One Stormwater RMLUI 2019

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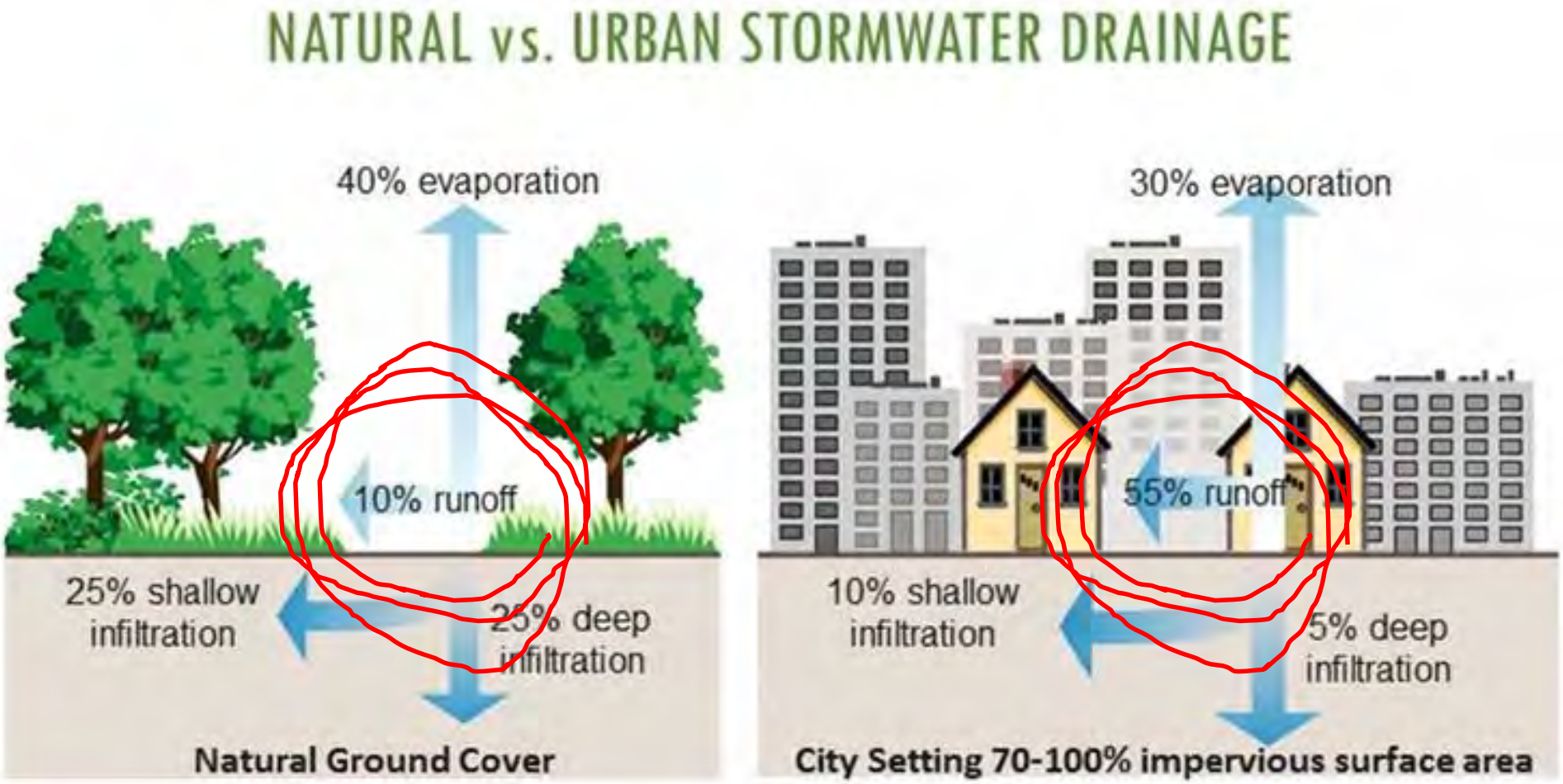
One Stormwater

Natural Disasters
Water Quality
Storm Pipes
Watershed Health
Green Infrastructure
Land Development
Resilience
Stream Health
Water Quantity
Flood Control
Erosion and Sediment
Low Impact Development
Clean Water Act
FEMA

The Challenge

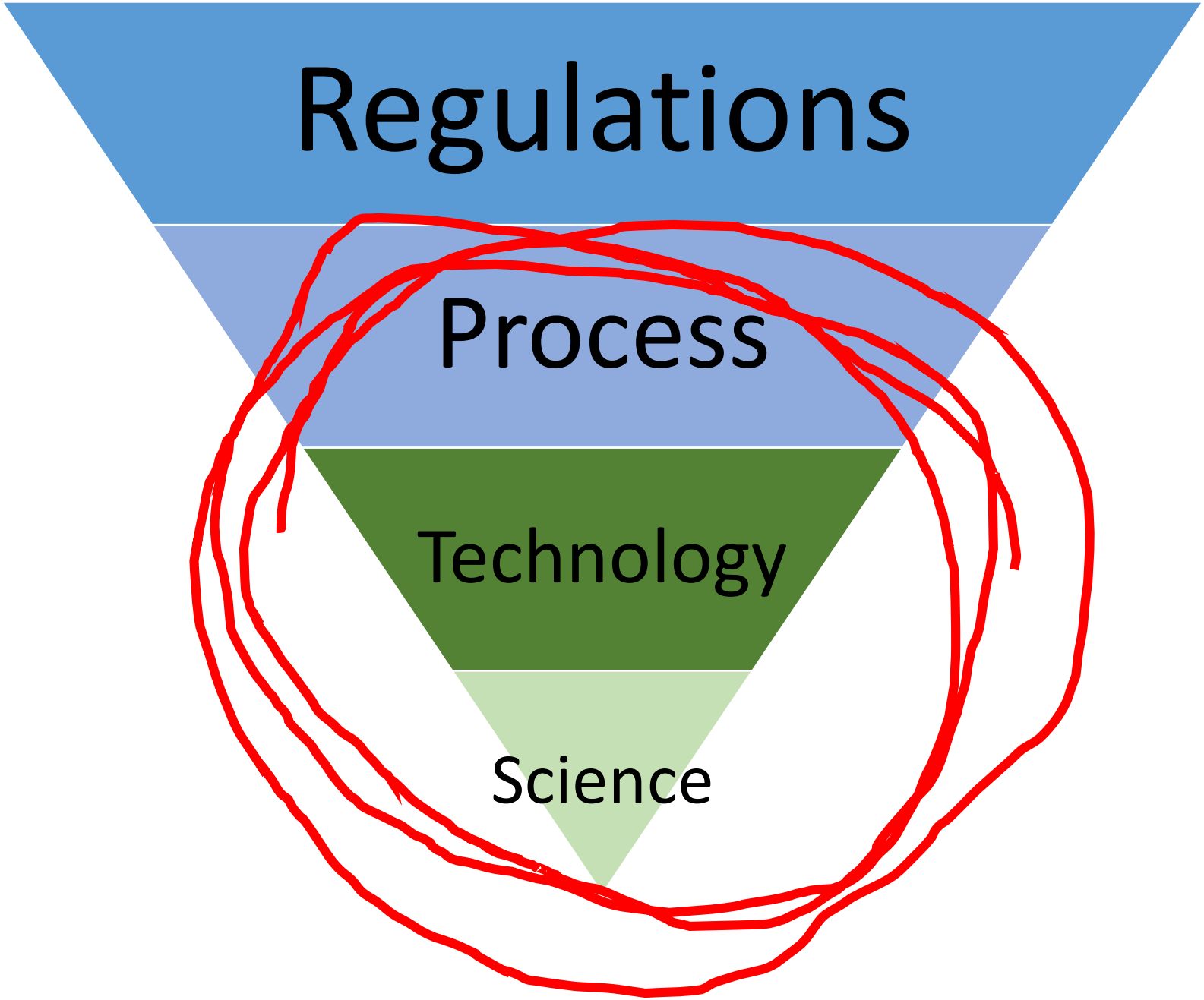


The Consequences

The Consequences

The Consequences

To overcome the challenge of “more water”

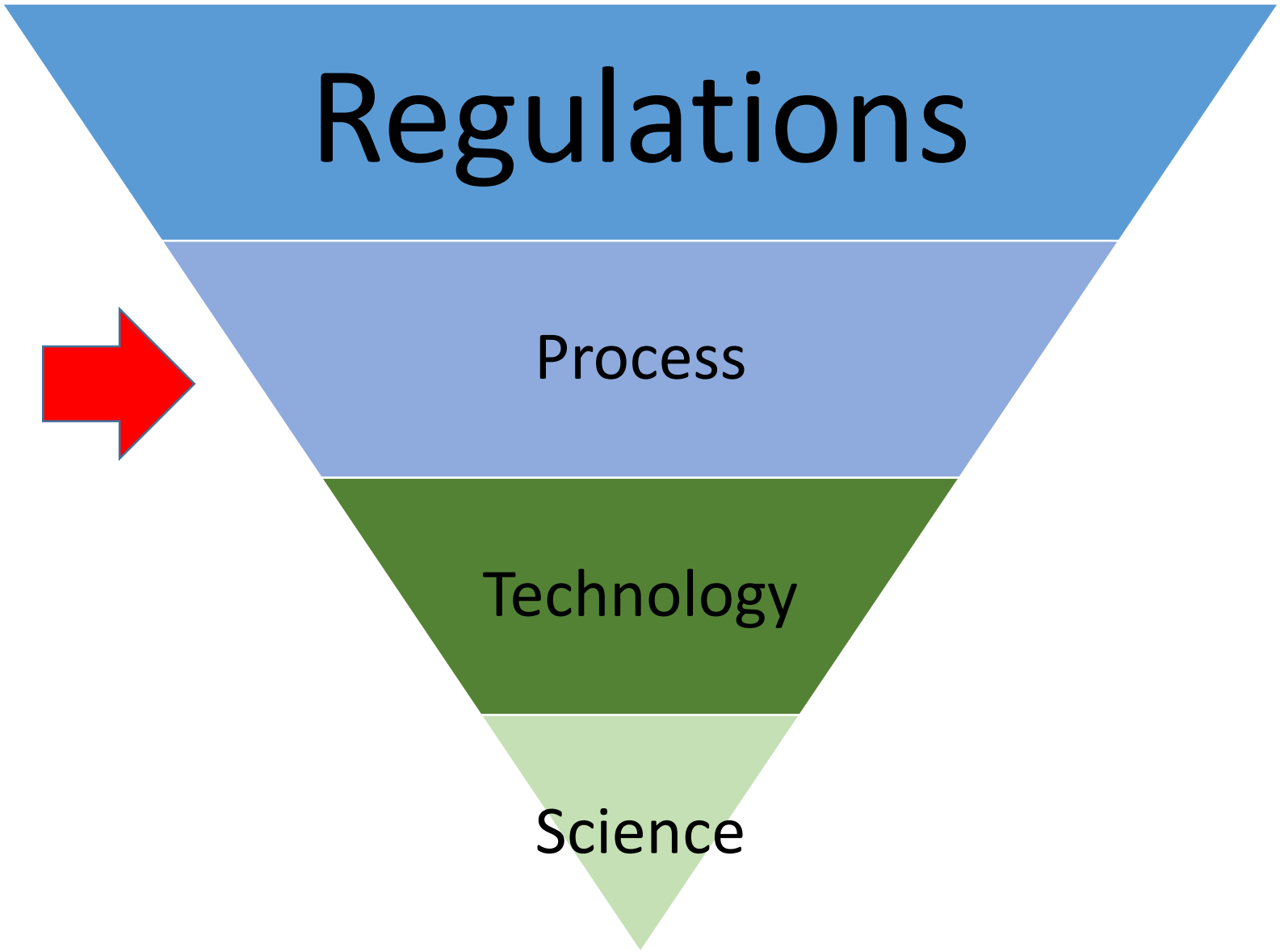

Regulations
Process
Technology
Science

What percentage of the watershed do municipalities *build*?

5%

What percentage of the watershed is built by *others*?

