

# Fountain Creek Flood Control Study

Appraisal-Level Evaluation of Flood Control Options on Fountain Creek



now  
part of



January 2017

# Presentation of Final Draft Report

- Based on December 2016 Final Draft Report
- Incorporates comments from November 21, 2016 presentation of Preliminary Draft Report
- Agenda:
  - Alternative Descriptions
  - Alternative Comparison

# Scope of Project

- Task 1: Incorporate previous work (e.g., water rights study, USGS analysis) and involve stakeholders
- Task 2: Appraisal-level layout and implementation issues for mainstem dam options
- Task 3: Appraisal-level layout and implementation issues for other options (off-channel)
- Task 4: Comparison of alternatives
- Task 5: Report

# Planning Assumptions

- Sized flood facilities based on 100-yr flood management
- Hydrology based on USGS 2014 hydrologic modeling (Q100 = 37,000 cfs at Pueblo)
- Best available topographic mapping
- No new channel hydraulics, sediment or water quality studies
- No new water rights analysis
- Minimum 100-yr flow target at Pueblo = 10,000 cfs



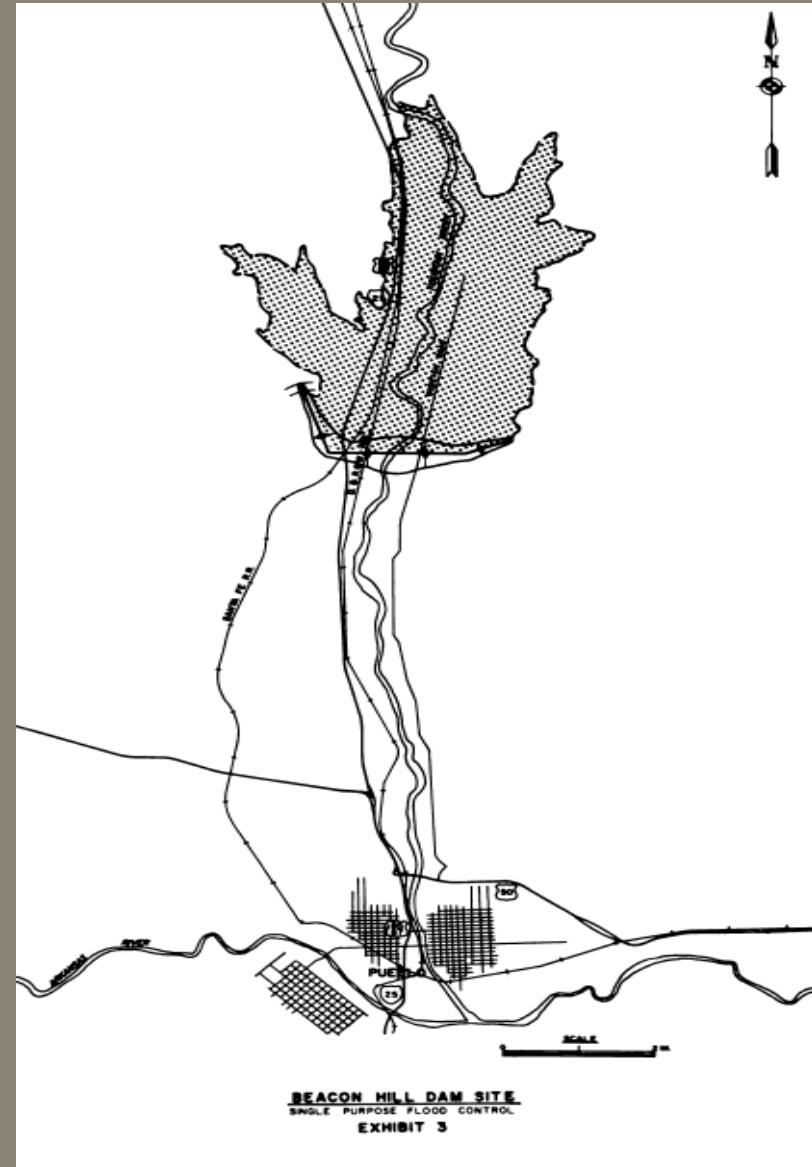
# Flood Control Alternatives

1. Mainstem Dam– Flood Control Only
2. Mainstem Dam with Permanent Pool
3. 10 Small Side Detention Ponds
4. One Large Side Detention Facility

# Mainstem Dam

## Previously Studied

- 1981 USACE EIS
- Considered 3 locations for flood control
- One site also with a recreation pool
- Low Benefit/Cost ratios eliminated alternatives from further study



# Mainstem Dam

## Previously Studied

- USGS SIR 2014 – Scenario 10
- 52,000 acre-foot reservoir
- Includes 25,700 acre-feet of permanent recreation pool
- Reduced simulated peak discharge 56.4%
- Reduced simulated sediment transport 62.1%

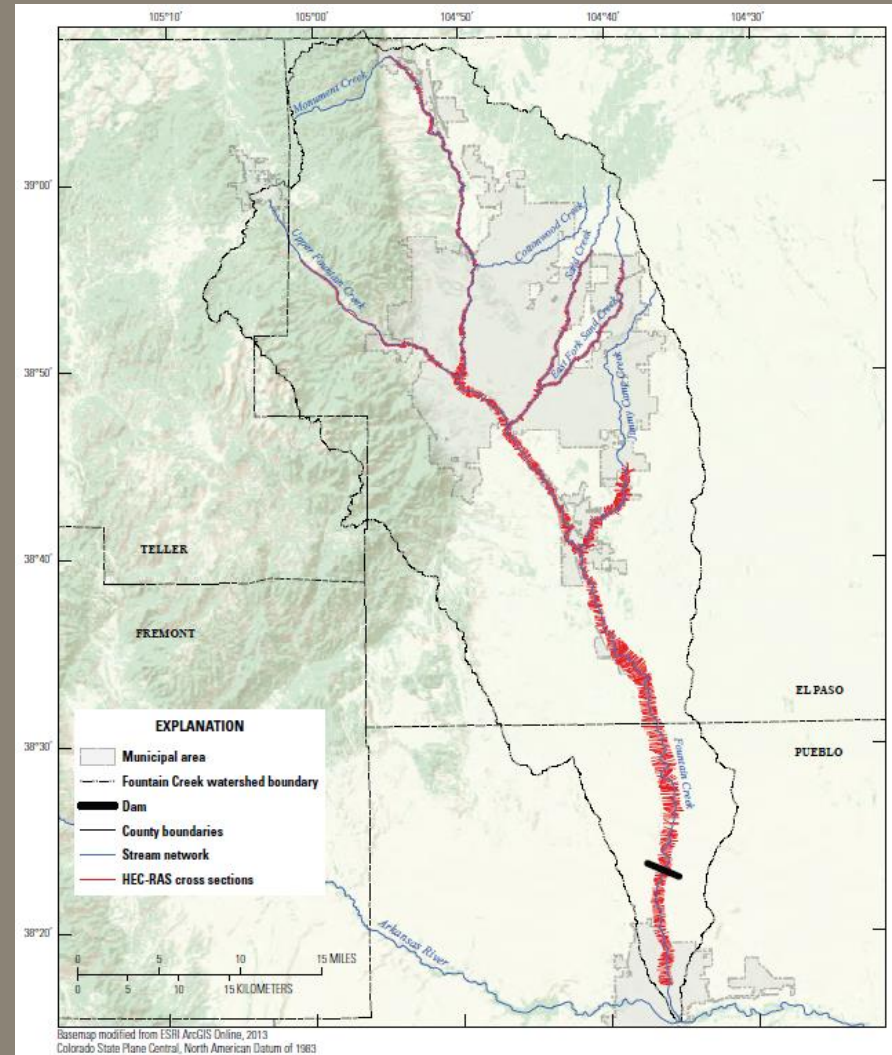
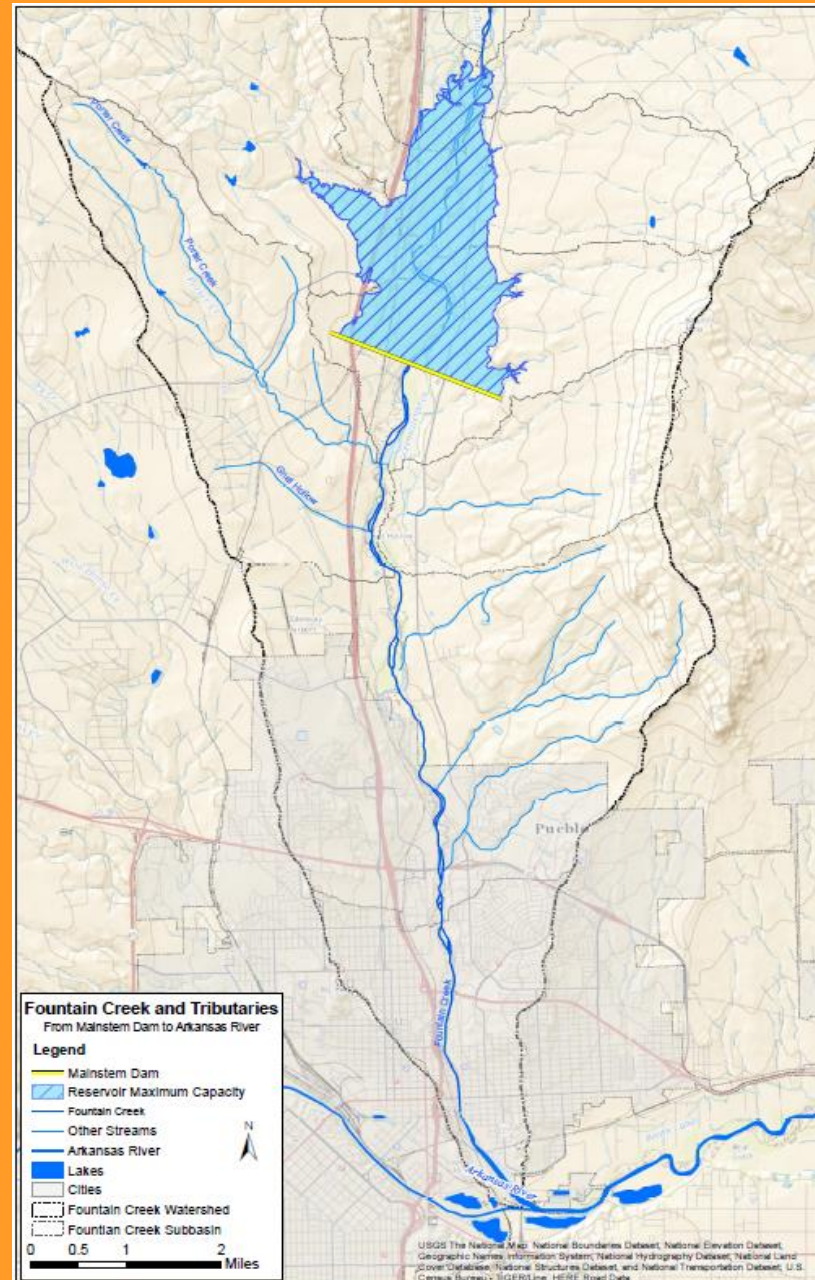


Figure 3-10. Location of the reservoir dam on the main stem of Fountain Creek in scenario 10. HEC-RAS, Hydrologic Engineering Center-River Analysis System.

