

# Cumberland County Regional Water Supply Plan

Systems Model Development, Regional Water  
Supply Need Determination, and Water Supply  
Alternatives Yield Evaluation

September 11, 2012



US Army Corps  
of Engineers.  
Nashville District



# PRESENTATION OVERVIEW



- » Introductions
- » Project history
- » Overall scope
- » Systems model



# PROJECT HISTORY



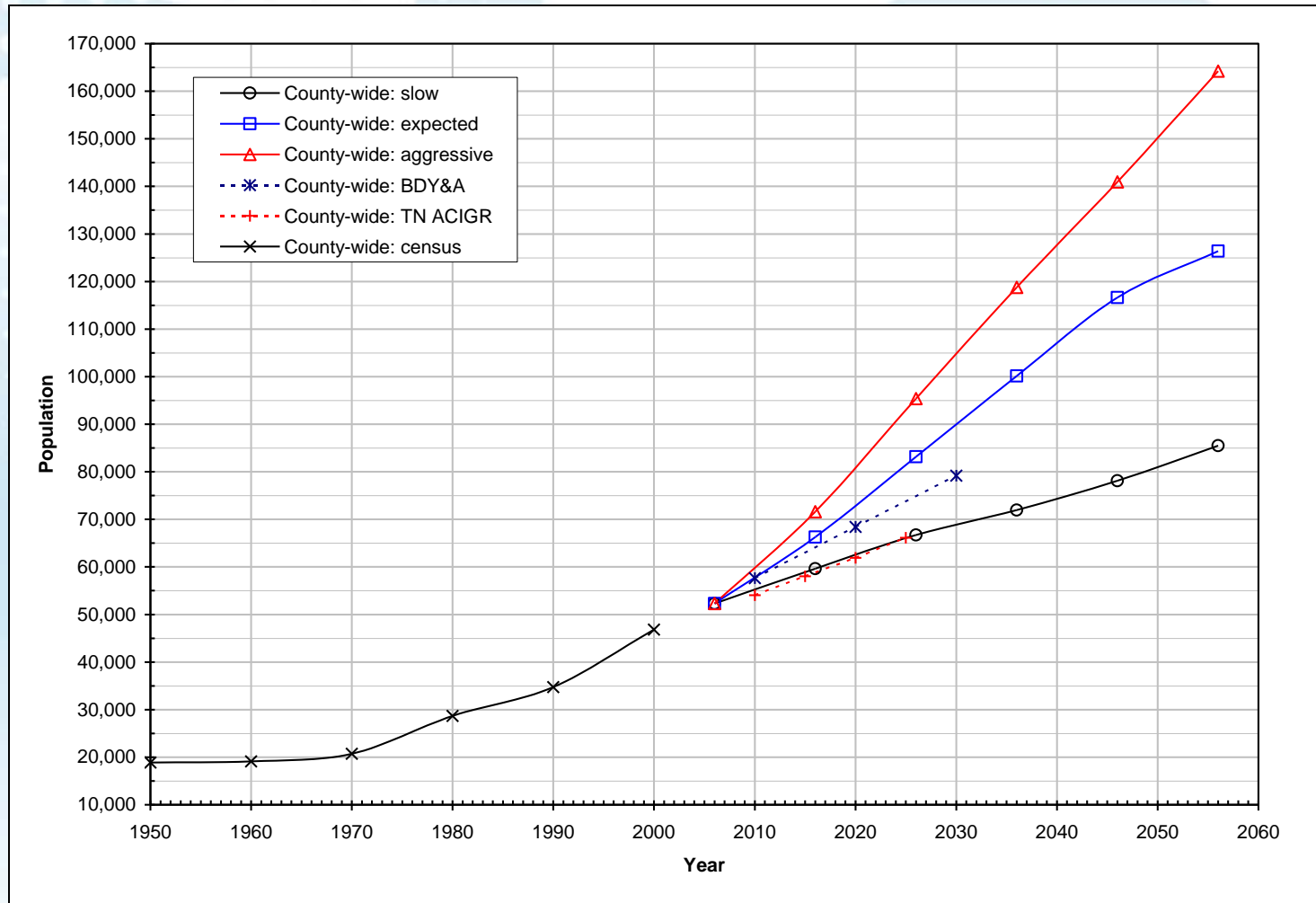
- » Regional water demand projections
- » Conservation plan



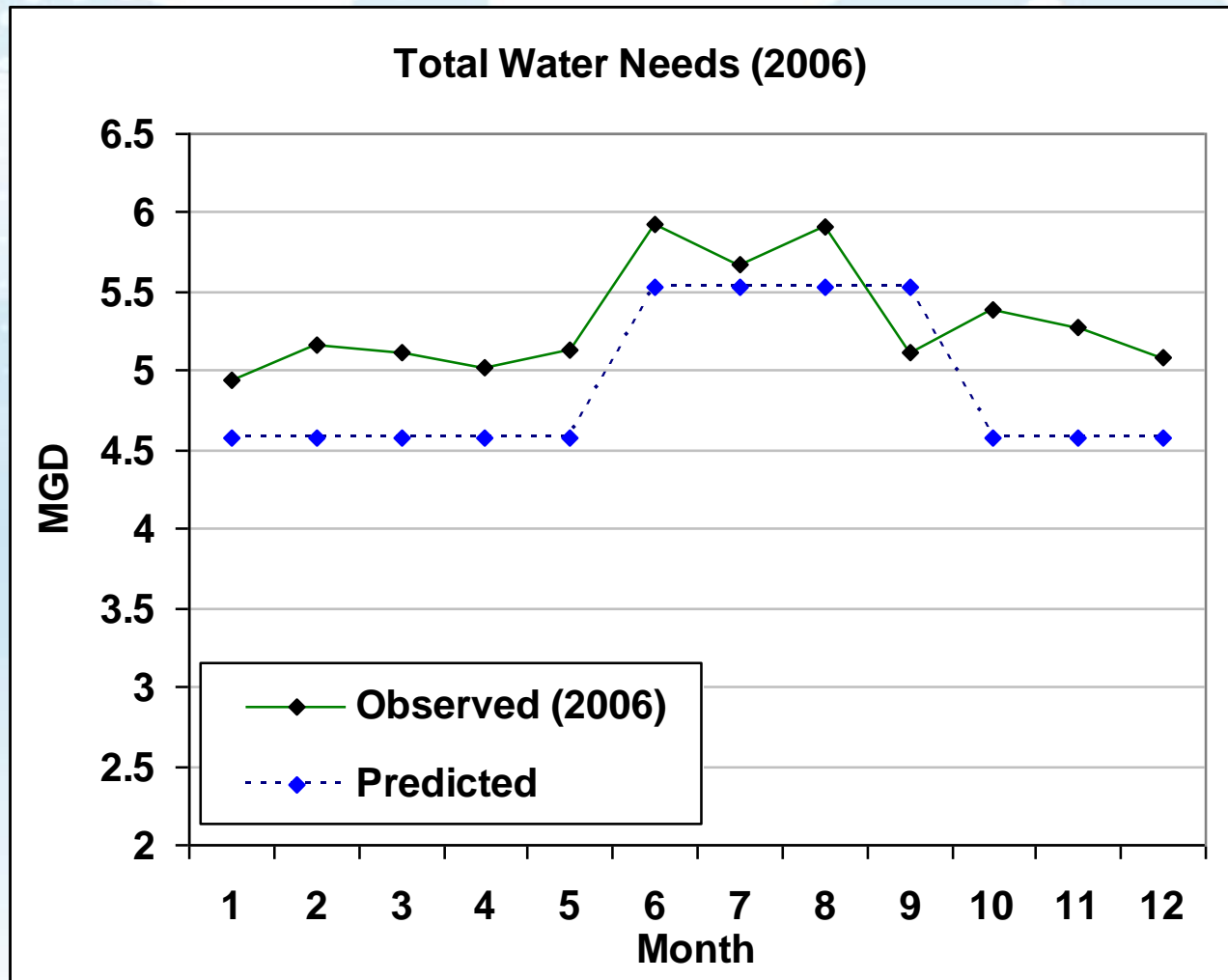
**US Army Corps  
of Engineers.**  
Nashville District