95%


Regulations
Process
Technology
Science

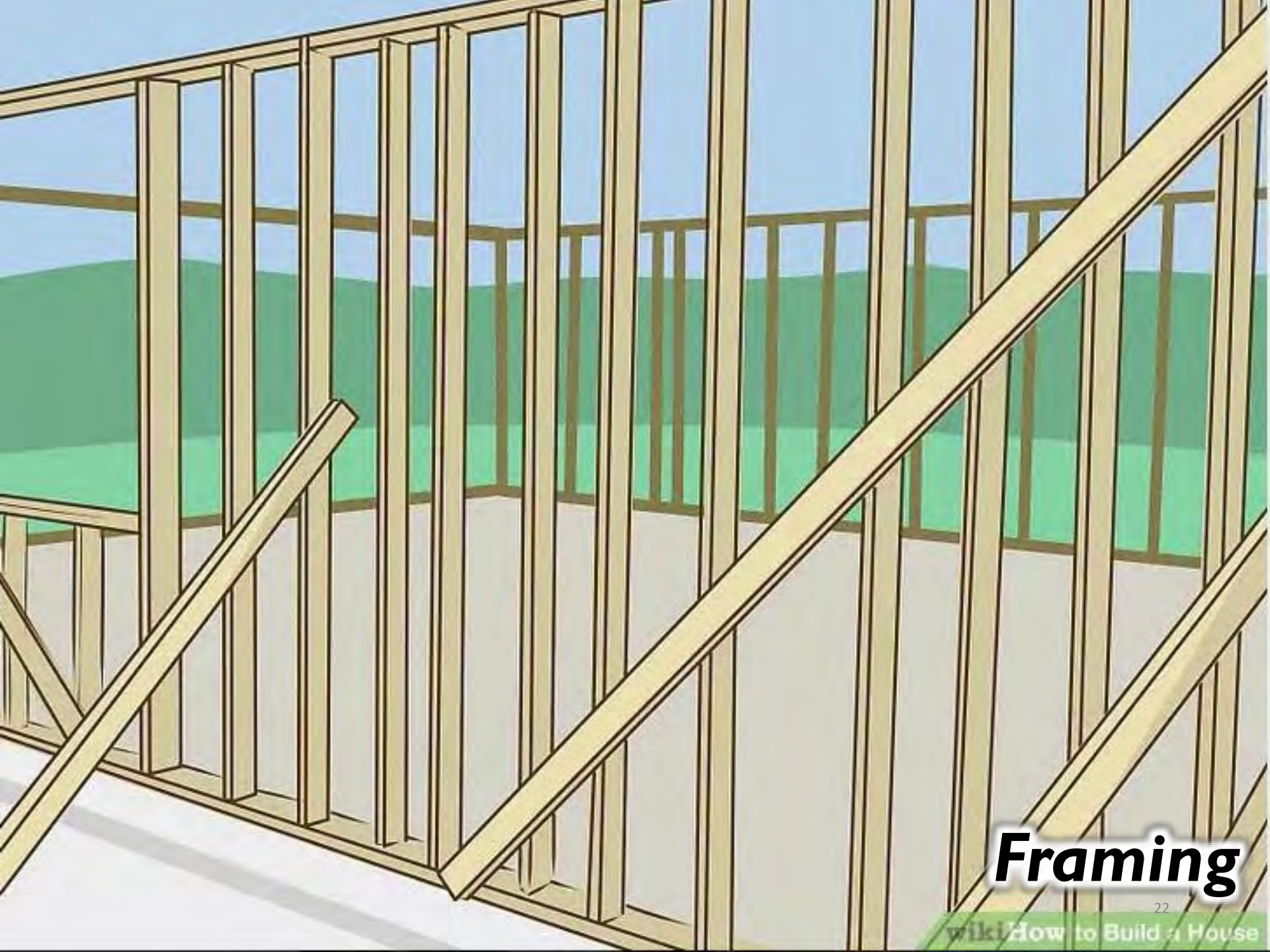

Public Sectors
Private Sectors

Common Vision

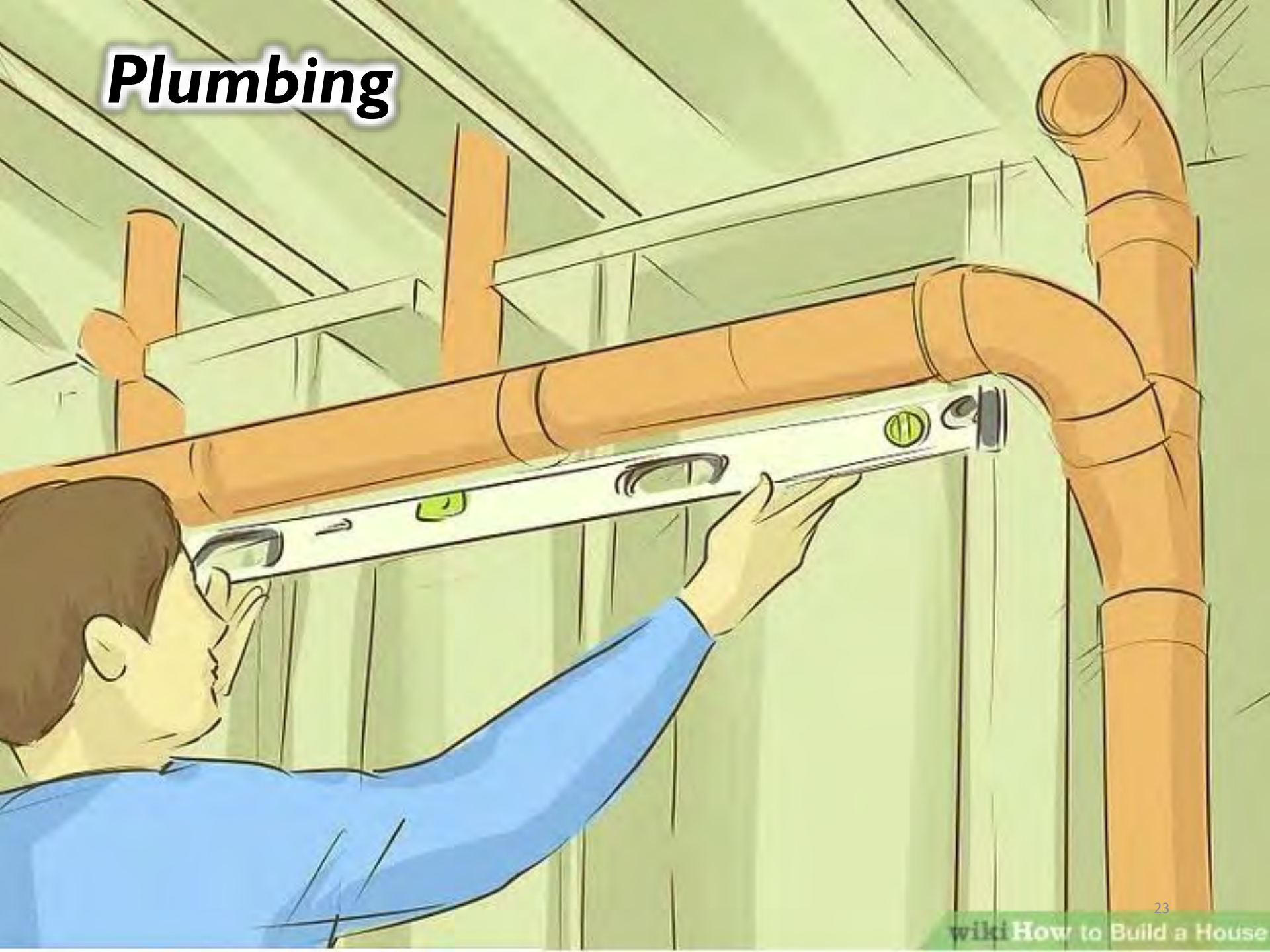

Westerly Creek


Westerly Creek

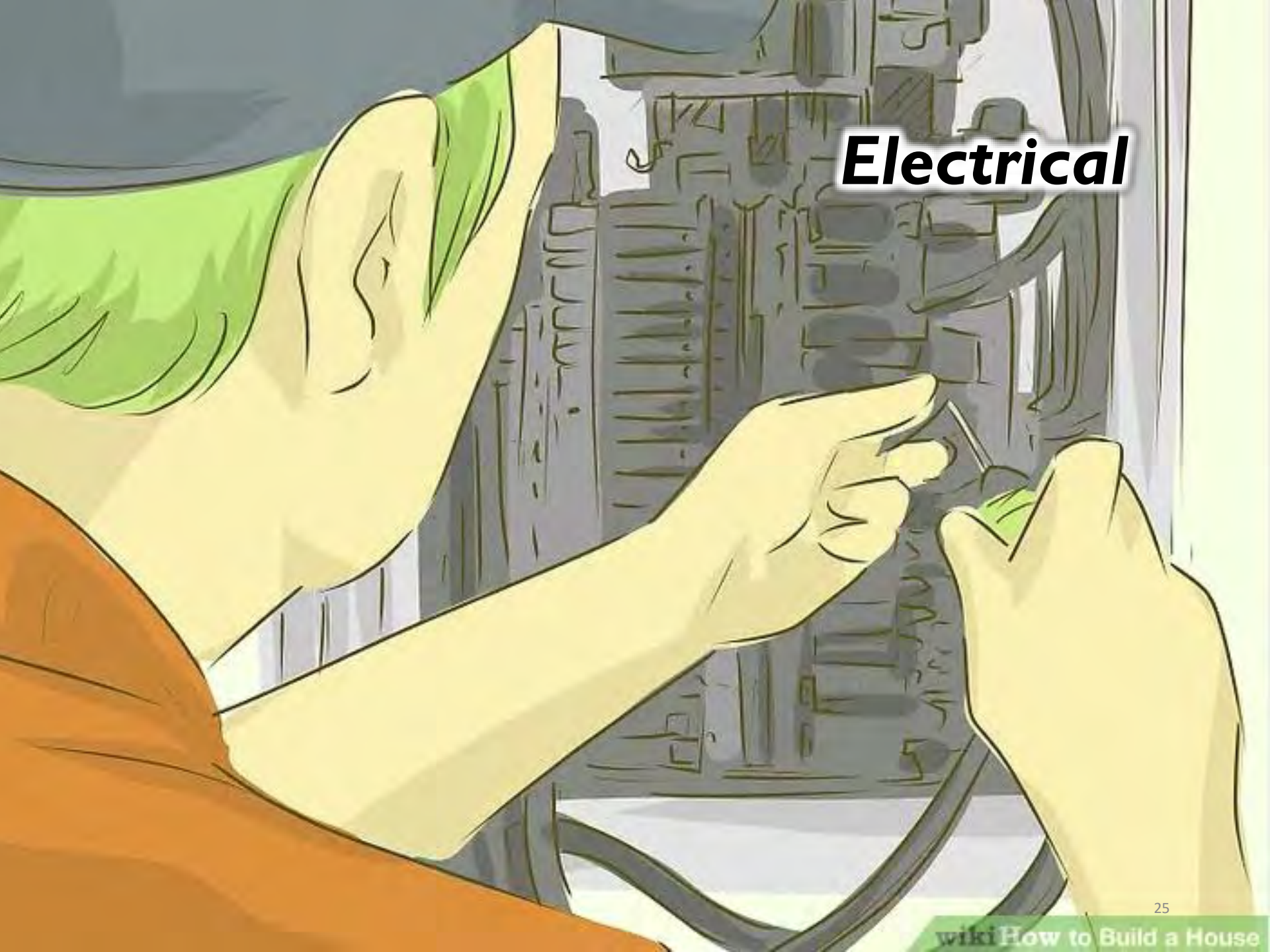

Foundation


Framing
wikiHow to Build a House

Plumbing




HVAC



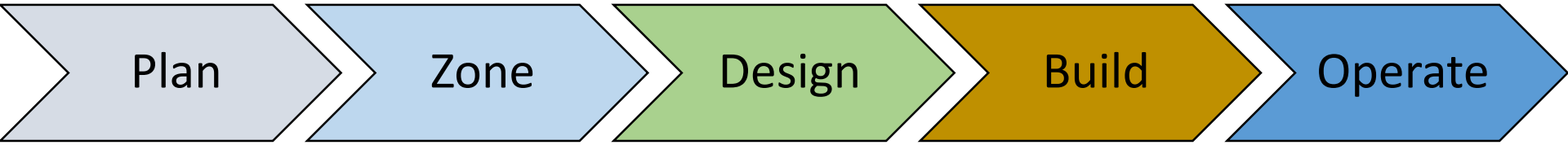

Insulation

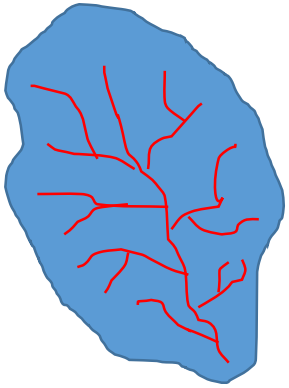
Interior Finishes


Watershed Health


Stream Health

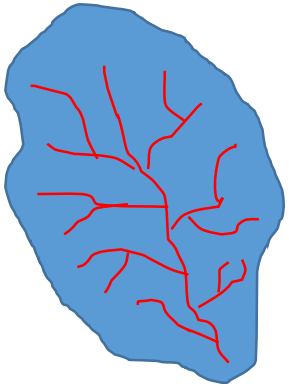
(*re)*Build Out Process



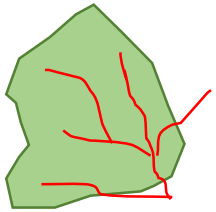


City

(*re*)Build Out Process



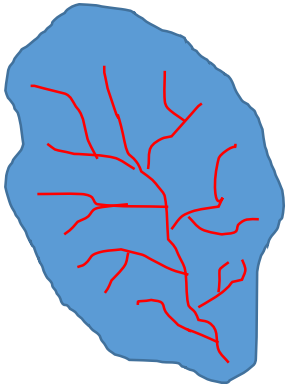
City



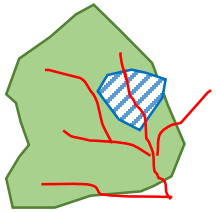
Subdivision

(*re*)Build Out Process

Plan | Zoning | Design | Build | Operate



City

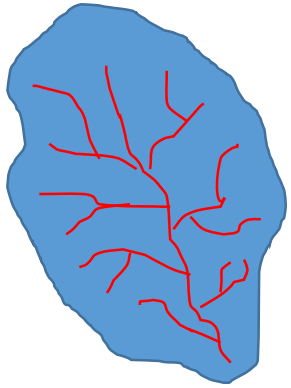


Subdivision

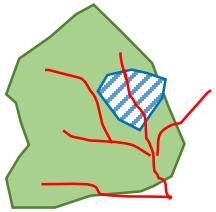
Neighborhood

(*re*)Build Out Process

MP | Zone | Design | Build | Operate

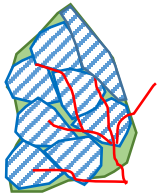


City

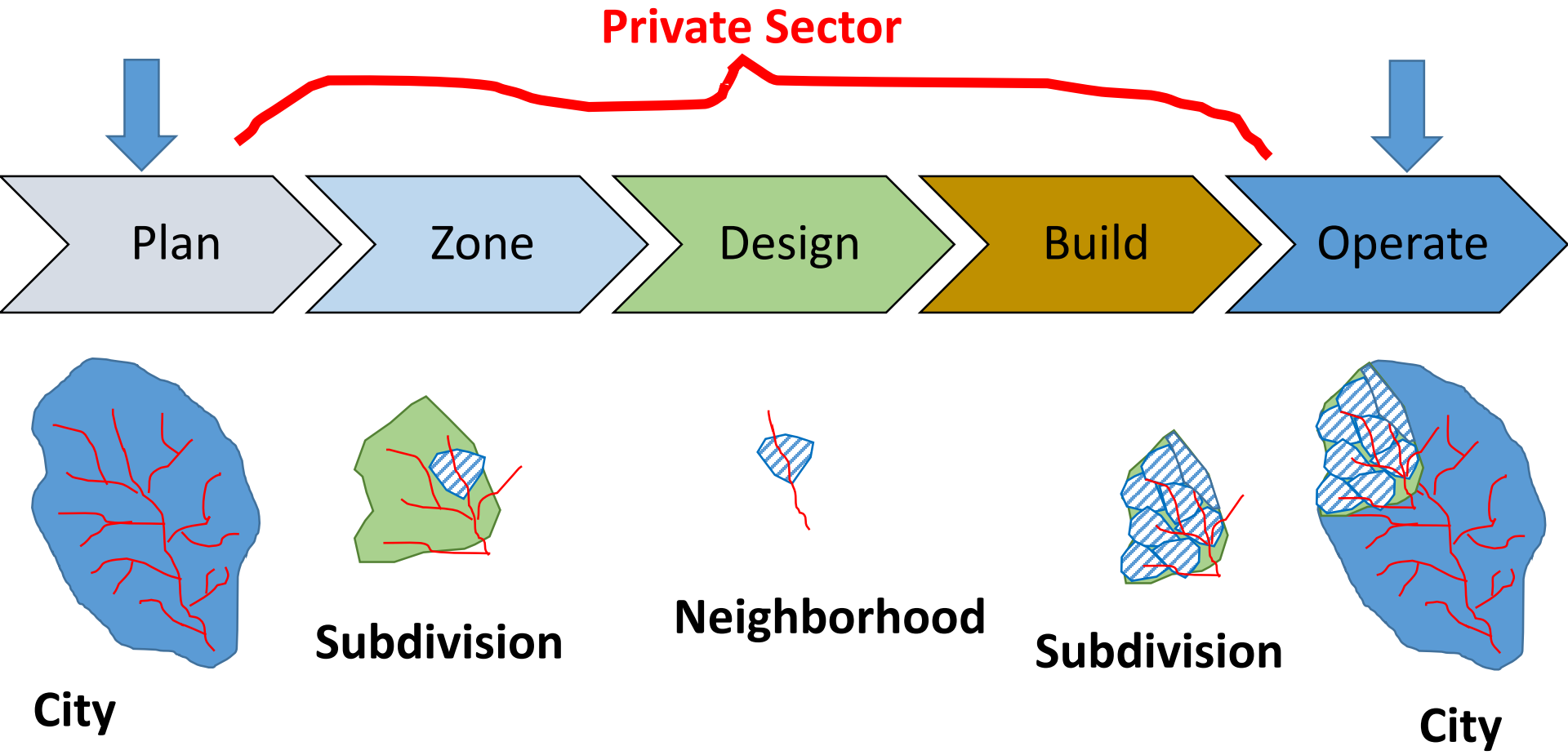


Subdivision

Neighborhood

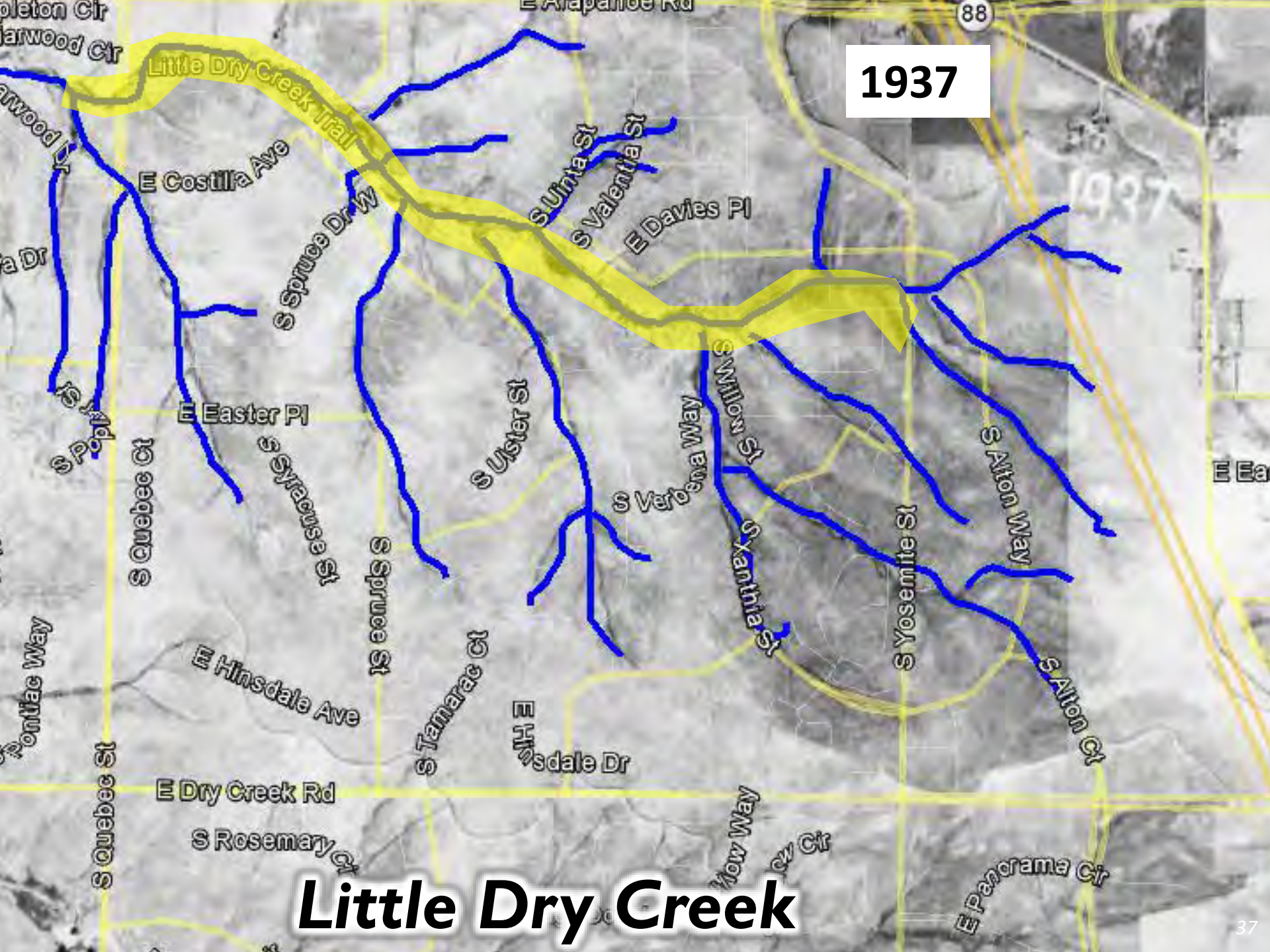


Subdivision


Private Sector
Plan
Zone
Design
Build
Operate
City
Subdivision
Neighborhood
Subdivision
City