# Mainstem Dam

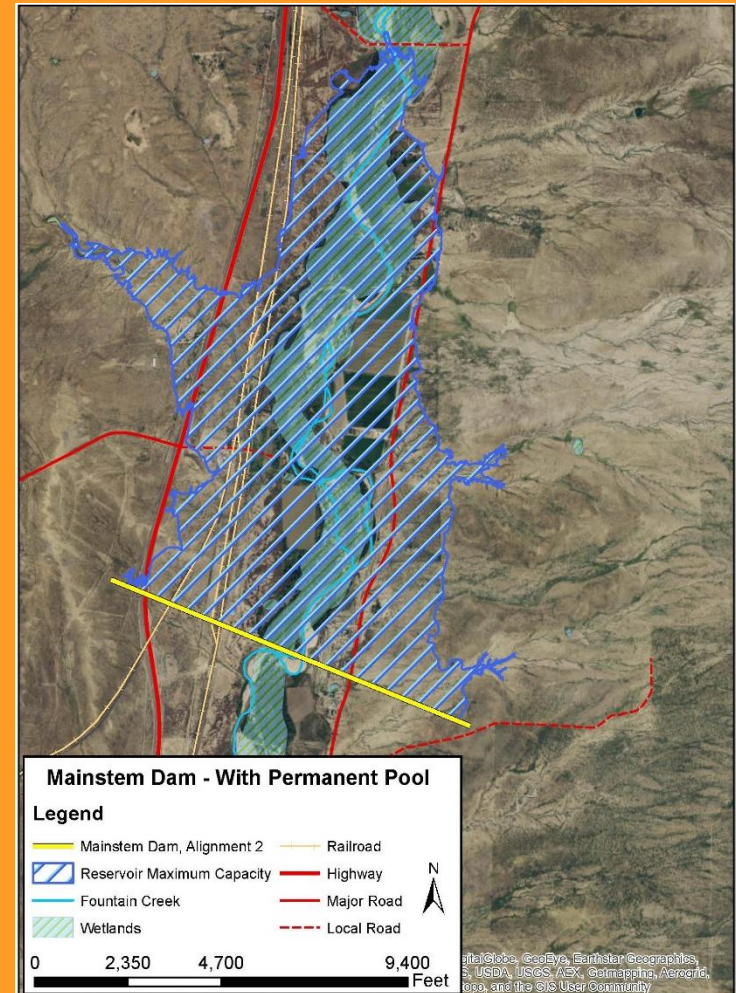
- Same location as USGS site
- Considered sizes with and without a permanent pool
- Used topographic contours from recent LiDAR data developed by Matrix Design Group





# Mainstem Dam – Flood Control Only

- 28,200 acre-feet
- Embankment 8,700 feet long, 82 feet high
- Infringes on Union Pacific Railroad, the Burlington Northern and Santa Fe Railroad, Interstate 25 and Overton Rd at full capacity

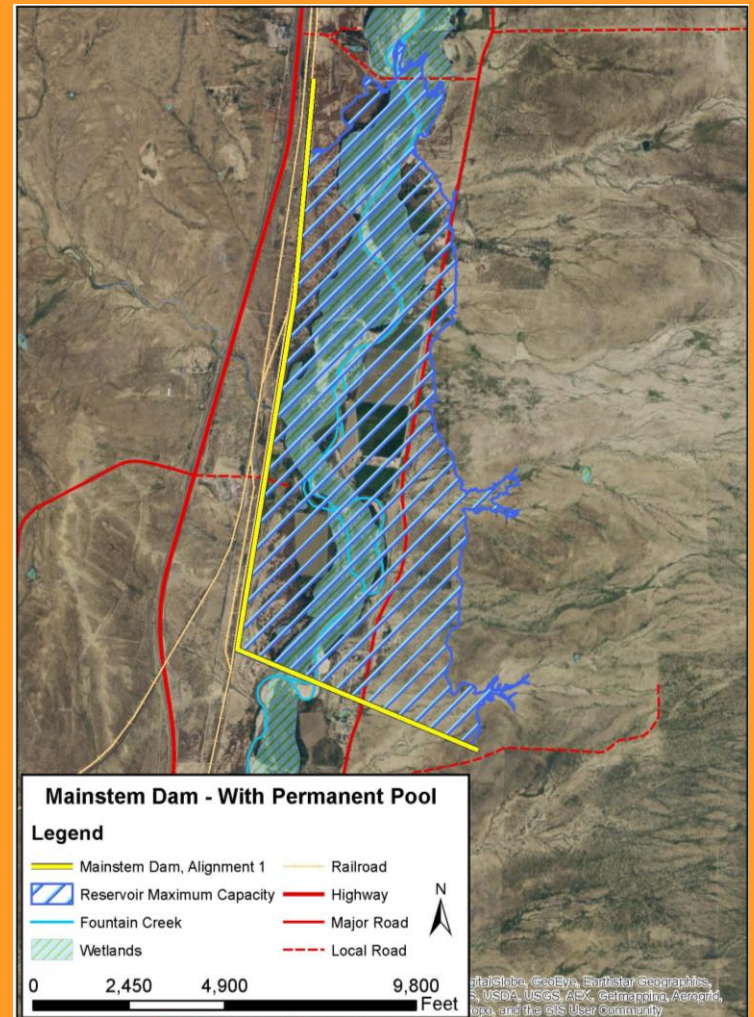




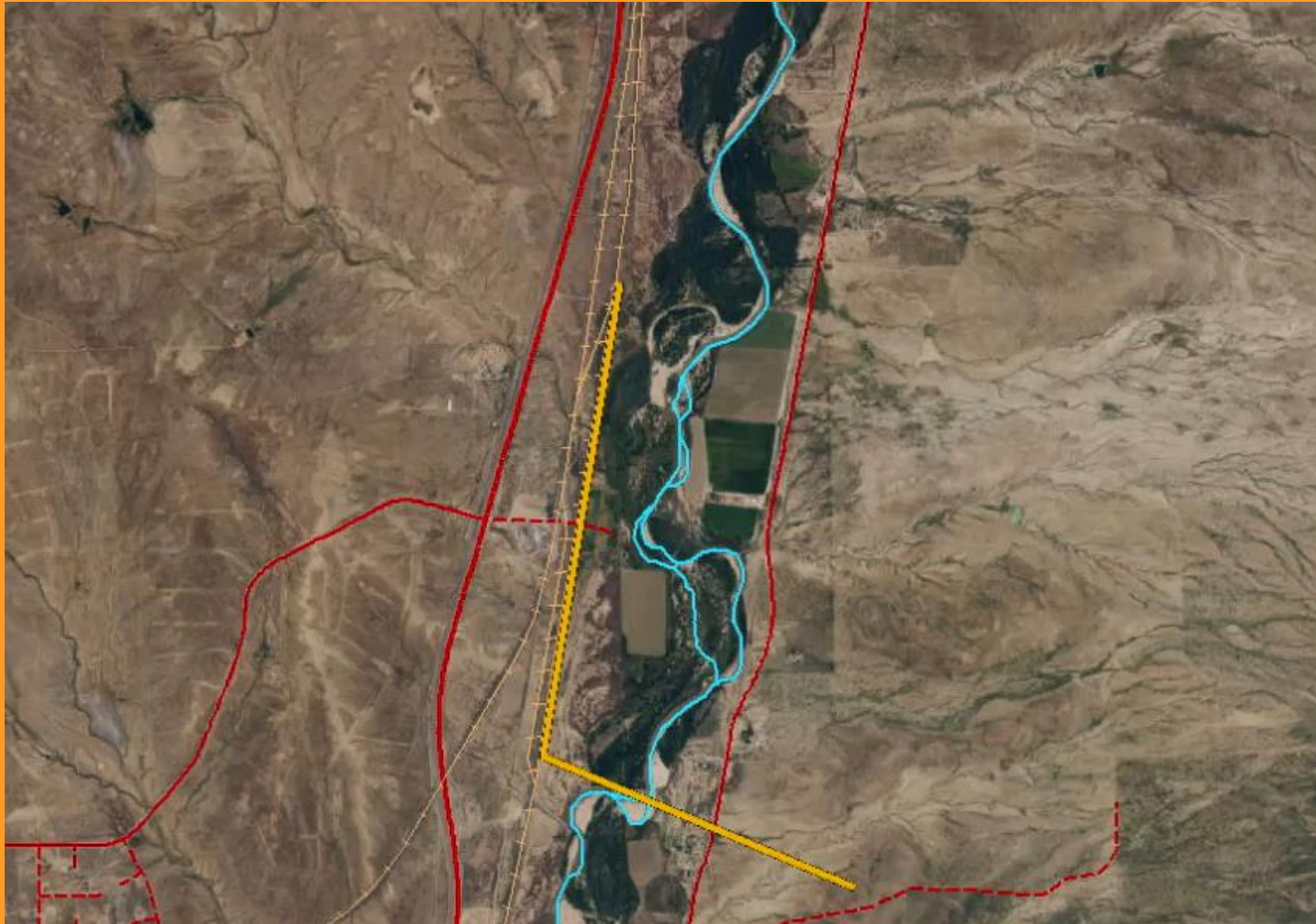


# Mainstem Dam – Flood Control Only

- 28,200 acre-feet
- Could be built to protect railroads and I-25
- Embankment 15,400 feet long, 83 feet high



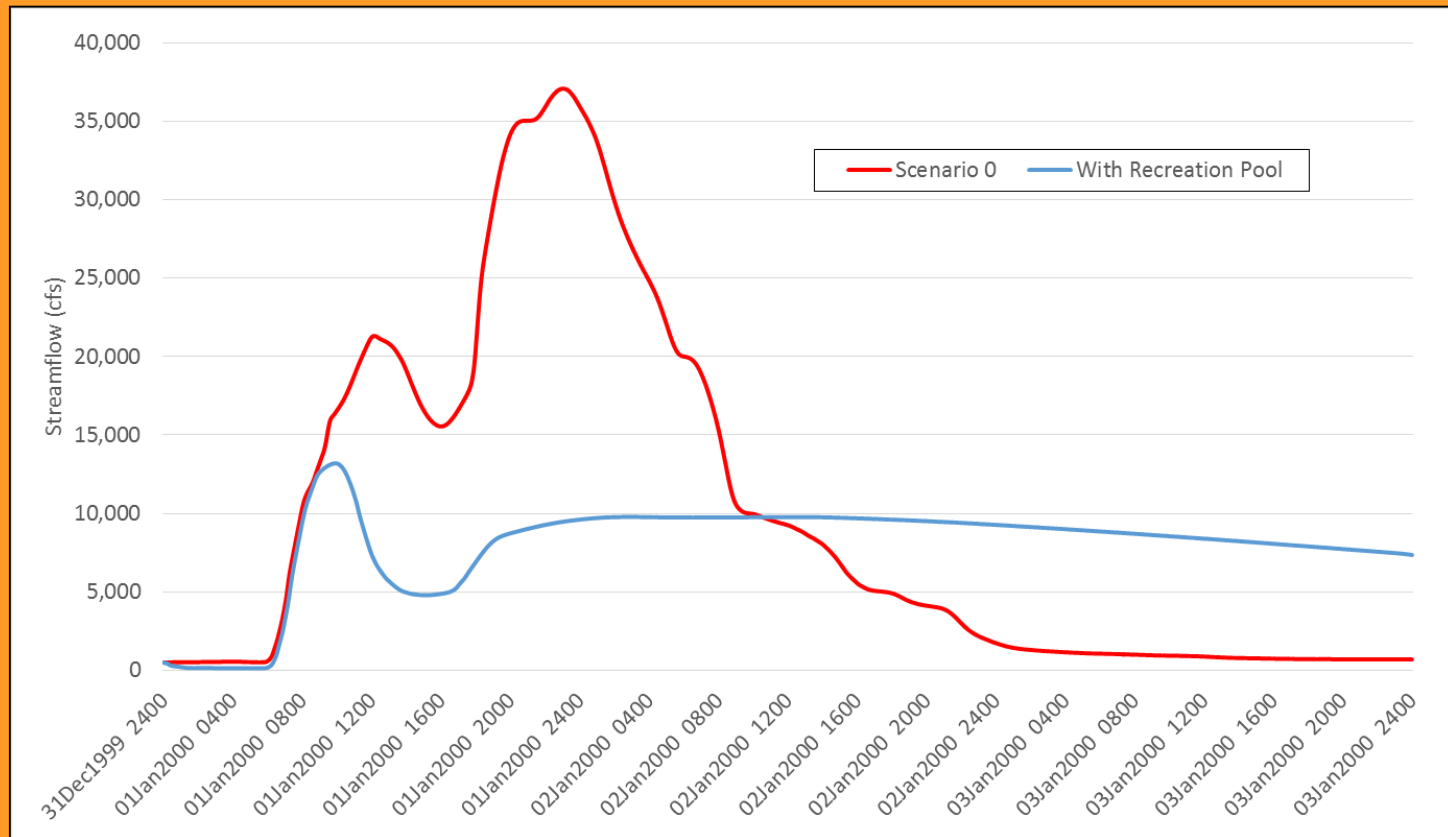
# Protective Embankment – Flood Control Only: Only: 24-hr, 100-yr Storm Animation



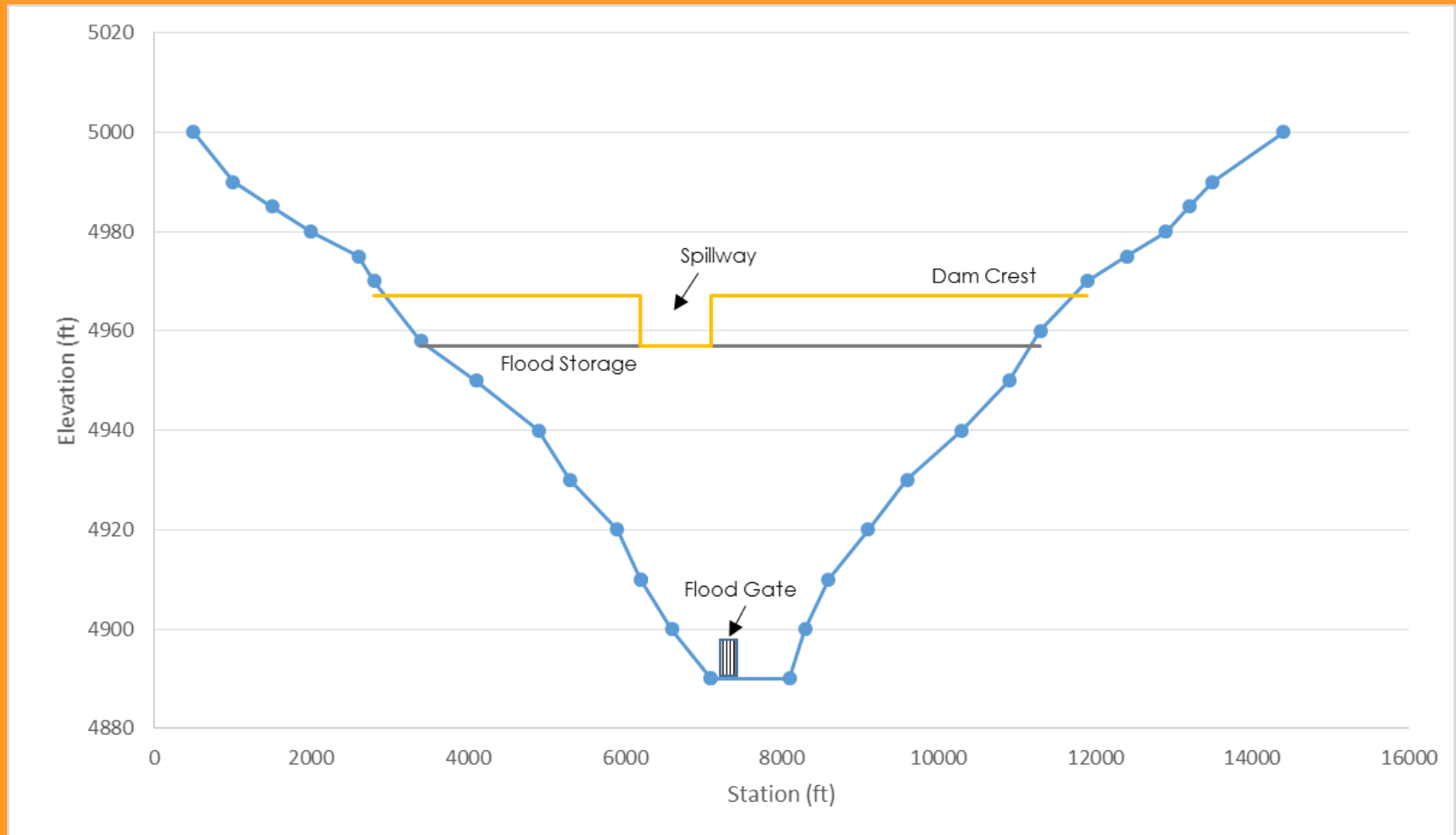


# Mainstem Dam - Hydrograph

- Could mostly achieve 10,000 cfs peak flow for 100-yr flood at Fountain Creek at Pueblo gage