# PROJECT HISTORY

## POPULATION PROJECTIONS



# PROJECT HISTORY PREDICTED AND OBSERVED CUMBERLAND COUNTY DEMAND



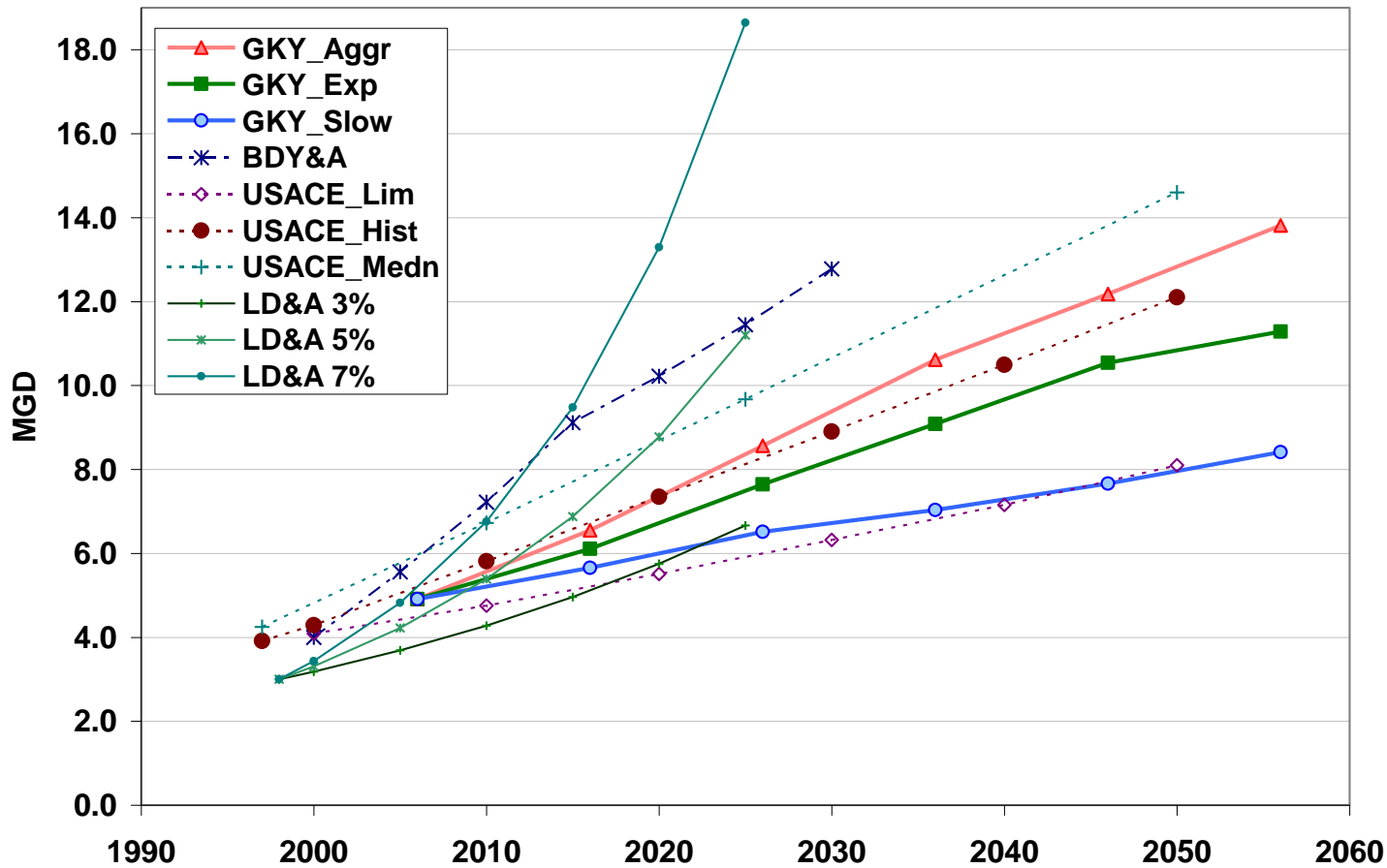
\*Above average losses in 2006



# PROJECT HISTORY

## DEMAND PROJECTIONS

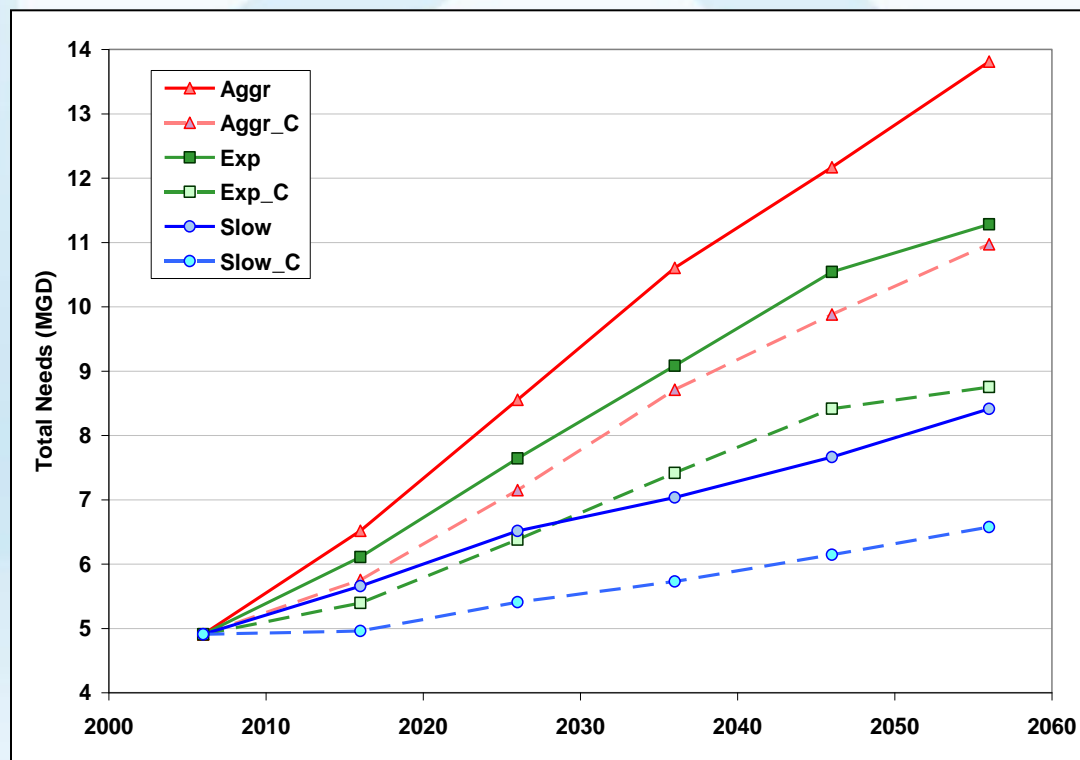
Cumberland Projections- Total Water Needs



# PROJECT HISTORY

## CONSERVATION ANALYSIS

- » Non-leakage UAW reduction
- » Leakage reduction
- » Education programs
- » Codes and ordinances



# OVERALL SCOPE



## Task 1 – Integrated System-wide Model of Cumberland County Water Supply System

- » Data collection
- » Report review
- » Systems model setup
- » Systems model analysis
- » Reporting, meetings, coordination





