Tar River Basin Hydrologic Model Overview

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Advancing the Management of Water Resources

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Meeting Objectives

- Review system-specific operating rules and input data
- Show preliminary results for current and future demand levels

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Concept of Tar Hydrologic Model

A basinwide model of the Tar River Basin at the finest practical geographic resolution and timestep.

Possible Uses:

1. Evaluation of the combined effects of municipal water supply plans
2. Evaluation of interbasin transfer permit applications
3. Development of individual water supply plans – model will be on the DWR server and available to stakeholders and their consultants
4. A platform for developing risk-based drought plans.

Project Timeline

- Components
  - Basin schematic: 1 - 2 months (complete)
  - Data collection (demands and discharges, including agricultural demands): 4 - 6 months (complete)
  - Inflow development: 6 – 10 months (complete)
  - Operating rules: 3 months (complete pending review)
  - Current and future demand model runs: 2 - 4 months (complete pending review)
  - Documentation, installation, and training: 1 month
  - Expected completion date: December 2011

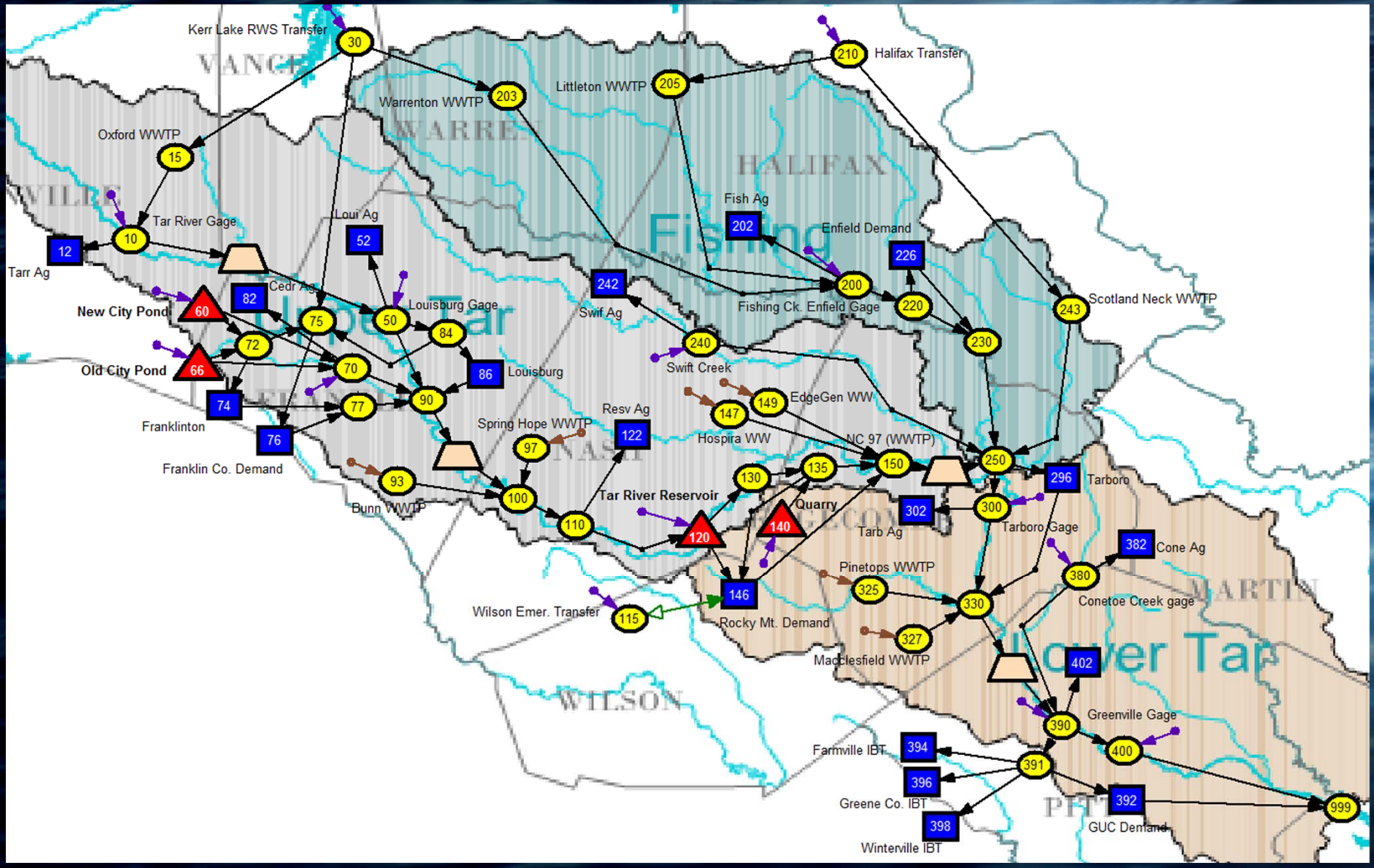
Why Data Collection Matters

- Unimpaired flows important because they allow alternative operating / demand scenarios to be run
  - Historic impairment data required to unimpair flows
- Model should mimic how your system performs
  - Operating rules
  - Reservoir operations
  - Demand and wastewater returns
  - Drought plans