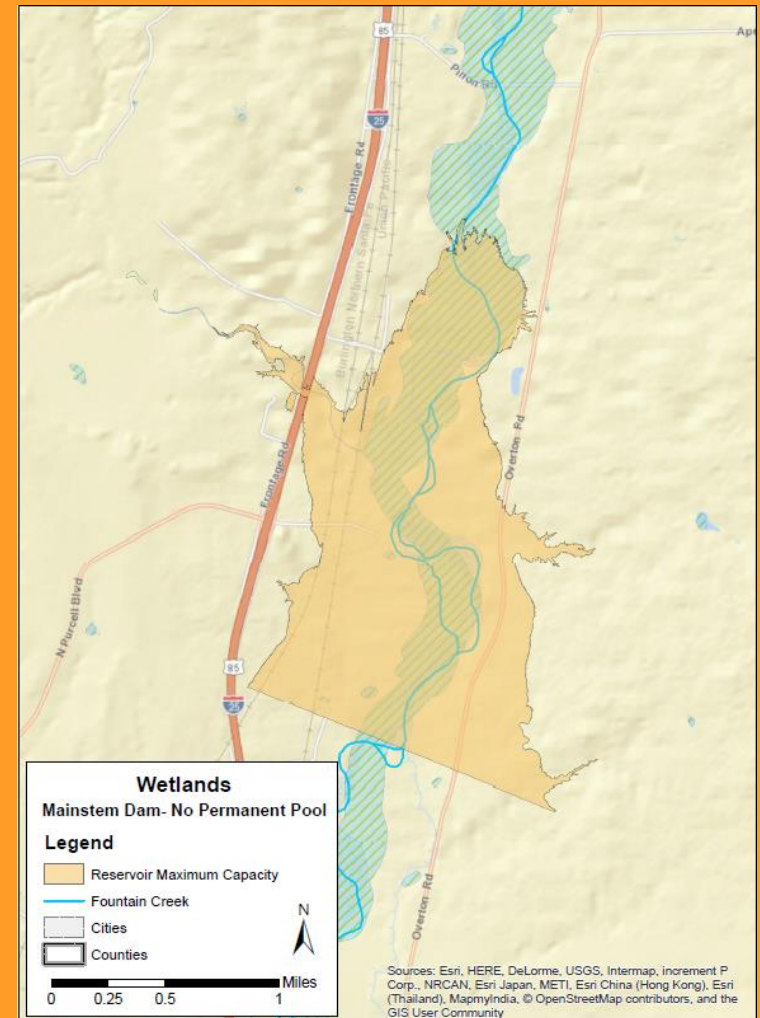


# Mainstem Dam Flood Control Only – Dam Cross-Section



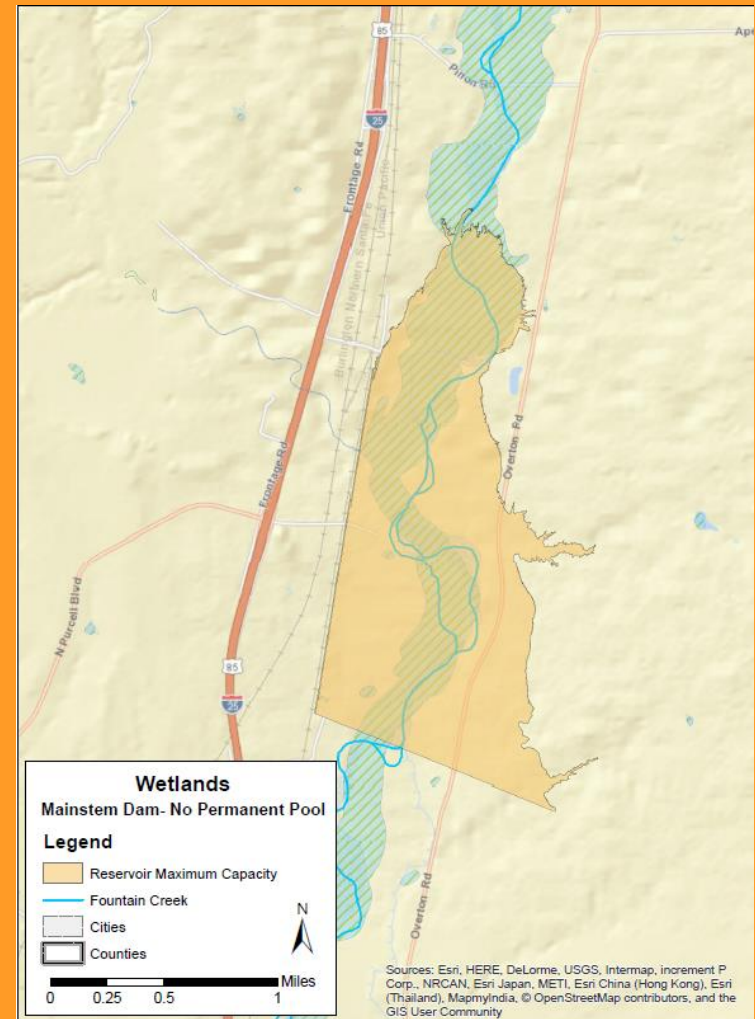
# Mainstem Dam – Original Embankment, Flood Only – Wetland Impacts

- Original Embankment
- 382 acres of wetlands temporarily inundated at full capacity



# Mainstem Dam – Protective Embankment, Flood Control Only – Wetland Impacts

- Embankment protects railroads/highway
- 386 acres of wetlands temporarily inundated at full capacity

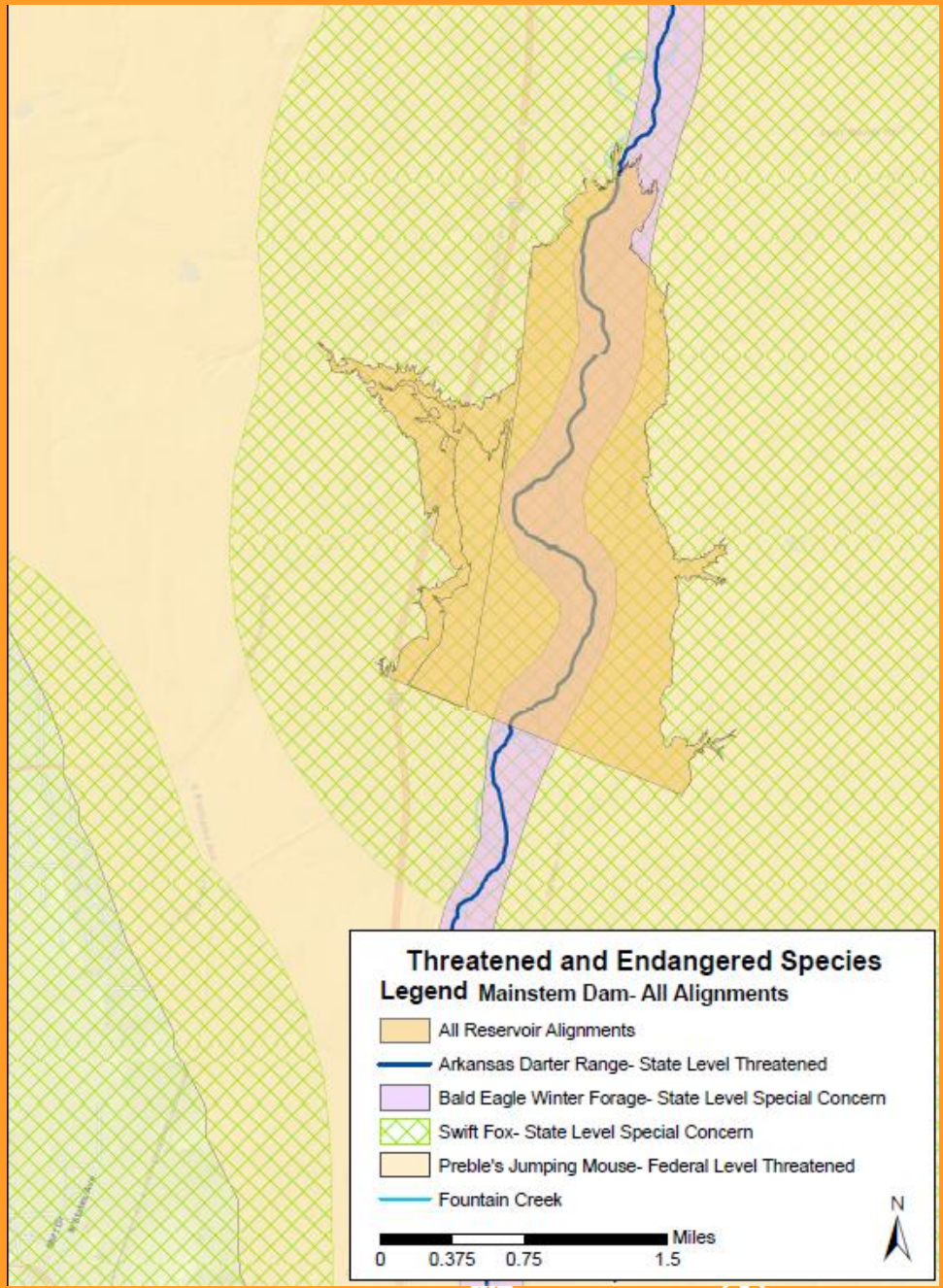




# Mainstem Dam, Flood Control Only

## – Habitat Impacts

- Located in Prebles Meadow Jumping Mouse and Arkansas Darter range
- Several species of State special concern in this area



# Mainstem Dam – Flood Control Only – Property Impacts

Dam Alternative	Private Land Inundated (acres)	Parcels of Private Land Effected
Original Embankment	1,100	49
Embankment protects railroads/highway	1,000	31

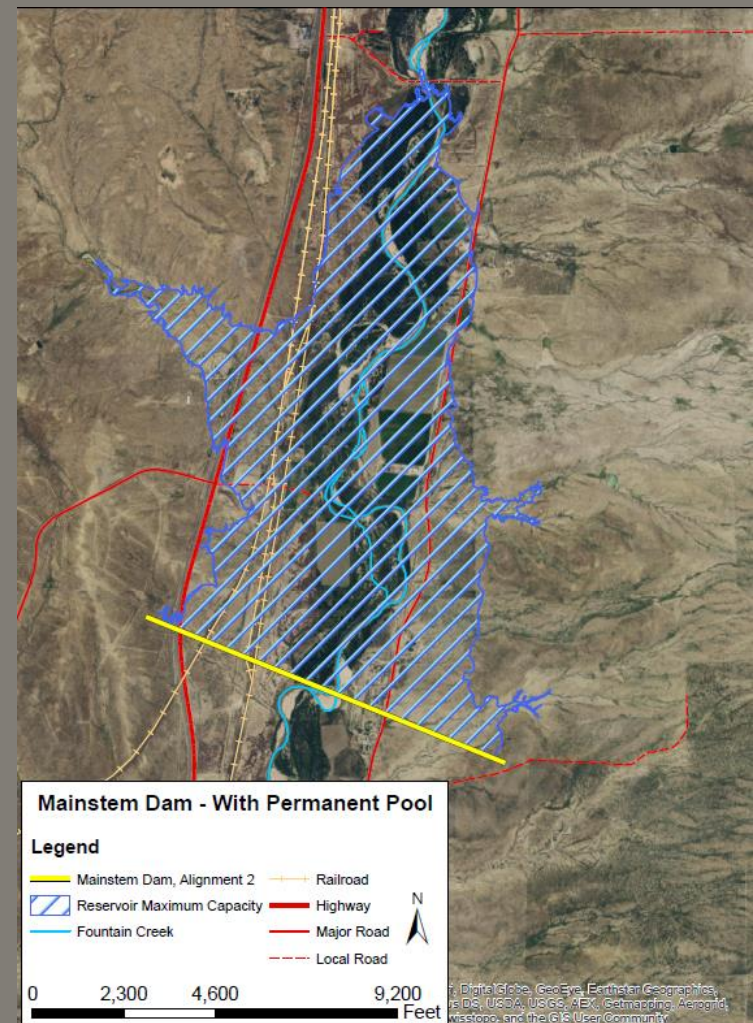
# Mainstem Dam – Flood Control Only – Cost Estimate