# OVERALL SCOPE

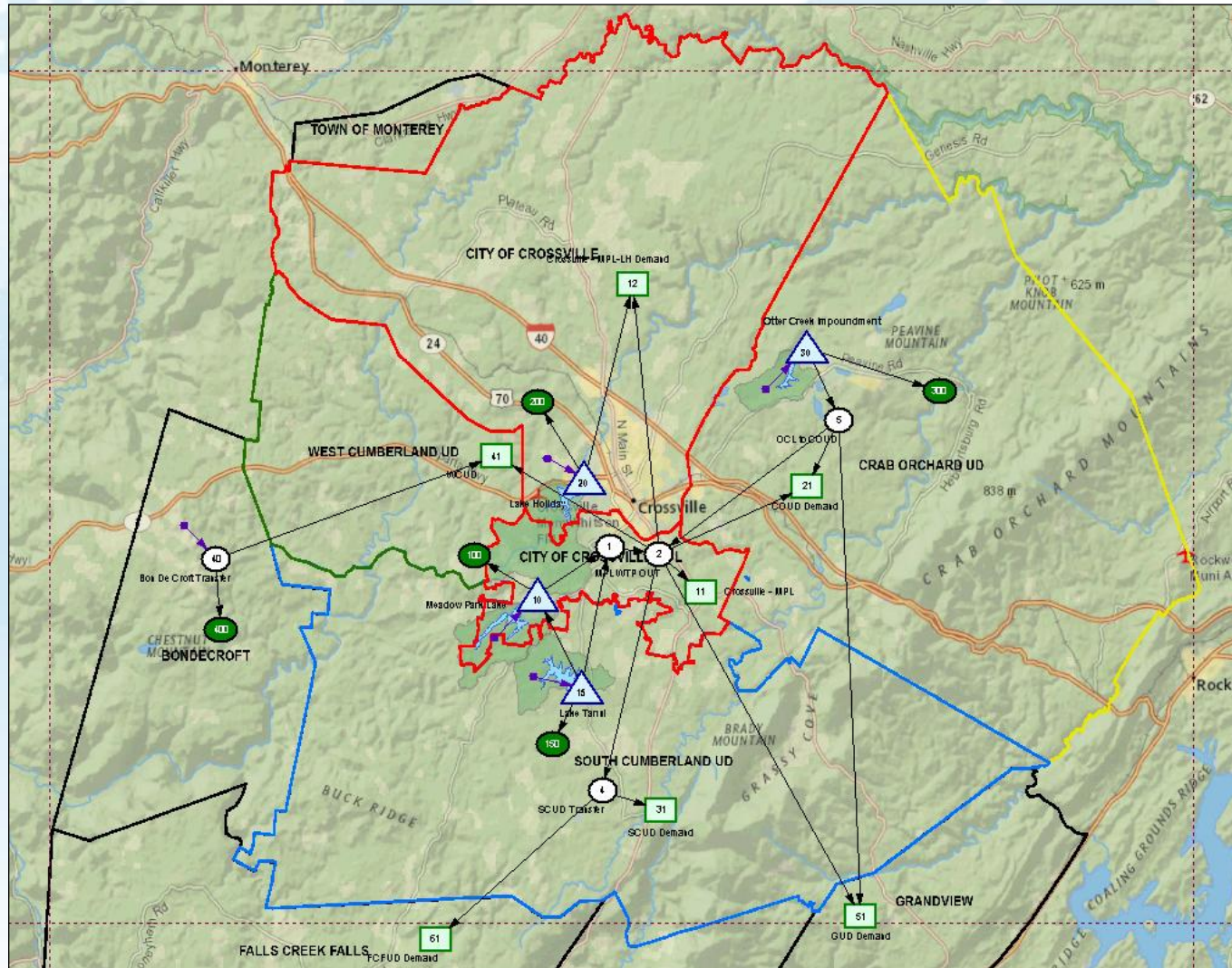


## Task 2 – Water Supply Alternatives Yield Analysis

- » Raising dams
- » New impoundments
- » Water conservation
- » Interconnection and operation modifications
- » Reporting, meetings, coordination



# SYSTEMS MODEL MODEL SCHEMATIC



# SYSTEMS MODEL DEMAND



- » Used GKY analysis for demand data
- » Disaggregated demand using 2006 parcel data
- » GKY “expected” growth scenario (w/ UAW)
- » Summer (June through Sept - 1.06) and winter (0.97) demand multipliers derived from 5 years of Crossville data
- » Demand nodes: Crossville (MPL Only), Crossville (MPL/LH), Crab Orchard UD, Falls Creek Falls UD, Grandview UD, South Cumberland UD, West Cumberland UD

Demand	UD	2006	2016	2026	2036	2046	2056	
Total	Crab Orchard	1.15	1.74	2.57	3.65	4.74	5.07	
	South Cumberland	0.54	0.94	1.54	2.06	2.50	2.77	
	West Cumberland	0.26	0.30	0.32	0.36	0.40	0.46	
	Crossville	MPL/Holiday	2.27	2.95	3.46	3.69	3.94	4.18
		MPL/Holiday Optional	0.43	0.47	0.50	0.51	0.52	0.54
		MPL	0.25	0.32	0.37	0.37	0.38	0.39
	Falls Creek Falls	0.00	0.03	0.07	0.10	0.13	0.17	
	Grandview	0.09	0.11	0.14	0.17	0.20	0.25	



# SYSTEMS MODEL SETUP OASIS



OASIS with OCL --- Run directory: D:\agorge\GKY\_TN\_OASIS\Runs\Simulation\Cumb\_Existing\_2036\_wdrought\_WTPlifted [Simulation Mode]

File Edit Run Output Help

Schematic Setup Time Node Arc OCL Misc

Zoom 100 %

NODES ARCS

**Reservoir Storage-Area-Elevation at Node 30, 'Otter Creek Impoundment'**

Elevation	Storage	Area
1705.000	63.996	6.400
1715.000	215.080	15.108
1725.000	487.112	27.203
1735.000	904.006	41.689
1745.000	1482.108	57.810
1755.000	2238.618	75.651
1765.000	3193.230	95.461
1772.500	3757.700	112.910
1775.000	4263.539	121.152
1776.000	4998.090	126.910
1780.000	5655.676	131.517

Units: Elevation FT, Storage ACFT, Area Acres

Graph: Storage vs Elevation

```

/* TOTAL SYSTEM */
/* Compute usable storage variables */
MPL_Usable_Stor ( W/LIN : max ( 0, storage010 - lower_rule010 ) )
MPL_Total_Usable_Stor ( W/LIN : upper_rule010 - lower_rule010 )
LT_Usable_Stor ( W/LIN : max ( 0, storage015 - lower_rule015 ) )
LT_Total_Usable_Stor ( W/LIN : upper_rule015 - lower_rule015 )
LH_Usable_Stor ( W/LIN : max ( 0, storage028 - lower_rule028 ) )
LH_Total_Usable_Stor ( W/LIN : upper_rule028 - lower_rule028 )
OC_Usable_Stor ( W/LIN : max ( 0, storage030 - lower_rule030 ) )
OC_Total_Usable_Stor ( W/LIN : upper_rule030 - lower_rule030 )
TS_Usable_Stor ( W/LIN : MPL_Usable_Stor + LT_Usable_Stor + LH_Usable_Stor + OC_Usable_Stor )
TS_Total_Usable_Stor ( W/LIN : MPL_Total_Usable_Stor + LT_Total_Usable_Stor + LH_Total_Usable_Stor + OC_Total_Usable_Stor )
TS_Total ( W/LIN : TS_Usable_Stor + TS_Total_Stor )
TS_Demand ( W/LIN : dDemand011 + dDemand012 + dDemand021 + dDemand031 + dDemand041 + dDemand051 + dDemand061 )
TS_Drop_Demand ( W/LIN : ICR_MPL_Demand + ICR_MPL_LH_Demand + ICRUD_Demand + ICRUD_Demand + ICRUD_Demand + ICRUD_Demand + ICRUD_Demand )
TS_Delivery ( W/LIN : deliv002 + deliv003 + deliv004 + deliv005 + deliv006 + deliv007 + deliv008 )
TS_Shortage ( W/LIN : shortage011 + shortage012 + shortage021 + shortage031 + shortage041 + shortage051 + shortage061 )
TS_DayStor ( W/LIN : TS_Usable_Stor / TS_Demand )
Elevation_MPL ( W/LIN : elevation010 )
Elevation_LT ( W/LIN : elevation015 )
Elevation_LH ( W/LIN : elevation028 )
Elevation_OC ( W/LIN : elevation030 )
/* Turn on triggers */
_Ts_Stage1_Brought_On
    
```

Hide Name Name Rotation OK Cancel

Source of Inflow Series

Data Source of Evaporation None

Edit Reservoir Storage / Area / Elevation Data

Zone	Weight	Pi
D -Zone	1	1
C -Zone	50	1
B -Zone	110	1
A -Zone	600	1

The A Zone is the lowest storage zone. Each zone must have higher (more positive) weight than the zone above it.