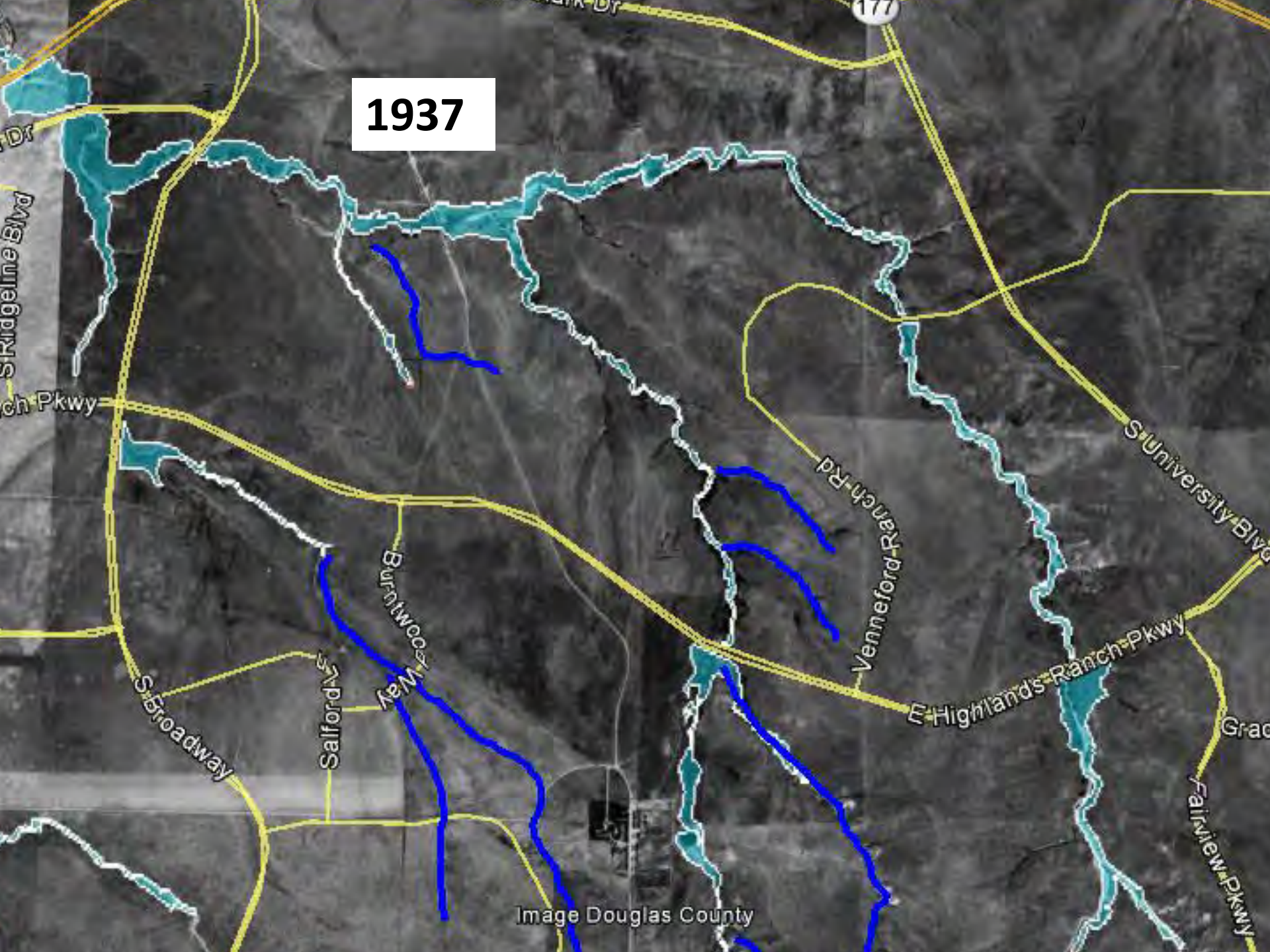
New Development Case Study

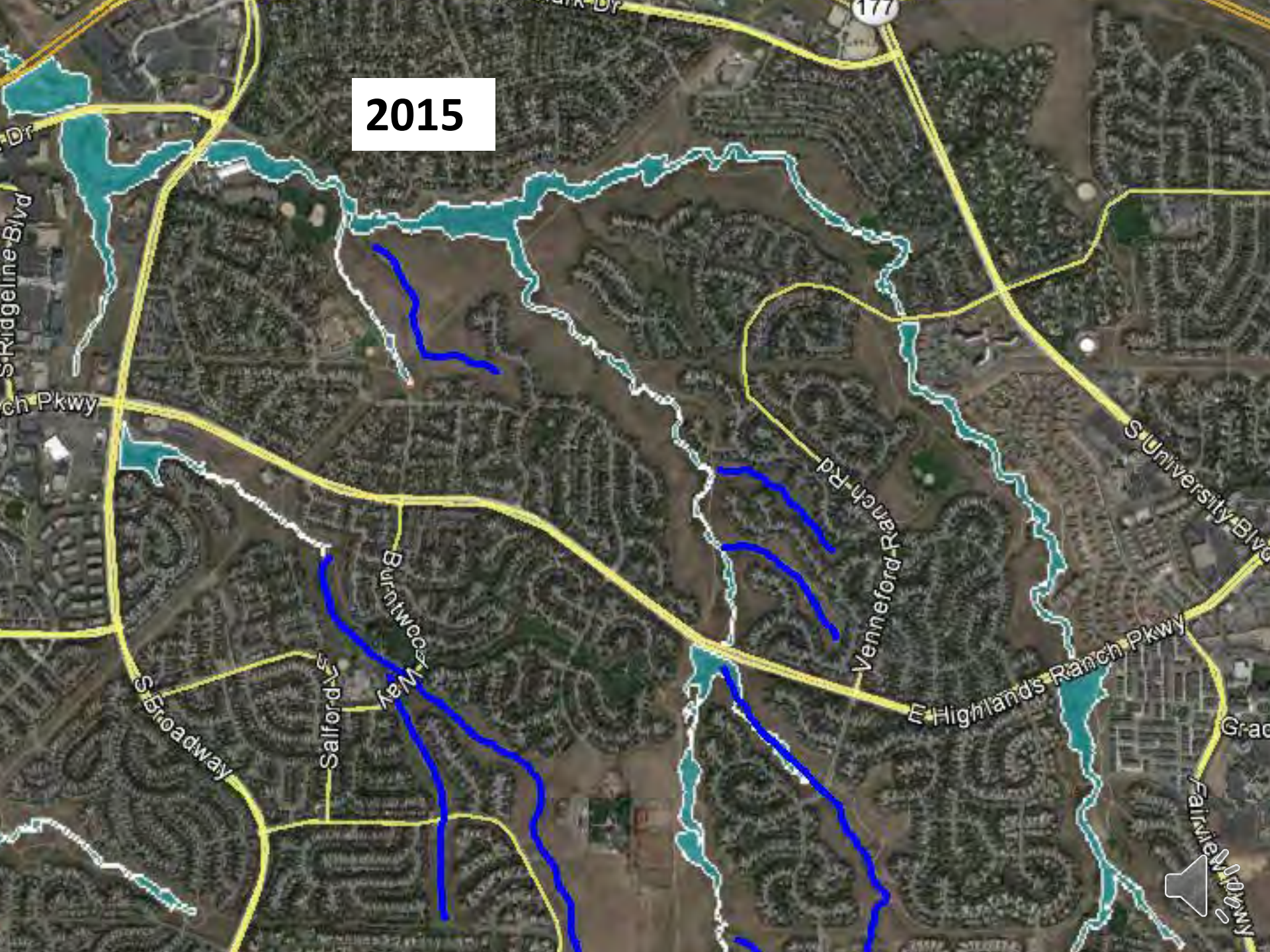
Process

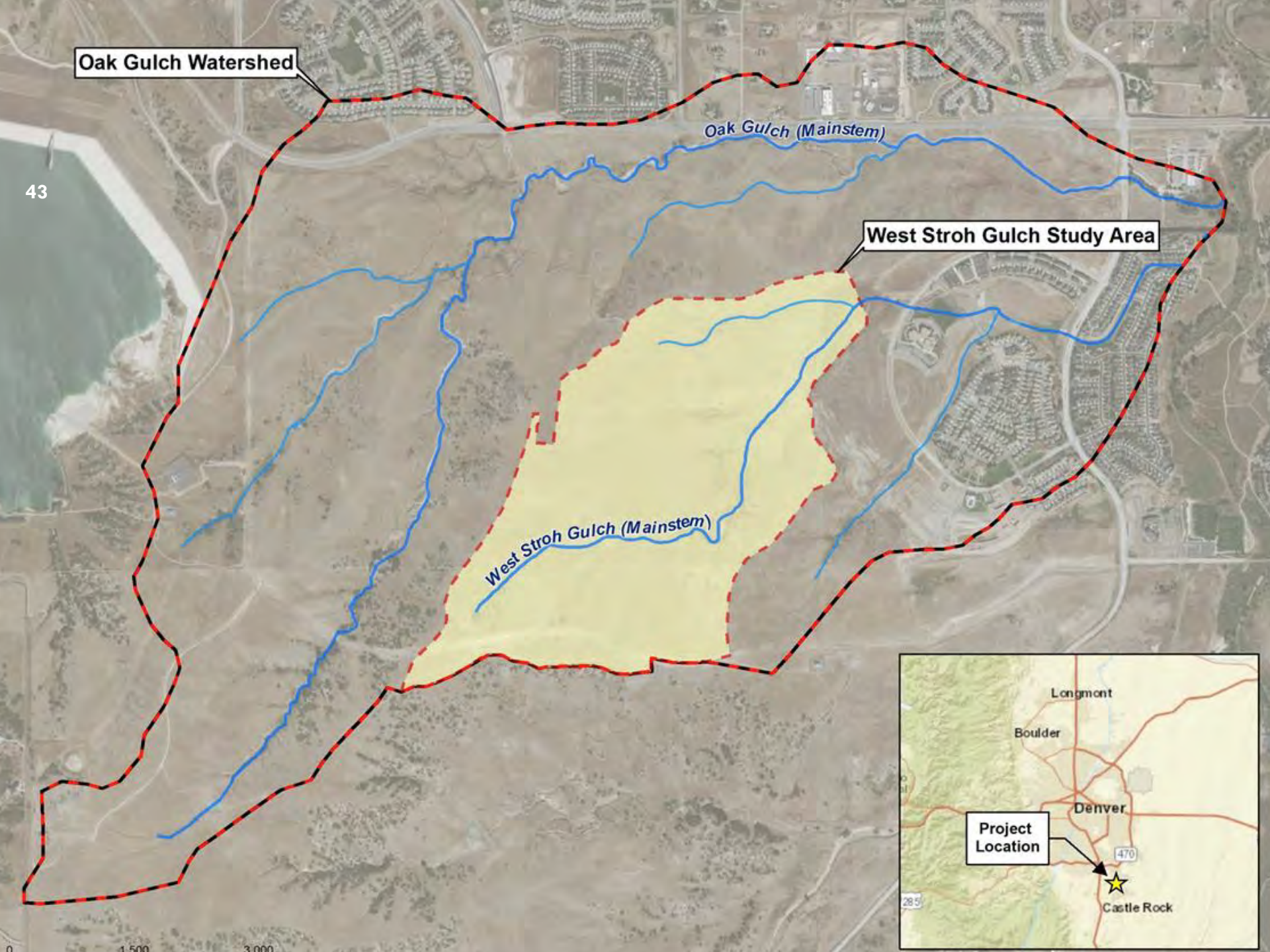


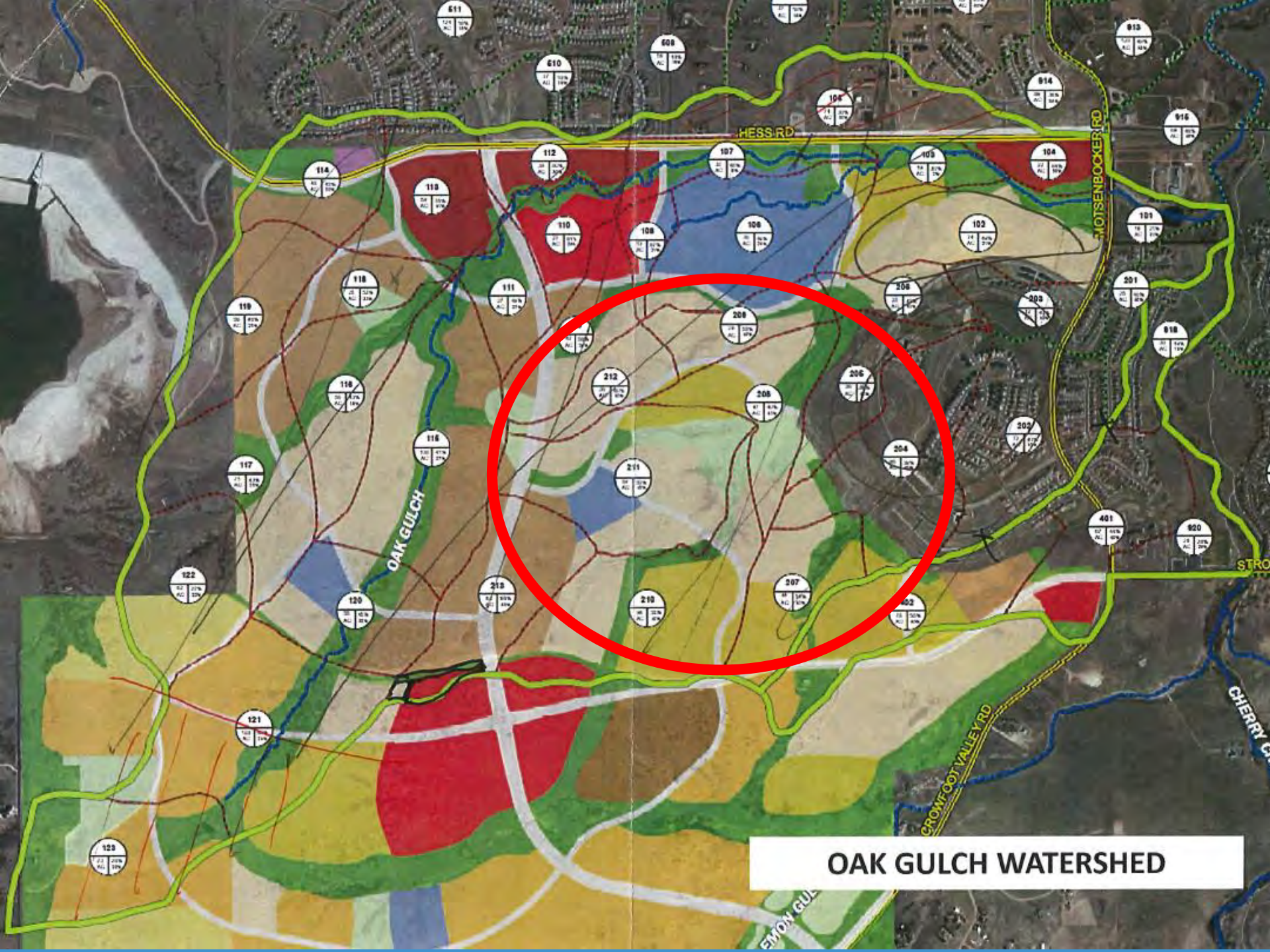
Little Dry Creek

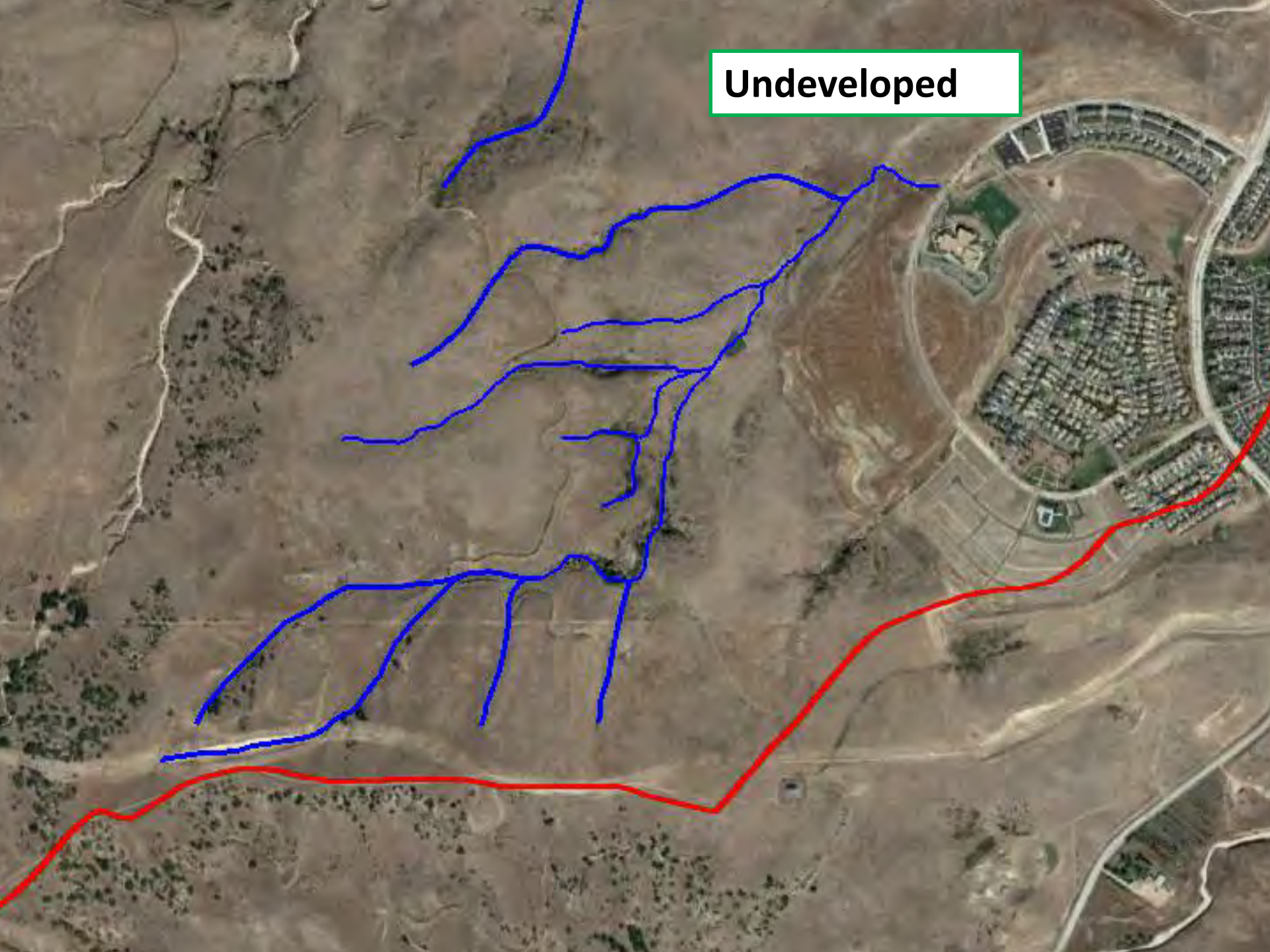

2015
Little Dry Creek Trail
E Costilla Ave
S Spruce Dr W
S Uinta St
S Valentia St
E Davies Pl
S Willow St
S Verbena Way
S Xanthia St
S Yosemite St
S Alton Way
S Alton Ct
E Panorama Cir
S Uster St
E Easter Pl
S Quebec Ct
S Syracuse St
S Spruce St
S Tamarac Ct
E Hinsdale Ave
E Hinsdale Dr
E Dry Creek Rd
S Quebec St
S Rosemary Ct
S Pontiac Way
88
Little Dry Creek
38

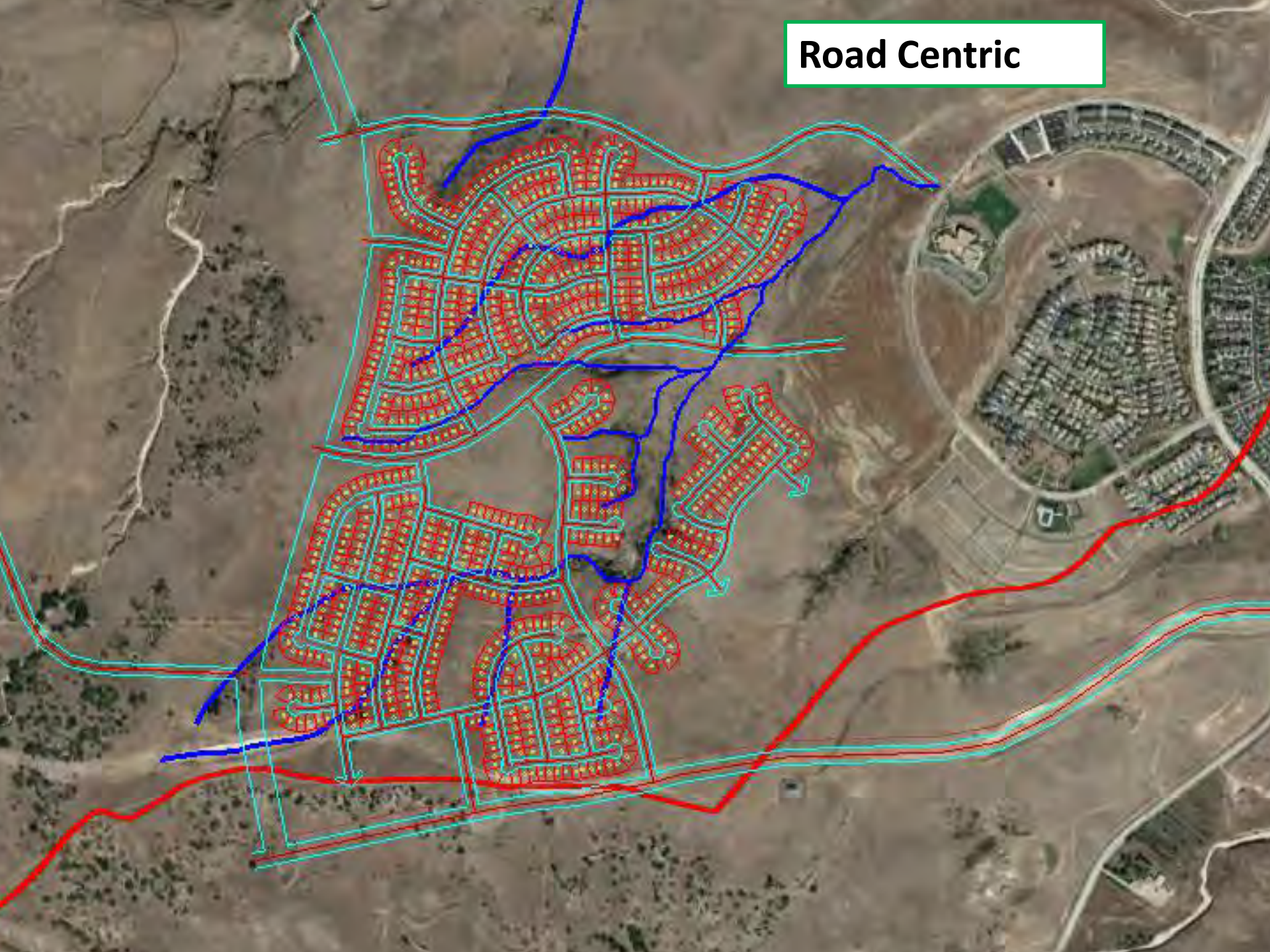

1937
S Ridgeline Blvd
ch Pkwy
S Broadway
Salford Way
Burntwood Way
Vennerford Ranch Rd
S University Blvd
E Highlands Ranch Pkwy
Fairview Pkwy
Image Douglas County