Dam Alternative	Dam Length (ft)	Dam Height (ft)	Storage Volume (acre-ft)	Pipeline Length (ft)	Total Cost (\$)	Cost/Vol. (\$/acre-ft)
Original Embankment	8,700	82	28,000	1000	165M - 220M*	5.9K - 7.9K*
Embankment protects railroads/highway	15,400	83	30,000	1000	145M - 215M	4.9K - 7.1K

\* Costs do not include costs for channel stabilization downstream of the dam, or any environmental impact mitigation costs

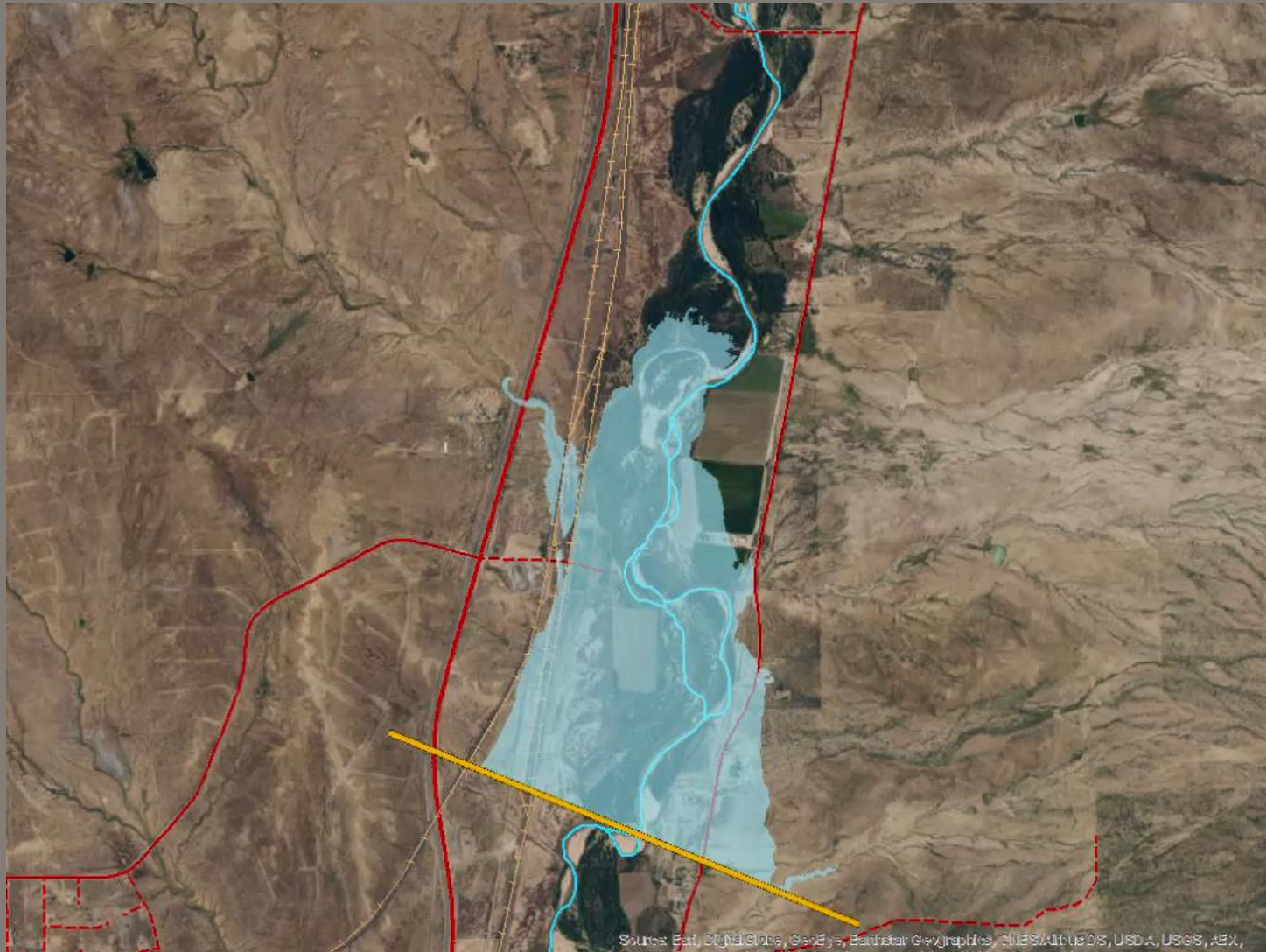
# Mainstem Dam with Permanent Pool – Original Embankment

- 52,000 acre-feet
- Embankment 9,800 feet long, 98 feet high
- Passive operation
- Infringes on Union Pacific Railroad, the Burlington Northern and Santa Fe Railroad, Interstate 25 and Overton Rd at full capacity





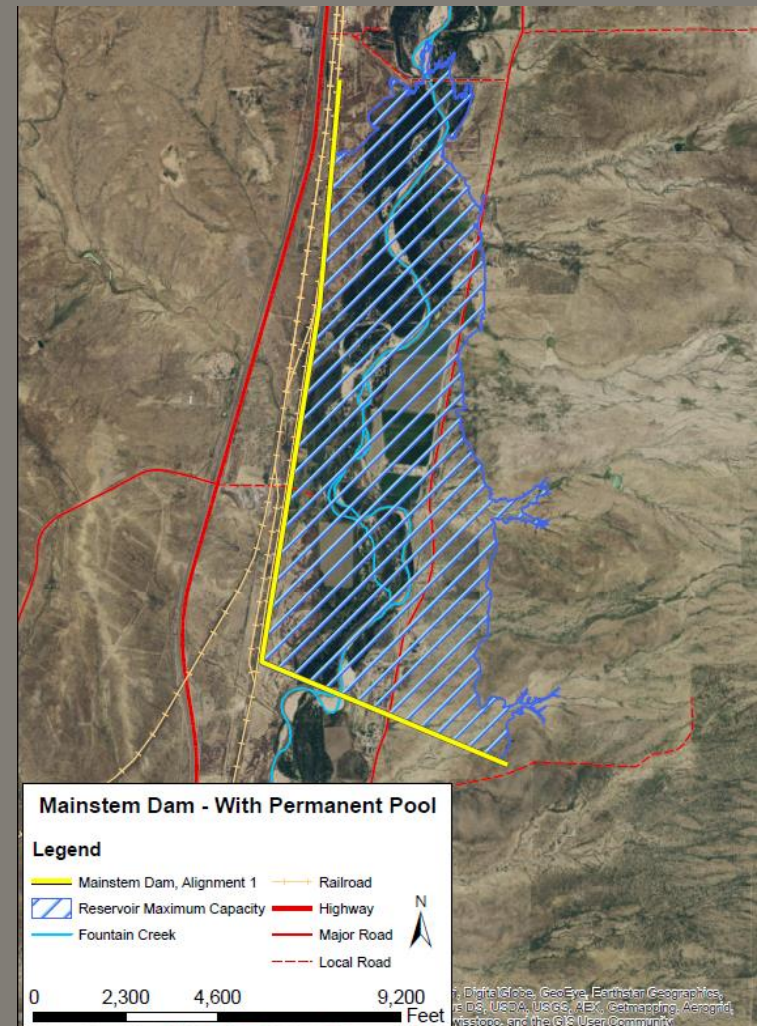
# Original Embankment – Permanent Pool: 24-hr, 100-yr Storm Animation



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroX,

# Mainstem Dam with Permanent Pool – Protective Embankment

- 52,000 acre-feet
- Could be built to protect railroads and I-25
- Embankment 21,300 feet long, 101 feet high