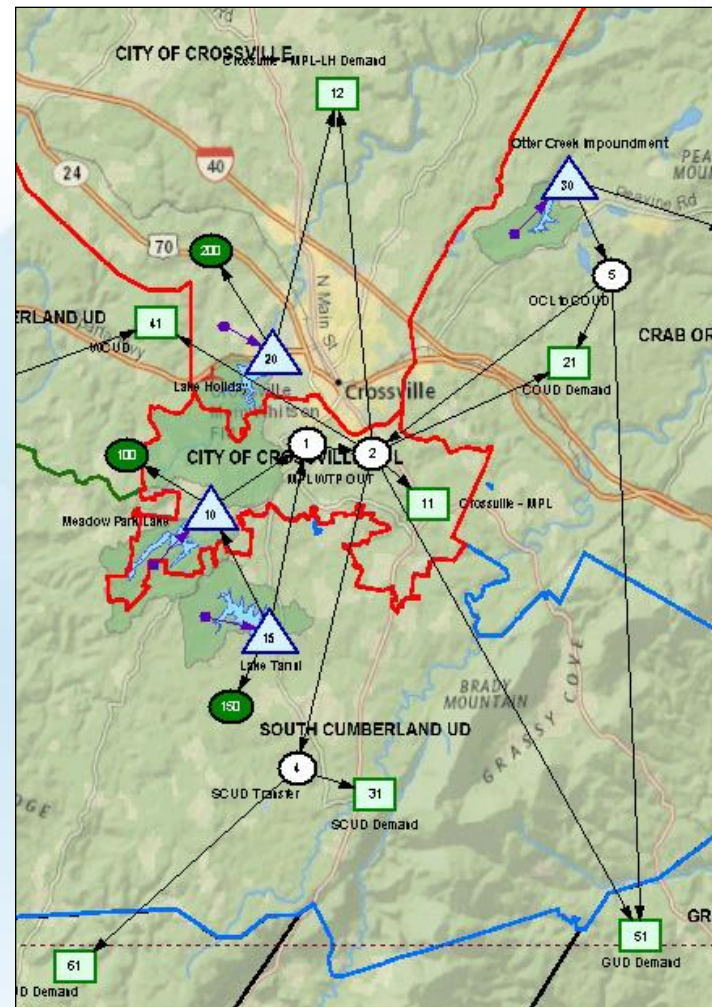
Select items for editing: Output CURRENT Node 030: Otter Creek Impoundment

Start [Taskbar icons] 3:19 PM 9/5/2012



# SYSTEMS MODEL CITY OF CROSSVILLE

- » Split into two demand nodes
- » Sells water to South Cumberland UD, Grandview UD, Falls Creek Falls UD
- » Emergency connections with Crab Orchard UD, Town of Monterey, and West Cumberland UD
- » Three water supply sources: Meadow Park Lake, Lake Holiday and a new connection to Lake Tansi



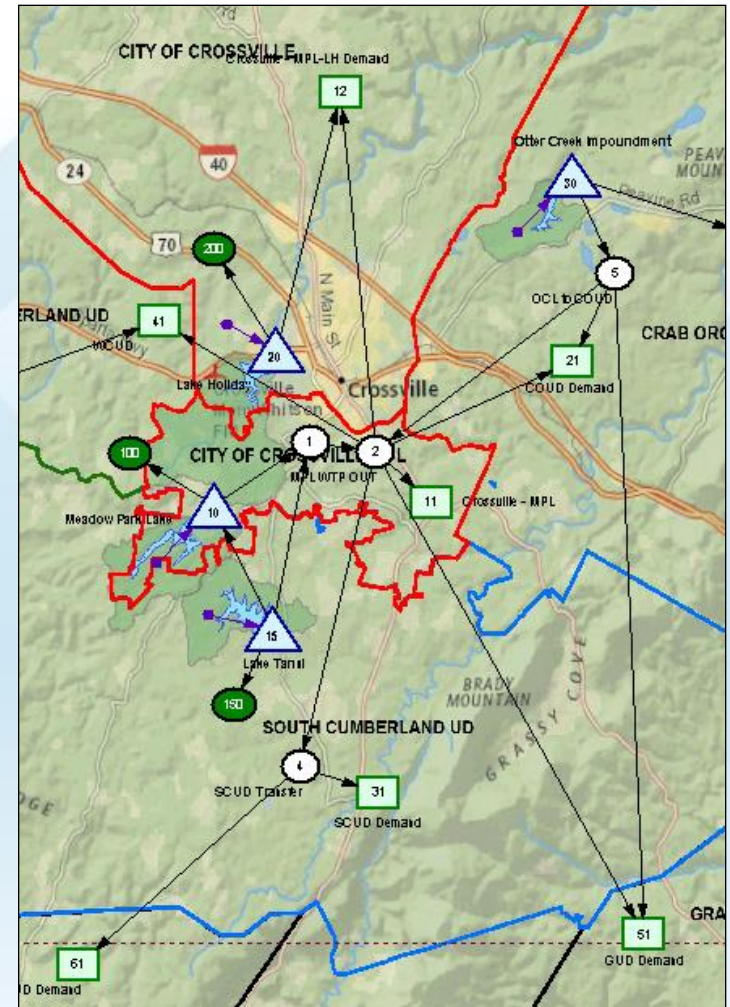
# SYSTEMS MODEL CITY OF CROSSVILLE

## Water Treatment (WTP)

- » Lake Holiday WTP Capacity = 2.0 MGD (4.0 MGD with increased staff)
- » Meadow Park Lake WTP Capacity = 3.5 MGD

## Interconnections

- » To Crab Orchard UD = 1.8144 MGD (Emergencies Only)
- » To Falls Creek Falls UD = 0.3 MGD (Physical/Institutional)
- » To Grandview UD = 0.72 MGD (Physical)
- » To S. Cumberland UD = 2.174 MGD (Physical)
- » To West Cumberland UD = 0.504 MGD (Emergencies Only)
- » From Town of Monterey = 0.2 MGD (Institutional) - not modeled