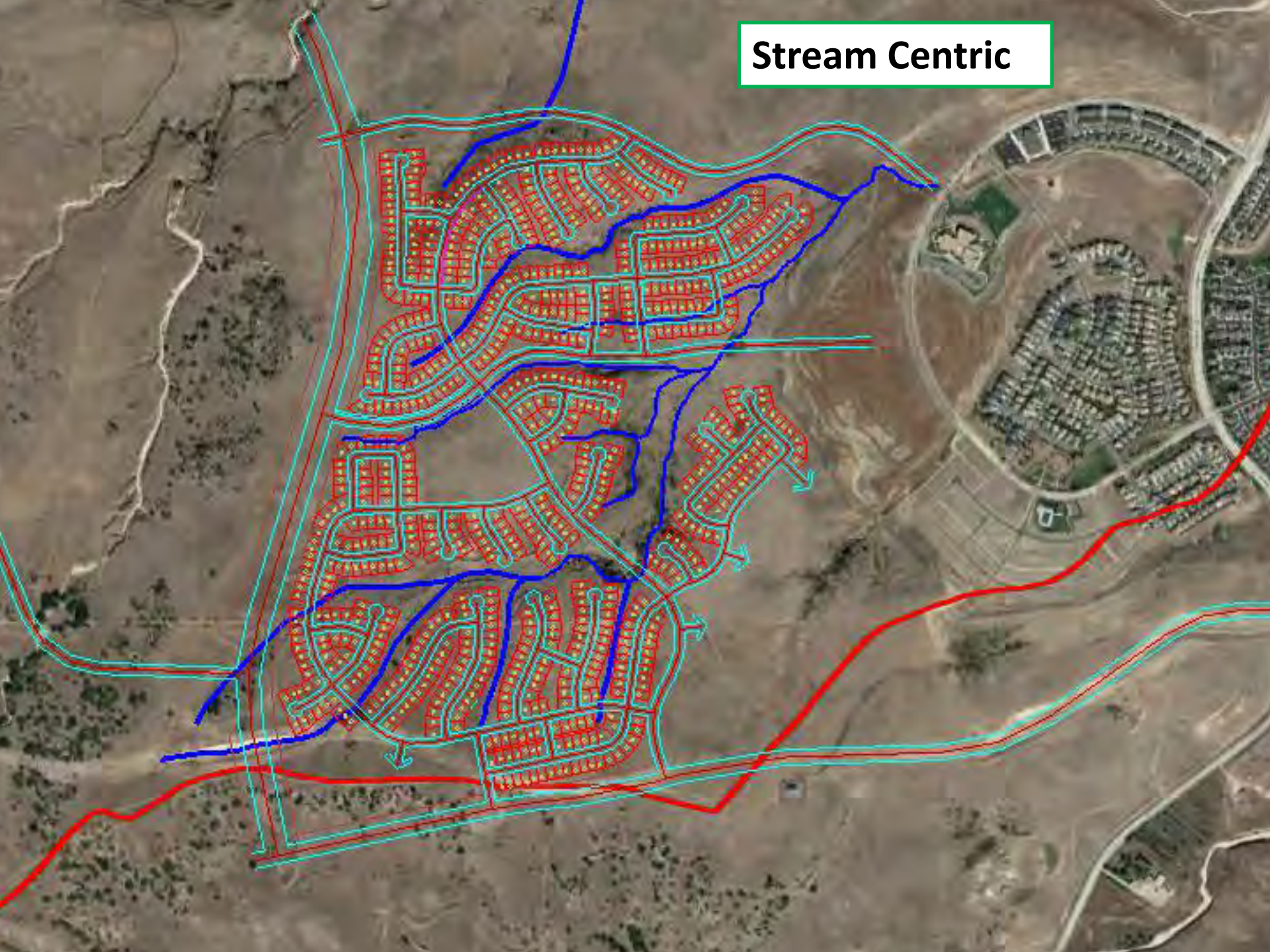

2015
S Ridgeline Blvd
ch Pkwy
S Broadway
Salford Ln
Burntwood Way
Venneford Ranch Rd
S University Blvd
E Highlands Ranch Pkwy
Fairview Pkwy


Oak Gulch Watershed
Oak Gulch (Mainstem)
West Stroh Gulch Study Area
West Stroh Gulch (Mainstem)
Longmont
Boulder
Denver
Project Location
470
285
Castle Rock
0
1,500
3,000

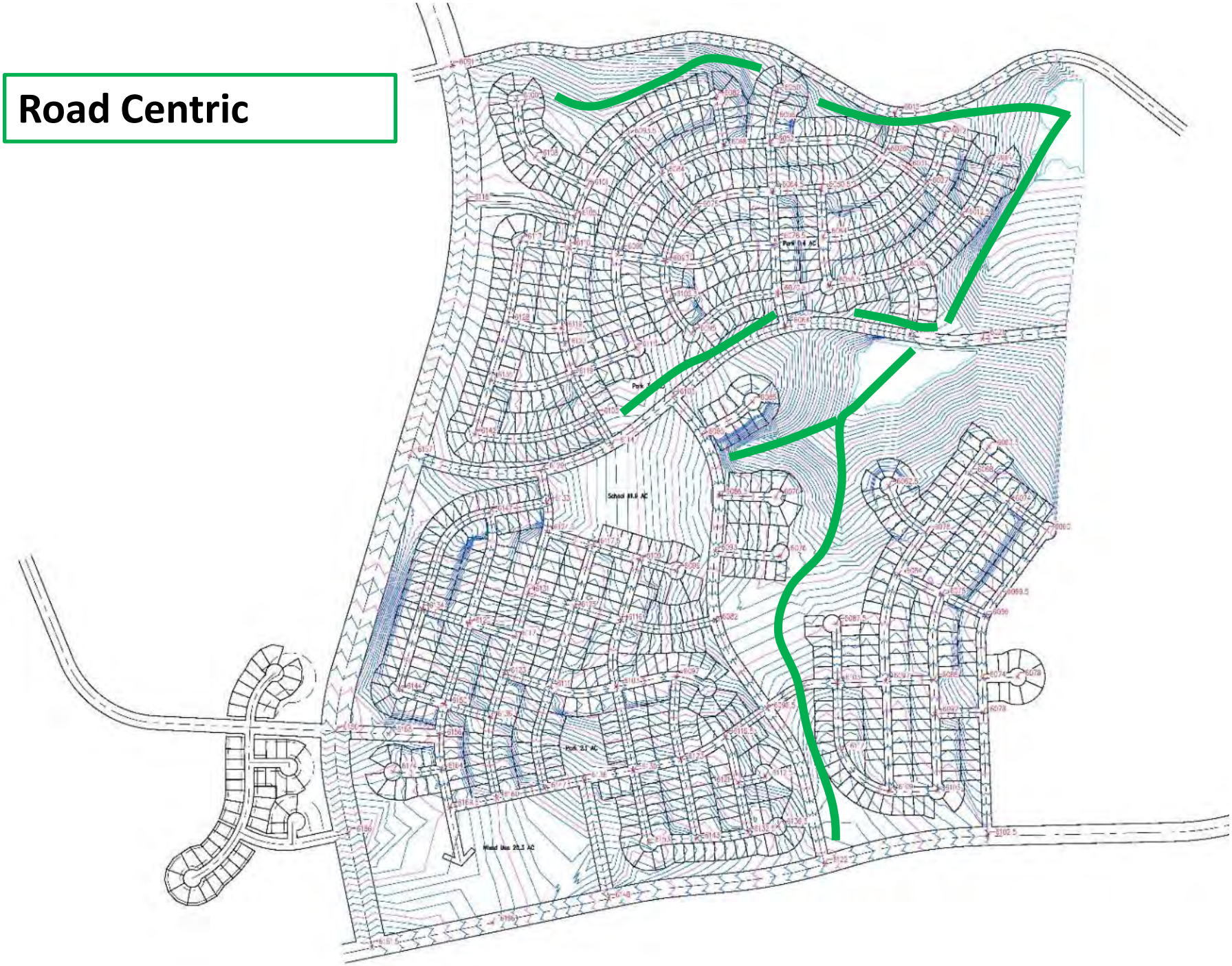

HESS RD
MOTSENBOCKER RD
OAK GULCH
CROWFOOT VALLEY RD
OAK GULCH WATERSHED


Undeveloped

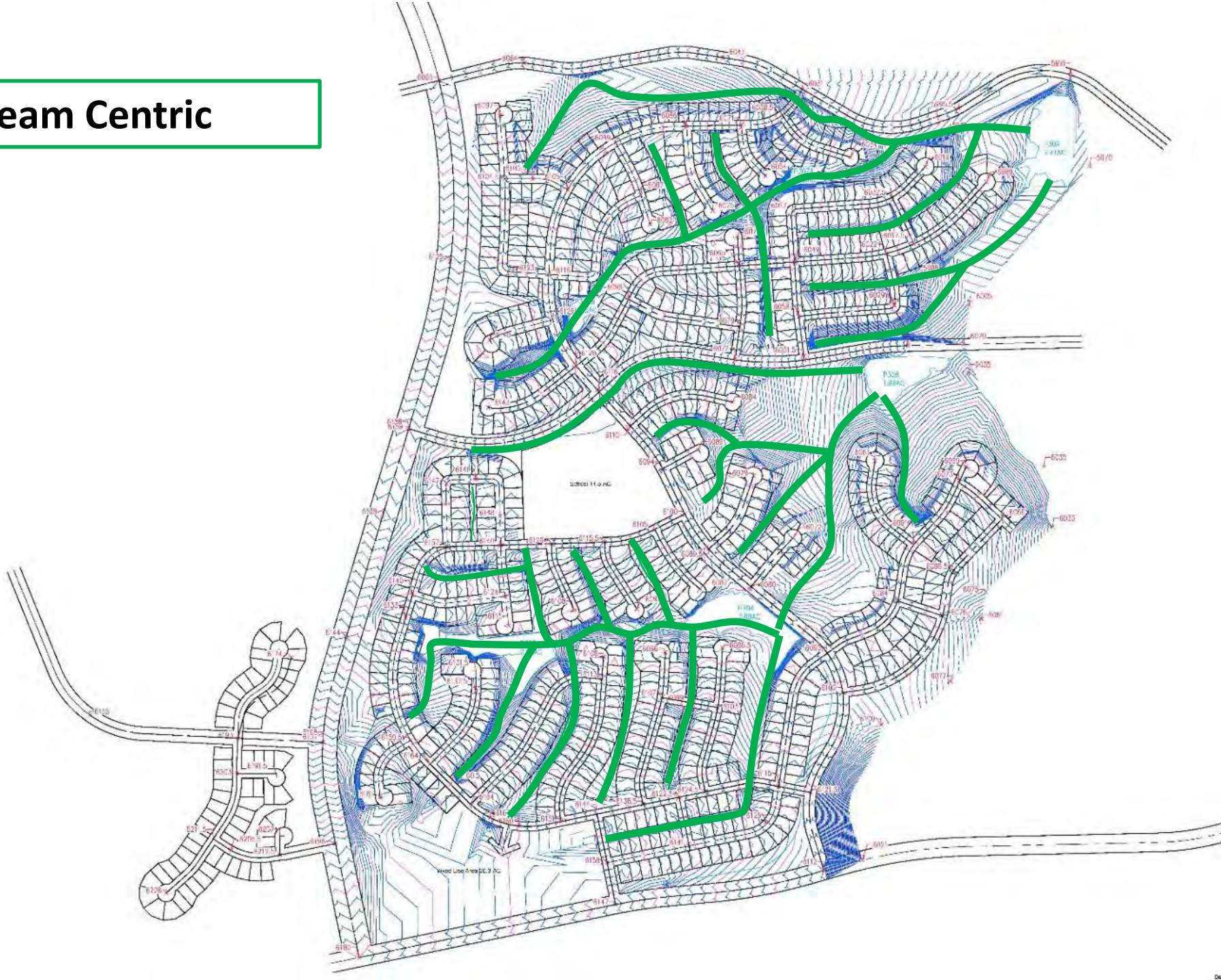

Road Centric


Stream Centric

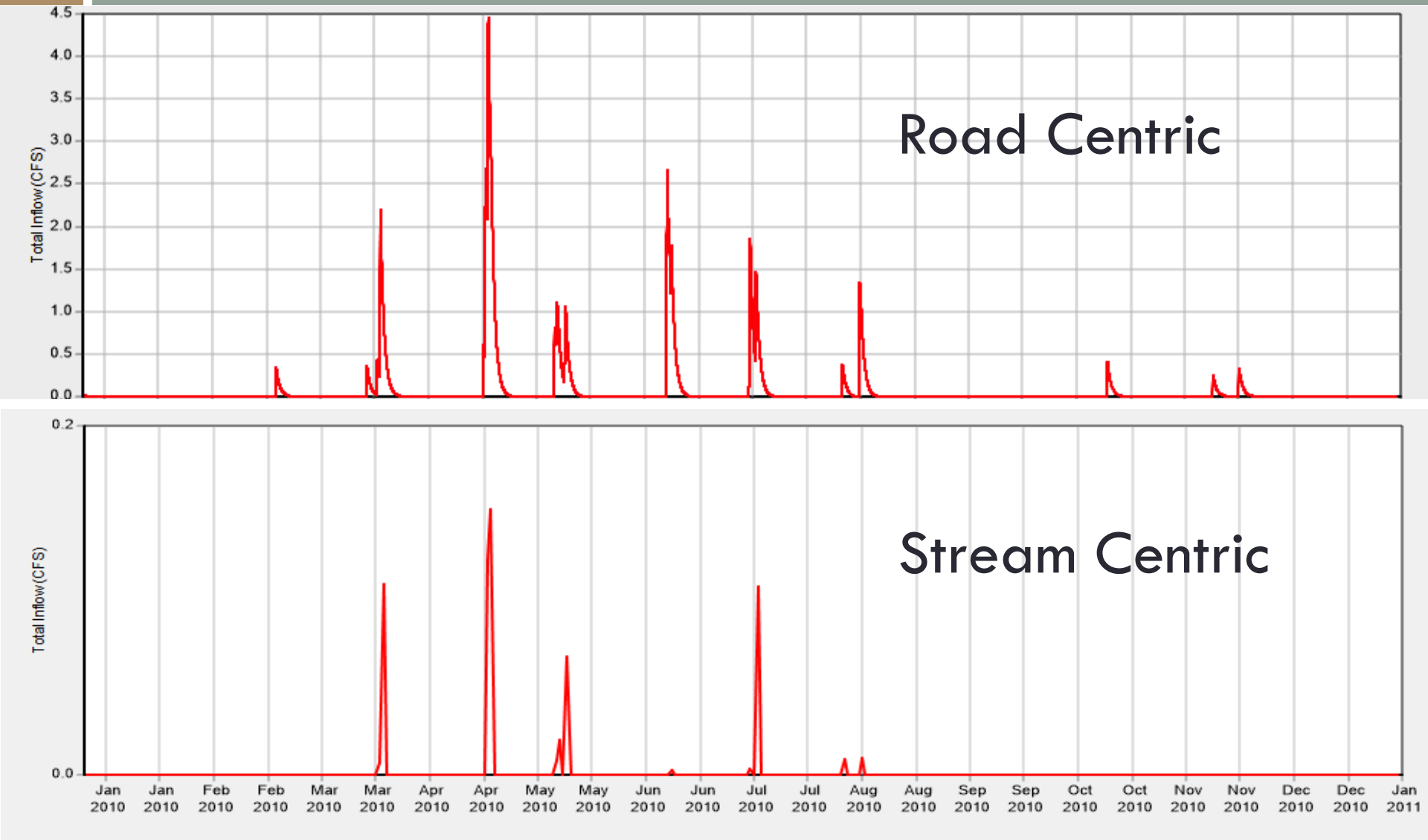
Road Centric



Stream Centric



Amount of Water



Development Metrics

Road Centric	
878	Lots
320	(AC) Total Boundary
5.6	(AC) Park
11.9	(AC) School
20.3	(AC) Mixed Use
2.7	Gross Density (Units/Acre)

Stream Centric	
797	Lots
320	(AC) Total Boundary
5.6	(AC) Park
11.9	(AC) School
20.4	(AC) Mixed Use
2.5	Gross Density (Units/Acre)

ROAD CENTRIC

STREAM CENTRIC

EARTHWORK / EROSION CONTROL		ɔL	$ 8,237,200
PUBLIC ROADWAY IMPROVEMENTS		ITS	$ 21,556,033
PARKS, TRAILS, AND RECREATION		I	$ 1,271,334
SIGNAGE & STRIPING			$ 503,706
DRAINAGE AND STORMWATER		MPROVEMENTS	$ 1,005,200
SANITARY IMPROVEMENTS			$ 3,779,383
WATER SYSTEM IMPROVEMENTS		;	$ 8,325,552

76,500

73,000

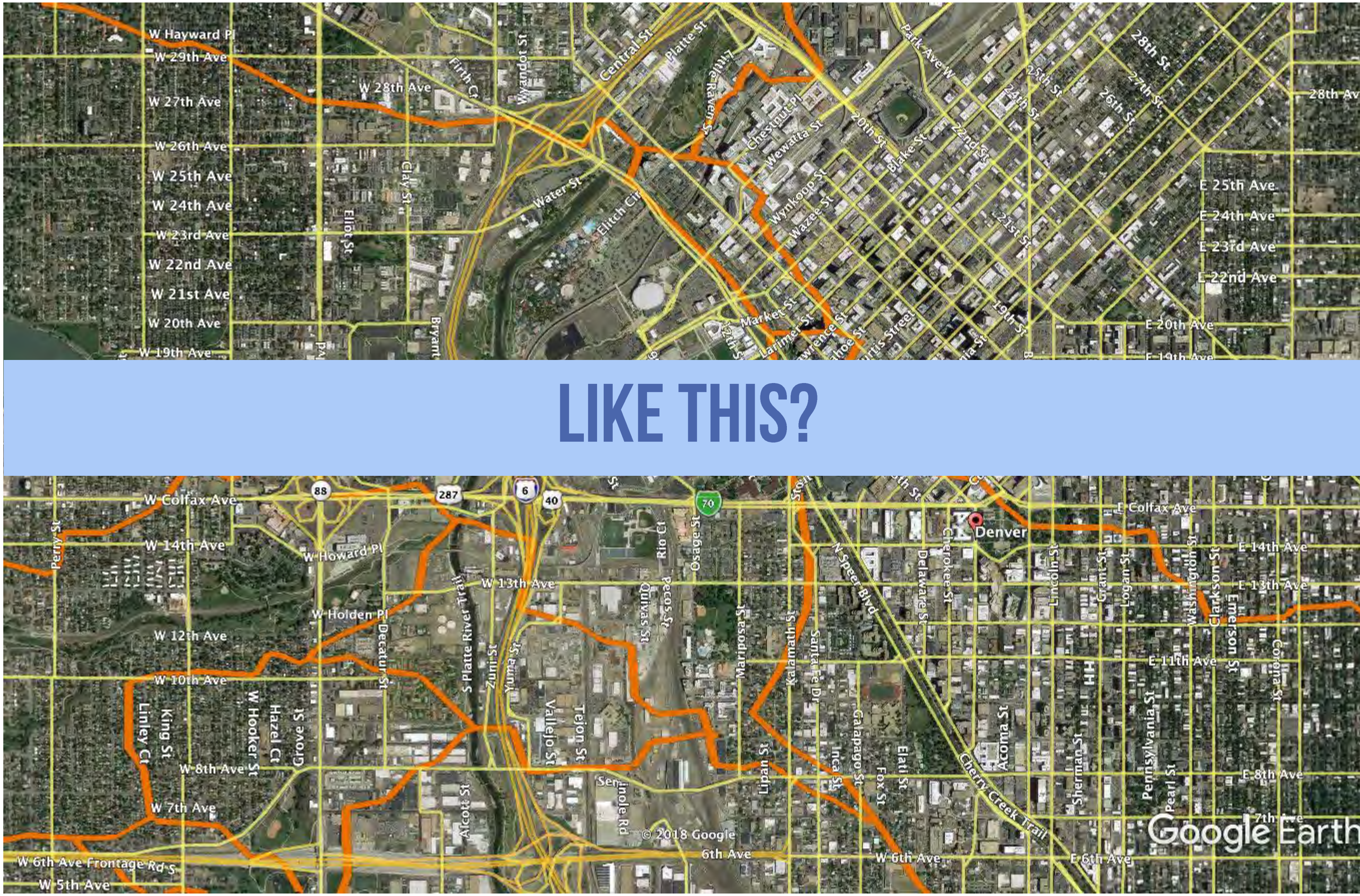
Redevelopment Case Study

Science and Technology


Double Angel Rd
S Chambers Rd
E Prairie Wind Ave
E Fire Fly Ave
Jordan Rd
Patty Ln
Tammy Ln
Randy Dr
Hadley St
Tack Dr
King Ct
W Hess Rd
E Saskatoon Pl
S Sopris Creek Dr
Bolero Dr
Stroh Rd
Cherry Creek Trail
N Crowfoot Valley Rd
© 2018 Google
Google Earth

HOW IS THIS?