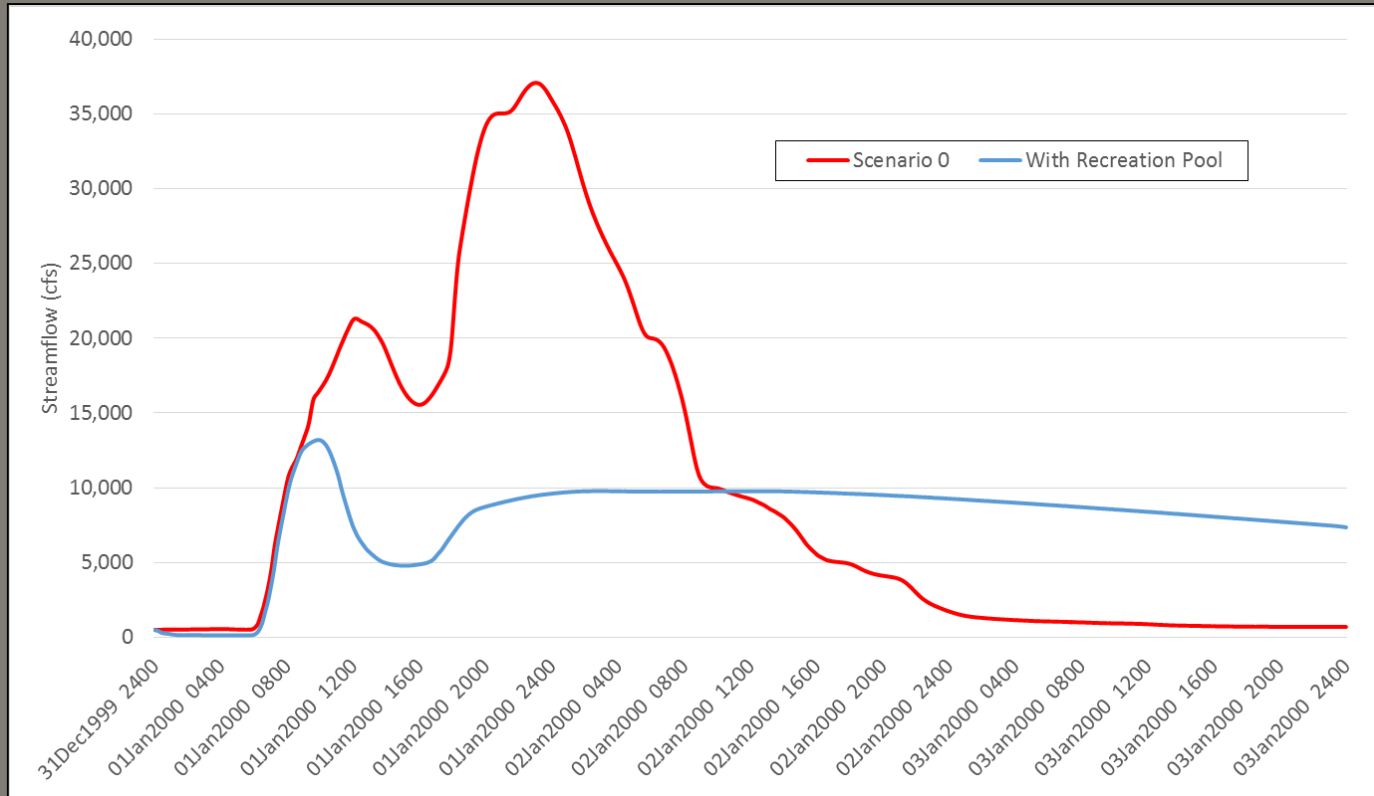






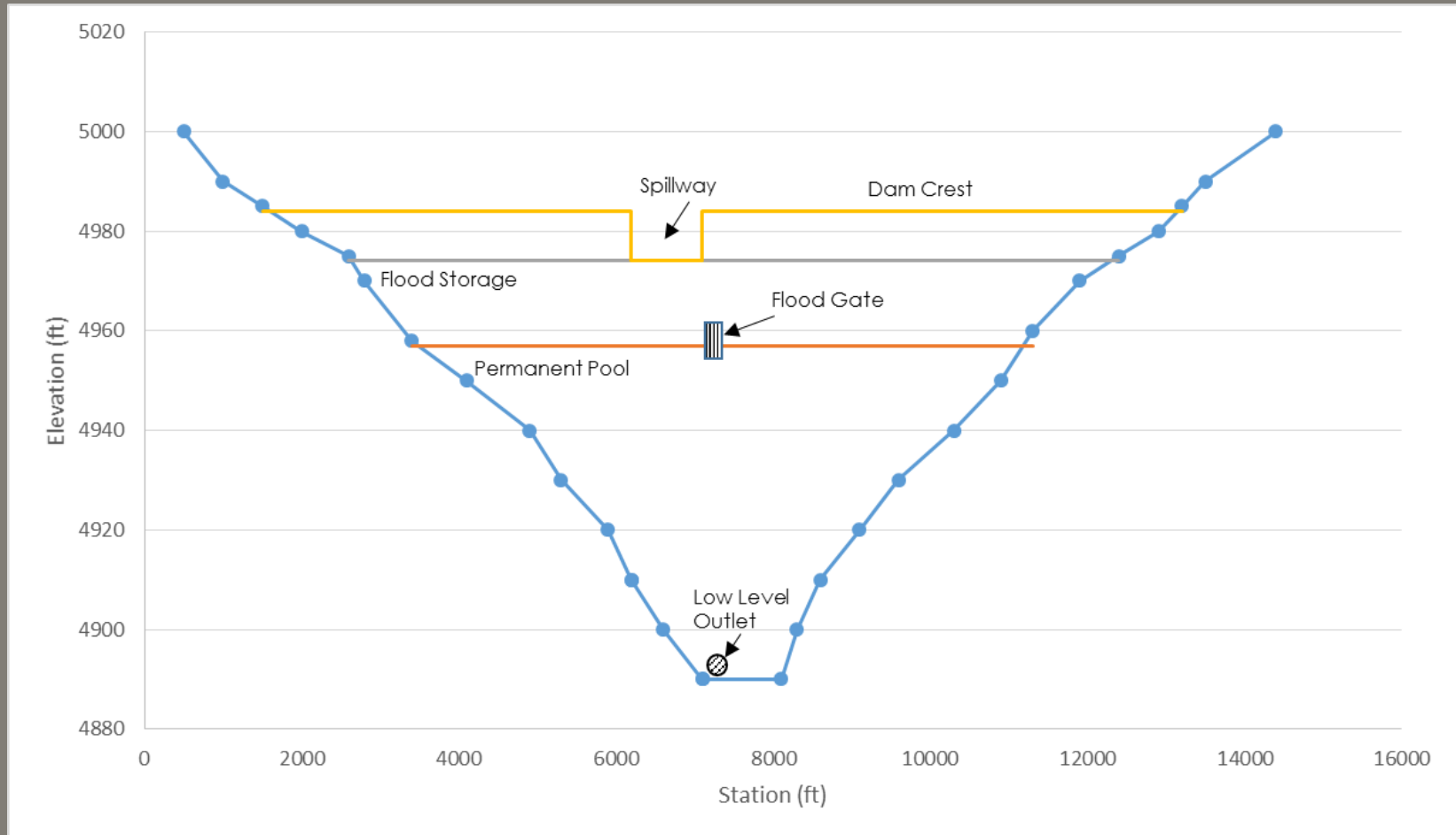
# Mainstem Dam with Permanent Pool - Hydrograph

- Same flood benefits as without permanent pool



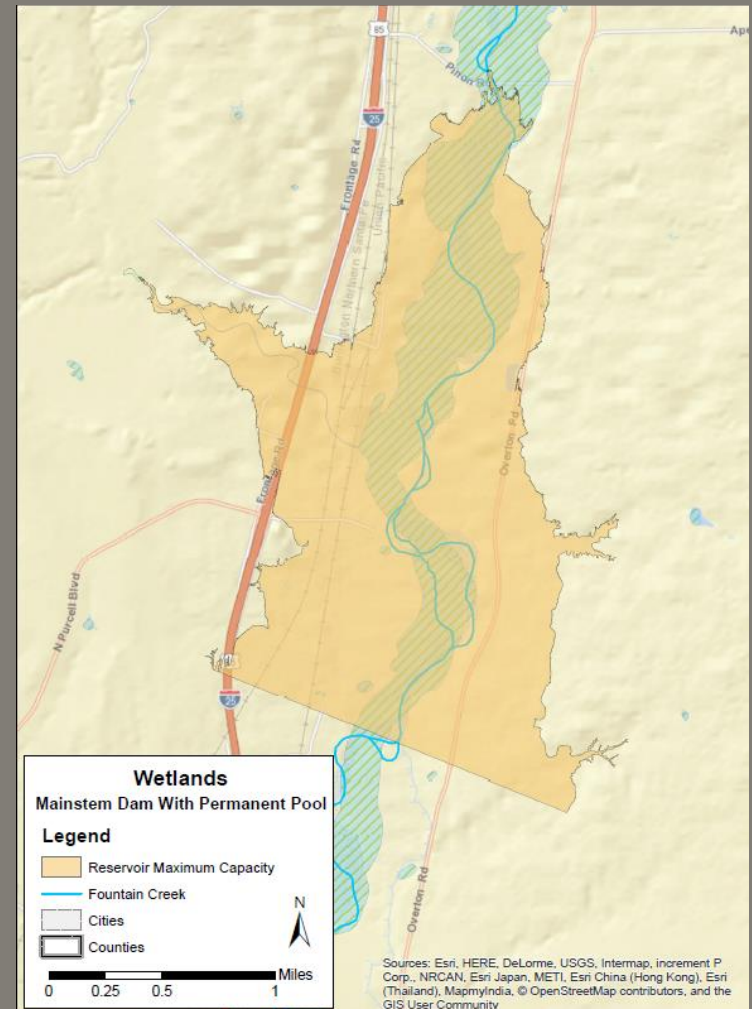


# Mainstem Dam with Permanent Pool – Dam Cross-Section



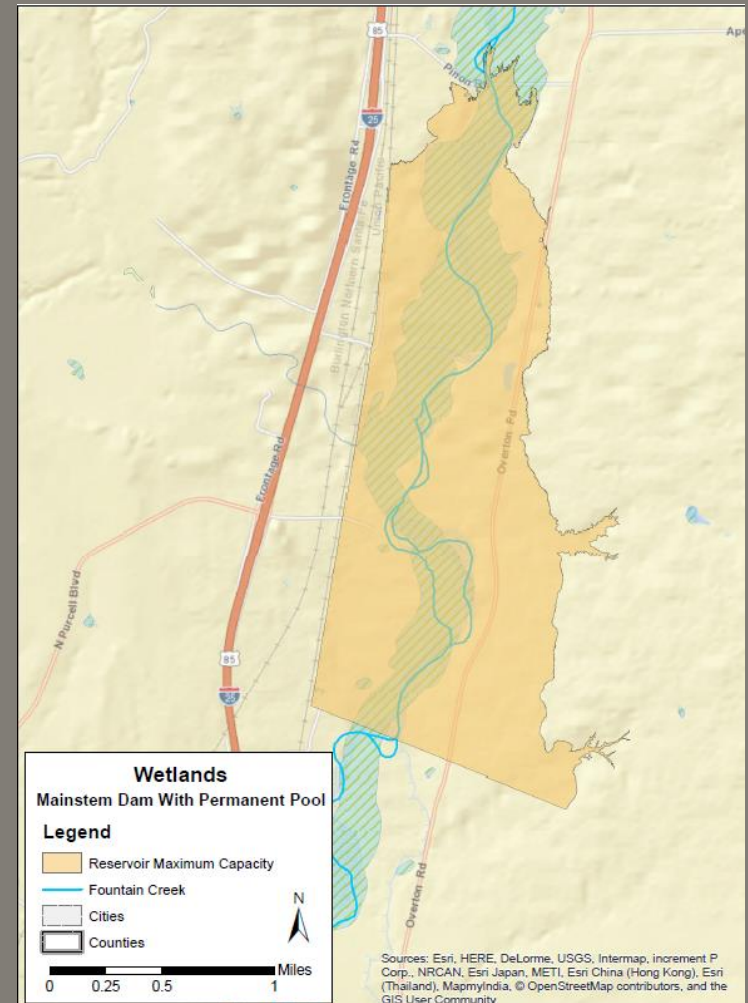
# Mainstem Dam with Permanent Pool – Original Embankment – Wetland Impacts

- 300 acres of wetlands inundated by permanent recreation pool
- 497 acres of wetlands inundated at full capacity



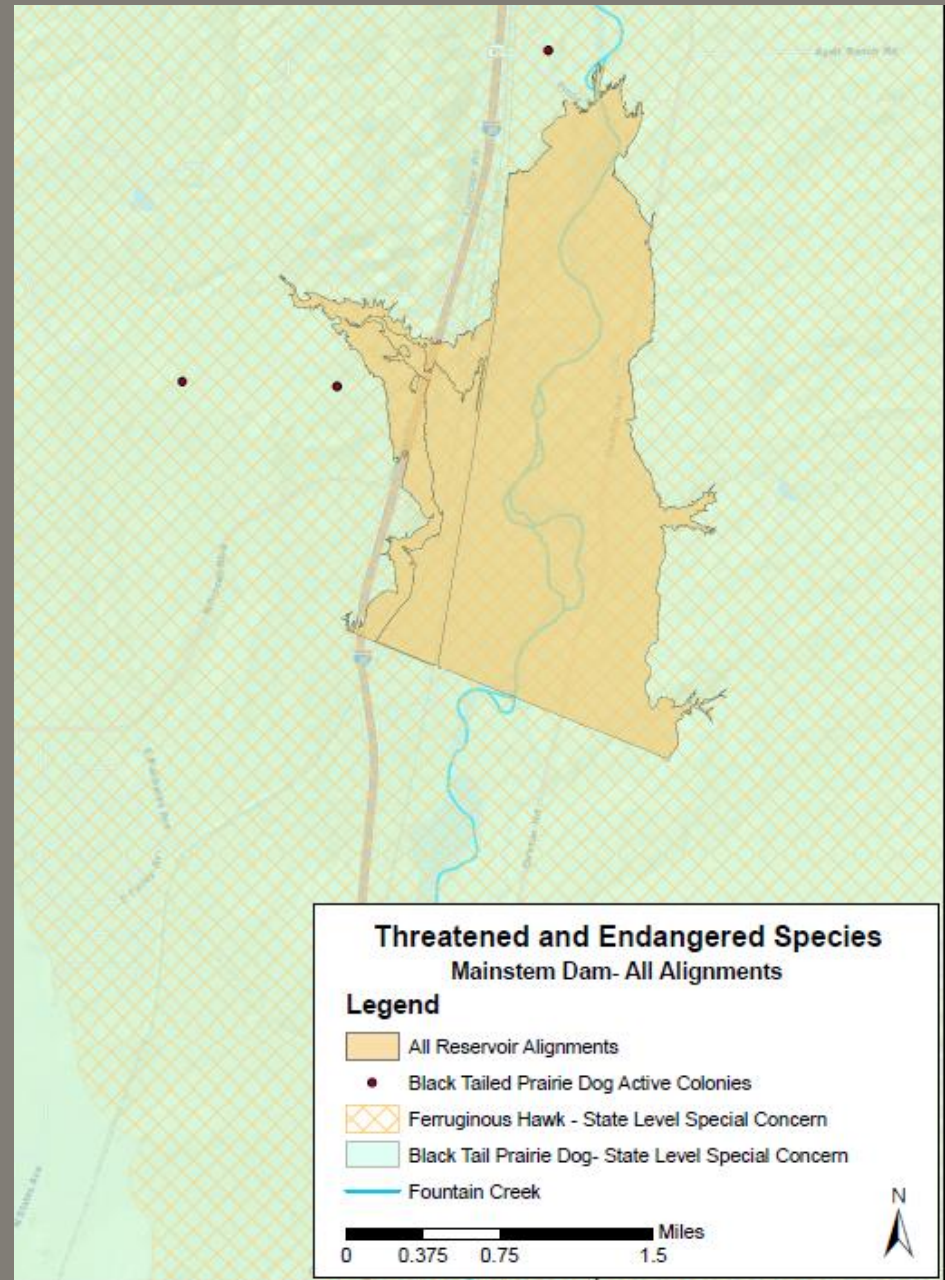
# Mainstem Dam with Permanent Recreation Pool – Protective Embankment – Wetland Impacts

- 357 acres of wetlands inundated by permanent recreation pool
- 512 acres of wetlands inundated at full capacity



# Mainstem Dam with Permanent Pool – Habitat Impacts

- Located in Prebles Meadow Jumping Mouse and Arkansas Darter range
- Several species of State special concern also have overall range in this area including active prairie dog colonies





# Mainstem Dam with Permanent Pool – Property Impacts

Dam Alternative	Private Land Inundated (acres)	Parcels of Private Land Effected
Original Embankment: Rec Pool Only	900	27
Original Embankment: Full Capacity	1,900	57
Embankment protects railroads/highway: Rec Pool Only	940	30
Embankment protects railroads/highway: Full Capacity	1,500	43

# Mainstem Dam with Permanent Pool – Cost Estimate

Dam Alternative	Dam Length (ft)	Dam Height (ft)	Storage Volume (acre-ft)	Pipeline Length (ft)	Total Cost (\$)	Cost/Volume (\$/acre-ft)
Original Embankment	9,800	98	52,000	1,000	185M – 255M*	3.6K – 4.9K*
Embankment protects railroads/highway	21,300	101	54,000	1,000	185M – 275M	3.5K – 5.1K

\* Costs do not include costs for channel stabilization downstream of the dam, costs for water rights to fill a permanent pool or any environmental impact mitigation costs

# Highway and Railroad Relocation for Original Alignment

- Highway
  - At least 2 miles of relocation
  - Approximate cost = \$30M- \$50M
- Railroad
  - At least 6 miles of relocation
  - Deep cuts and/or tunnels
  - Approximate cost = \$50M
- Overton Road
  - At least 5 miles of relocation
  - Approximate cost = \$8M - \$10M