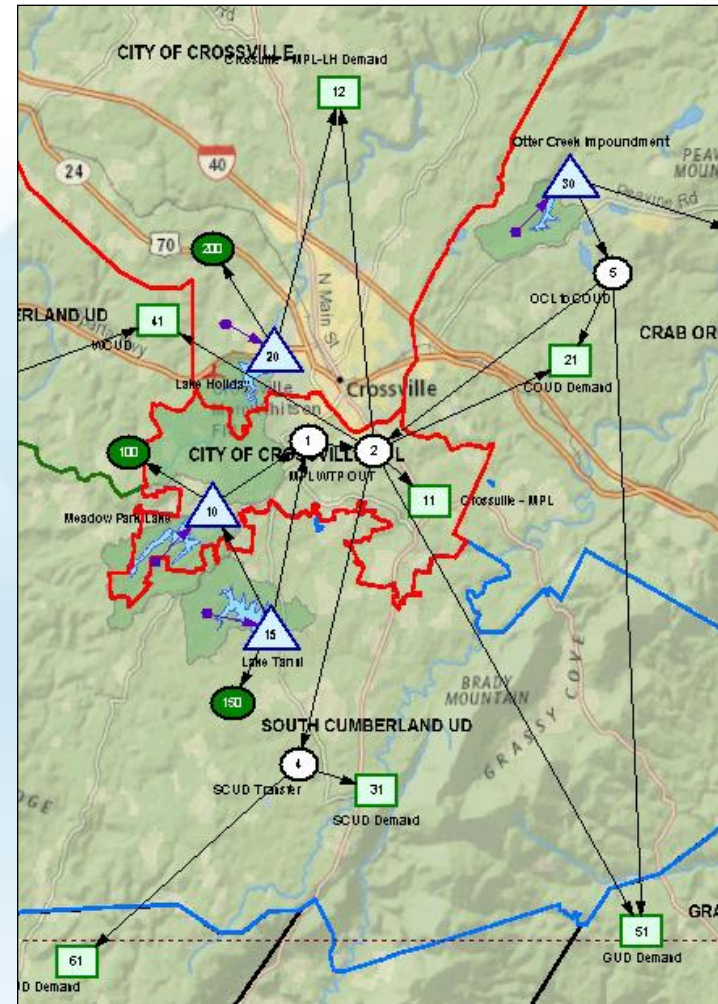
# SYSTEMS MODEL CITY OF CROSSVILLE

## Water Supply

- » Lake Holiday
  - » Normal Pool @ 1761.38 (ECE)
  - » Low Intake @ 1742
- » Meadow Park Lake
  - » Normal Pool @ 1818.10
  - » Low Intake @ 1803.6
- » Lake Tansi
  - » Normal Pool @ 1862.71
  - » Low Intake @ 1858.25

## Lake Tansi Connection

- » Primary transfer to MPL WTP
- » Able to transfer to both WTP and MPL with 14 MGD pump capacity
- » Does not operate April 15 – October 15
- » Allowed to take overflow and draw down 4” from normal pool October 15 – April 15



# SYSTEMS MODEL CRAB ORCHARD UD

## Water Treatment (WTP)

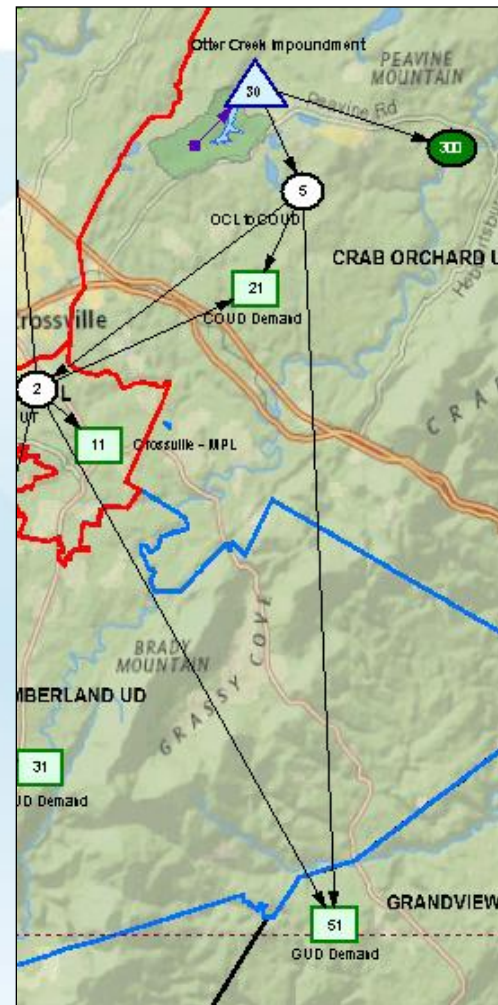
- » Crab Orchard WTP Capacity = 4.0 MGD

## Interconnections

- » To Crossville = TBD (Emergencies Only)
- » To Grandview UD = 0.216 MGD (Emergencies Only)

## Water Supply

- » Otter Creek Lake
  - » Normal Pool @ 1775
  - » Low Intake @ 1755





# SYSTEMS MODEL SOUTH CUMBERLAND UD

## Water Treatment (WTP)

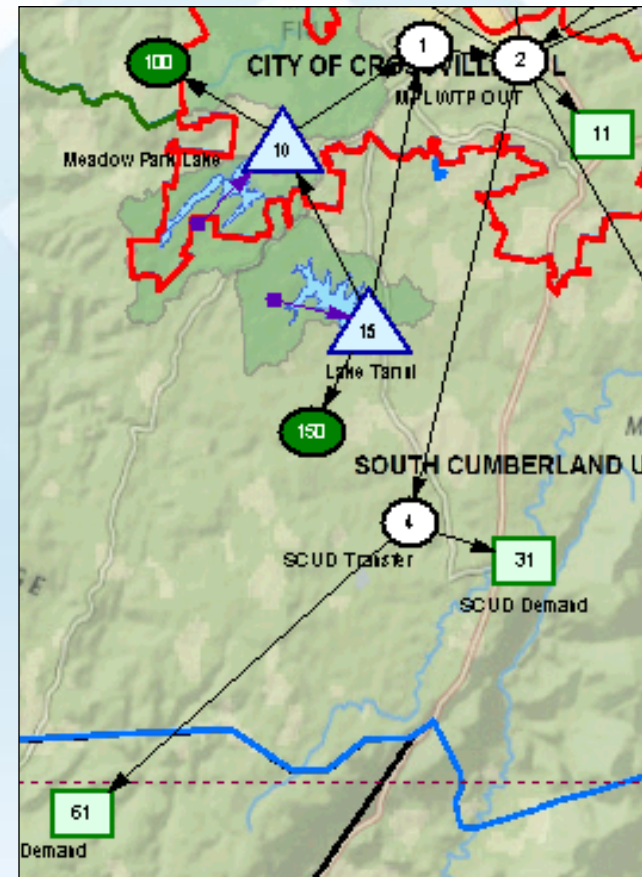
» N/A

## Interconnections

- » From Crossville = 2.174 MGD (Physical)
- » To Falls Creek Falls UD = 0.3 MGD (Physical/Institutional)

## Water Supply

» N/A



# SYSTEMS MODEL WEST CUMBERLAND UD

## Water Treatment (WTP)

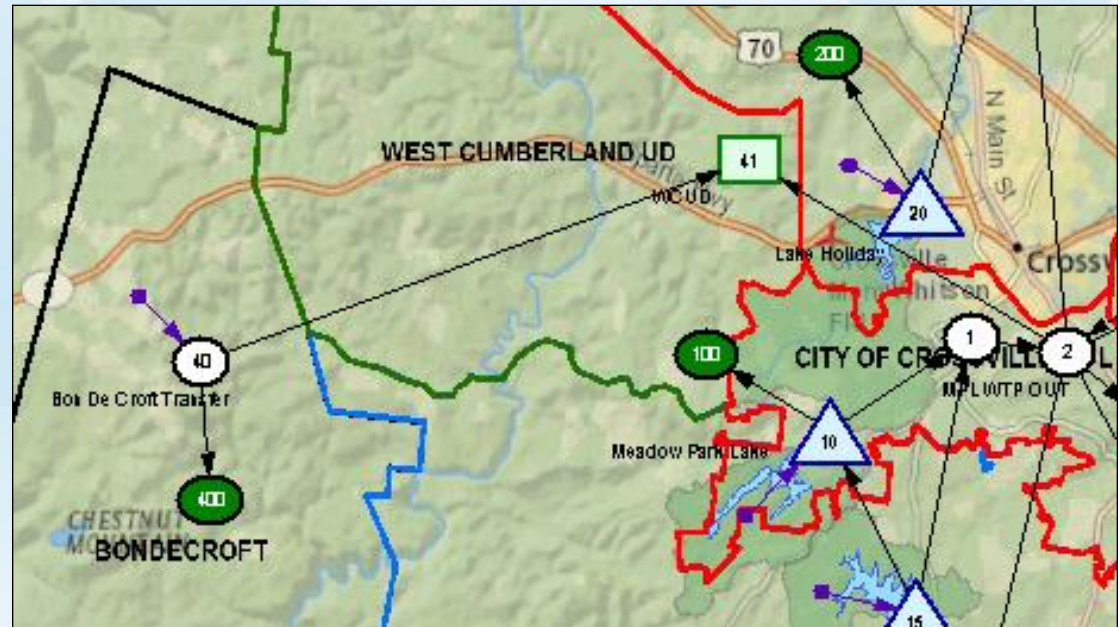
» N/A

## Interconnections

- » From Bondecroft UD = 0.75 MGD (Institutional)
- » From Crossville = 0.504 MGD (Emergencies Only)

