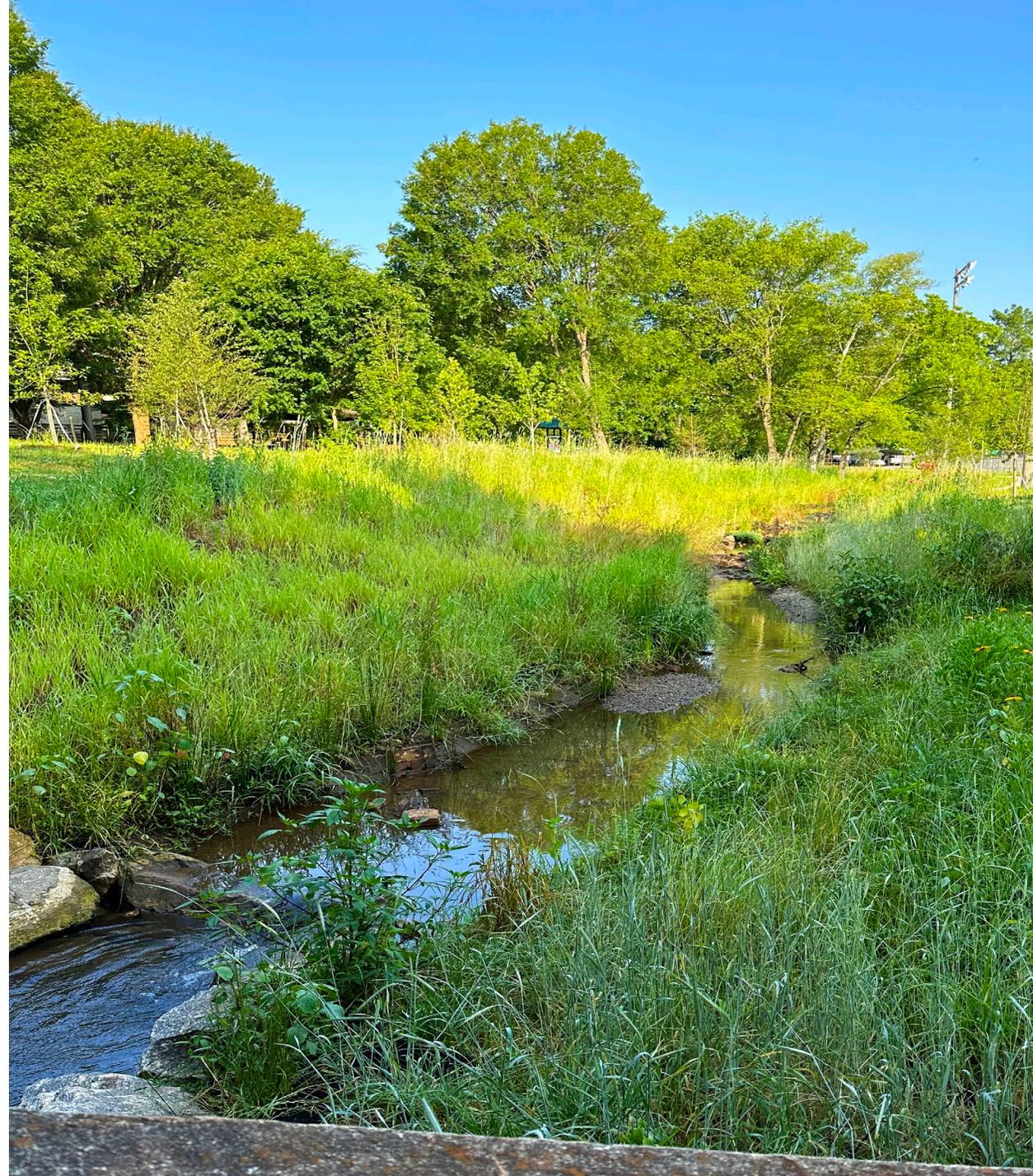


# From Recurring Residential Flooding to Floodplain Restoration:

*Greenville County's multi-  
faceted water quantity and  
quality success story*



# Recurring Residential/Road Flooding

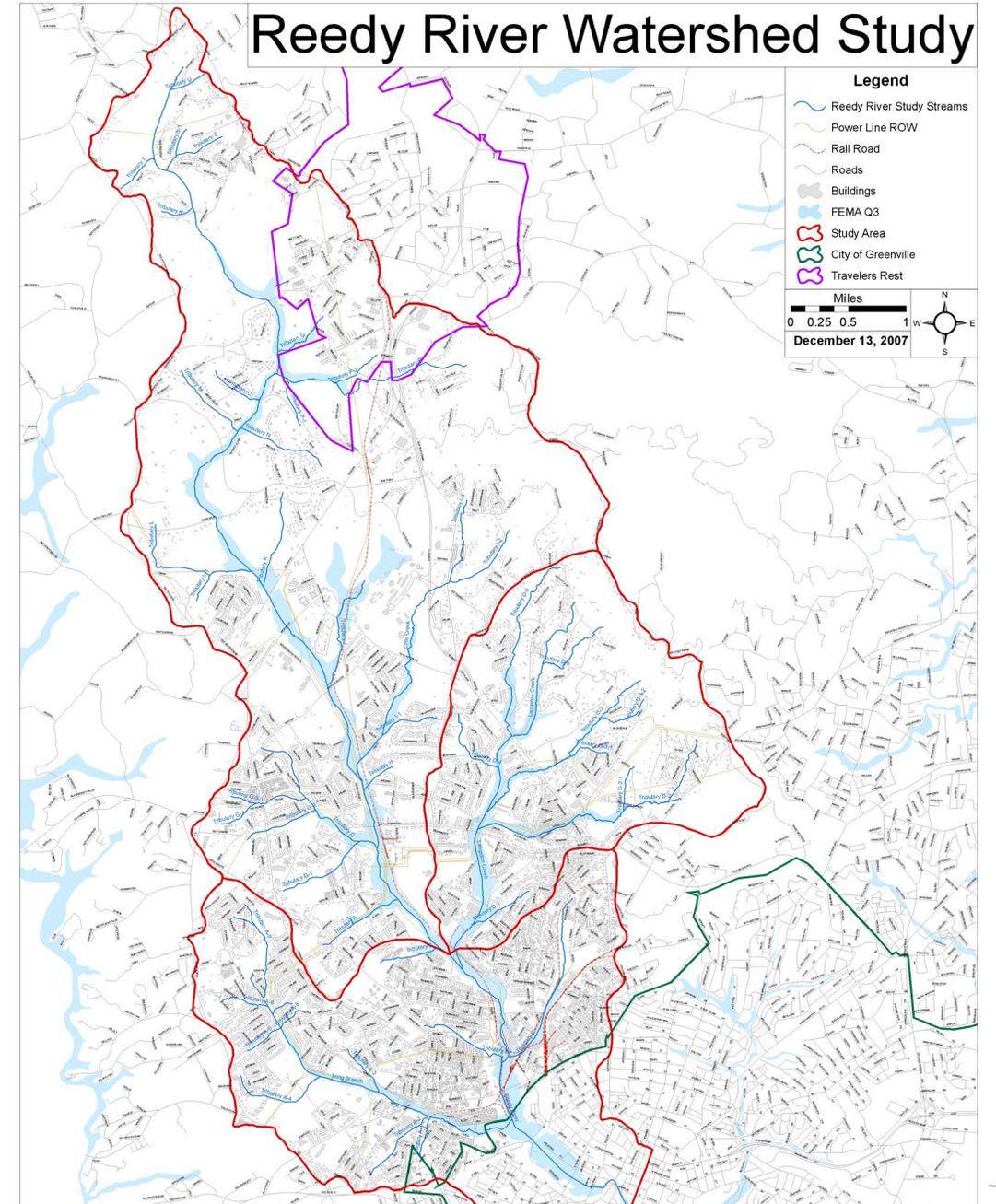
- Initial Purpose:

- Develop models to determine existing flooding
- Recommend potential capital improvement solutions
- Submit results to FEMA to revise local flood maps



# Upper Reedy River Watershed

- Approximately 32 square miles
- Modeled Reedy River and 51 tributaries
- Included nearly 200 sub-watersheds



# Field Data Collection

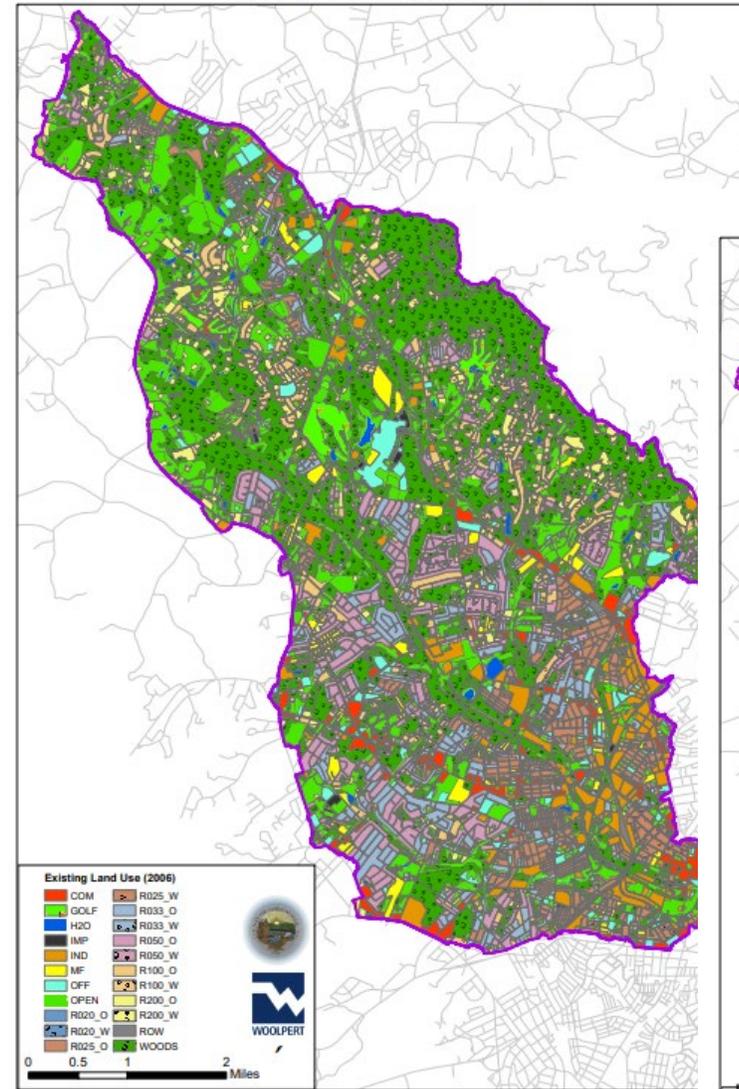
- Field inspections - 58 stream miles
- Surveying
  - FFEs/LAG - 400 homes
  - Public bridge/culvert crossings – 140 structures