\*permitting issues and uncertainties surrounding highway and rail relocation could increase costs 50-100% of above estimates

# Key Pros and Cons of Mainstem Dam Alternatives

## Pros

- Efficient flood storage
- One facility to maintain
- Best performance in reducing peak flood flow in Pueblo

## Cons

- High cost
- Challenging relocations
- Sediment management
- Release of clear water downstream
- Wetland, habitat and property impacts
- Water quality concerns for permanent pool option



# Side Detention Facilities

## Previously Studied

- USGS SIR 2014 – Scenario 12
- 10 side detention basins
- Reduced simulated peak discharge 48%
- Reduced simulated sediment transport 8%

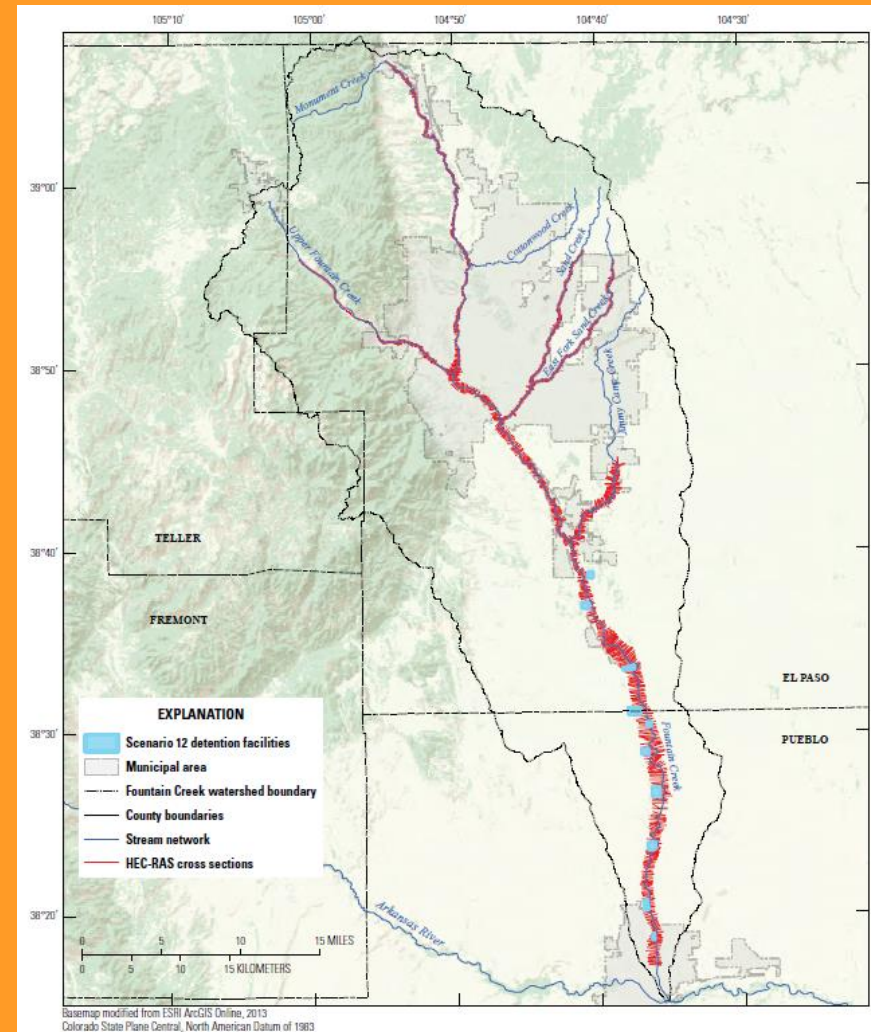
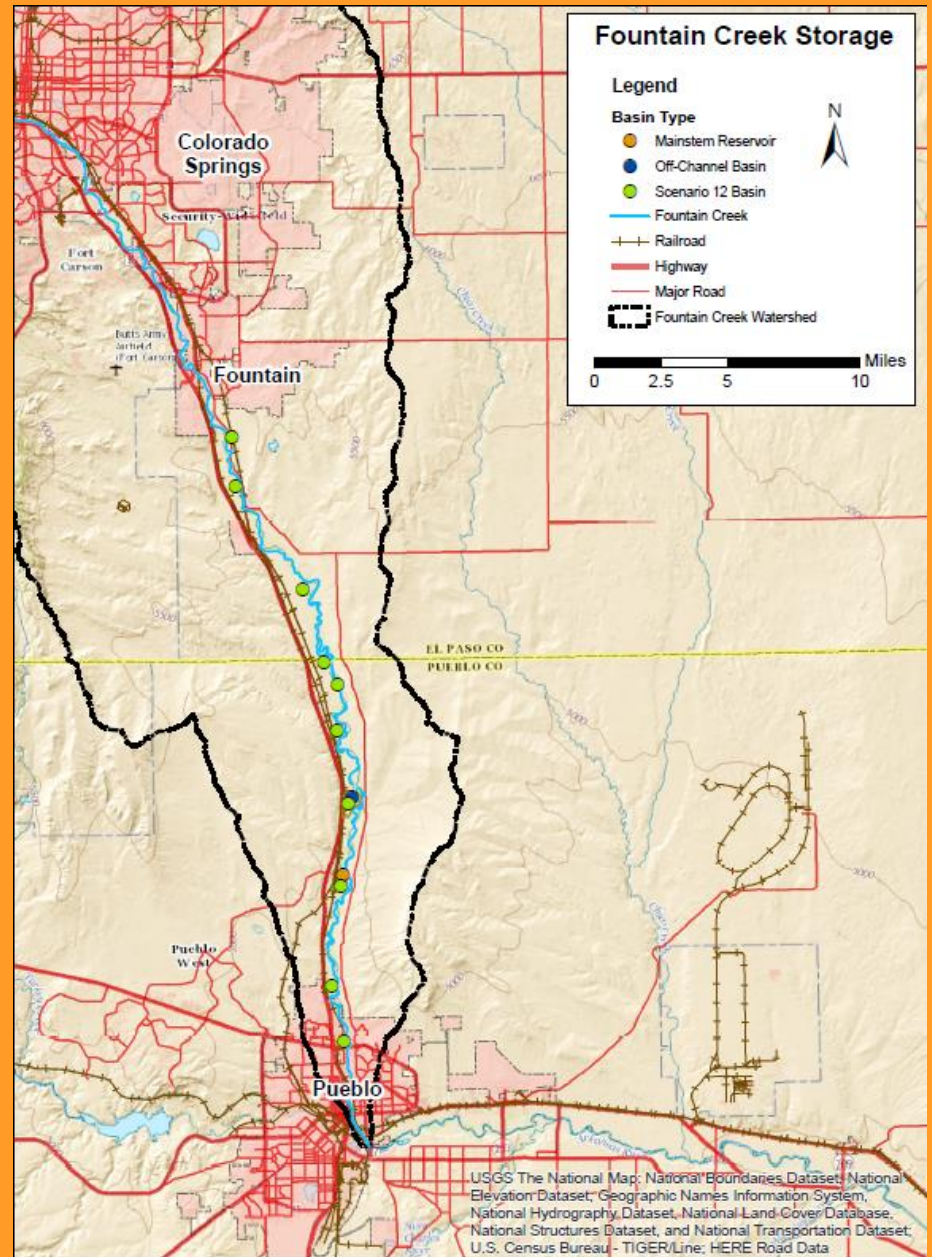


Figure 3-12. Location of the 10 detention facilities in scenario 12. HEC-RAS, Hydrologic Engineering Center-River Analysis System.

# Side Detention Facilities

- Same locations
- Used topographic contours from recent LiDAR data developed by Matrix Design Group
- Configured embankments
- Re-evaluated sizes





# 10 Small Side Detention Ponds

Detention Basin Name	Total Volume (acre-ft)	Surface Area (acre)	Dam Length (ft)	Dam Height (ft)
FC192849	100	15	5000	15
FC179652	850	105	7300	25
FC147349	550	105	7900	21
FC125690	812	112	6200	23
FC120940	30	13	3000	10
FC107049	1,500	127	9000	36
FC89851	2,800	206	15000	37
FC64131	1,400	128	11000	33
FC40049	2,600	160	7300	43
FC26354	55	18	4000	12
<b>Total</b>	<b>11,700</b>	<b>989</b>	<b>75,700</b>	<b>--</b>



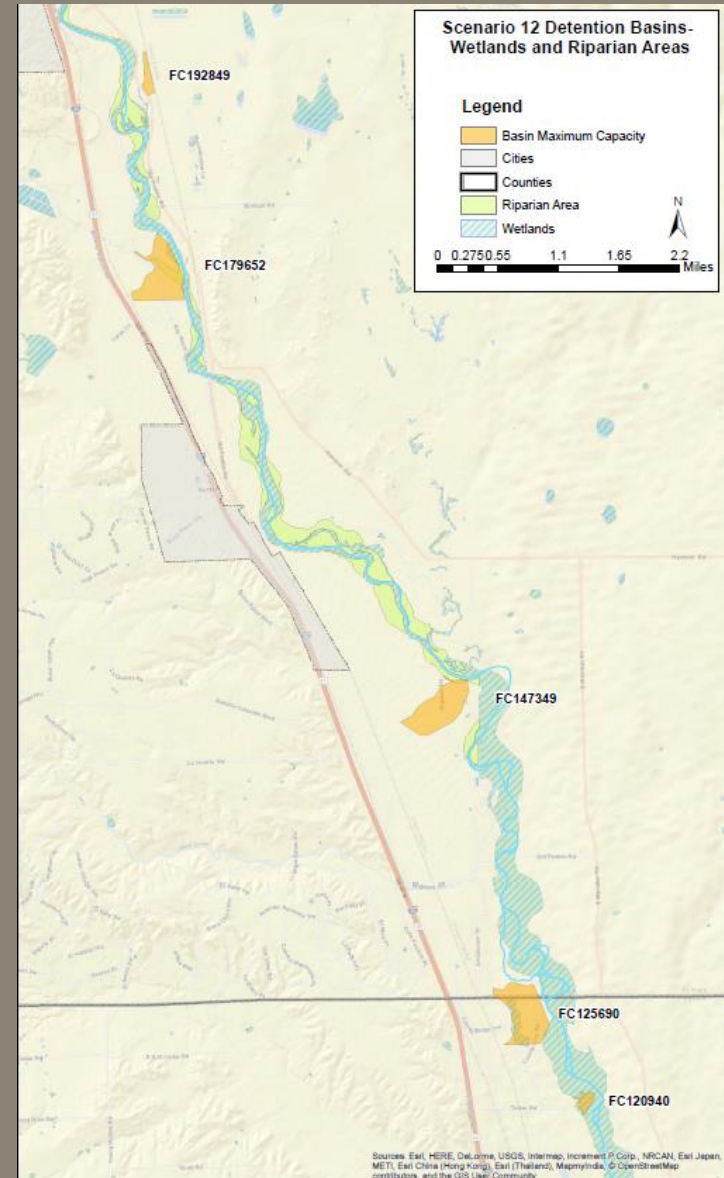
# 10 Small Side Detention Ponds - Hydrology

- 100-yr peak flow at Fountain Creek at Pueblo gage is about 18,000 cfs



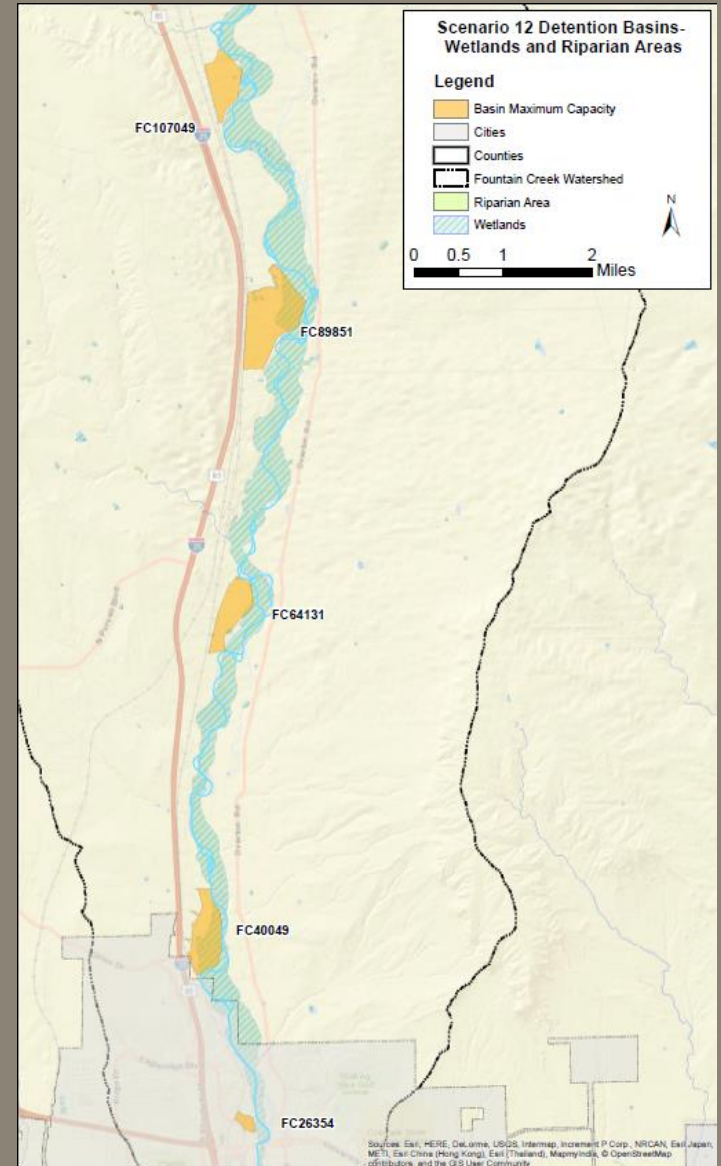
# 5 Small Side Detention Ponds: North End – Wetland Impacts