## Water Supply

» N/A



# SYSTEMS MODEL OUTSIDE UTILITY DISTRICTS



## **Grandview UD**

- » Purchases from Crossville (Crab Orchard during emergencies)

## **Falls Creek Falls UD**

- » Purchases from Crossville (though S. Cumberland)

## **Bondecroft UD**

- » Sells to West Cumberland UD (NOTE: 0.75 MGD is available in all scenarios, Bondecroft water supply not modeled)

## **Town of Monterey**

- » No transfer through existing connection to Crossville



# SYSTEMS MODEL DROUGHT OPERATIONS



**Derived from Crossville/Cumberland County Drought Management Plan**

## **Stages of drought**

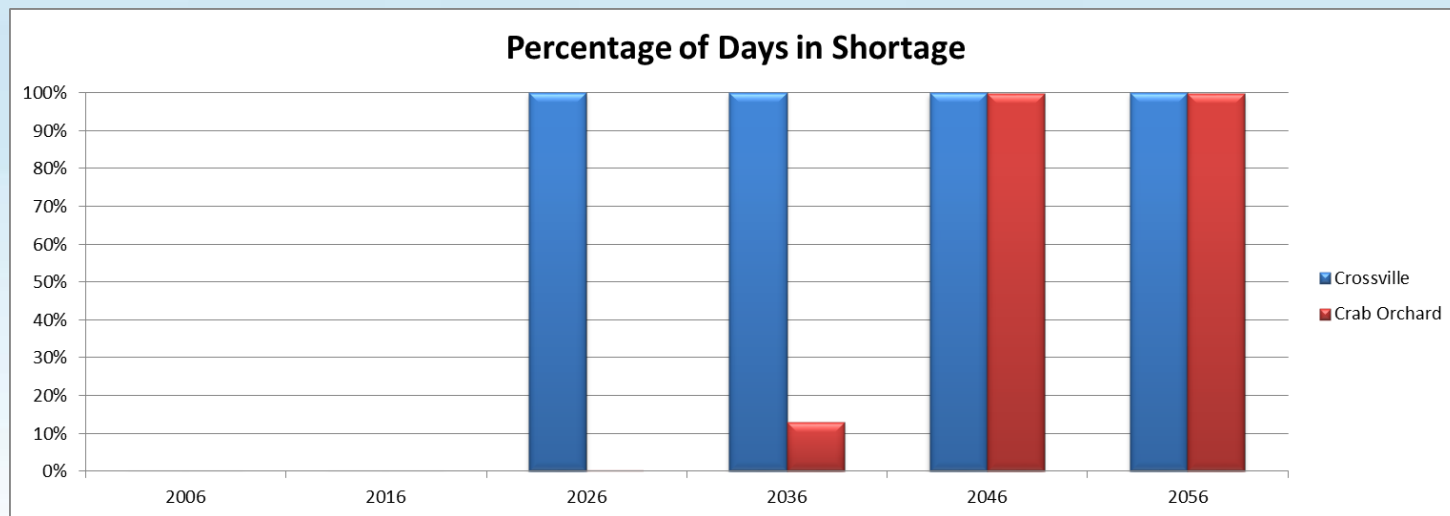
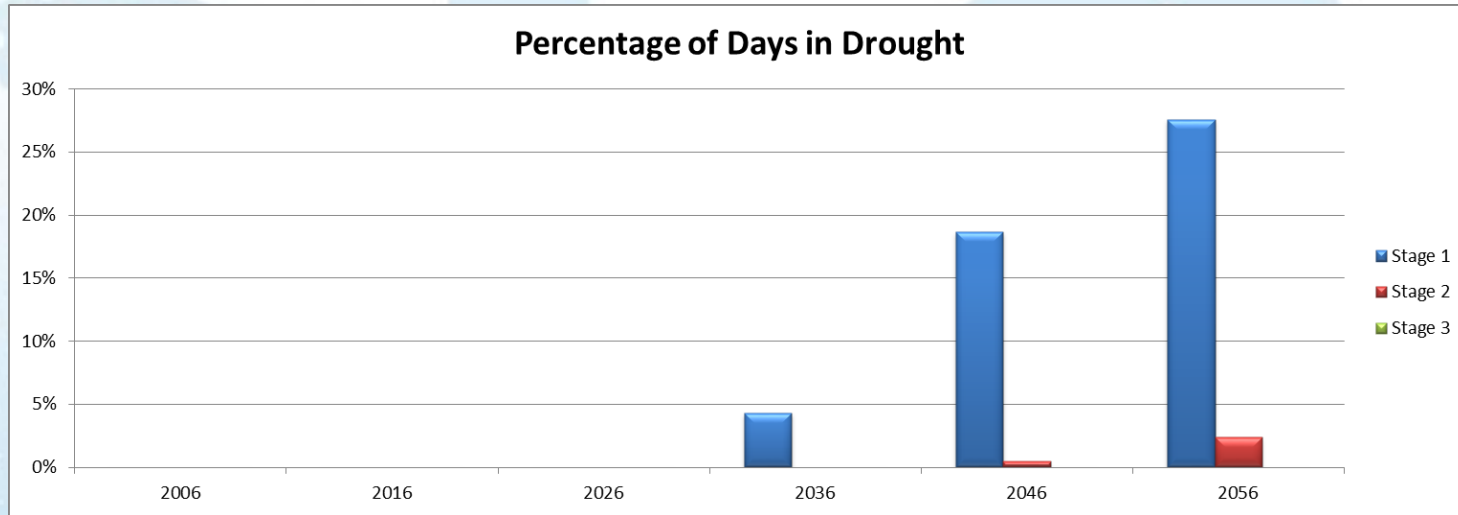
- » Stage 1 drought
  - » 120 days usable storage in system
  - » 7.5% reduction in demand
- » Stage 2 drought
  - » 90 days usable storage in system
  - » 15% reduction in demand
- » Stage 3 drought
  - » 60 days usable storage in system
  - » 30% reduction in demand