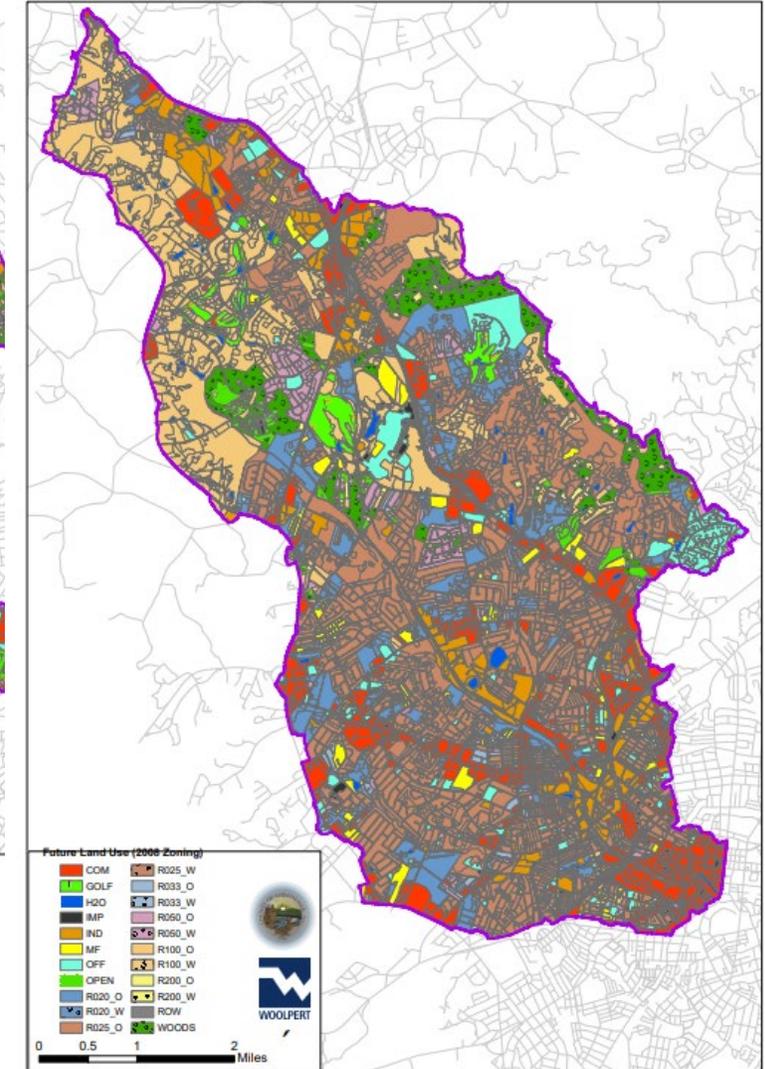
**Table 2-2. Land Use Distribution, Upper Reedy River Watershed**

Land Use Category Code	Land Use Description	Existing (% of Watershed)	Future (% of Watershed)
COM	Urban Commercial Centers – Malls, Strip Shopping Centers	2.8%	10.5%
GOLF	Golf Courses	1.4%	1.4%
H2O	Water Bodies	0.6%	0.6%
IMP	Impervious – Paved Parking Lots	0.6%	0.6%
IND	Urban Industrial and Manufacturing	4.6%	5.6%
MF	Multi Family Dwellings – Apartments/Town Homes	2.3%	2.2%
OFF	Schools/colleges/hospitals & office parks and centers	2.8%	4.1%
OPEN	Lawns, Parks – Fair condition	15.2%	0.9%
R20_O	Single Family Residential – 0.20 acre lots – Open	0.0%	8.0%
R20_W	Single Family Residential – 0.20 acre lots – Wooded	0.0%	0.0%
R25_O	Single Family Residential – 0.25 acre lots – Open	5.2%	29.3%
R25_W	Single Family Residential – 0.25 acre lots – Wooded	1.0%	0.5%
R33_O	Single Family Residential – 0.33 acre lots – Open	4.9%	0.6%
R33_W	Single Family Residential – 0.33 acre lots – Wooded	0.5%	0.0%
R50_O	Single Family Residential – 0.50 acre lots – Open	6.8%	2.6%
R50_W	Single Family Residential – 0.50 acre lots – Wooded	1.9%	0.4%
R100_O	Single Family Residential – 1.00 acre lots – Open	4.0%	15.6%
R100_W	Single Family Residential – 1.00 acre lots – Wooded	2.3%	0.4%
R200_O	Single Family Residential – 2.00 acre lots – Open	1.9%	0.1%
R200_W	Single Family Residential – 2.00 acre lots – Wooded	1.0%	0.2%
ROW	Right-of-Way –Streets and Roads	6.5%	11.8%
WOODS	Woods /brush (Good Condition)	33.6%	4.5%

**Figure 2-2. Existing Land Use**



**Figure 2-3. Future Land Use**



# Model Development

- Hydrologic model – HEC-HMS
- Hydraulic model – HEC-RAS

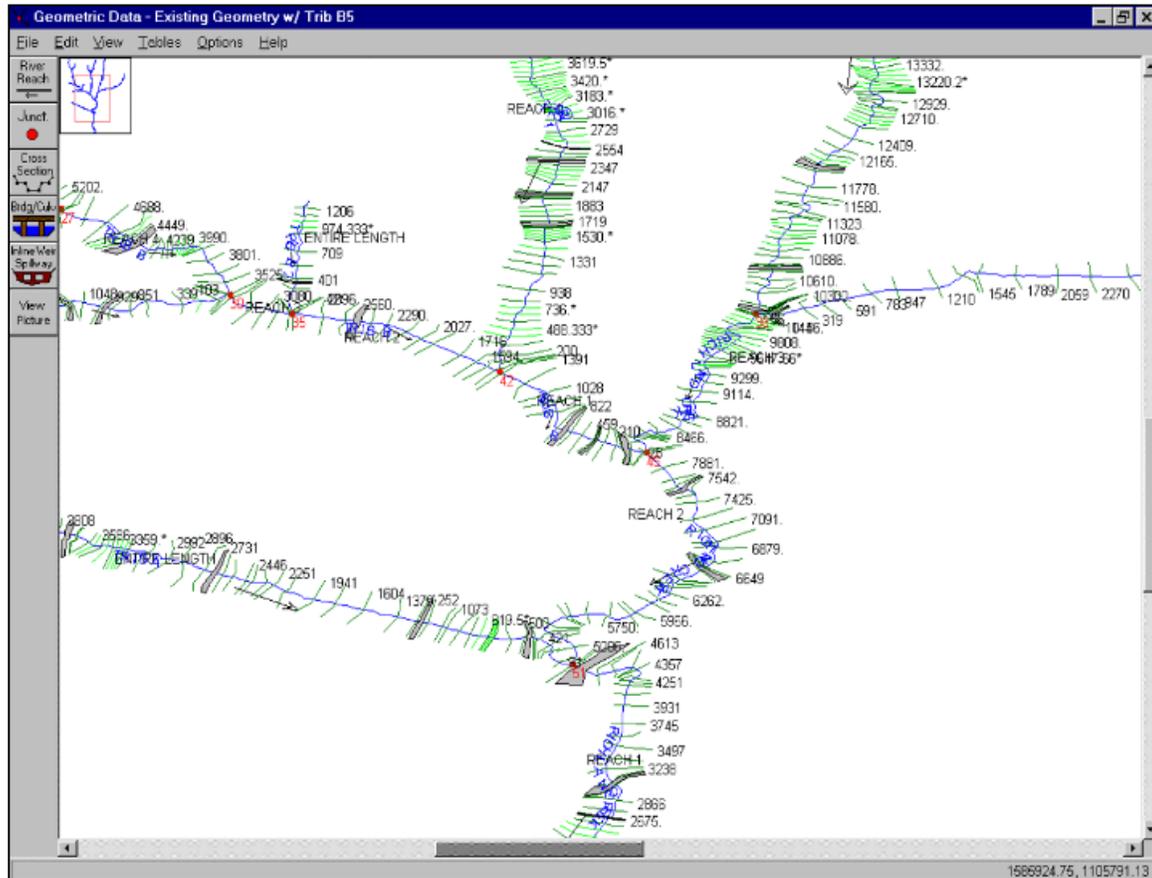
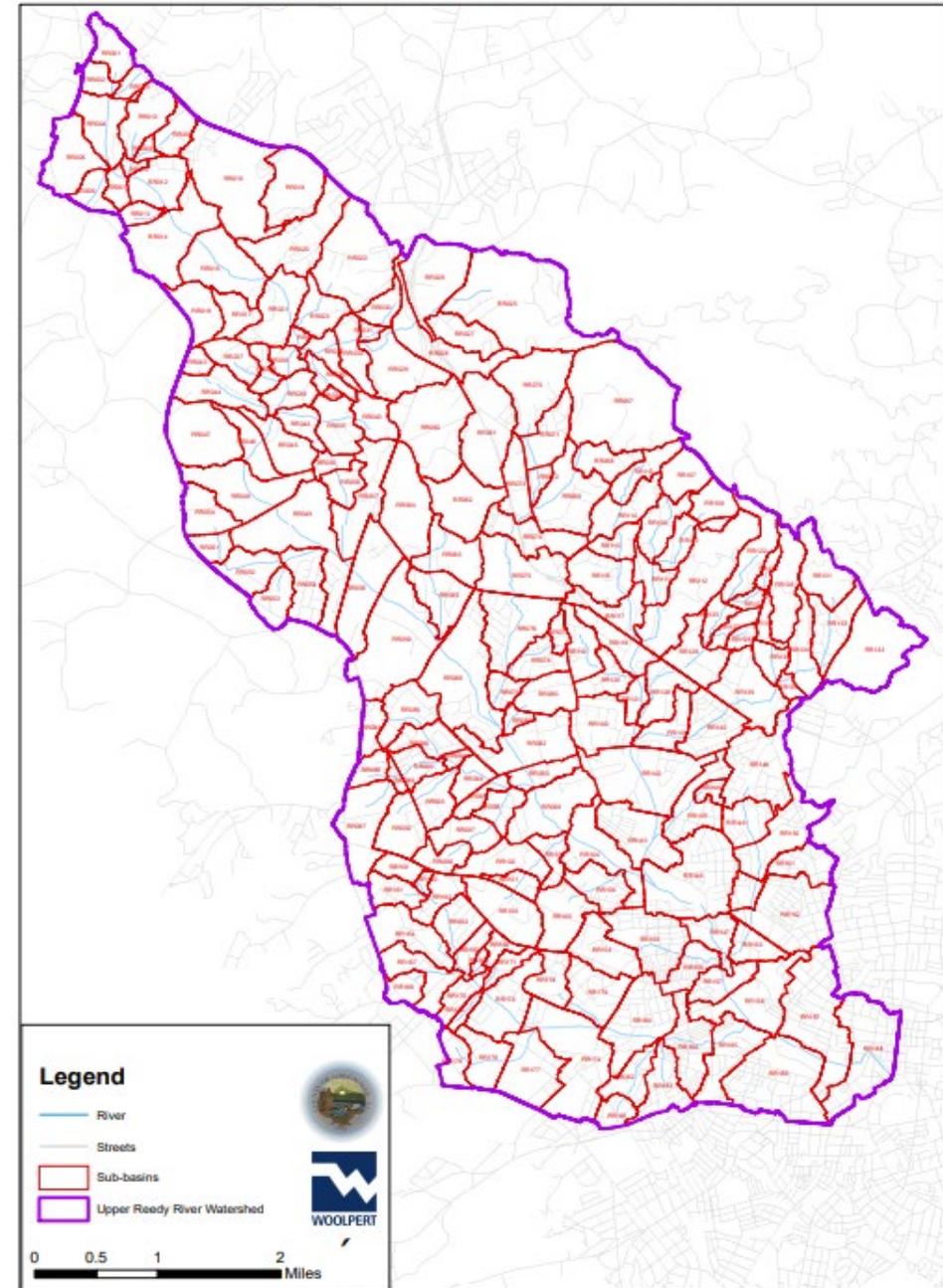
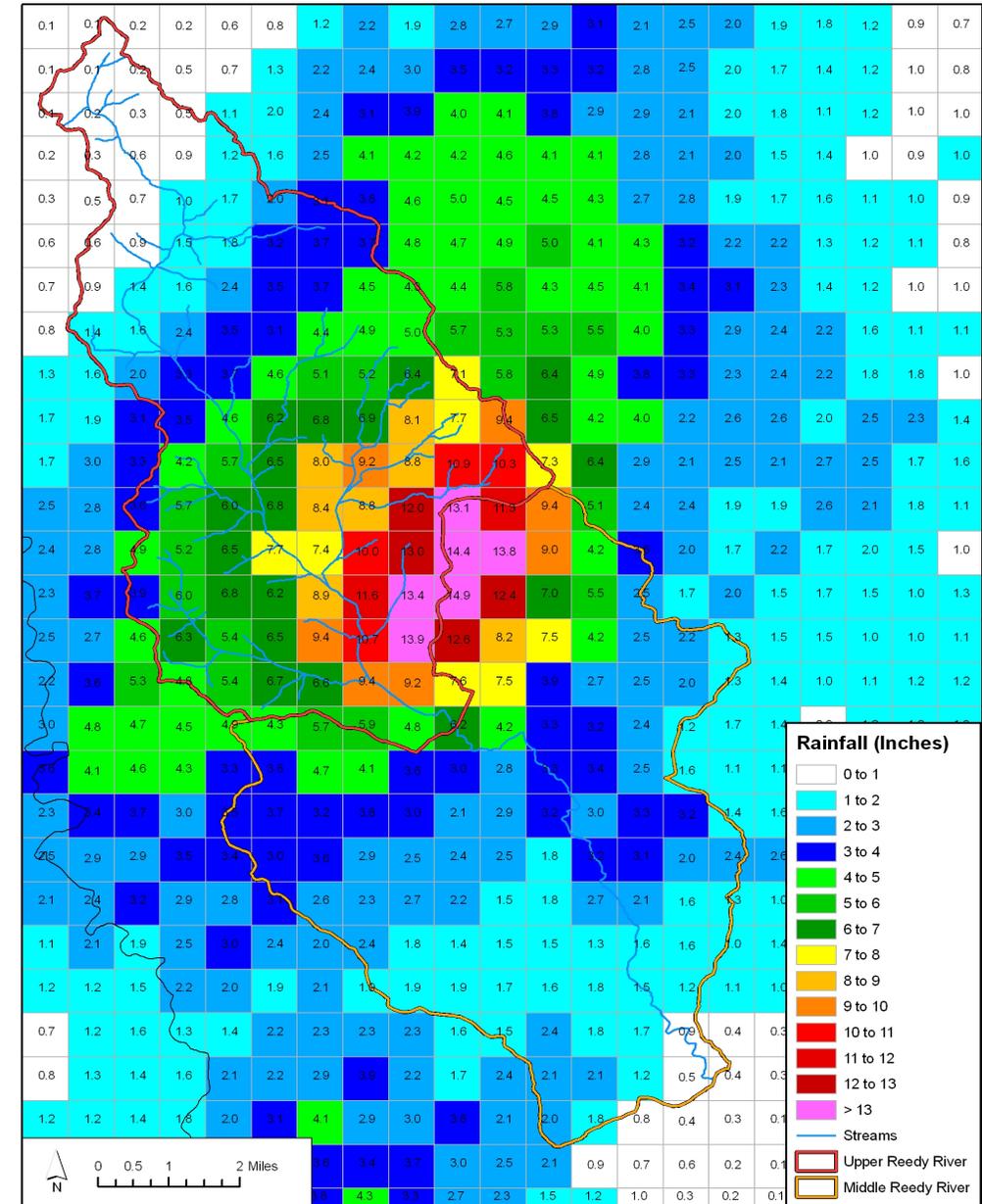