Side Detention Basin Name	Wetland Area Affected (acres)
FC192849	0
FC179652	4
FC147349	0
FC125690	24
FC120940	12



# 5 Small Side Detention Ponds: South End – Wetland Impacts

Side Detention Basin Name	Wetland Area Affected (acres)
FC107049	4
FC89851	81
FC64131	7
FC40049	87
FC26354	0



# 10 Small Side Detention Ponds – Habitat Impacts

- Located in Prebles Meadow Jumping Mouse range
- Several species of State special concern also have overall range in this area





# 10 Small Side Detention Ponds – Property Impacts

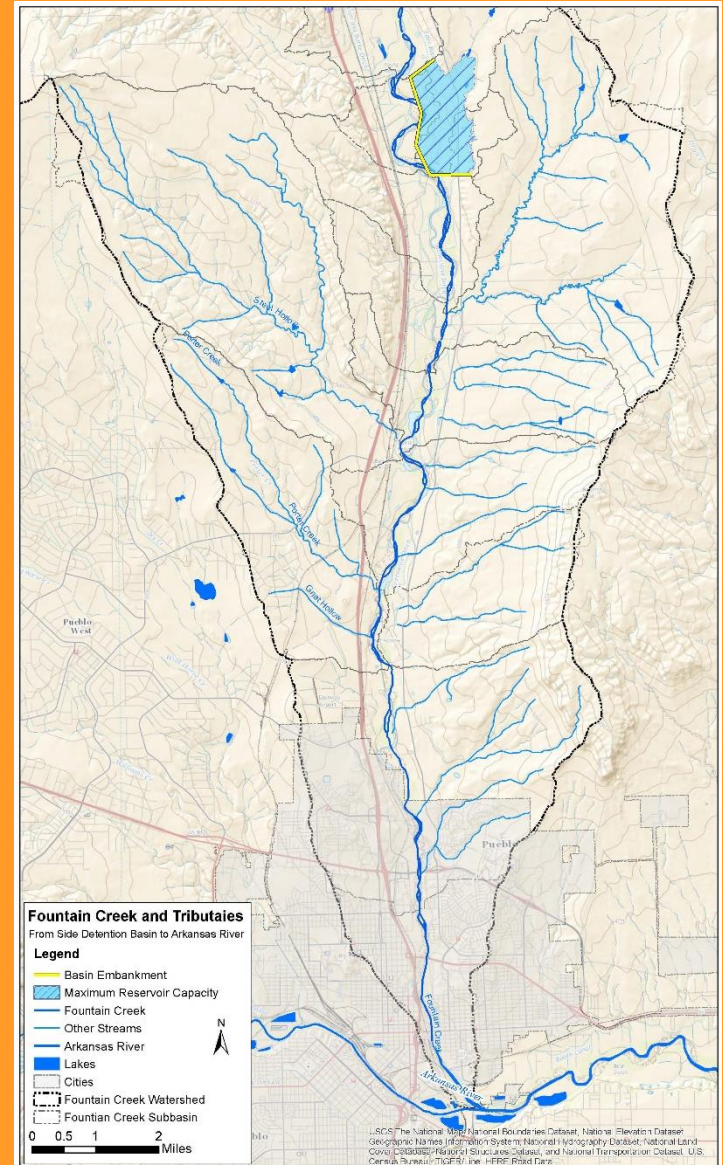
Detention Basin Name	Private Land Inundated (acres)	Parcels of Private Land Effected
FC192849	15	4
FC179652	105	1
FC147349	105	3
FC125690	112	3
FC120940	13	4
FC107049	127	3
FC89851	297	6
FC64131	128	4
FC40049	160	23
FC26354	18	7
<b>Total</b>	<b>1,080</b>	<b>58</b>

# 10 Small Side Detention Ponds – Cost Estimate

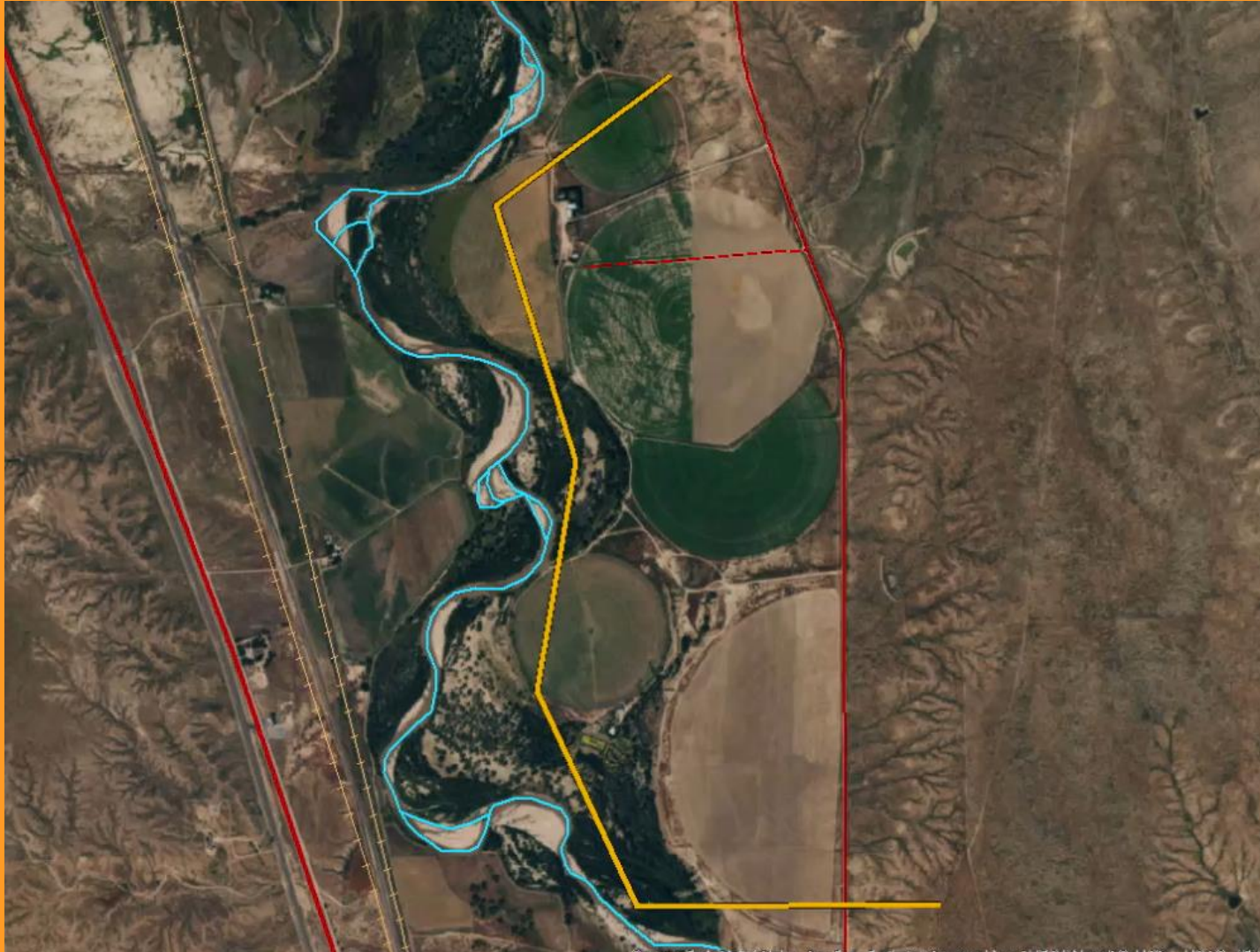
Detention Basin Name	Total Cost (\$)	Cost/Volume (\$/ac-ft)
FC192849	\$5 - \$8M	\$50 - \$80K
FC179652	\$11 - \$17M	\$12.9 - \$20K
FC147349	\$11 - \$17M	\$20 - \$30.9K
FC125690	\$7 - \$12M	\$8.6 - \$14.8K
FC120940	\$3 - \$5M	\$100 - \$166.7K
FC107049	\$21 - \$31M	\$14 - \$20.7K
FC89851	\$33 - \$50M	\$11.8 - \$17.9K
FC64131	\$26 - \$40M	\$18.6 - \$28.6K
FC40049	\$15 - \$22M	\$5.8 - \$8.5K
FC26354	\$5 - \$7M	\$90.9 - \$127.3K
<b>Total</b>	<b>\$140 - \$210M</b>	<b>\$12 - \$17.9K</b>

# Single Large Side Detention Basin

- 26,100 acre feet needed for flood control
- Could be as large as 35,000 acre-feet
- Embankment 14,800 feet long, 93 feet high
- Passive operation with side overflow weir



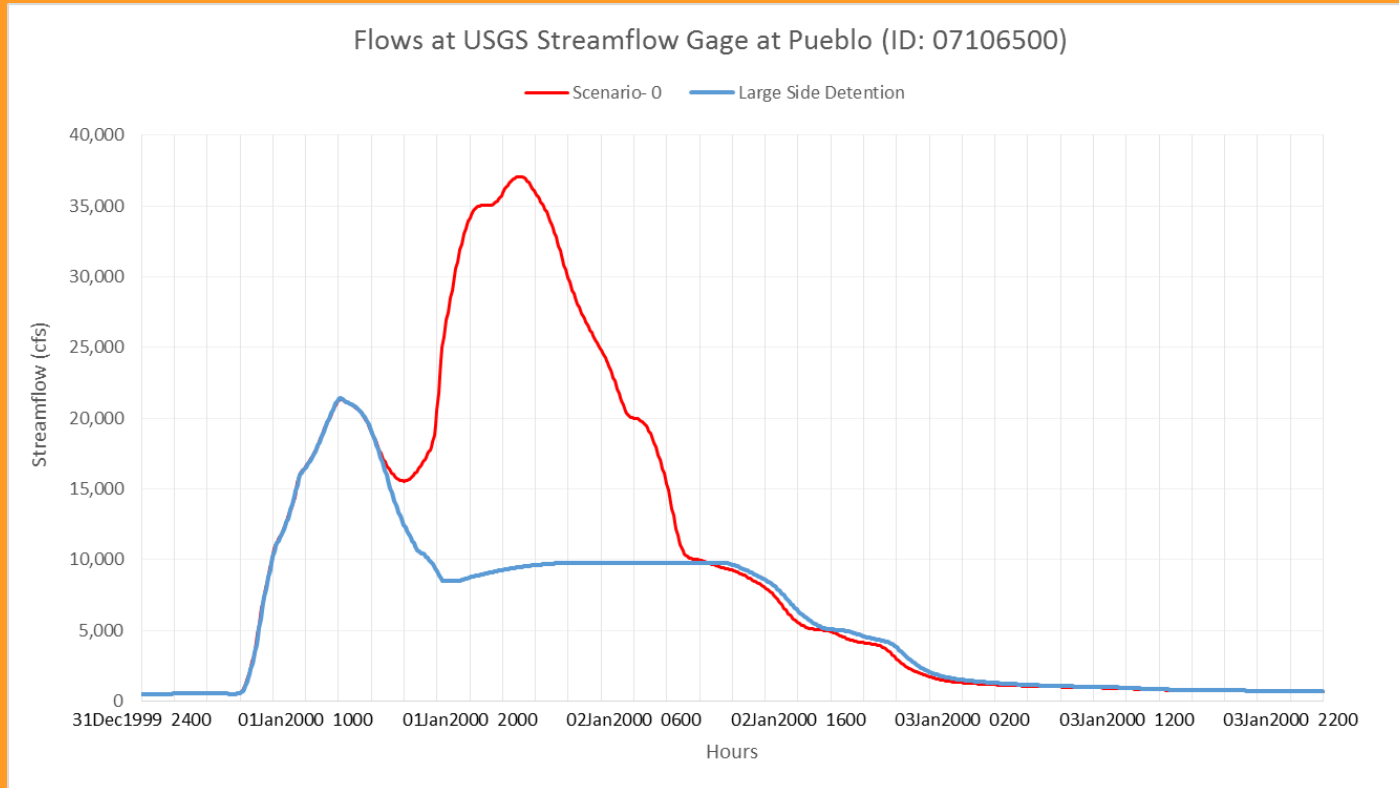
# Single Large Detention Basin – 24-hr, 100-yr Storm Animation