## **Emergency interconnections**

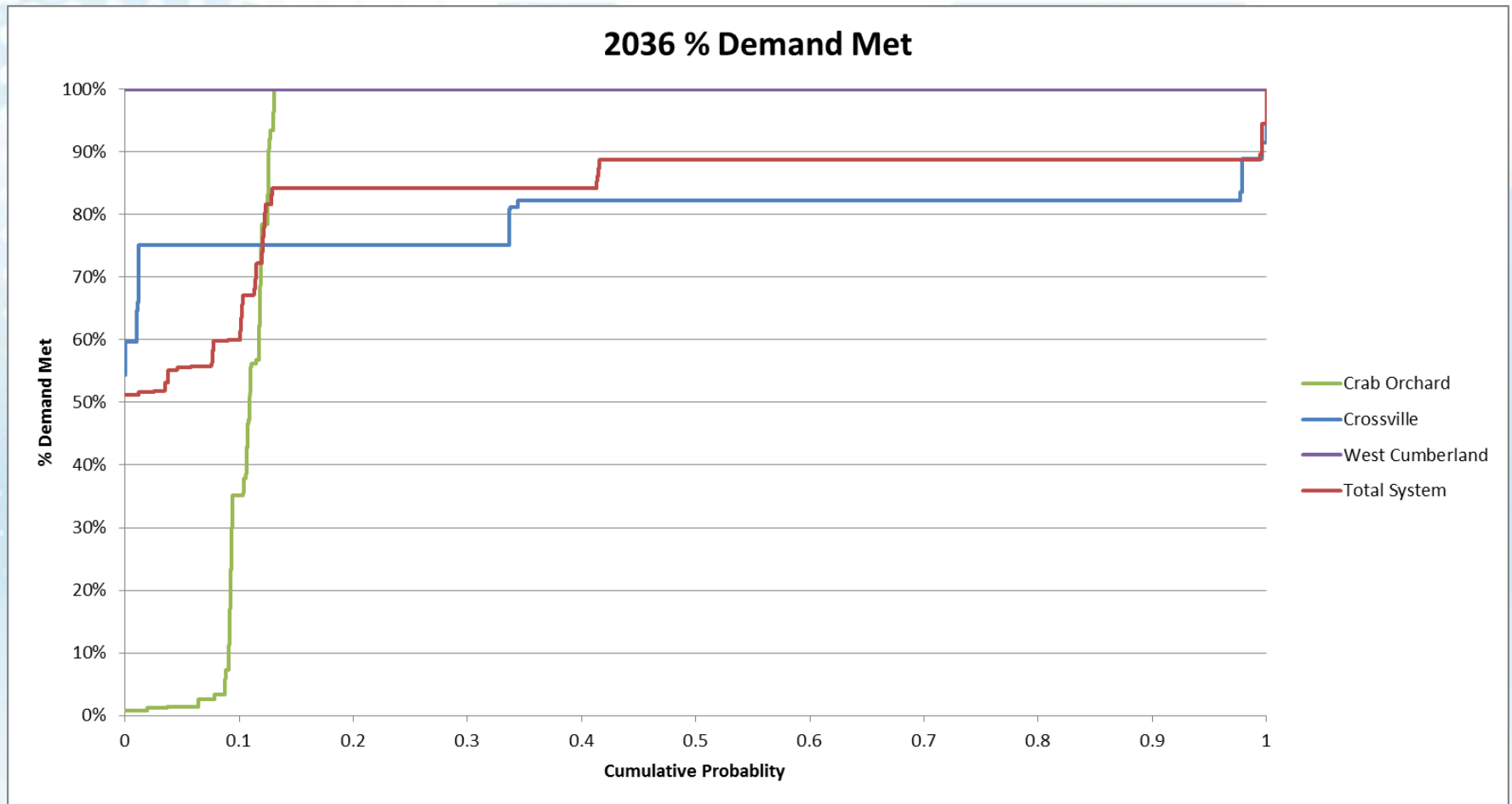
- » Turned on during all stages of drought