LIKE THIS?


W Hayward Pl
W 29th Ave
W 28th Ave
W 27th Ave
W 26th Ave
W 25th Ave
W 24th Ave
W 23rd Ave
W 22nd Ave
W 21st Ave
W 20th Ave
W 19th Ave
Firth Ct
Wyandot St
Central St
Platte St
Little Raven St
Park Ave W
28th St
27th St
26th St
25th St
24th St
28th Ave
Chestnut Pl
Wewatta St
20th St
Blake St
22nd St
Water St
Elitch Cir
Wynkoop St
Wazee St
21st St
Clay St
Eliot St
Bryant St
E 25th Ave
E 24th Ave
E 23rd Ave
E 22nd Ave
E 20th Ave
E 19th Ave
Market St
Larimer St
19th St
W Colfax Ave
88
287
6
40
70
W 14th Ave
W Howard Pl
W 13th Ave
W Holden Pl
W 12th Ave
W 10th Ave
Perry St
Linley Ct
King St
W Hooker St
Hazel Ct
Grove St
Decatur St
S Platte River Trail
Zuni St
Yuma St
Vallejo St
Tejon St
Quivas St
Pecos St
Rio Ct
Osage St
Mariposa St
Kalamath St
Santa Fe Dr
N Speer Blvd
Delaware St
Cherokee St
Denver
E Colfax Ave
E 14th Ave
E 13th Ave
E 11th Ave
Lincoln St
Grant St
Logan St
Washington St
Clarkson St
Emerson St
Corona St
W 8th Ave
W 7th Ave
Alcott St
Seminole Rd
Lipan St
Inca St
Galapago St
Fox St
Elati St
Acoma St
Cherry Creek Trail
Sherman St
Pennsylvania St
Pearl St
E 8th Ave
7th Ave
W 6th Ave Frontage Rd S
W 5th Ave
6th Ave
W 6th Ave
E 6th Ave
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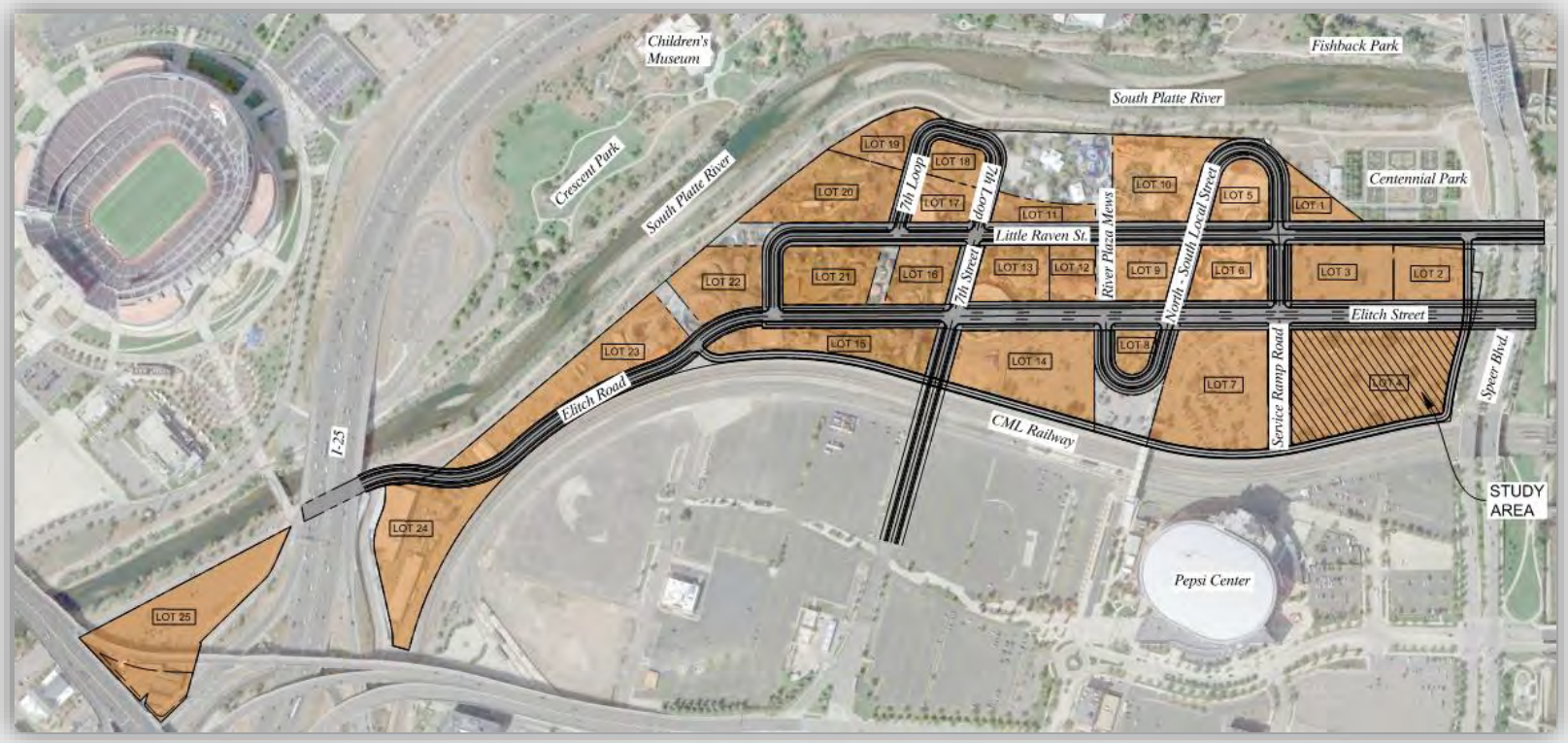
Google Earth

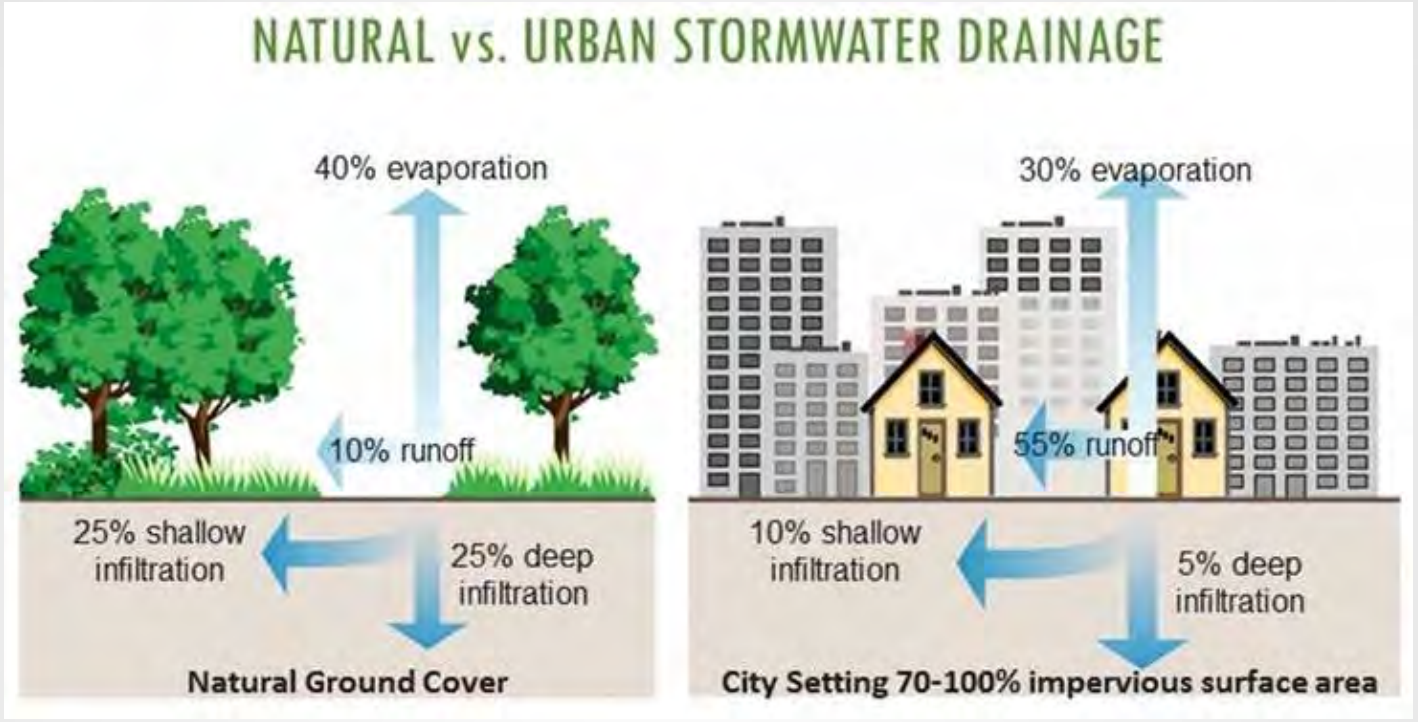
ONE STORMWATER

- More efficient use of the watershed
- Holistic design approach to stormwater management

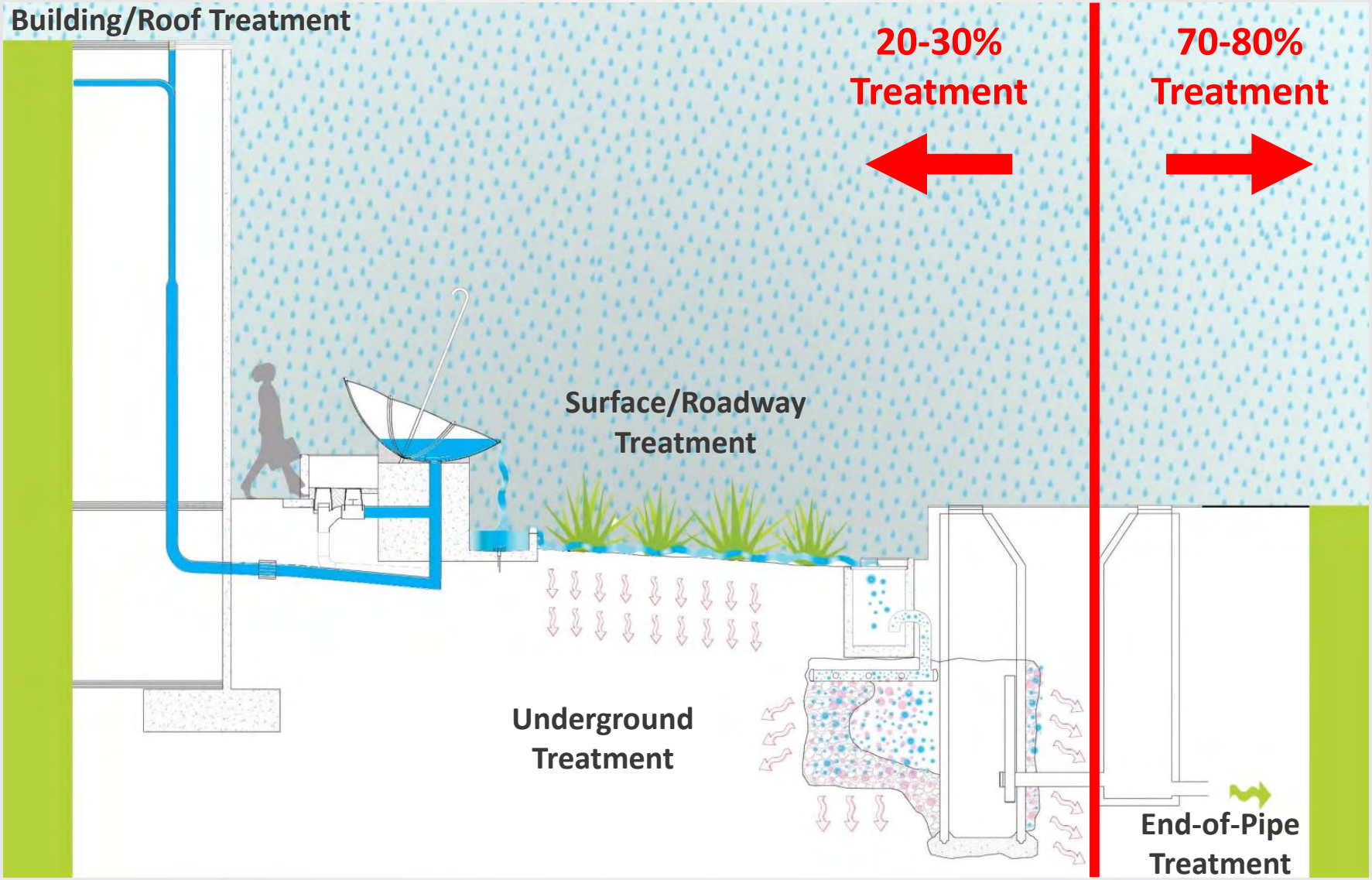
- Benefit the receiving waters
- Strategic use of the river corridor
- More effectively manage land use and community amenities
- Allows for site scale flexibility in design



DESIGN APPROACH



DESIGN APPROACH



DESIGN APPROACH

WHAT DOES THIS MEAN?

Minimize Impervious Area

Increase Tree Health

Cool Roofs

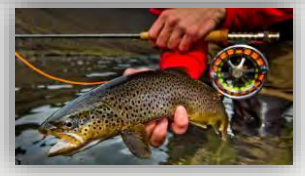
Trash/Debris Collection

Vegetated Streetscapes

Infiltration/Storage

DESIGN APPROACH

WHAT IS THE RESULT AT THE RIVER CORRIDOR?



POLICY AND CRITERIA

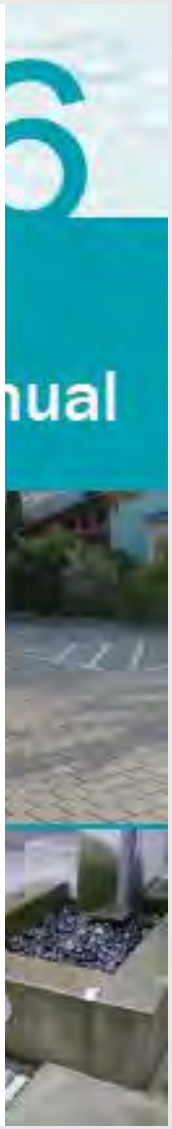
Goal 3: Use Stormwater as a Design Element

Unlike piped systems that hide water beneath the surface and work independently of site topography, infiltration systems can work with natural landforms and land uses to become a major site design element. When stormwater management is considered during the conceptual design phase, the infiltration and drainage system can suggest building footprints and circulation routes. In this way, the drainage pattern helps generate the urban form, creating a more aesthetically pleasing relationship to the natural features of the site.

The drainage system can be integrated into development plans to provide multiple project benefits:

- Improve site aesthetics.
- Provide recreational opportunities.
- Maximize land values.
- Improve project marketability.
- Help meet landscape and screening requirements.
- Provide wildlife habitat.
- Provide environmental education for employees, visitors, and the public.

Fencing or hiding stormwater facilities out of view not only precludes the opportunity to create an aesthetically pleasing site design, but also sends the message that stormwater is an attractive nuisance. While there are legitimate concerns for safety and liability, these concerns can usually be resolved with careful design consideration, such as specifying shallow facility depths with gentle side slopes.



ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

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ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

DEVELOPMENT GOALS

Smart Growth
support the City's environmental initiatives

Sustainable Community
social, economic and environmental balance

Urban Scale
critical mass essential to a strategic solution

Human Scale
people-friendly, inviting

Mixed Use
residential, commercial, retail, entertainment, education

Connectivity
technology, mobility, public access

Inclusivity
open, diversified, a place for everyone

High Design
attention to detail

Very Denver
active lifestyle, health and wellness, connection to nature

Reclaim the River
re-imagine and revitalize

ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

DEVELOPMENT GOALS

COMMUNITY AMENITIES

Affordable housing

One mile of South Platte River improvements

Three riverfront parks

137,900 sf of public space - recreation center, daycare, school

Regional flood control improvements

Two bike and pedestrian crossings of the South Platte River

New bridge crossing of CML Rail at 7th Street

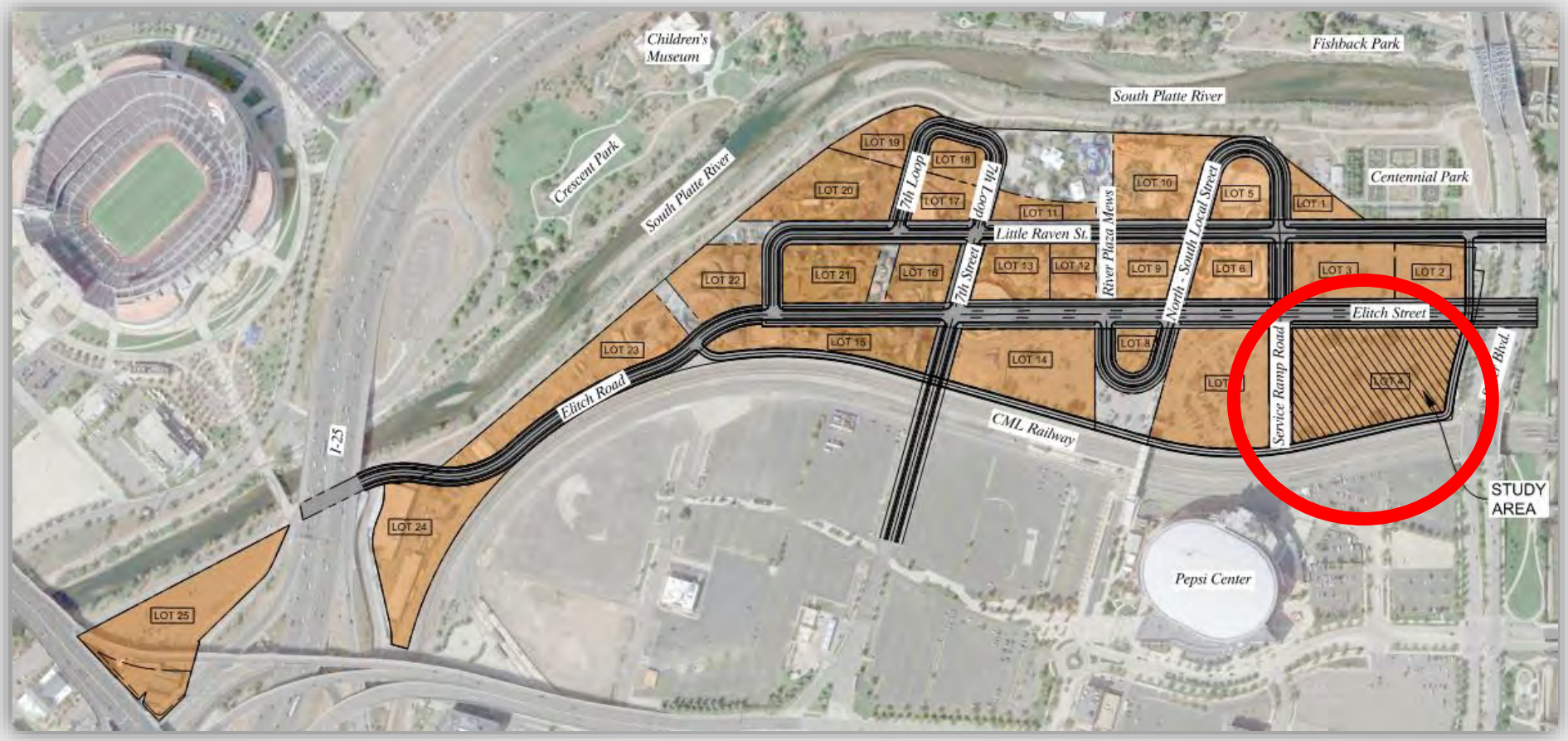
Pedestrian tunnel under Speer Blvd.

Two new pedestrian crossings over CML at light rail stations

Horizontal city improvements - including dedicated bike lanes

ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

HOW DO WE ACCOMPLISH AN HOLISTIC DESIGN APPROACH?



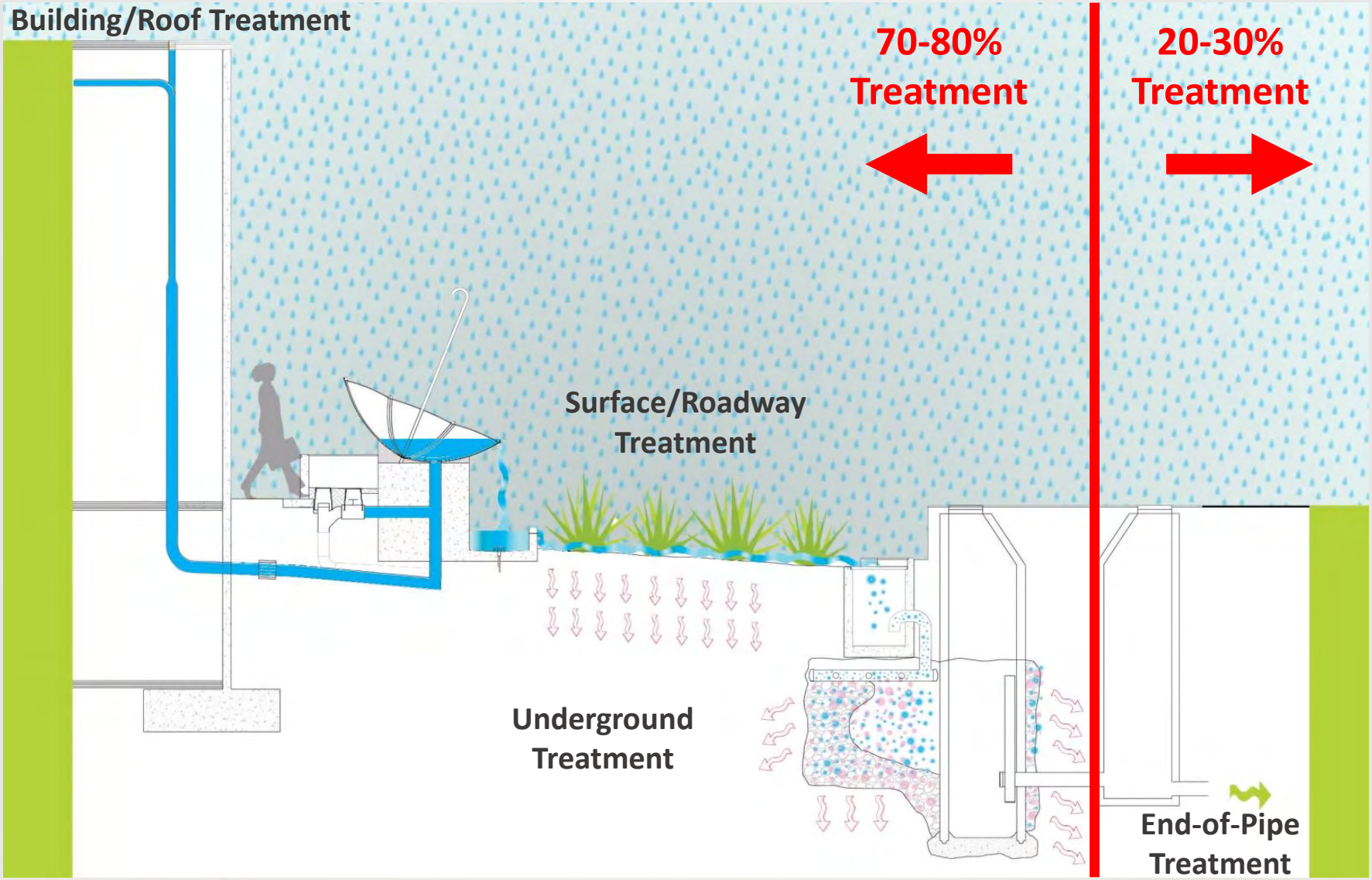
ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

HOW DO WE ACCOMPLISH THIS WATERSHED MANAGEMENT APPROACH?

- Key Components
  - Building/roof footprint
  - Right-of-way (curb to building face)
  - Roadway limits
- Goals
  - Holistic design approach
  - Design flexibility
  - Runoff volume reduction
  - Infiltration and WQ
  - Meet regulations

Let's meet the INTENT of the regulations

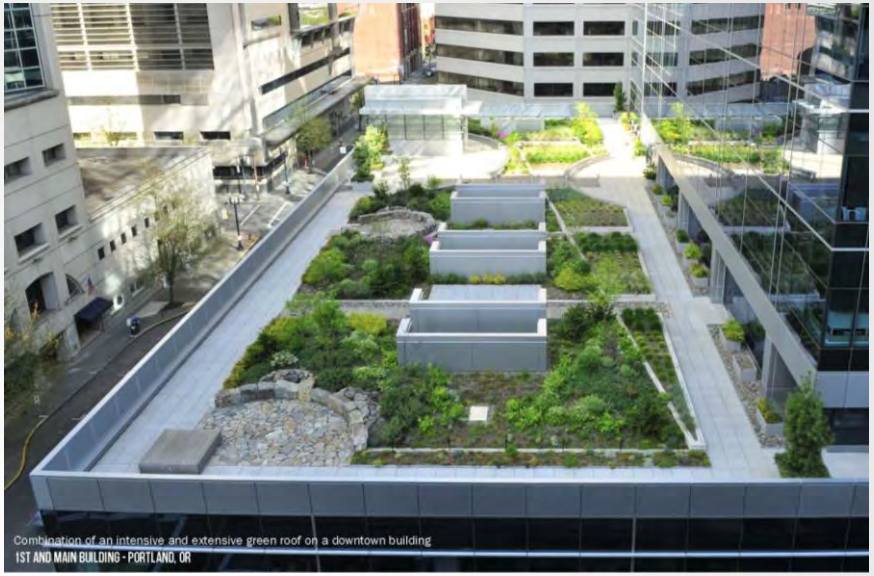
TREATMENT "TRAIN" DESIGN APPROACH



TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Building & Roof

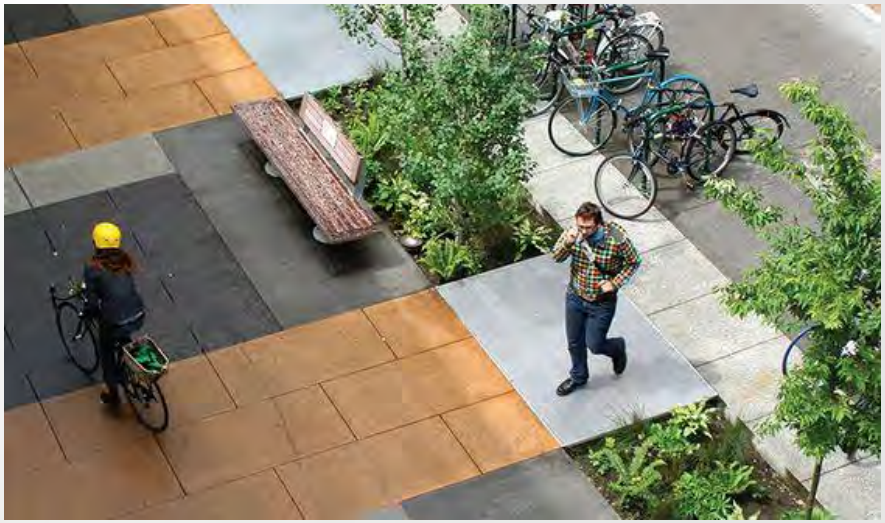
- Green/Blue Roof
- Aesthetic
- Functional
- Social
- Improve quality of life
- Provide economic opportunities



TREATMENT "TRAIN" DESIGN CONSIDERATIONS

<u>Right-of-way</u>
<u>Pedestrian Zone</u>

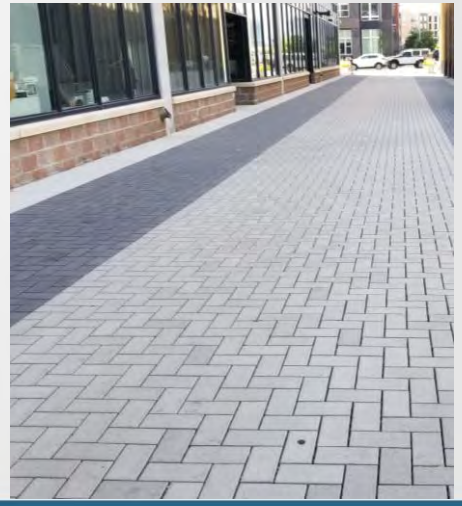
- Multi-functional & Multi-modal
- Aesthetic
- Provide balance and efficient use of space
- Improve safety



TREATMENT "TRAIN" DESIGN CONSIDERATIONS

<u>Surface Treatment</u>

- Multi-functional
- Flexible & modular
- Provide context
- Aesthetic
- Convey stormwater to treatment facilities



TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Tree Wells

- Versatile & Flexible
- Low Maintenance
- Improve tree health
- Runoff reduction

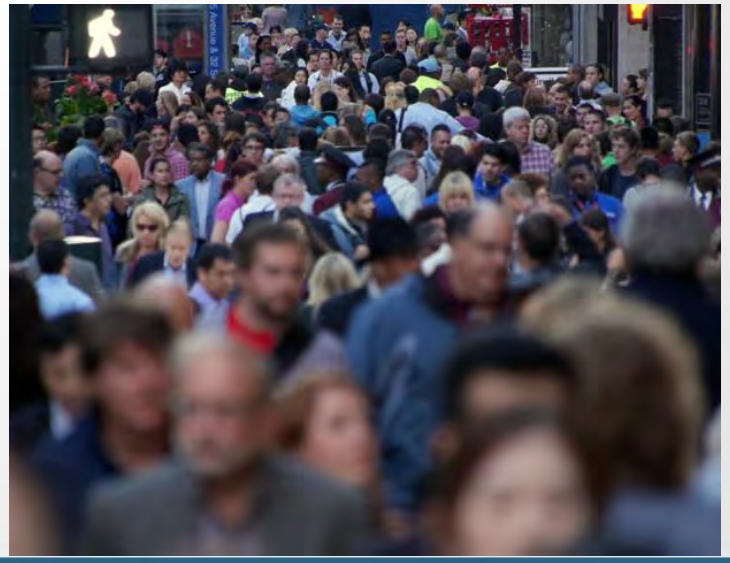
TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Underground Treatment

- Multi-functional
- Low Maintenance
- Promote Infiltration & improve tree health
- Runoff reduction
- Work with pedestrian mobility

TREATMENT "TRAIN" DESIGN CONSIDERATIONS

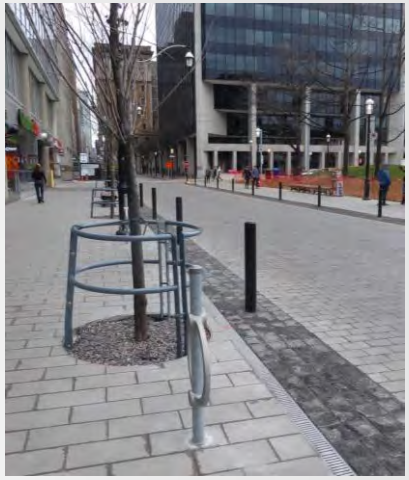
Pedestrian Zone Context

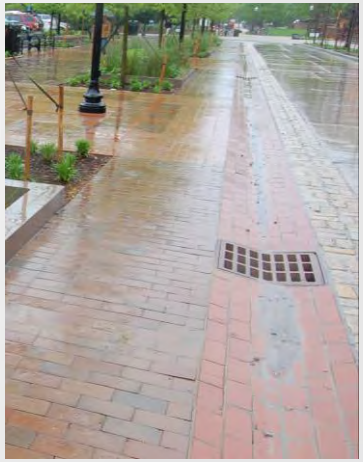


TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Roadway Treatment

- Multi-modal
- Low Maintenance
- Pedestrian Safety
- Stormwater conveyance

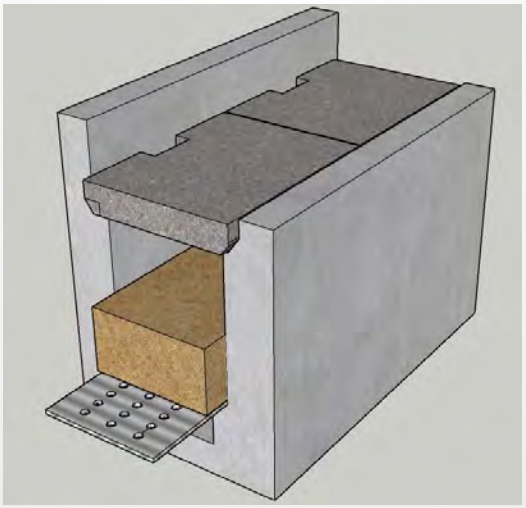


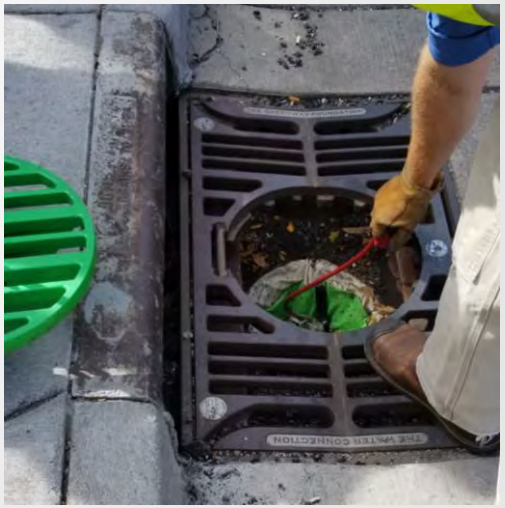


TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Inlet Options

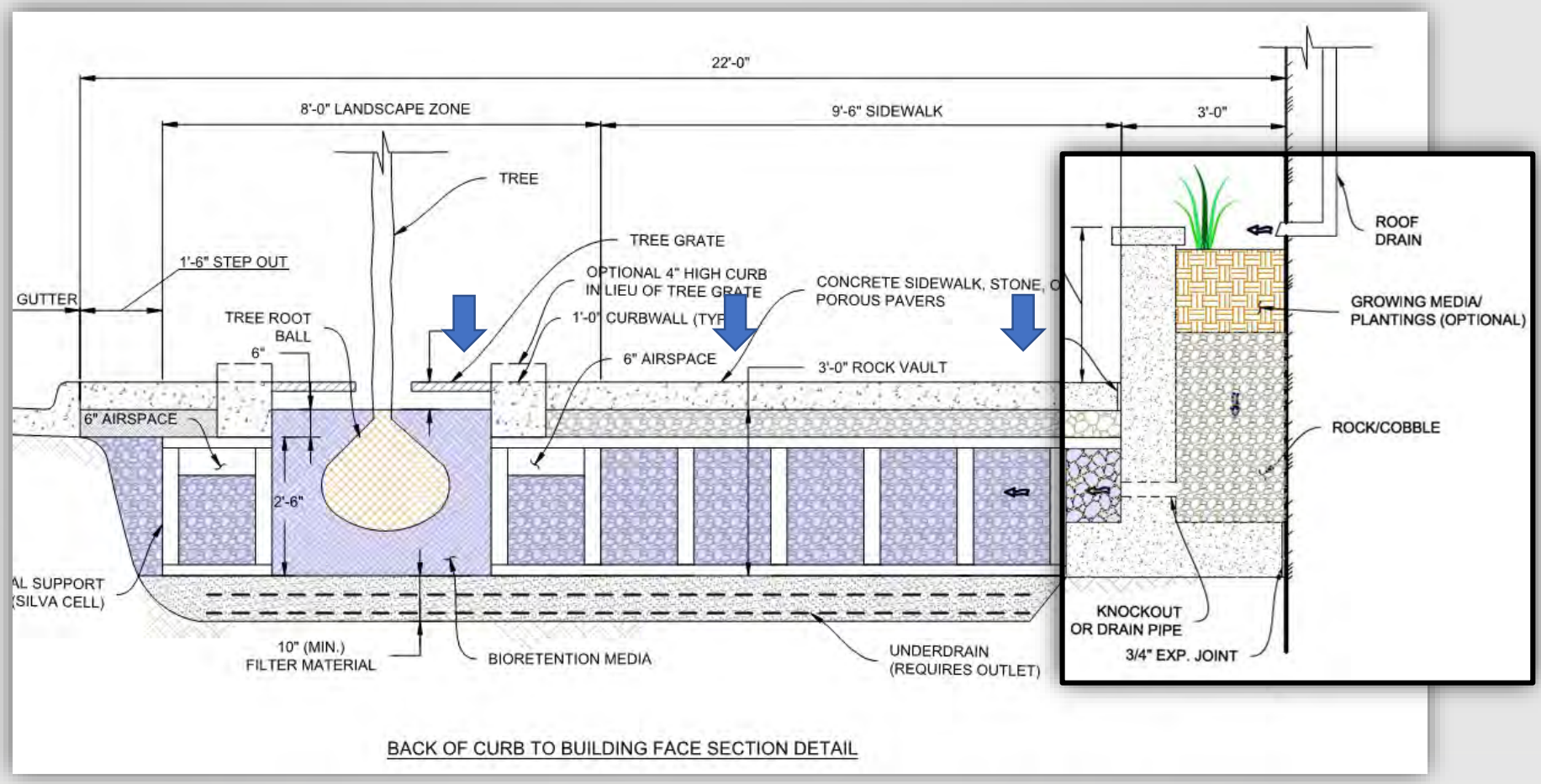
- Design flexibility
- Low Maintenance
- Pedestrian Safety
- Stormwater conveyance
- Trash Collection





ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

MODULAR AND FLEXIBLE DESIGN COMPONENTS



TREATMENT "TRAIN" DESIGN CONSIDERATIONS

Design Retrofit Example
"Urban Street Stormwater Guide"

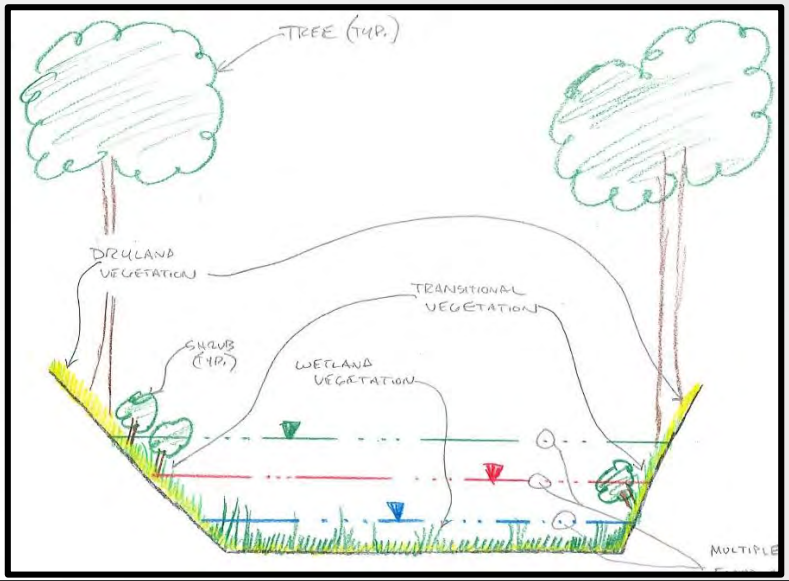
Capital Reconstruction

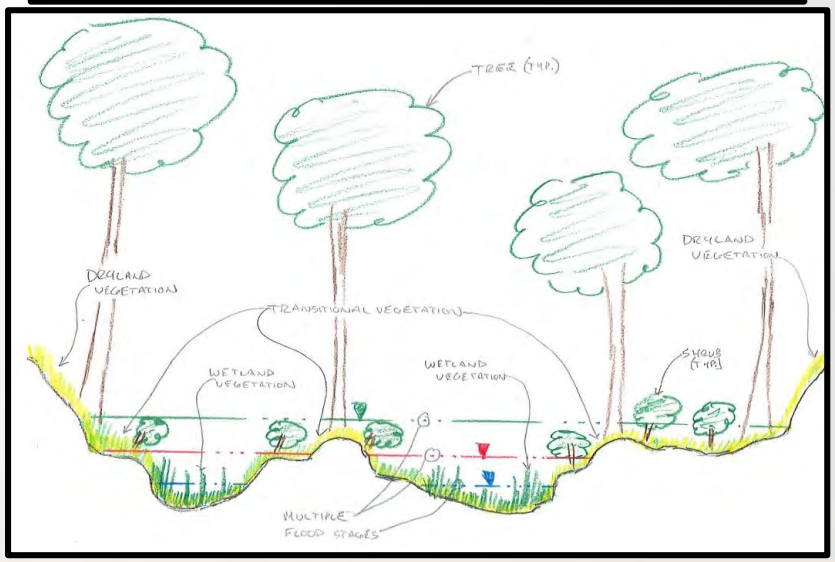
New York, NY

TREATMENT "TRAIN" DESIGN CONSIDERATIONS

End-of-Pipe Treatment

- Max Infiltration Surface
- Low Maintenance
- Aesthetics
- Vegetation Diversity & Resilience
- Use of Trees
- Elevation Variation
- Multi-functional
- Bottom Slope

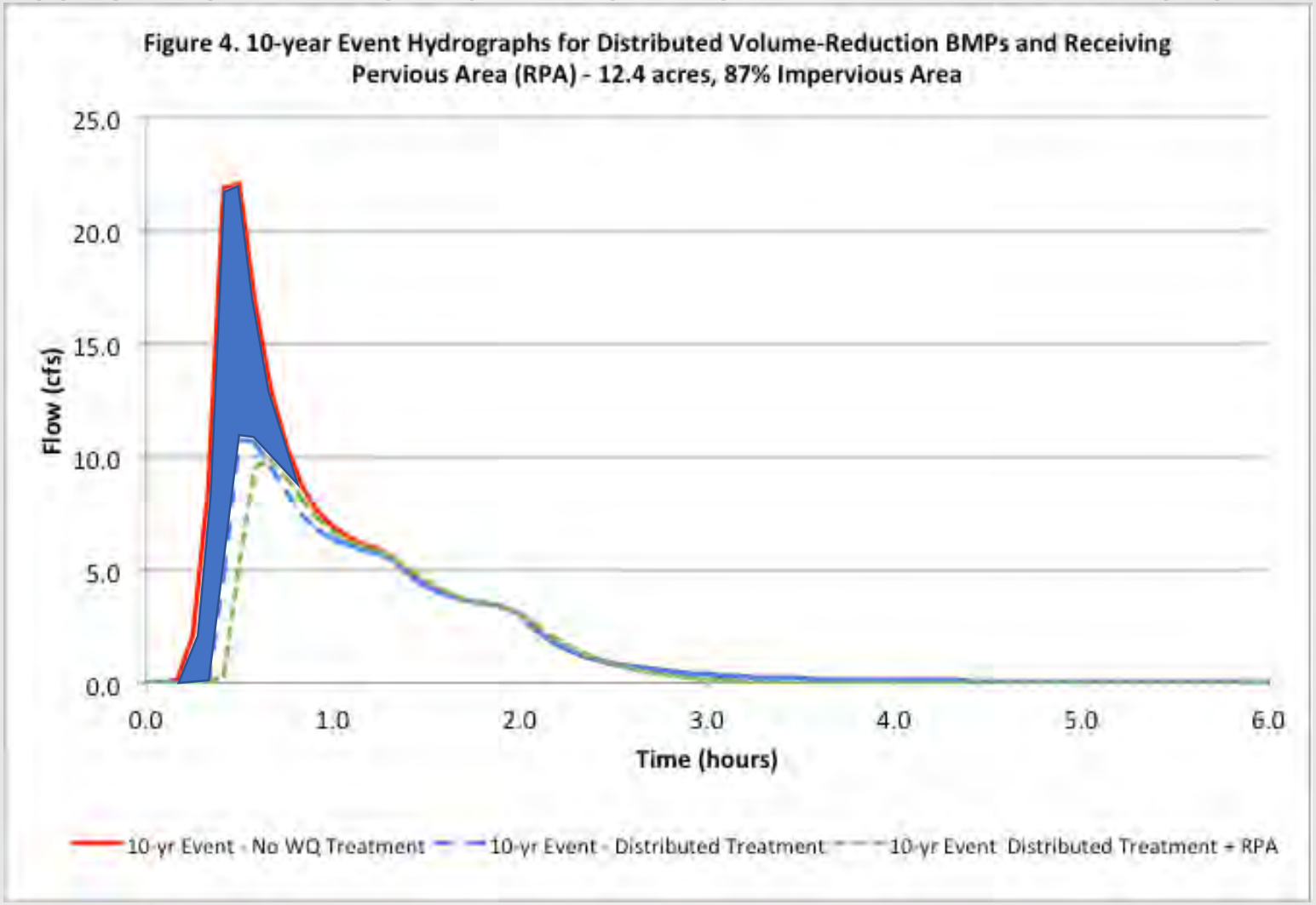




TREATMENT "TRAIN" DESIGN CONSIDERATIONS

ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

CONCEPTUAL EVALUATION – DISTRIBUTED TREATMENT APPROACH



ULTRA URBAN CASE STUDY: RIVER MILE REDEVELOPMENT

HOW DO WE ACHIEVE SUCCESS?

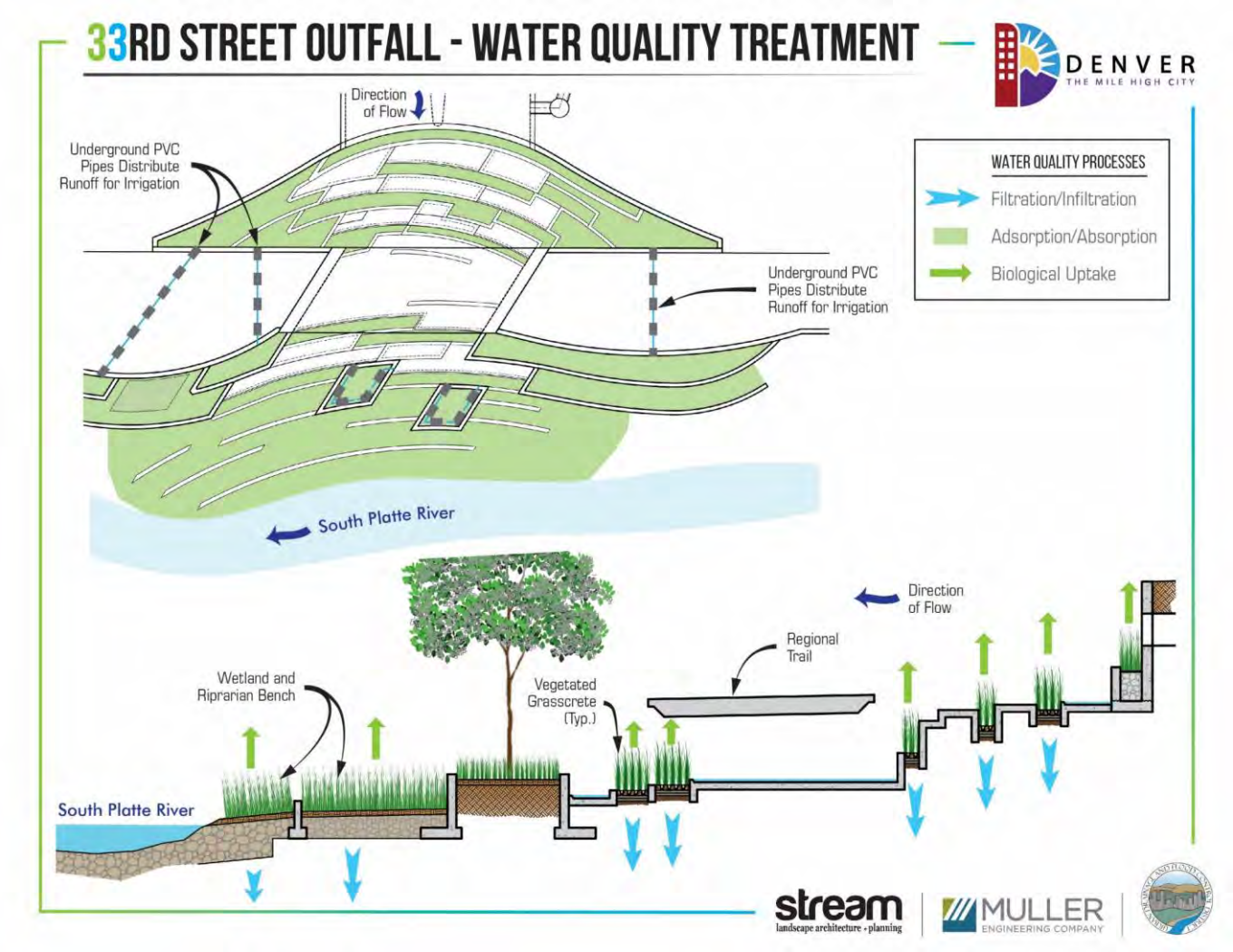
- **PARTNERSHIPS & COLLABORATION**
- Public & private sectors
- Use all of the available tools
- Meet the INTENT of the regulations and make adjustments to policy and criteria
- Avoid being constrained by criteria-driven "checklists"
- Community/amenity focus
- Keep an open mind
- Each project is case-by-case

CASE STUDY: RIVER NORTH OUTFALL (33RD STREET)

RIVER NORTH DISTRICT – DENVER

CASE STUDY: RIVER NORTH OUTFALL (33RD STREET)

RIVER NORTH DISTRICT – DENVER



CASE STUDY: RIVER NORTH OUTFALL (33RD STREET)

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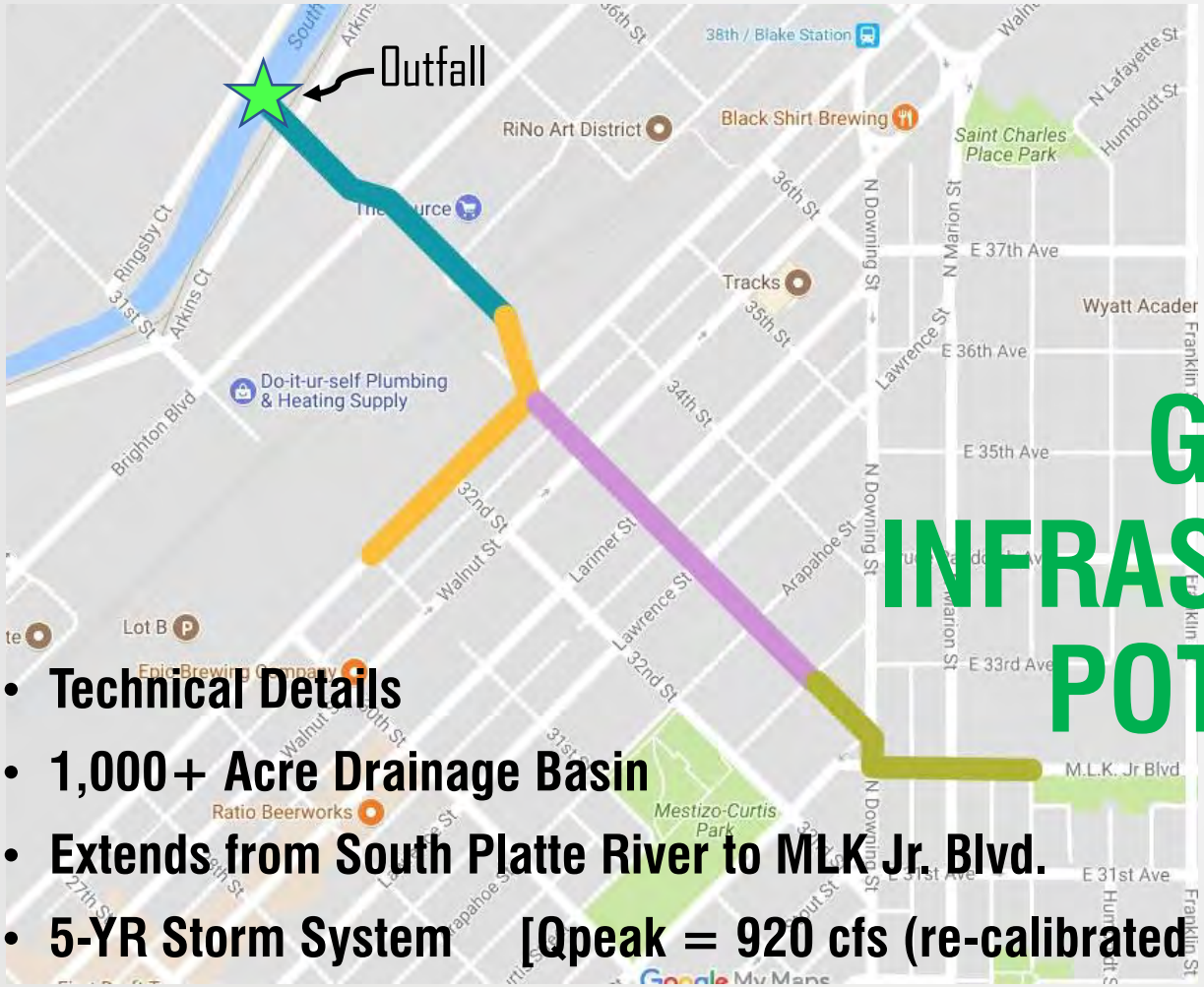


Primary Goals:

- Flood reduction
- Conveyance
- Replace undersized inlets

GREEN INFRASTRUCTURE POTENTIAL

- Technical Details
- 1,000+ Acre Drainage Basin
- Extends from South Platte River to MLK Jr. Blvd.
- 5-YR Storm System [Qpeak = 920 cfs (re-calibrated CUHP v. 2)]

CASE STUDY: MARION STREET GREEN INFRASTRUCTURE

RIVER NORTH DISTRICT – DENVER

Existing Conditions Aerial Image
(Source: Google Earth)


Conceptual Green Infrastructure - Marion Street & 30th Avenue (Plan View)


Conceptual Green Infrastructure - Marion Street & 29th Avenue (Plan View)

EXISTING

WITH GREEN INFRASTRUCTURE

CASE STUDY: MARION STREET GREEN INFRASTRUCTURE

RIVER NORTH DISTRICT – DENVER

View A - Marion Street & 30th Avenue Green Infrastructure Concept

View B - Marion Street & 30th Avenue Green Infrastructure Concept

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

Project Snapshot
Project Location | Benedict Park to Ballpark
Site Owner | CCD
Site Land Use | Right-of-Way
Site Area (AC) | 6.6
Proposed BMP Type | Bioretention
Total Tributary Area (AC) | 10.5
Required WQCV (AC-FT) | 0.20
Available Storage Volume (AC-FT) | 0.46
Additional WQCV Needed Upstream (AC-FT) | None
Dry Weather Flow Treatment Possible | None
Basin Score | 68
Sub-basin Score | 31
BMP Opportunity Score | NA