Figure 3-1. Sub-Basin Delineation



# Model Calibration

- 1995 Storm
- 2004 Storm



# Model Results

- Culvert/Bridge Overtopping
  - 21 County roads – 2-year storm
- Structures at Risk
  - 35 homes – 100-year storm
  - No neighborhoods with more than 8 flooded homes



Residential Flooding (100-yr)	Number of Homes
Vinson/Plano Drive area	6
Dukeland/Langston Drive area	6
Agnew/Bramlett Road area	8

# Model Results

## 4.2.2. Tributary B

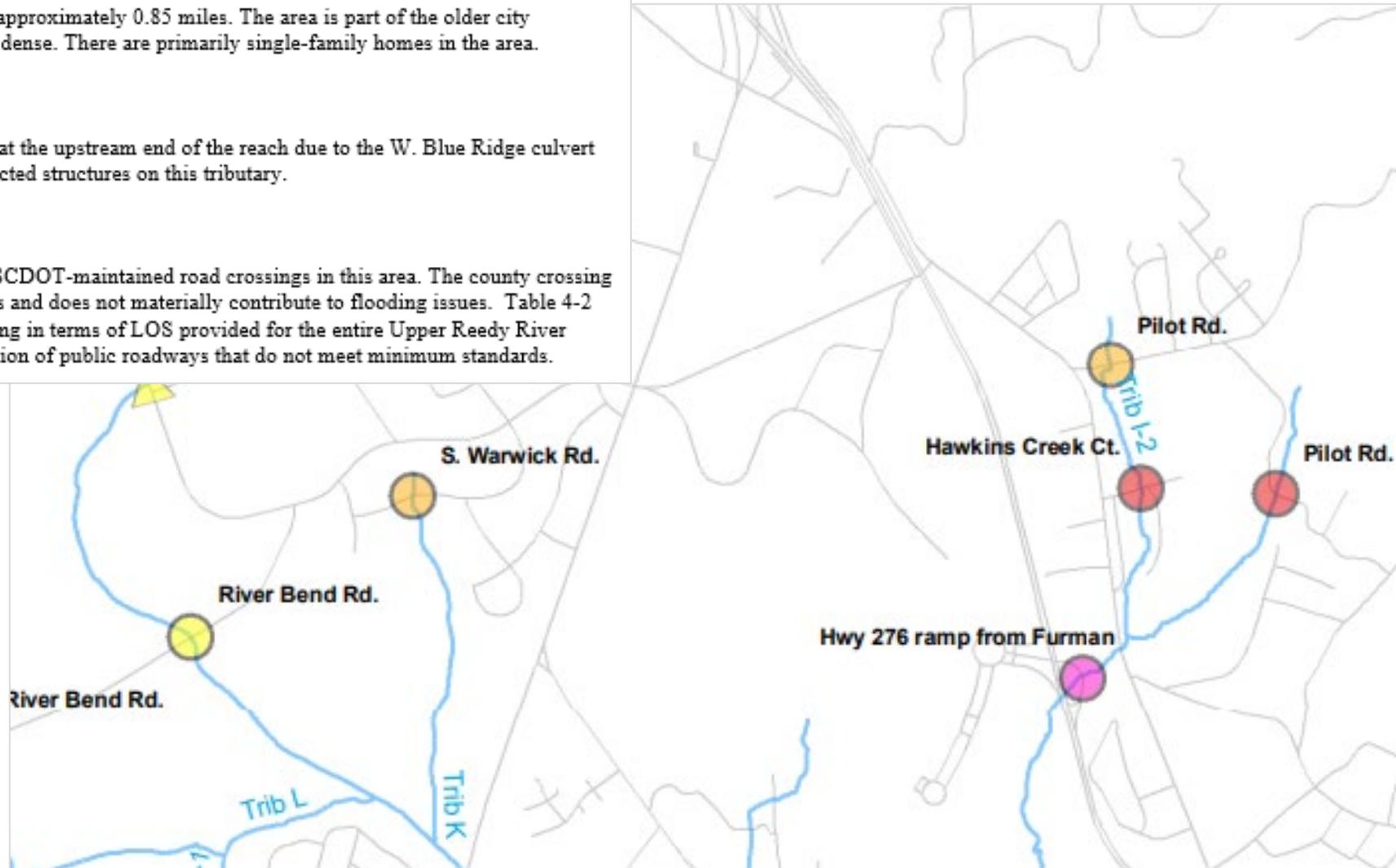
The modeled length of Tributary B is approximately 0.85 miles. The area is part of the older city developments but is not exceptionally dense. There are primarily single-family homes in the area.