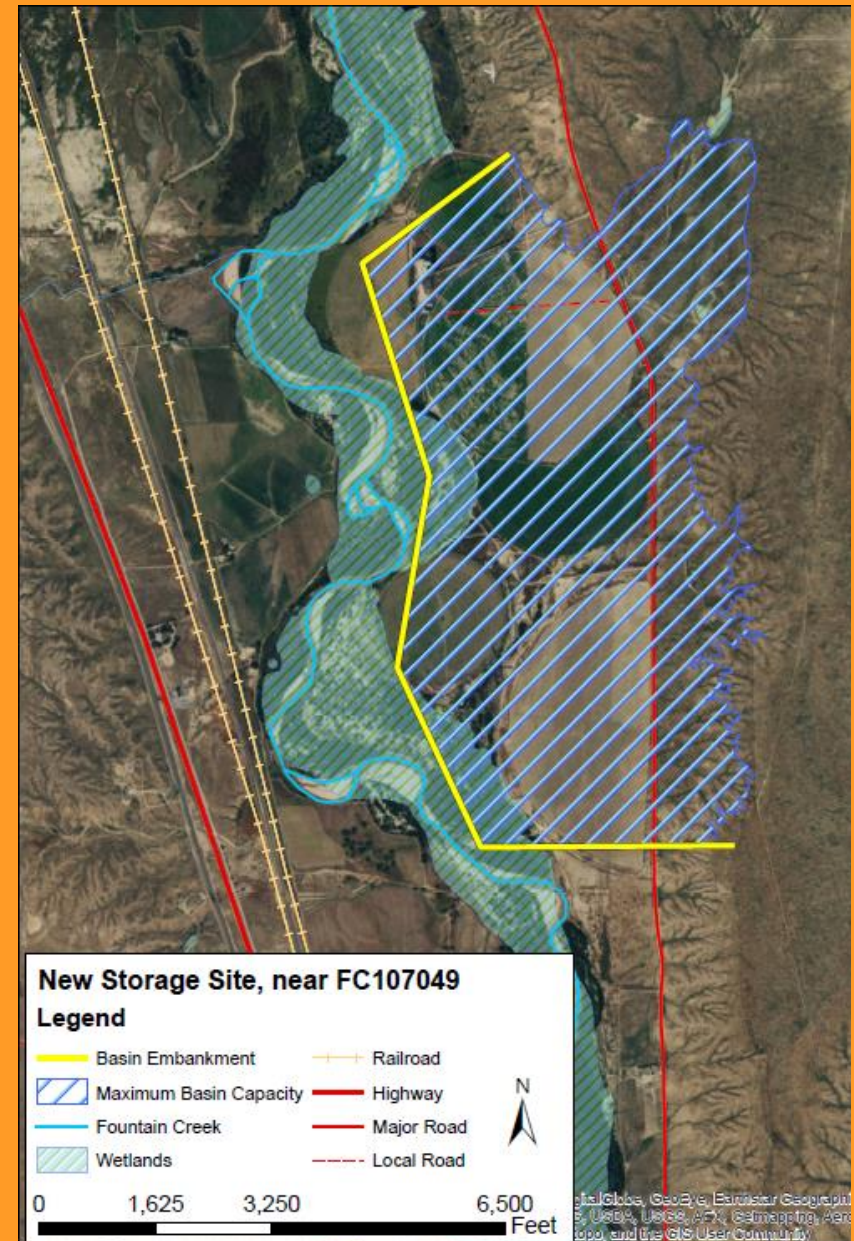
# Single Large Detention Basin-Hydrograph

- 100-yr peak flow at Fountain Creek at Pueblo gage is about 21,000 cfs



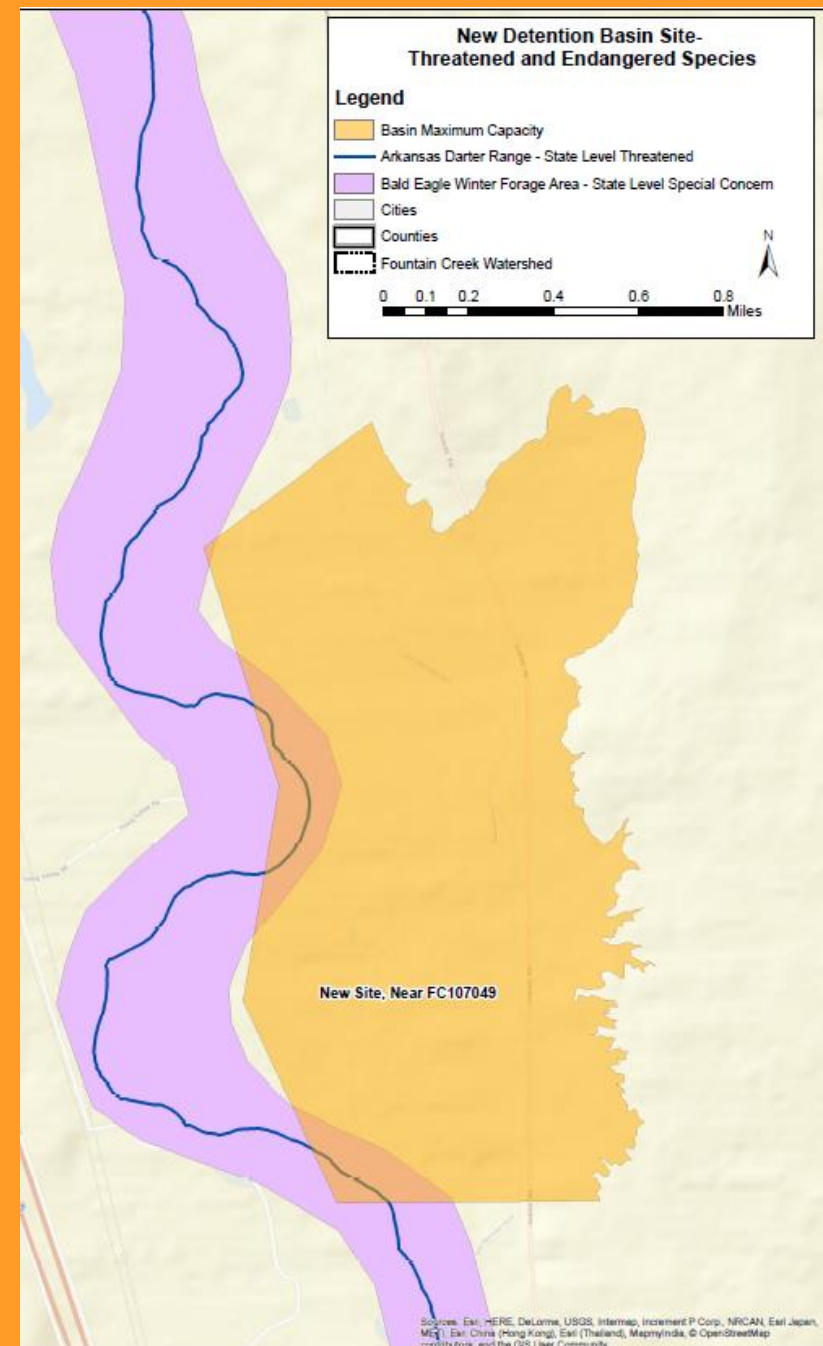
# Single Large Detention Basin – Wetland Impacts

- 60 acres of wetlands would be temporarily inundated at full capacity



# Single Large Detention Basin – Habitat Impacts

- Located in Prebles Meadow Jumping Mouse and Arkansas Darter range
- Several species of State special concern also have overall range in this area



# Side Detention Alternatives – Property Impacts

Dam Alternative	Total Private Land Inundated (acres)	Total Parcels of Private land Effected
10 Small Side Detention Ponds	1,080	58
Single Large Side Detention Basin	800	15



# Side Detention Alternatives – Cost Estimates

Dam Alternative	Dam Length (ft)	Dam Height (ft)	Storage Volume (acre-ft)	Pipeline Length (ft)	Total Cost (\$)	Cost/Volume (\$/acre-ft)
10 Small Side Detention Ponds	75,700	10 to 43	11,700	47,000	140M - 210M	12K – 17.9K
Single Large Side Detention Basin	14,800	93	35,000	11,000	130M - 195M	3.7K – 5.6K

\*Costs do not include any permitting or environmental mitigation costs

# Key Pros and Cons of Side Detention Alternatives

## Pros

- Easier to permit than on-channel dam
- Trap less sediment
- Reduce 100-yr peak to leveed section capacity

## Cons

- Less efficient storage
- For 10 basin option, multiple facilities to maintain
- Impacts on wetlands, habitat and private property
- Less effective flood reduction than on-channel alternatives
- Overton Rd relocation

# Comparison of Alternatives

	Original Embankment Flood Control Only	Embankment protects railroads/ highway Flood Control Only	Original Embankment with Permanent Pool	Embankment protects railroads/ highway with Permanent Pool	10 Side Detention Ponds	Single Side Detention Facility
Relative area of inundation (acre)	1,100	1,000	1,900	1,500	1,080	890
Total Volume (acre-ft)	28,200	28,000	52,000	52000	11,697	36,000
Infrastructure Infringement	UPRR, the BNSSRR, and Interstate 25. Overton Rd. Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings	UPRR, the BNSSRR, and Interstate 25. Overton Rd. Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings	Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings
Wetland Inundation (acres)	382	386	497	512	219	60
Federal Endangered Species	Arkansas Darter, Preble's Meadow Jumping Mouse	Arkansas Darter, Preble's Meadow Jumping Mouse	Arkansas Darter, Preble's Meadow Jumping Mouse	Arkansas Darter, Preble's Meadow Jumping Mouse	Preble's Meadow Jumping Mouse	Preble's Meadow Jumping Mouse
Private Land Inundation (acres)	1,100	1,000	1,900	1,500	1,080	800
Number of Parcels Affected	49	31	57	43	58	15
Dam construction cost	\$165 – \$220M	\$145 – \$215M	\$185 - \$255M	\$185 – \$275M	\$140 - \$210M	\$130 - \$195M
Q100 max at Pueblo gage	13,200 cfs	13,200 cfs	13,200 cfs	13,200 cfs	19,400 cfs	21,400 cfs
Permitability	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Some jurisdictional dams. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.



	Original Embankment Flood Control Only	Embankment protects railroads/ highway Flood Control Only	Original Embankment with Permanent Pool	Embankment protects railroads/ highway with Permanent Pool	10 Side Detention Ponds	Single Side Detention Facility
Relative area of inundation (acre)	1,100	1,000	1,900	1,500	1,080	890
Total Volume (acre-ft)	28,200	28,000	52,000	52000	11,697	36,000
Infrastructure Infringement	UPRR, the BNSSRR, and Interstate 25. Overton Rd. Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings	UPRR, the BNSSRR, and Interstate 25. Overton Rd. Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings	Local roads, residential and agricultural buildings	Overton Rd. Local roads, residential and agricultural buildings
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Permitability	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.	Some jurisdictional dams. 404 permit. EIS.	Jurisdictional Dam. 404 permit. EIS.

# Cost Estimate Summary

Cost Type	Main-Flood-Original	Main-Flood-Protect	Main-Perm-Original	Main-Perm-Protect	10 Side Detention Basins	Single Side Detention
Dam, Inlet, Outlet	\$75-\$105M	\$135-\$200M	\$85-\$135M	\$170-\$250M	\$135-\$200M	\$115-\$175M
Relocation	\$85-\$100M	\$5M	\$90-\$100M	\$10M	\$0	\$10M
Land	\$5-\$15M	\$5-\$10M	\$10-\$20M	\$5-\$15M	\$5-\$10M	\$5-\$10M
Total	\$165-\$220M	\$145-\$215M	\$185-\$255M	\$185-\$275M	\$140-\$210M	\$130-\$195M



\* Does not include costs for design, construction management, permitting, environmental mitigation, downstream channel stabilization, or water rights issues































# Cost Estimate Summary

Cost Type	Main-Flood-Original	Main-Flood-Protect	Main-Perm-Original	Main-Perm-Protect	10 Side Detention Basins	Single Side Detention
Dam, Inlet, Outlet	\$75-\$105M	\$135-\$200M	\$85-\$135M	\$170-\$250M	\$135-\$200M	\$115-\$175M
Relocation	\$85-\$100M	\$5M	\$90-\$100M	\$10M	\$0	\$10M
Land	\$5-\$15M	\$5-\$10M	\$10-\$20M	\$5-\$15M	\$5-\$10M	\$5-\$10M
Total	\$165-\$220M	\$145-\$215M	\$185-\$255M	\$185-\$275M	\$140-\$210M	\$130-\$195M

\* Does not include costs for design, construction management, permitting, environmental mitigation, downstream channel stabilization, or water rights issues

# Alternative Comparison

 Best performance  
 Worst performance

Flood Control Alternative	Flood Benefits	Cost	Technical Challenges	Permitting and Environmental Impacts	Social Impacts
Mainstem, Flood Control, Protect I-25/RR					
Mainstem, Flood Control, Relocate I-25/RR					
Mainstem, Permanent Pool, Protect I-25/RR					
Mainstem, Permanent Pool, Relocate I-25/RR					
10 Side Detention Basins					
Single Side Detention Basin					

Notes:

“Flood benefits” is based on objective of 10,000 cfs for 100-yr flood peak for Fountain Creek at Pueblo.

“Cost” is based on total project cost.

“Technical challenges” include major relocations and difficult hydraulic structures.

“Permitting and environmental impacts” include NEPA compliance, wetland impacts, species impacts, and sediment management.

“Social impacts” include number and size of affected private properties.



# Key Issues

- Operation for water rights protection
- Sediment management
- Maintenance
- Wetland and habitat impacts
- Water quality (permanent pool)
- Land acquisition requirements
- Cost

# Discussion