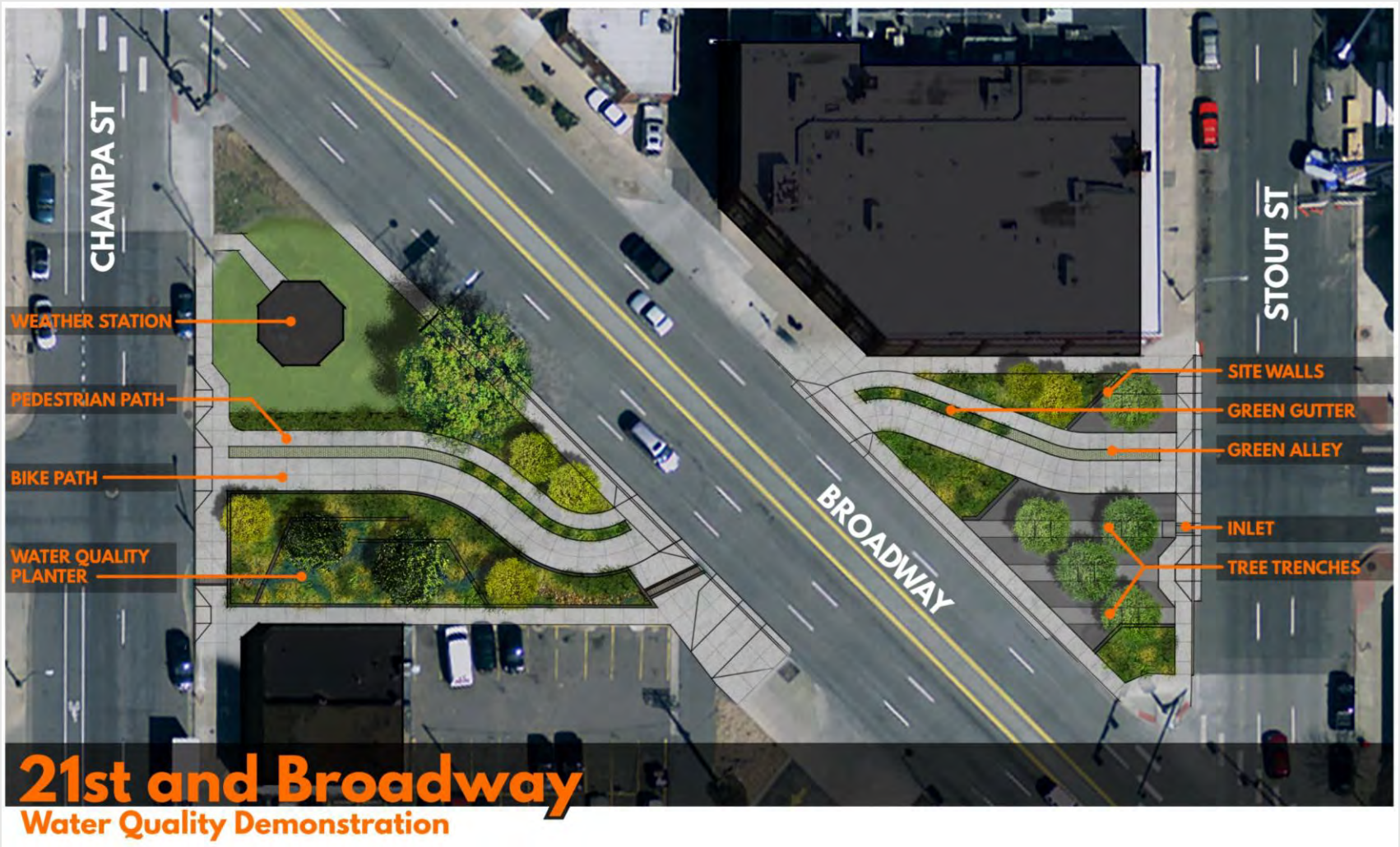
- Shared use corridor
- Active & passive park space
- Integrate green infrastructure
- Bioswales, stormwater planters, curb extensions & permeable pavers

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER



21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

21ST STREET + WYNKOOP STREET DESIGN PLAN

DOWNTOWN DENVER

The Challenge to You

- Build strong partnerships that share win-win visions.

- Growth that sheds *less stormwater*.

Thank you

Additional Case Studies

ON THE RIGHT TRACK

CITY OF DENVER GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGY

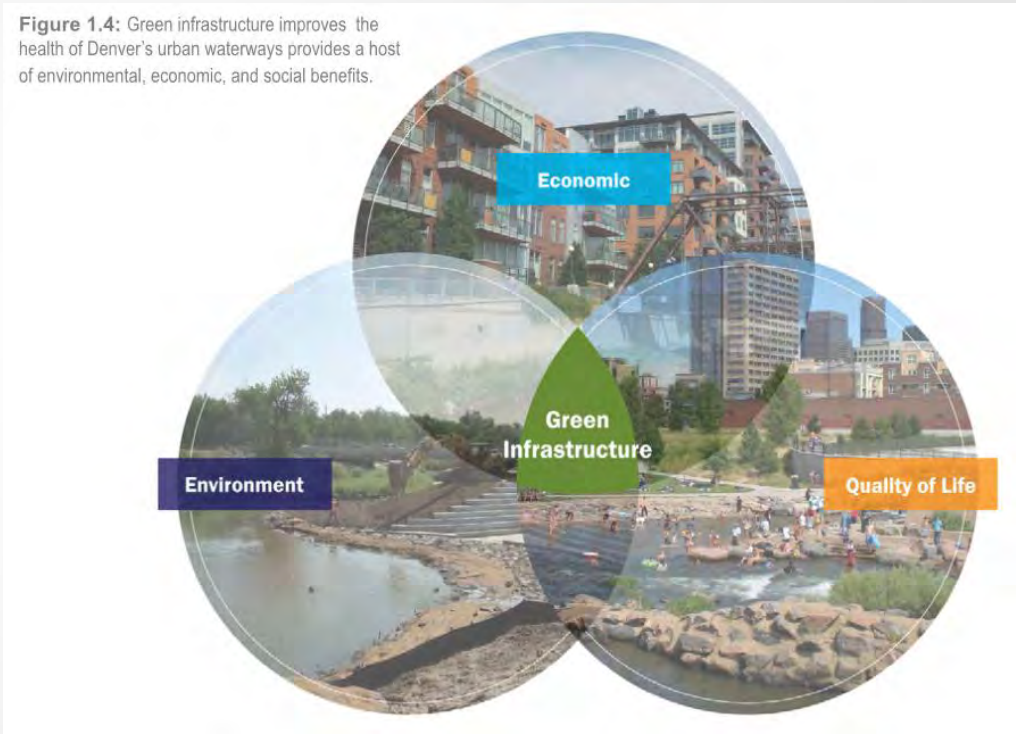


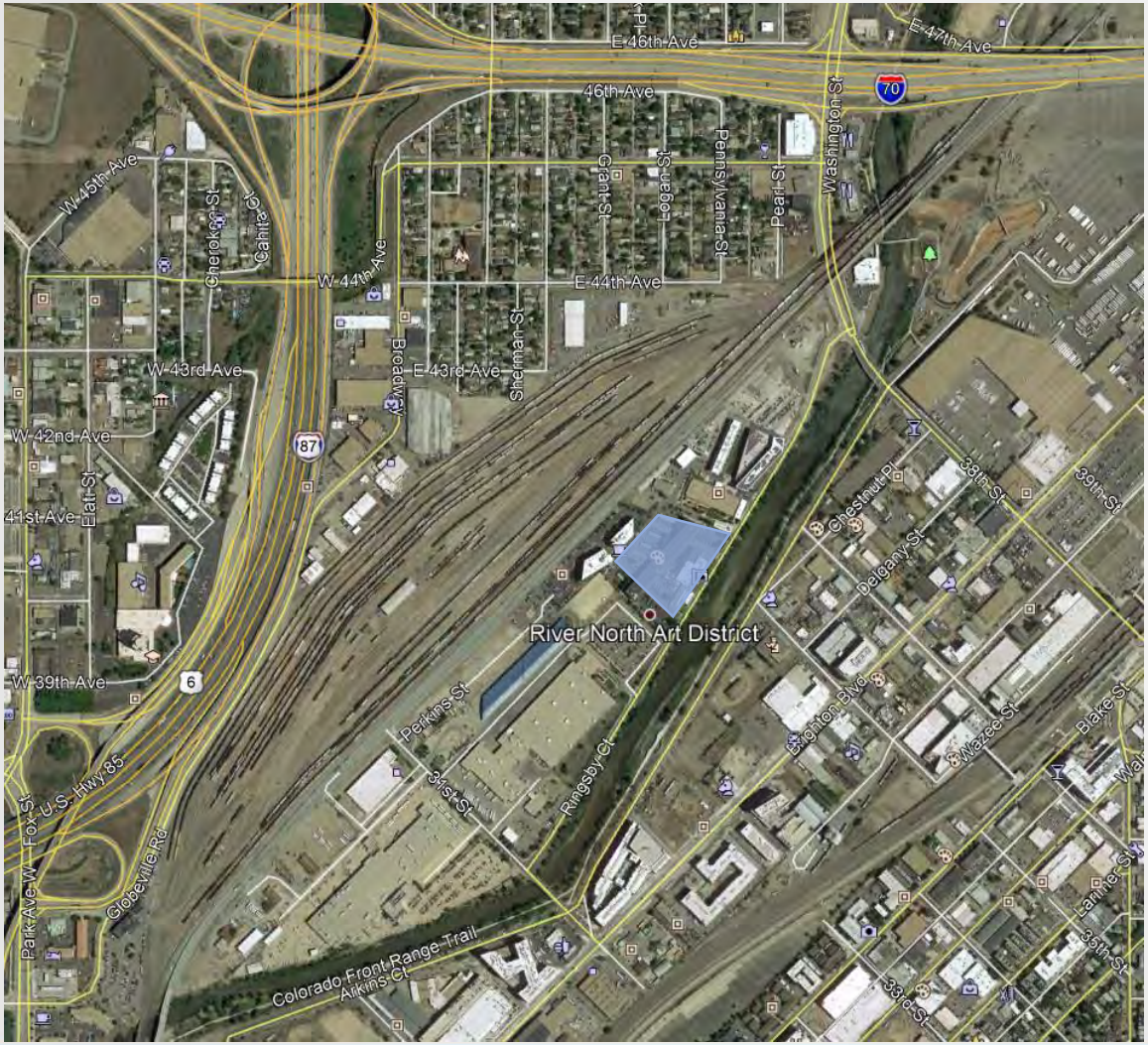
Figure 1.4: Green infrastructure improves the health of Denver's urban waterways provides a host of environmental, economic, and social benefits.

ON THE RIGHT TRACK

NATIONAL ASSOCIATION OF CITY TRANSPORTATION OFFICIALS

CASE STUDY: TAXI II REDEVELOPMENT

RIVER NORTH DISTRICT – DENVER



Taxi II

Wenk Associates, Inc. *Landscape Architect*

Will Bruder & Partners Ltd. *Associate Architect - Building Massing and Materials*

David Baker & Partners *Associate Architect - Residential Unit Design*

Alan Eban Brown Architects *Associate Architect - Owners' Representative*

Harry Teague Architects *Associate Architect*

York Engineering Services *Civil Engineer*

Mortenson Construction Company *General Contractor*

Designscapes *Landscape Contractor*

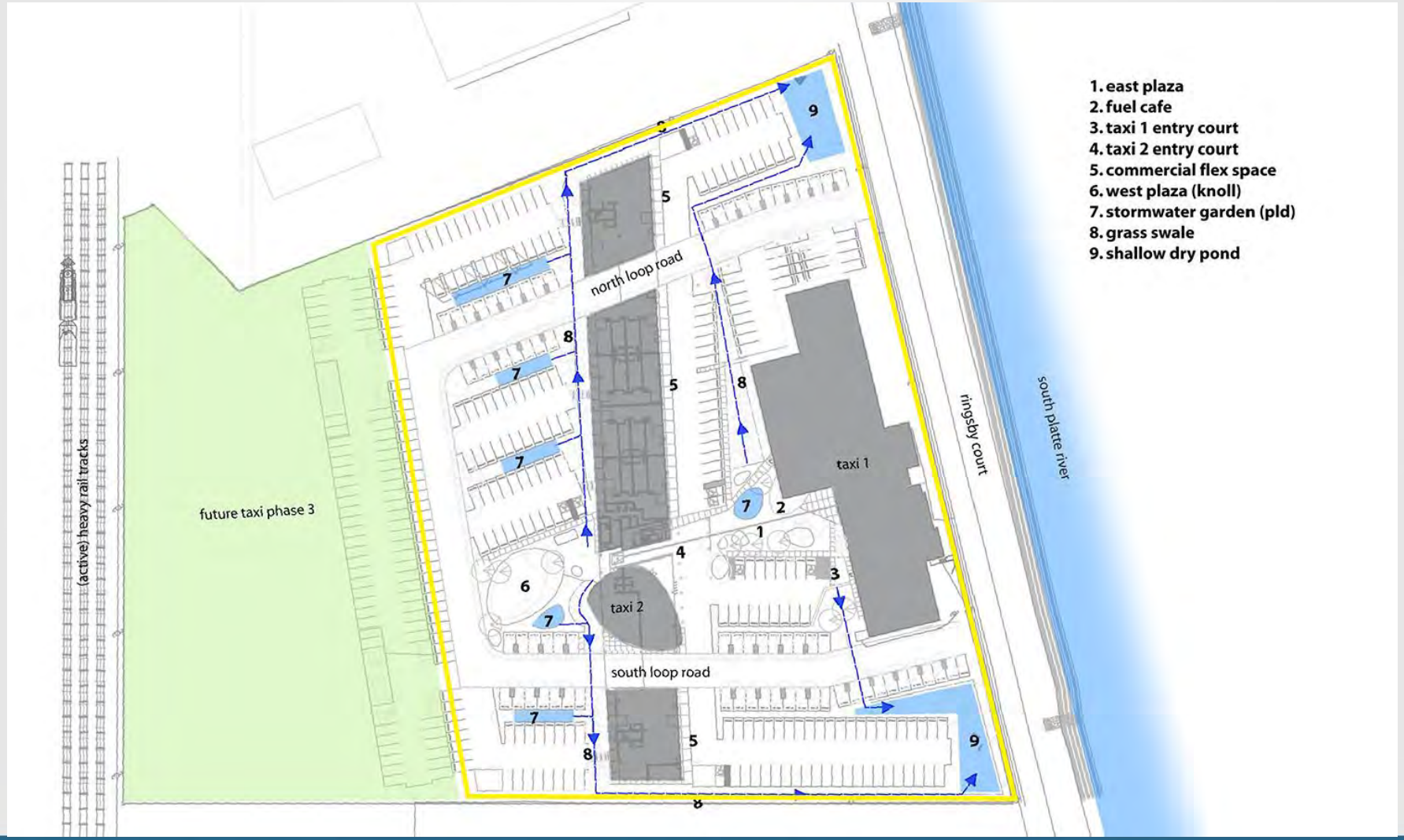
CASE STUDY: TAXI II REDEVELOPMENT

RIVER NORTH DISTRICT – DENVER

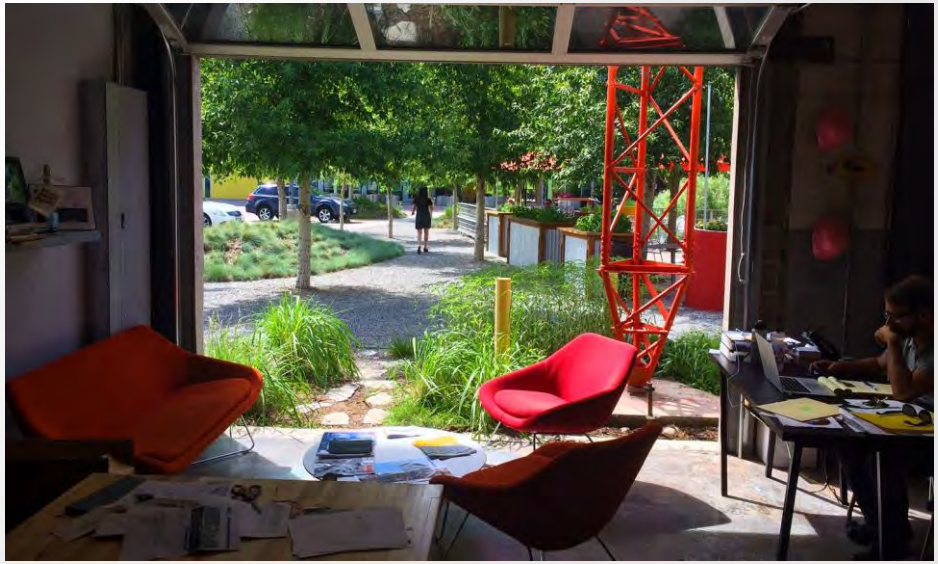
The new site strategy was a holistic approach that integrated the multi-use outdoor spaces with the site's stormwater infrastructure to create flexible spaces that can be used for everyday leisure as well as events, and that encourages activity throughout the workday and evening. Stormwater gardens infiltrate runoff from buildings and paved areas to create native landscapes that reflect the South Platte River ecosystem.

CASE STUDY: TAXI II REDEVELOPMENT

RIVER NORTH DISTRICT – DENVER



CASE STUDY: TAXI II REDEVELOPMENT



CASE STUDY: TAXI II REDEVELOPMENT

CASE STUDY: TAXI II REDEVELOPMENT

CASE STUDY: CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

Project Snapshot
Project Location | Central Denver Recreation Center
Site Owner | CCD
Site Land Use | Parks & Recreation
Site Area (AC) | 2.9
Proposed BMP Type | Streetside Stormwater Planter
Total Tributary Area (AC) | 2.9
Required WQCV (AC-FT) | 0.05
Available Storage Volume (AC-FT) | 0.05
Additional WQCV Needed Upstream (AC-FT) | None
Dry Weather Flow Treatment Possible | No
Basin Score | 70
Sub-basin Score | 38
BMP Opportunity Score | 41

CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

- Reduce overall impervious area
- Promote infiltration
- Integrate stormwater management with community amenities
- Distributed treatment approach

CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

CARLA MADISON RECREATION CENTER

DOWNTOWN DENVER

PROVIDENCE PORTLAND OFFICE PARK

PORTLAND, OREGON

- Previously a large warehouse
- Medical office complex
- Multi-functional design project
- Art component
- Treatment-train approach to stormwater management

PROVIDENCE PORTLAND OFFICE PARK

PORTLAND, OREGON

PROVIDENCE PORTLAND OFFICE PARK

PORTLAND, OREGON

PROVIDENCE PORTLAND OFFICE PARK

YouTube Video

(Stop at 3 Min)

https://www.youtube.com/watch?v=PB5VBZqo3vI&t=2s