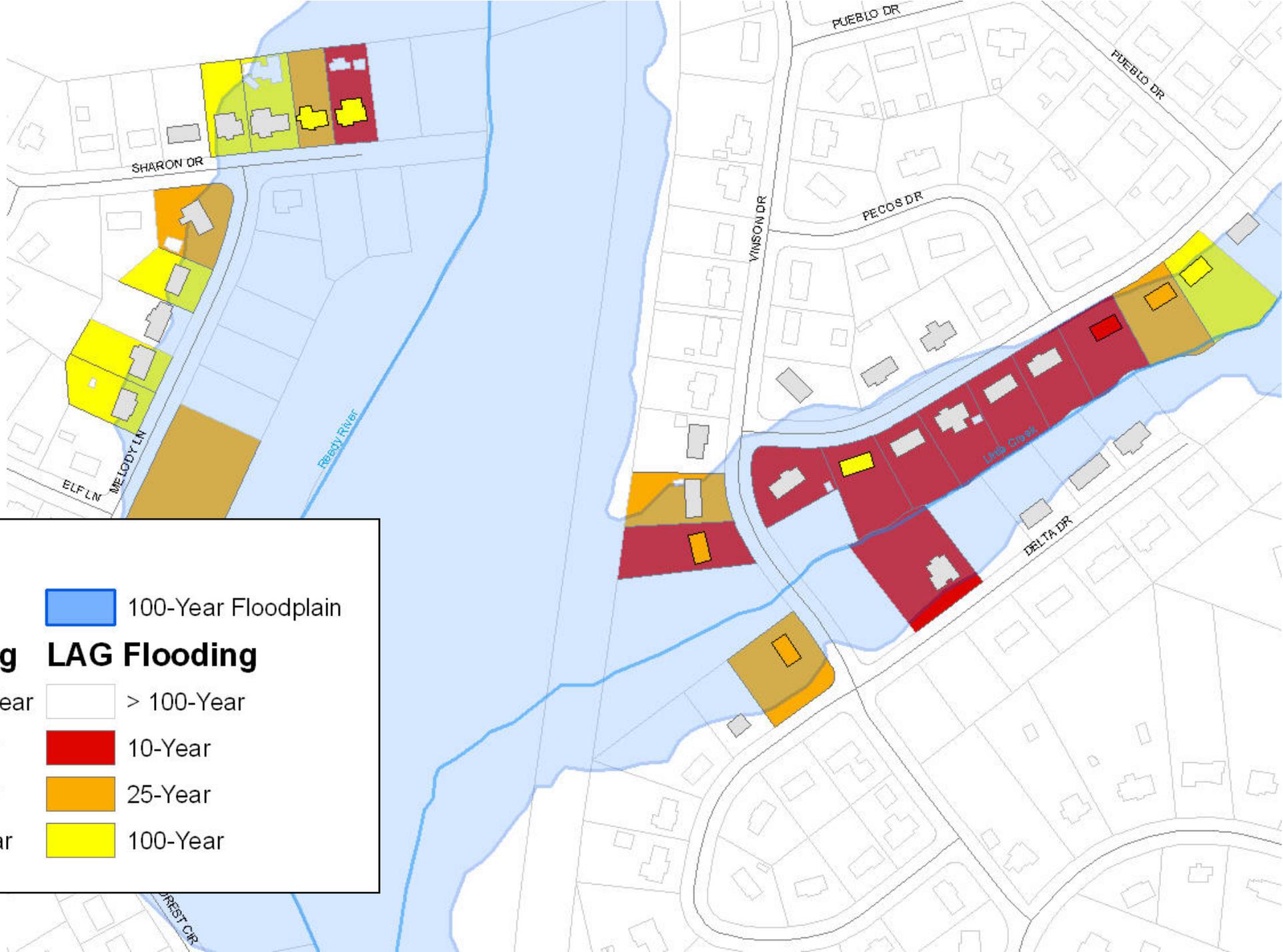
### Structure Flooding

One home experiences LAG flooding at the upstream end of the reach due to the W. Blue Ridge culvert crossing (SCDOT). There are no impacted structures on this tributary.

### Roadway Overtopping

There are 1 county-maintained and 3 SCDOT-maintained road crossings in this area. The county crossing meets minimum overtopping standards and does not materially contribute to flooding issues. Table 4-2 summarizes public roadway overtopping in terms of LOS provided for the entire Upper Reedy River Watershed. Figure 4-2 shows the location of public roadways that do not meet minimum standards.





### Legend

— River       100-Year Floodplain

### FF Flooding      LAG Flooding

<span style="background-color: lightgrey; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> > 100-Year	<span style="background-color: white; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> > 100-Year
<span style="background-color: red; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 10-Year	<span style="background-color: red; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 10-Year
<span style="background-color: orange; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 25-Year	<span style="background-color: orange; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 25-Year
<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 100-Year	<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 20px; height: 10px;"></span> 100-Year



# Alternatives Analysis

- Large scale capital improvement projects such as regional detention, channel improvements, or diversions were not cost effective due to the sparse nature of flooding
- Localized solutions deemed more effective such as:
  - Culvert upgrades
  - Elevating individual structures
  - Floodproofing
  - Buyouts

Table 5-5. Summary of Recommended Roadway Crossing Priorities

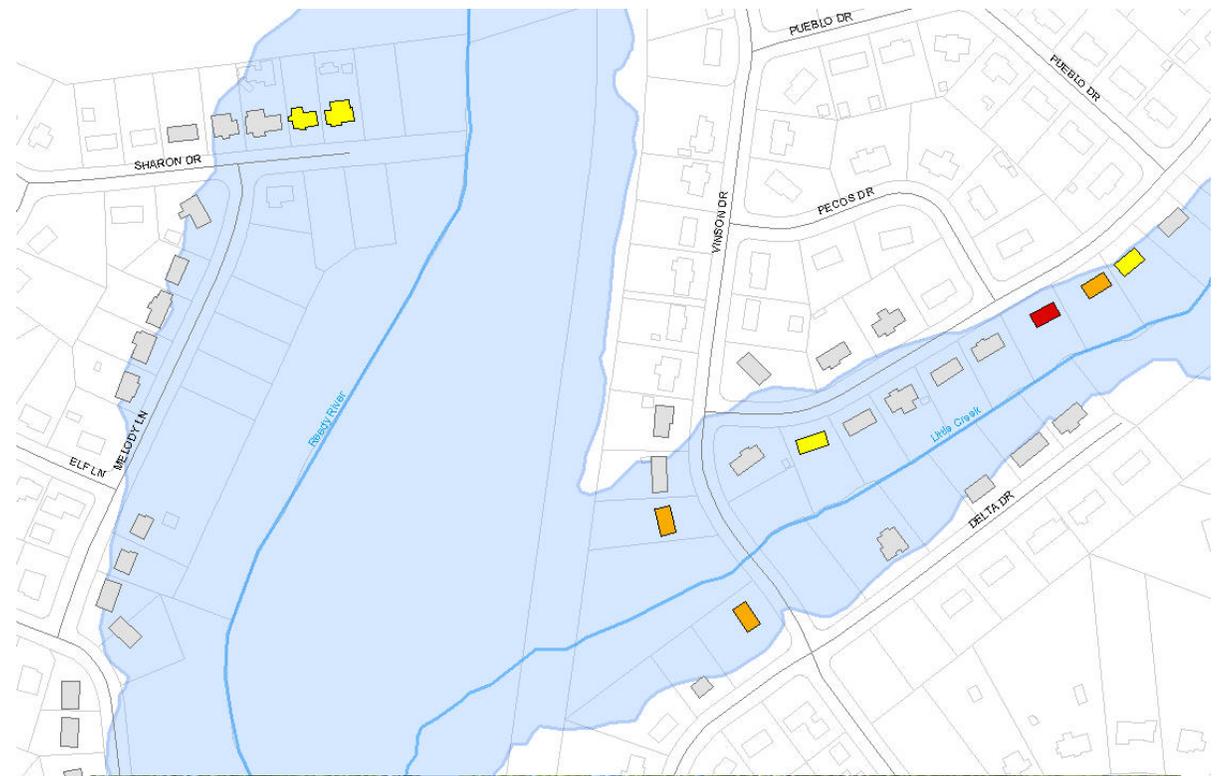
Priority	Stream Name	River Station	Road Name	Type	Existing LOS	Proposed LOS	Cost
1	Tributary F	2613	Lakeview Cir.	Culvert	<2-YR	25-YR	\$391,000.00
	Tributary G	5002	Blue Mountain Dr.	Culvert	<2-YR	25-YR	\$190,000.00
	Tributary I-2	1907	Hawkins Creek Ct.	Culvert	<2-YR	10-YR	\$215,000.00
	Reedy River	341861	Hodgens Dr.	Bridge	5-YR	25-YR	\$470,000.00
	Reedy River	323660	River Bend Rd.	Bridge	10-YR	25-YR	\$586,000.00
	Tributary D-3	4560	Hillandale Rd.	Culvert	10-YR	25-YR	\$340,000.00
	Tributary D-2	4326	Christopher St.	Bridge	10-YR	(removed)	\$191,000.00
	Little Creek	1577	Vinson Dr.	Bridge	10-YR	10-YR	\$508,000.00
Reedy River	330866	Foothills Rd	Bridge	25-YR	25-YR	\$556,000.00	
2	Tributary G-3	1113	Alice Farr Dr.	Culvert	<2-YR	(removed)	\$97,000.00
	Tributary A-7	468	Penarth Dr.	Culvert	<2-YR	2-YR	\$200,000.00
	Tributary F	906	Jones Cir.	Culvert	<2-YR	5-YR	\$526,000.00
	Little Creek	14488	Pilot Rd.	Culvert	<2-YR	10-YR	\$390,000.00
	Tributary A-4	3118	Ashe Dr.	Culvert	<2-YR	10-YR	\$196,000.00
	Tributary A-4	3873	Stacy Dr.	Culvert	<2-YR	10-YR	\$196,000.00
	Tributary A-8	1869	Enchanted Cir.	Culvert	<2-YR	10-YR	\$201,000.00
	Tributary A-5	887	Grady Dr.	Culvert	<2-YR	50-YR	\$161,000.00
	Tributary D-3	8412	Dreamland Way	Culvert	<2-YR	10-YR (culvert)	\$231,000.00
						500-YR (bridge)	\$363,000.00
Tributary G-1	973	Pine Grove Ln.	Culvert	<2-YR	25-YR (culvert)	\$253,000.00	
					25-YR (bridge)	\$499,000.00	
Tributary P	8176	Pine Forest Rd.	Culvert	<2-YR	2-YR (culvert)	\$228,000.00	
					5-YR (bridge)	\$499,000.00	
3	Langston Creek	14275	Davidson Rd.	Culvert	2-YR	10-YR	\$213,000.00
	Tributary A-4	1111	Emile St.	Culvert	2-YR	25-YR	\$213,000.00
	Tributary D-1	2693	Berkley Ave.	Culvert	2-YR	25-YR	\$202,000.00
	Tributary D-5	2452	Nora Dr.	Culvert	2-YR	25-YR	\$181,000.00
	Tributary D-6	838	Davidson Rd.	Culvert	2-YR	25-YR	\$182,000.00
	Tributary G	4521	Tucson Dr.	Culvert	2-YR	25-YR	\$270,000.00
	Tributary U	669	Elizabeth Ln.	Culvert	2-YR	25-YR	\$125,000.00
	Tributary H	1310	Long Forest Dr.	Culvert	2-YR	50-YR	\$232,000.00
	Tributary K	4313	S. Warwick Rd.	Culvert	2-YR	50-YR	\$163,000.00
	Tributary L	6425	River Bend Rd.	Culvert	2-YR	50-YR	\$223,000.00
	Tributary P-1	1929	Foot Hills Rd.	Culvert	2-YR	50-YR	\$175,000.00
	Tributary S	1921	New Circle Rd.	Culvert	2-YR	50-YR	\$236,000.00
	Tributary I-2	3583	Pilot Rd.	Culvert	5-YR	25-YR	\$340,000.00
	Tributary D-4	539	Montis Dr.	Culvert	10-YR	25-YR	\$189,000.00
Tributary I-1	2640	Trinity Way	Culvert	10-YR	50-YR	\$141,000.00	