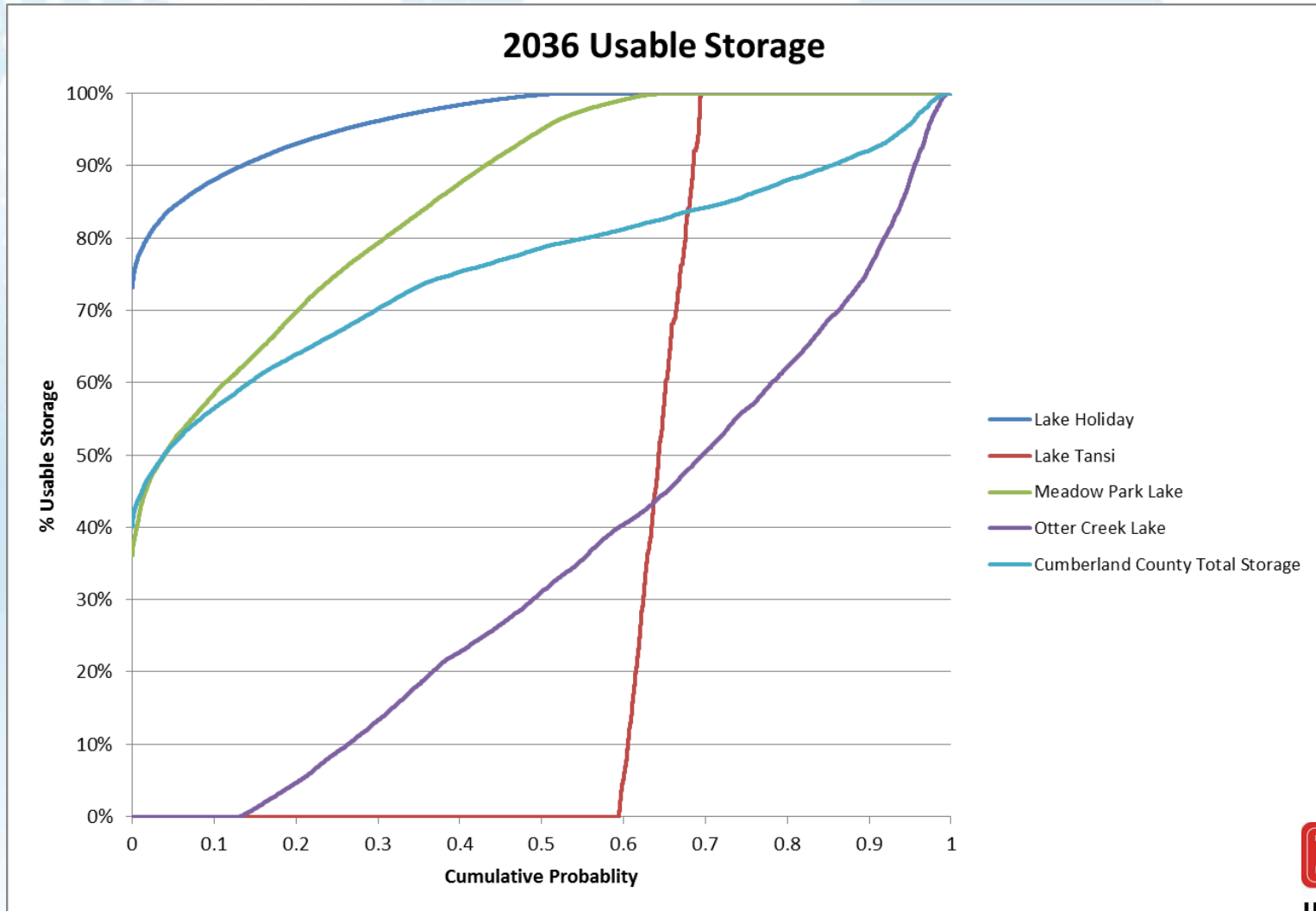
# SYSTEMS MODEL DRAFT RESULTS



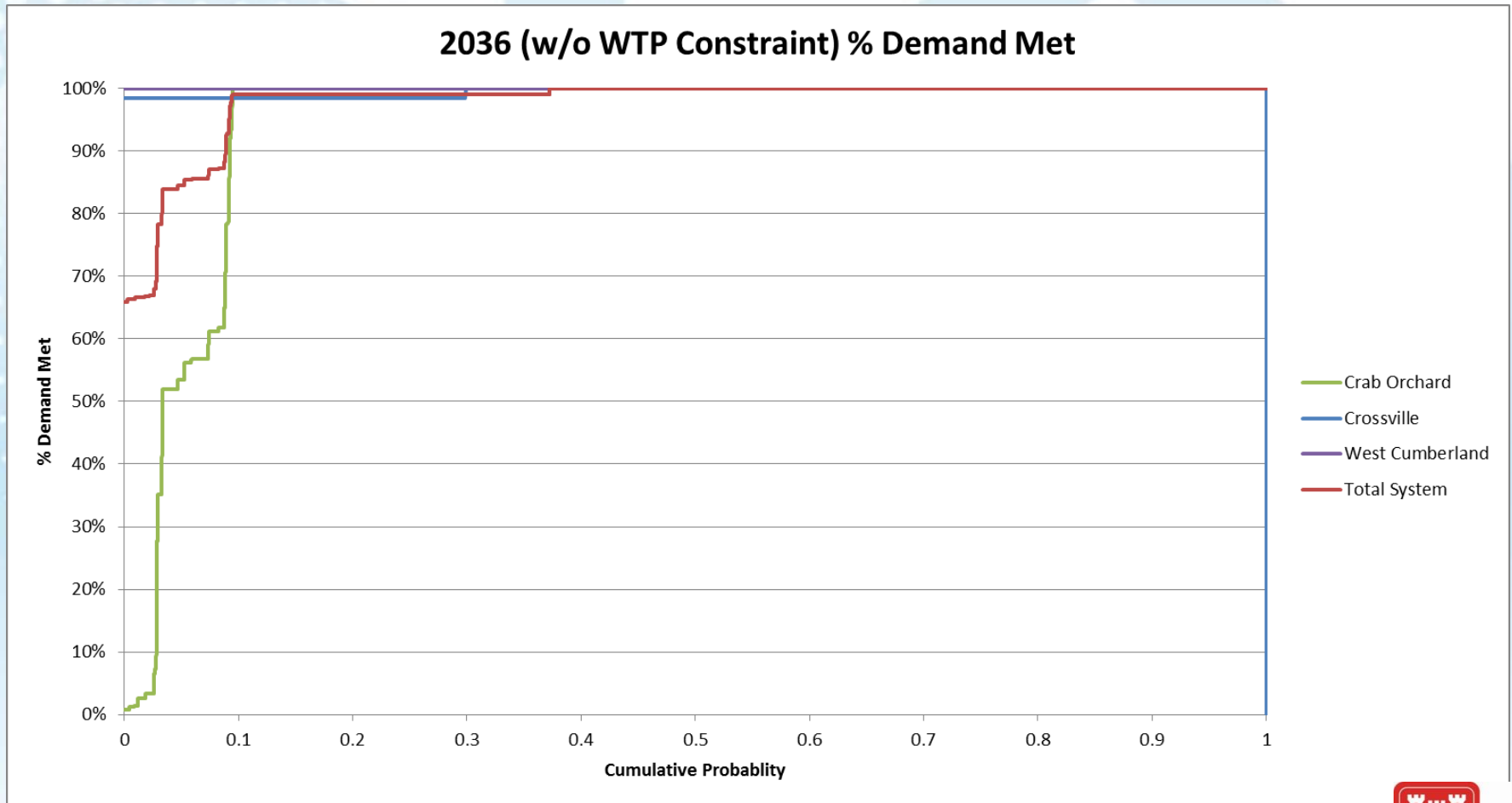
# SYSTEMS MODEL DRAFT RESULTS



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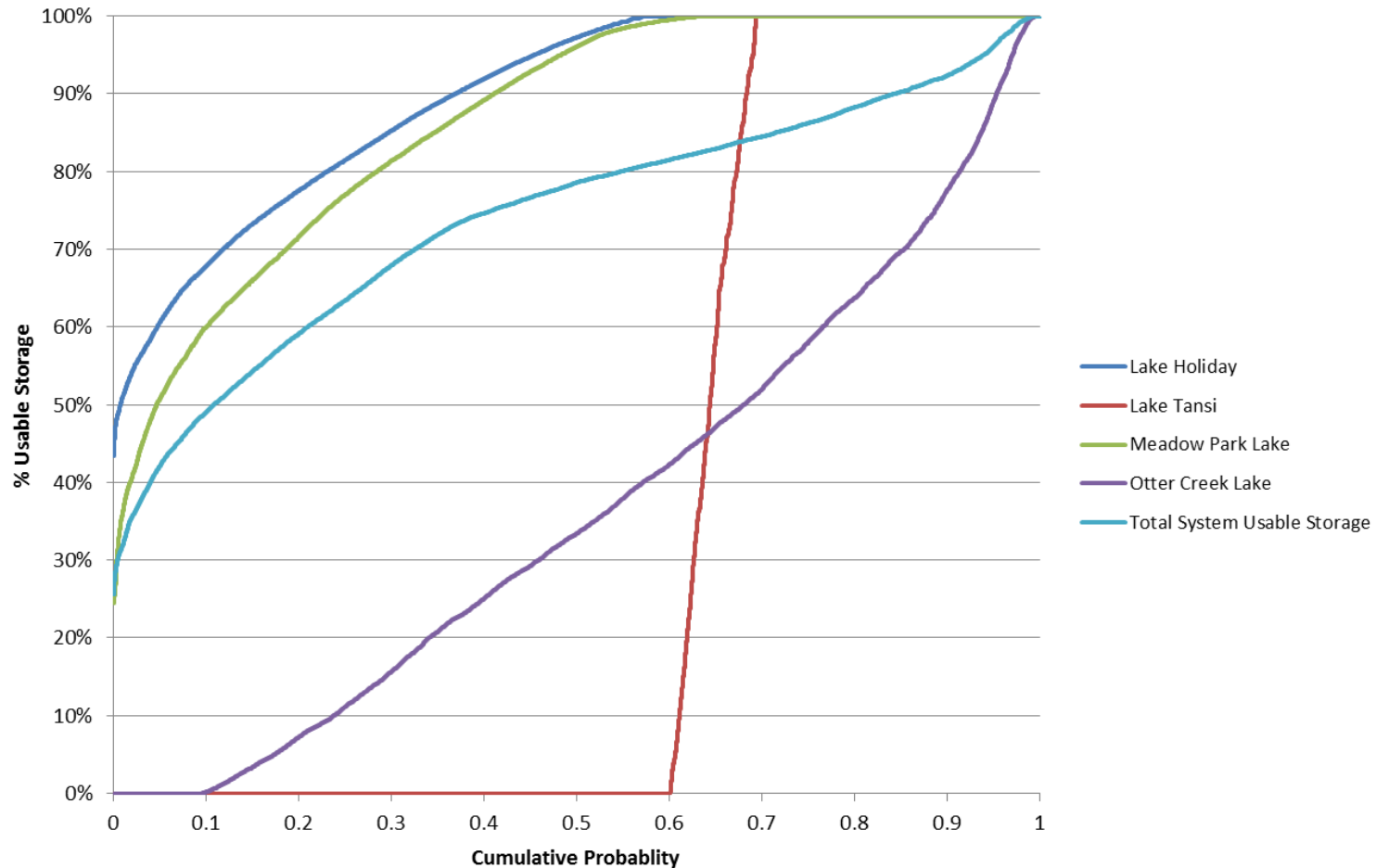
# SYSTEMS MODEL DRAFT RESULTS





# SYSTEMS MODEL DRAFT RESULTS

### 2036 (w/o WTP constraint) Usable Storage



# SYSTEMS MODEL LIMITATIONS/OUTSTANDING WORK



## Limitations

- » West Cumberland UD demand met by Bondecroft in all future scenarios
- » WTP capacity limits existing model analysis
- » System-wide drought stages limited by WTP capacity
- » Drought operations/Lake Tansi pumping duration
- » All customers treated equally

## Outstanding Work

- » Add emergency connection between Crossville and Crab Orchard
- » Fine-tuning of Lake Tansi – MPL operation



# TASK 1

## NEXT STEPS



- » Address outstanding work to finalize model
- » Estimate firm yield
- » Identify constraints on yield (“areas of need”)
- » Recommend alternatives that address constraints
- » Develop technical memorandum summarizing task results



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