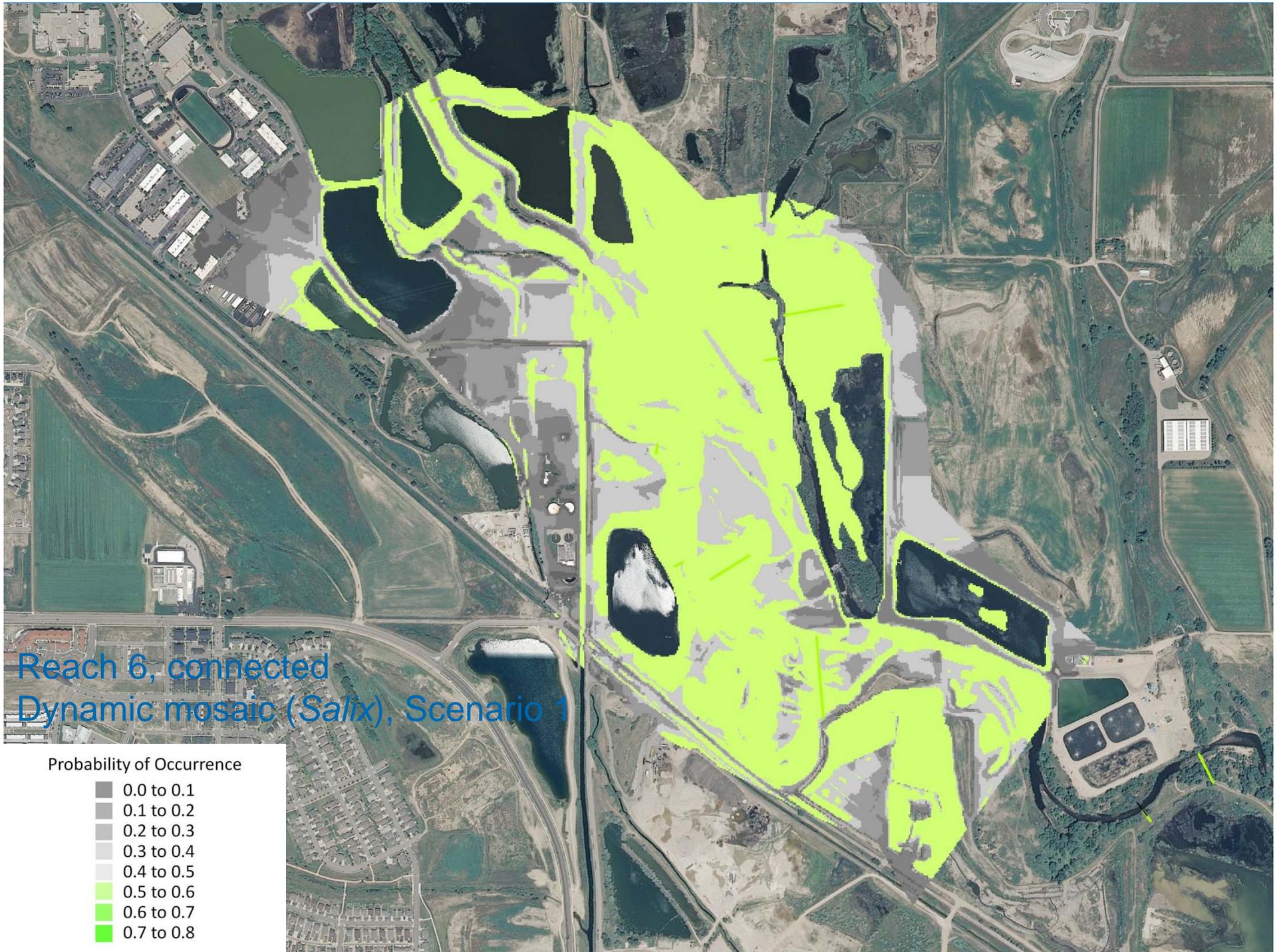


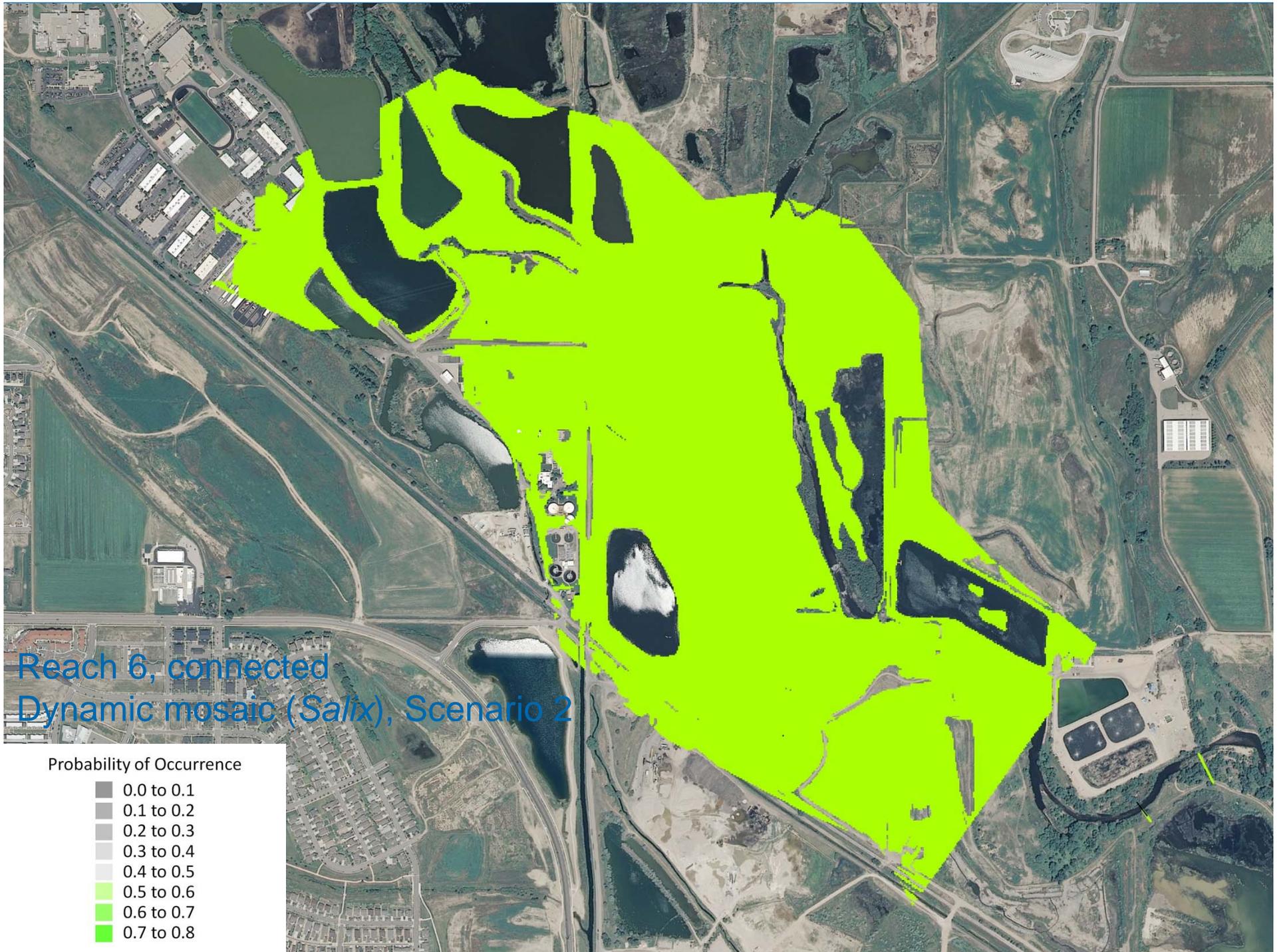


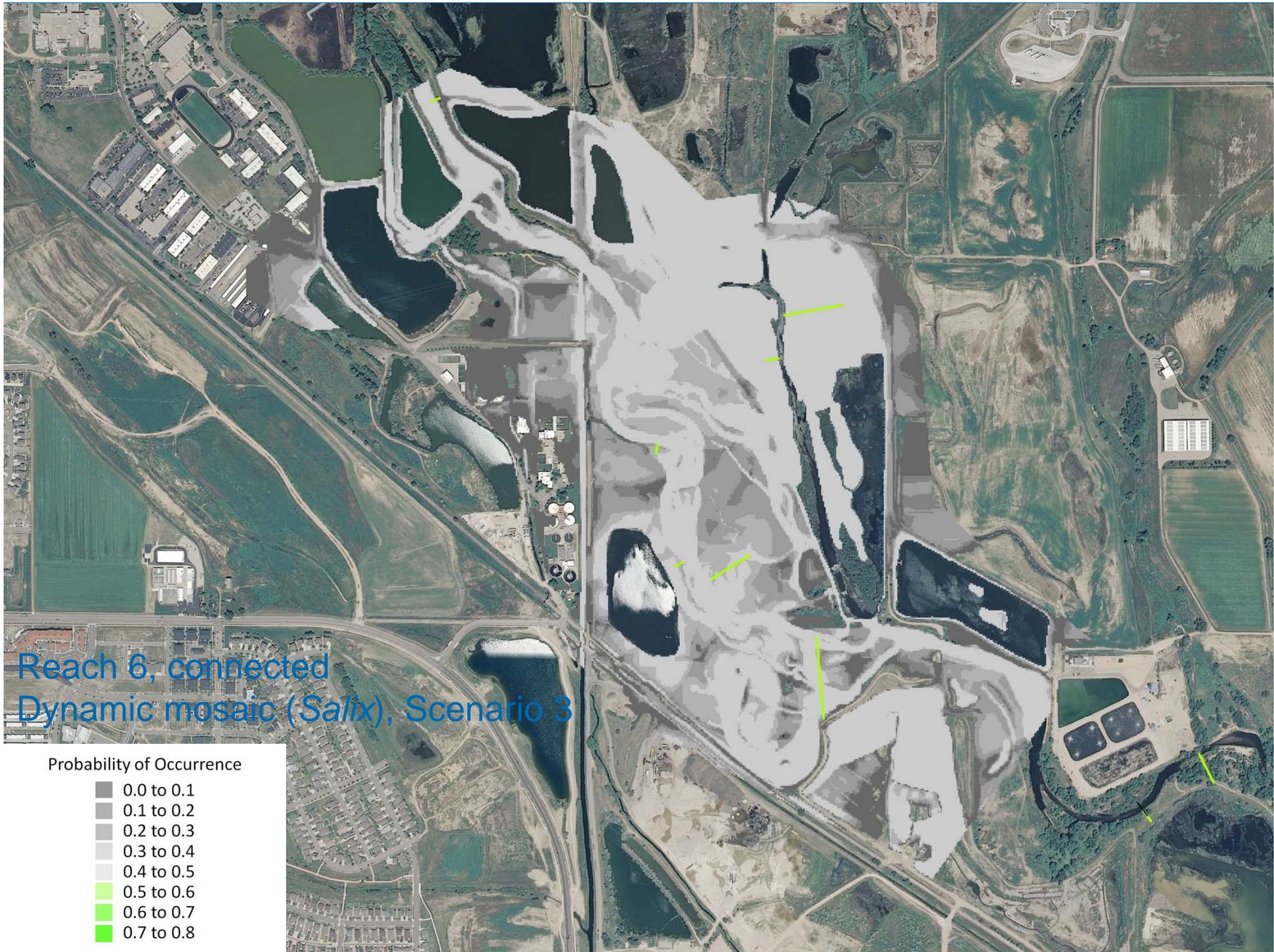


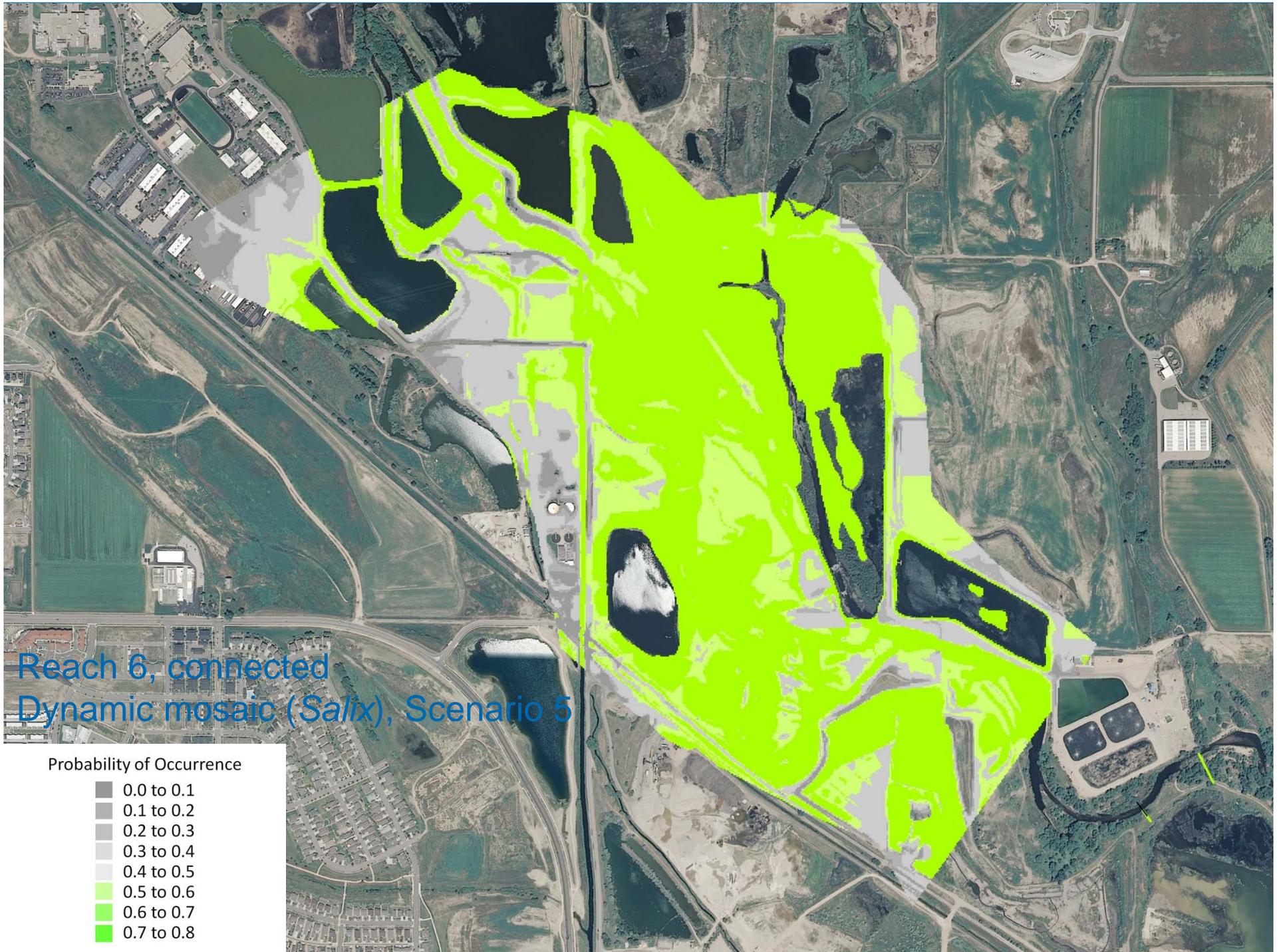












*“The significant problems we face cannot be solved at the same level of thinking we were at when we created them.”*

-Albert Einstein

Einstein also studied rivers:

Einstein, A., 1926. The cause of the formation of meanders in the courses of rivers and of the so-called Baer's Law. Read before the Prussian Academy, January 7, 1926. Published in *Die Naturwissenschaften*, Vol. 14. [English translation in "Ideas and Opinions," by Albert Einstein, Modern Library, 1994].