# Residential Flooding

Table 5-1. Structure Acquisition List

Address	River	River Station (ft)	Finish Floor Elevation (ft)	Lowest Adjacent Ground Elevation (ft)	Cost (Fair Market Value) (USD)	Finish Floor Flooding Recurrence (yr)	Benefit to Cost Ratio
14 N. Chastain Dr	Langston Creek	7432	954.3	953.5	\$57,000	<10	0.39
1603 Old Cedar Lane Rd	Tributary F	3844	976.0	971.5	\$10,000	<25	0.39
204 Claxton Dr	Tributary A-5	583	986.3	986.3	\$125,000	<25	0.36
201 Alice Farr Dr	Tributary G-3	516	963.3	962.9	\$44,000	<10	0.34
109 Aladdin St	Tributary D-1	873	943.5	943.0	\$34,000	<10	0.29
12 Eunice Dr	Tributary A-9	4616	1030.7	1028.4	\$86,000	<25	0.26
218 Alice Farr Dr	Tributary G-3	1195	968.3	968.3	\$103,000	<25	0.20
102 Plano Dr	Little Creek	2347	953.7	953.3	\$81,000	<25	0.17
1408 Bramlett Rd	Long Branch	5912	940.7	940.1	\$21,000	<25	0.13
207 Vinson Dr	Little Creek	1467	952.1	951.8	\$62,000	<25	0.12
104 Plano Dr	Little Creek	2439	954.2	954.1	\$76,000	<25	0.09
56 / 58 Circle Dr	Tributary D-2	525	956.5	956.4	\$116,000	<25	0.08
1407 Bramlett Rd	Long Branch	5801	941.5	937.8	\$63,000	<50	0.07
203 Vinson Dr	Little Creek	1528	952.7	952.1	\$60,000	<25	0.07
306 / 308 Meadow St	Reedy River	288183	928.4	928.2	\$45,000	<50	0.07
15 Wood St	Long Branch	5726	941.2	938.6	\$29,000	<50	0.06
107 Aladdin St	Tributary D-1	804	945.1	944.7	\$21,000	<25	0.06
1409 Bramlett Rd	Long Branch	5813	941.5	936.8	\$47,000	<50	0.06
1501 Bramlett Rd	Long Branch	5829	941.3	937.8	\$12,000	<50	0.06
2408 Old Parker Rd.	Little Creek	11653	1004.9	1001.7	\$171,000	<100	0.05
1503 Bramlett Rd	Long Branch	5826	941.7	938.4	\$12,000	<50	0.04
1505 Bramlett Rd	Long Branch	5819	942.4	938.7	\$44,000	<100	0.04
108 Plano Dr	Little Creek	2512	954.9	954.7	\$77,000	<50	0.04
48 / 50 Circle Dr	Tributary D-2	543	957.2	957.1	\$122,000	<50	0.03
113 Sharon Dr	Reedy River	311488	953.9	950.2	\$68,000	<100	0.03
13 N. Chastain Dr	Langston Creek	7565	957.5	954.6	\$60,000	<100	0.03
8 Plano Dr	Little Creek	1779	955.2	951.5	\$58,000	<100	0.02
1406 Bramlett Rd	Long Branch	5912	942.9	941.1	\$73,000	<100	0.02
310 Mcmakin Dr	Tributary D-2	2677	966.2	964.1	\$46,000	<100	0.02
4 N. Chastain Dr	Langston Creek	7166	957.6	954.0	\$49,000	<100	0.02
310 Dukeland Dr	Tributary D-2	3400	968.2	966.0	\$54,000	<100	0.02
12 Eunice Dr	Tributary A-9	4610	1033.1	1032.9	\$86,000	<100	0.02
306 Dukeland Dr	Tributary D-2	3463	968.5	966.5	\$21,000	<100	0.01
---	---	---	---	Total Cost	\$2,033,000	---	---

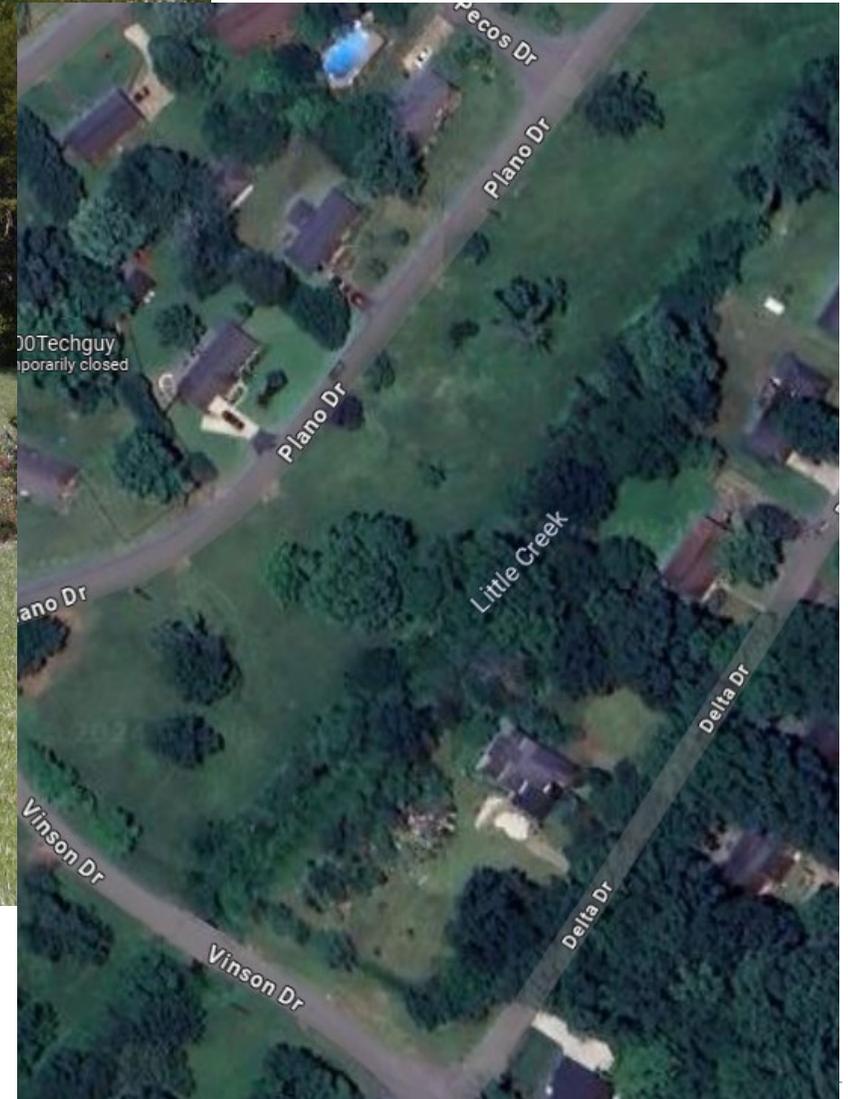


# Floodplain Buyouts

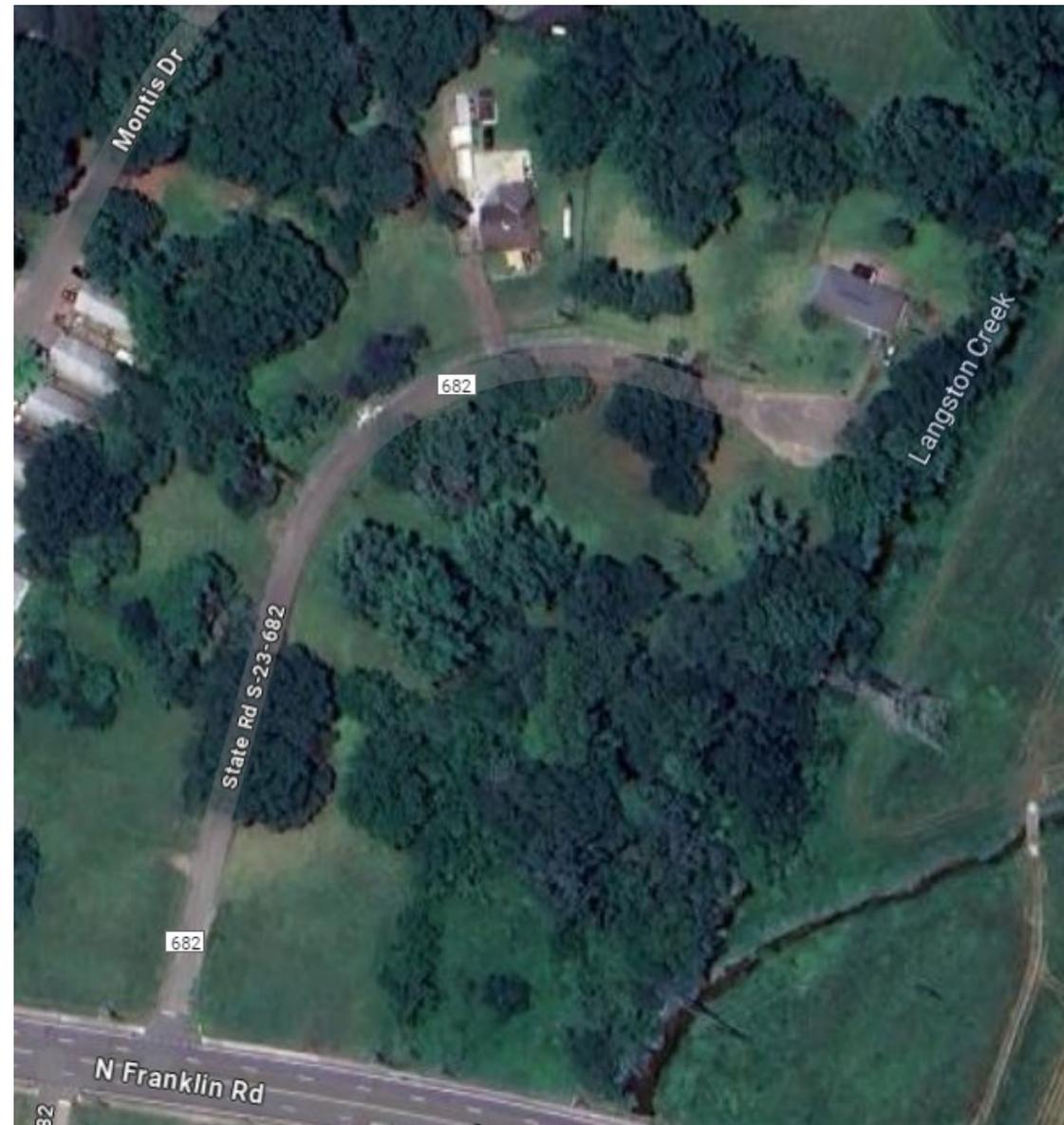
- County retained third party to broker potential negotiations with homeowners for residential buyouts
- Purchase and removal of structures took place over several years
- Isolated holdouts remain but have forfeited further assistance from the County



# Little Creek – Plano Drive



# Langston Creek – North Chastain Drive



# Solve One Problem, More Arise

After Floodplain buyouts:

- ✓ People no longer in harms way
- ✓ Floodplains are allowed to flood
- ✓ The problem is not shifted downstream

....but new problems arise:

- Water Quality
- The Dreaded M-word



# The New Problems



- Defining maintenance requirements
- Define Costs
  - Mowing/personnel
  - Resident complaints

- Water Quality
  - Total Nitrogen
  - Total Phosphorous
  - Bio/E. Coli

- Stream Erosion
- Lack of riparian buffer (old homesites)



# Alternatives Analysis



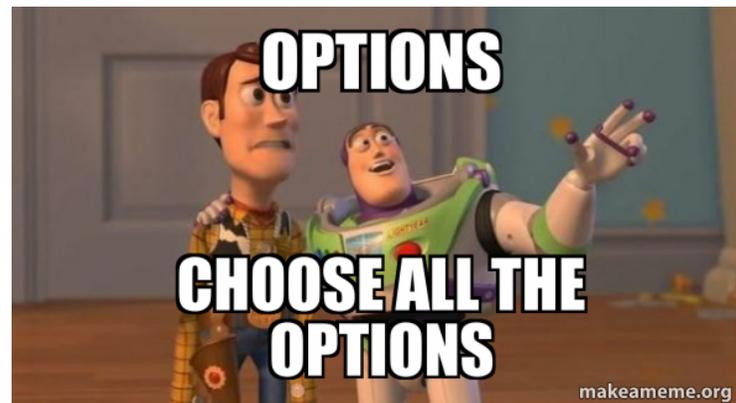
Infiltration?



Stream Restoration?



Riparian Buffers?



# Searching for Funding

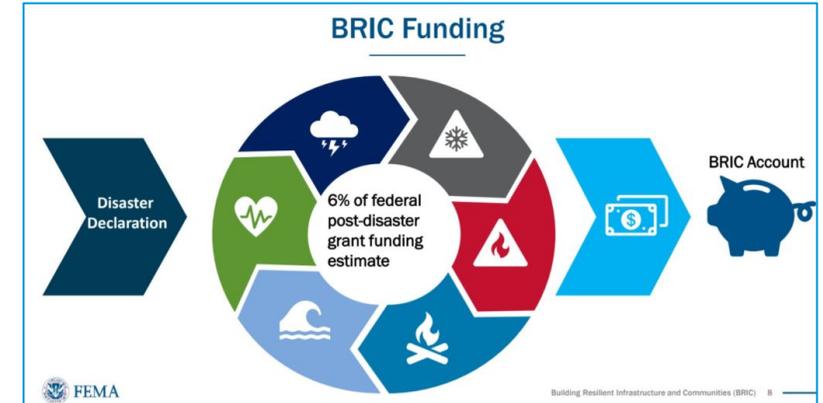
Google Search:

“Stream Restoration/LID grant funding”

Google Result:

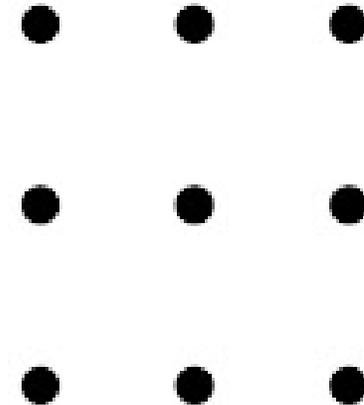


- Locally
- FEMA BRIC
- State Grants
  - South Carolina Rural Infrastructure Authority
  - South Carolina Office of Resiliency



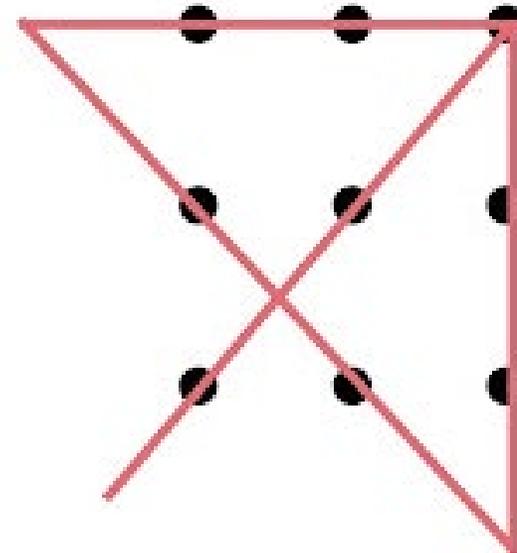
# More on Funding: Thinking Outside the Box

- Maximize Benefit Cost Ratios
- Leverage Location/Demographics
- Add additional “features”
- Make something else the *main course*

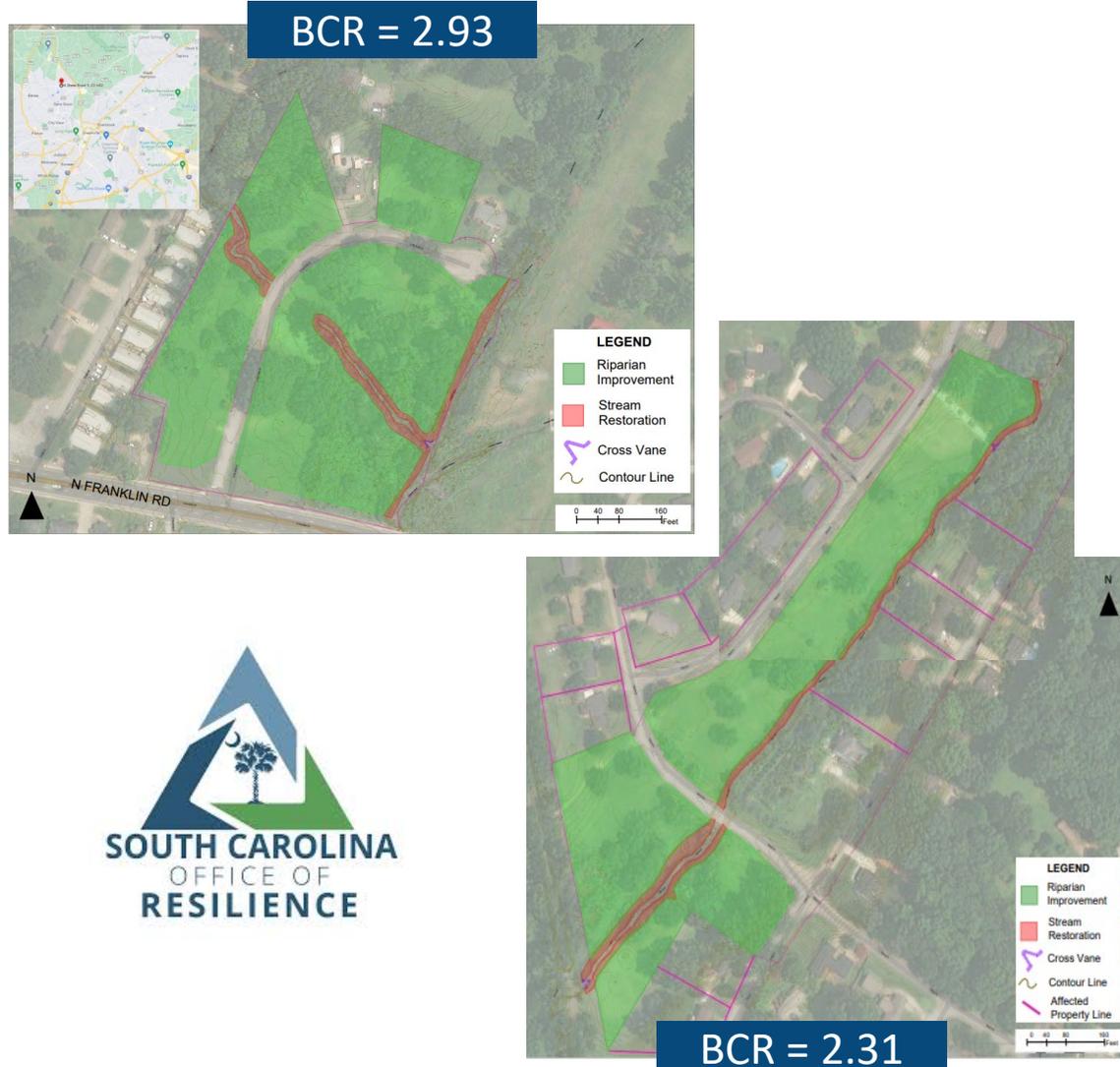


# More on Funding: Thinking Outside the Box

- Maximize Benefit Cost Ratios
  - *Nature-led solutions*
- Leverage Location/Demographics
  - *High density/Low income*
- Add additional “features”
  - *Parks/trails*
- Make something else the *main course*
  - *Trails/Mobility*



# Finding Funding: Case Study

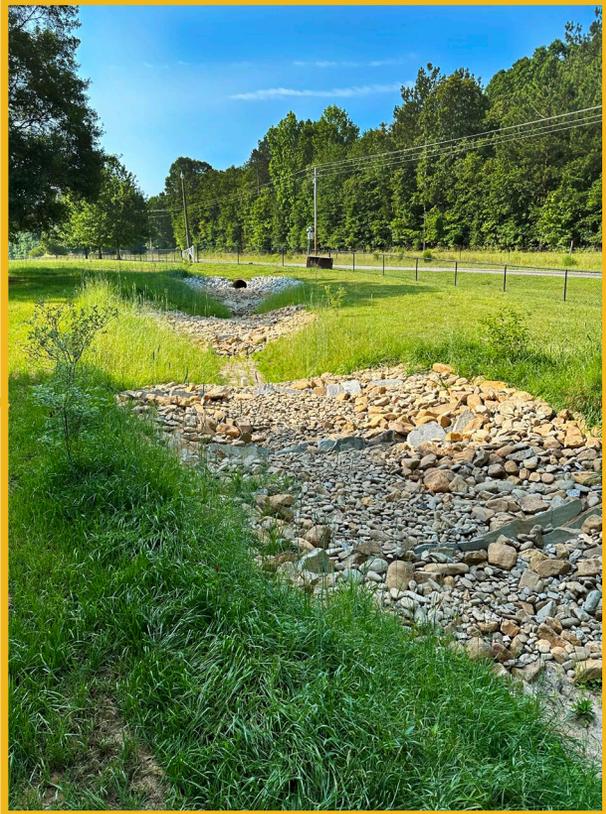
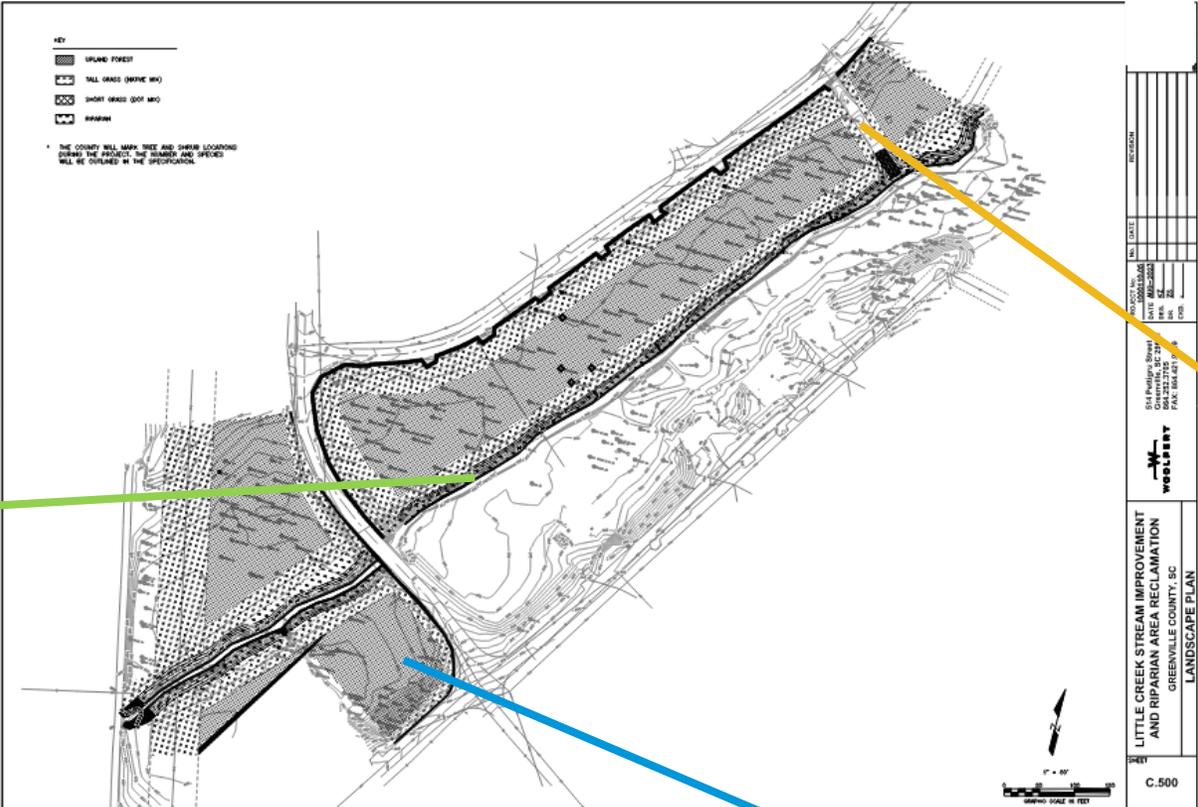


- Selected two communities with multiple buyout properties
  - Little Creek
  - North Chastain
- Each area had multiple contiguous properties
- Each area incorporated stream improvements
  - Little Creek → 1,400 linear feet
  - North Chastain → 1,100 linear feet
- Each area incorporated riparian forestation
  - Little Creek → 6.5 acres
  - North Chastain → 5.5 acres



# Mitigate the Problem(s) – Little Creek

Stream restoration is among the best “bang for buck” for target nutrients/pollutants



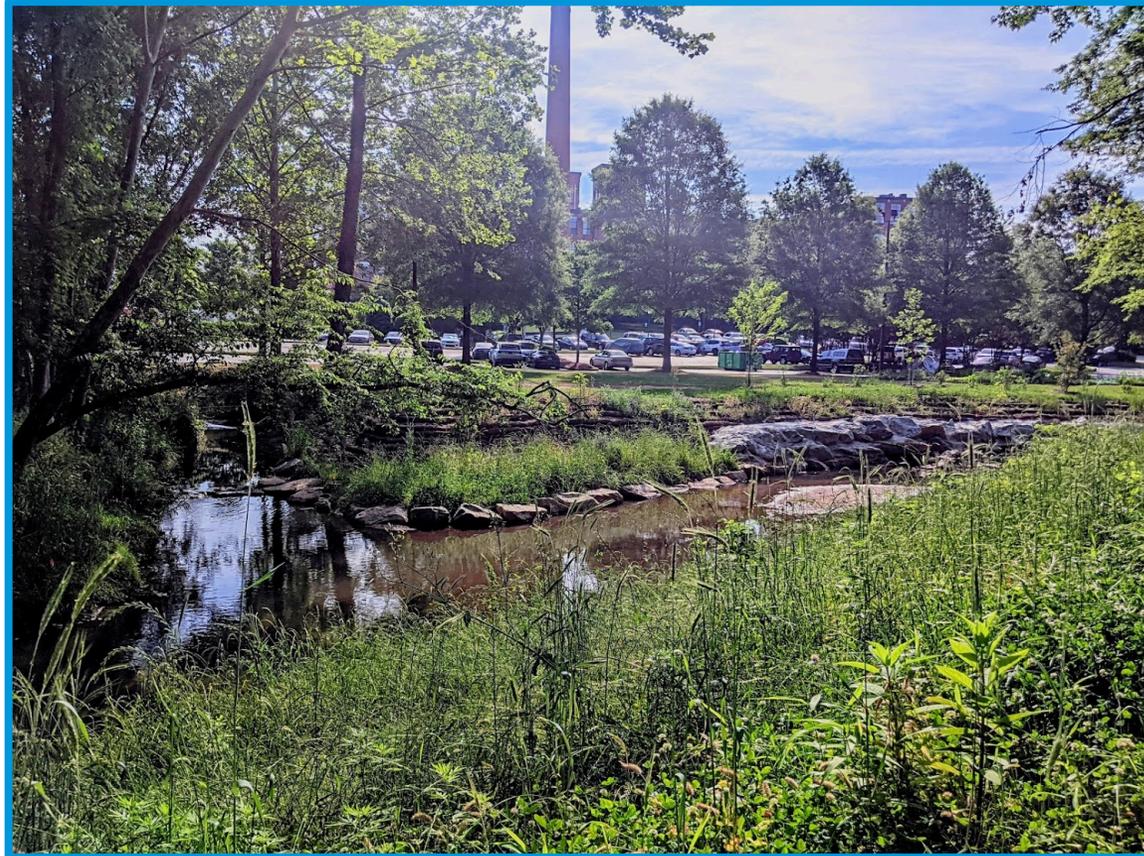
County Council just adopted a stream buffer requirement, so why not restore them where possible? (They also have a surprisingly high BCR value, especially when coupled with cost savings of Trees Upstate, a local nonprofit partner)



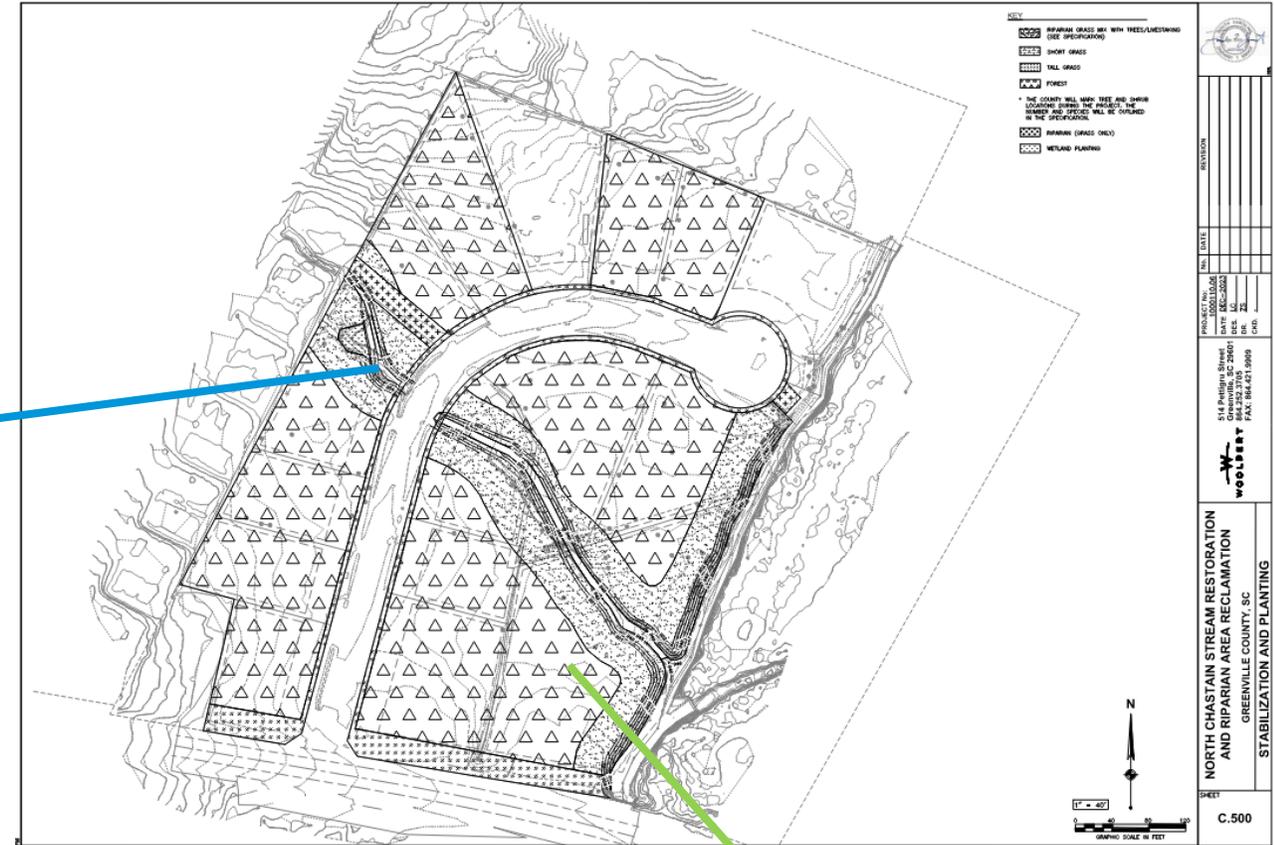
RSC already installed in 2021



# Mitigate the Problem(s) – North Chastain



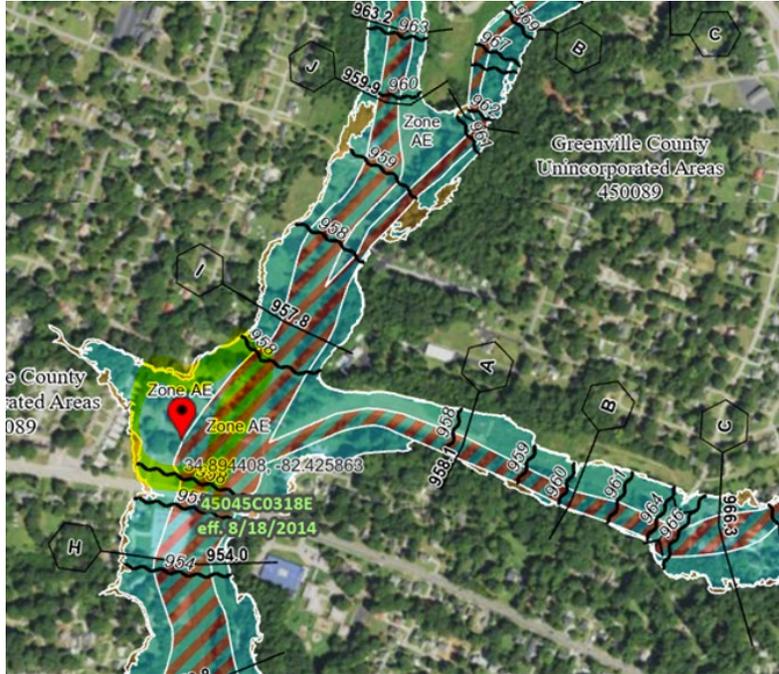
A stable, well-vegetated stream reduces nutrients and contributes less sediment, encouraging a healthier ecosystem overall



Trees Upstate helps make this and other projects possible



# Additional Challenges



No Change Flood Model Required  
(If not, CLOMR/LOMR)



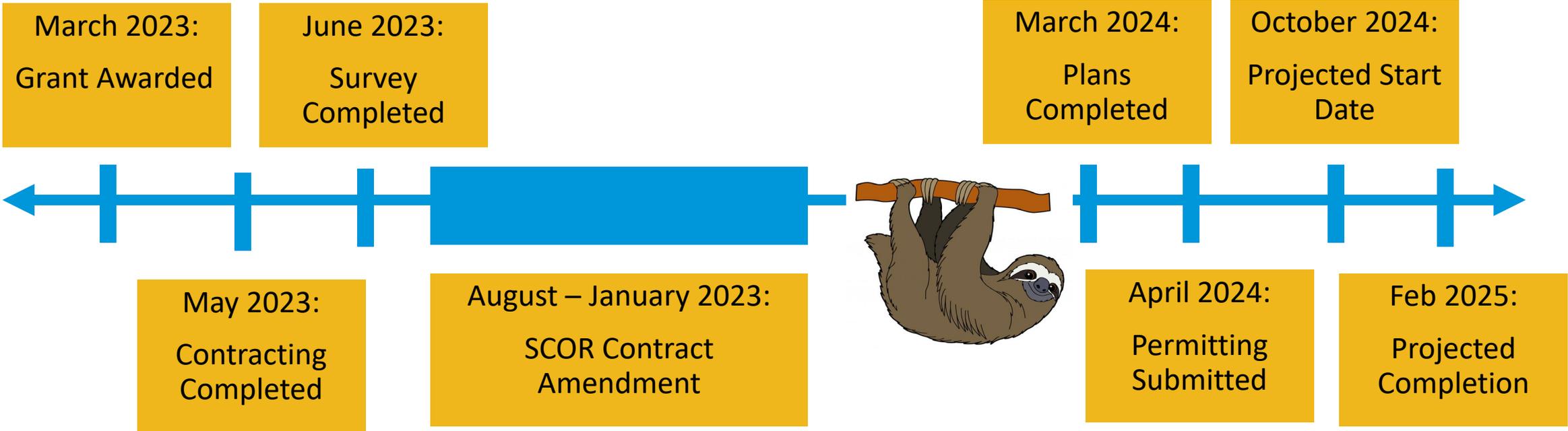
Sewer Easement Challenges



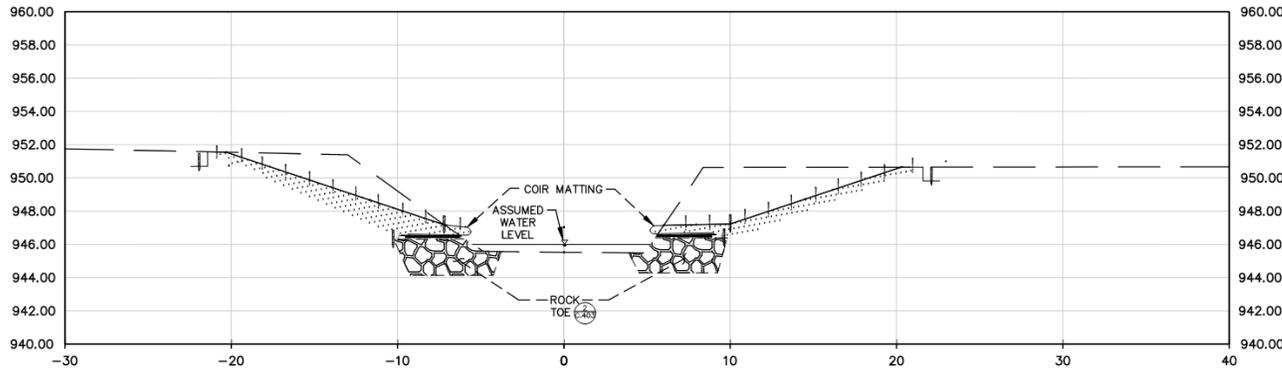
Old Pedestrian Bridge



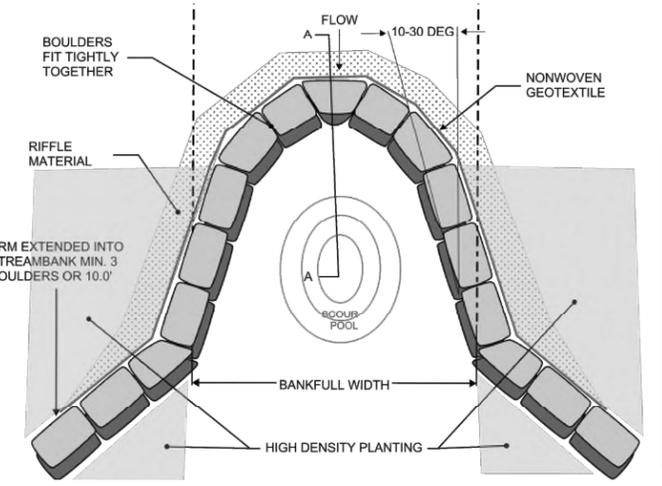
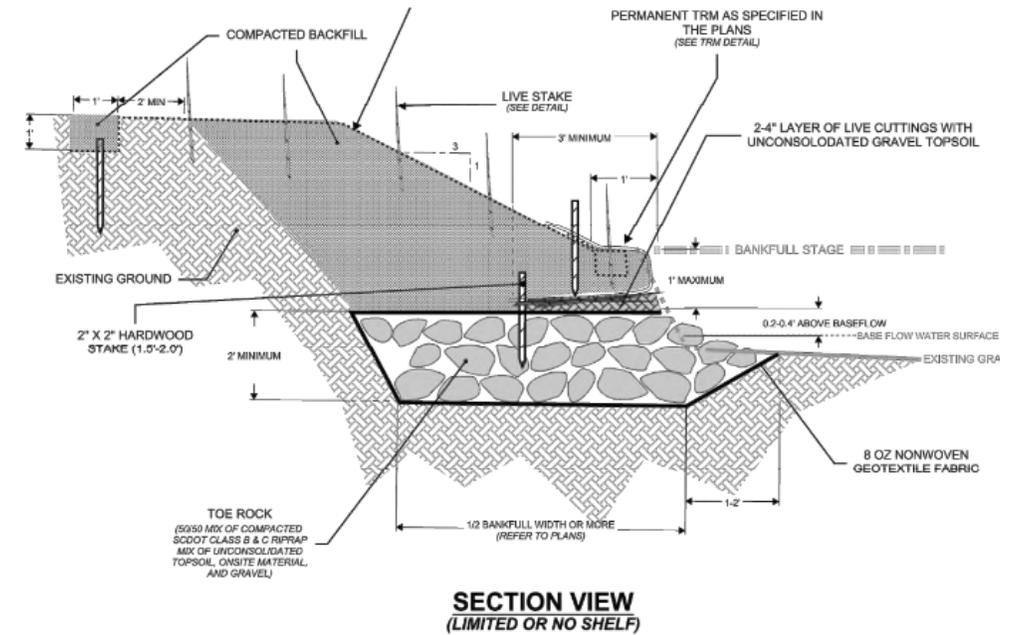
# Project Timeline



# What's Next?

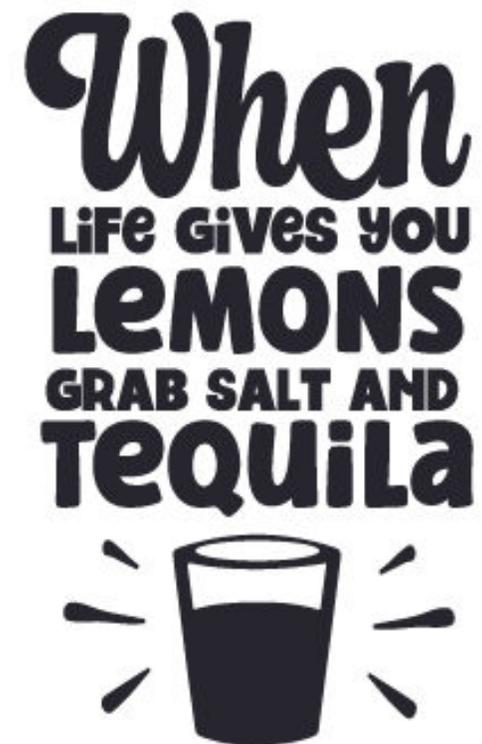


- Public meetings
- Determining the best way to bid the project
- Addressing permitting agency comments
- SCOR's review of the bid package



# Takeaways

- Maintaining current floodplain mapping and aggressive floodplain regulations/restrictions highly important
- There is always a bigger storm – floodplain buyouts eliminate flood risk once and for all
- Community blight can become an amenity over time
- Grant funding is available once you find the right fit for your project



Thank You



WOOLPERT