Typical Model Output

- Flow in the river
- Storage and elevation at reservoirs
- Derived attributes
  - Frequency and duration of drought plan activation
  - Frequency and duration of transfer / sales
  - Environmental / instream flow statistics

Overall Schematic



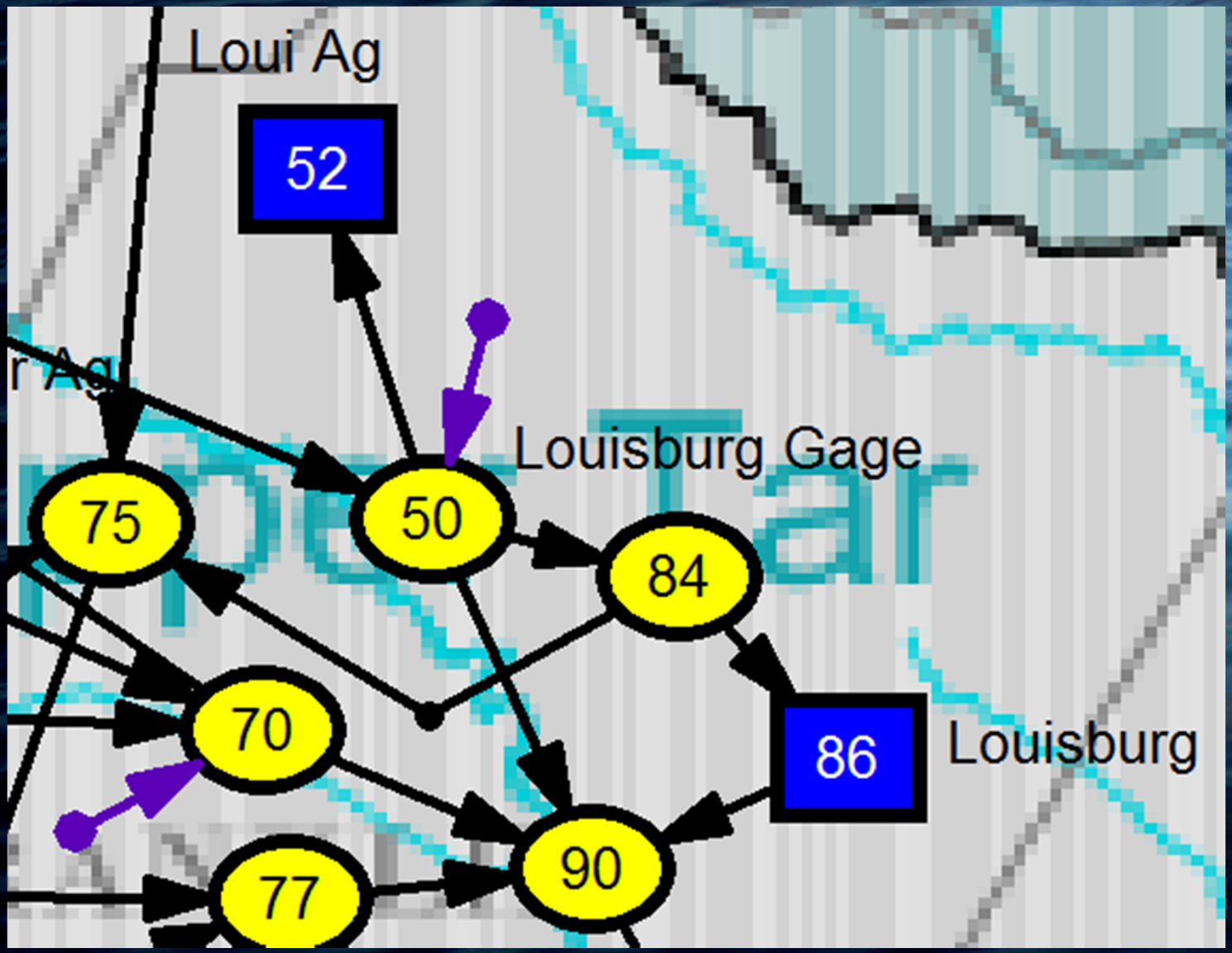
HYDROLOGICS

Louisburg

- Primary source – Tar River
- Sells water to Franklin County
- Annual Average Demand = 0.56 MGD
  - After sales to Franklin Co.
- Treatment capacity = 2.0 MGD
- Drought Plan
  - Stage 1 – Intake < 183 ft river elevation
    - 5% demand reduction
  - Stage 2 – Intake < 182 ft river elevation
    - 10% demand reduction
  - Stage 3 – Intake < 181 ft river elevation
    - 20% demand reduction
  - Stage 4 – Intake < 180 ft river elevation
    - 25% demand reduction
  - Stage 5 – Intake < 179 ft river elevation
    - Rationing
  - Can convert gage flow to elevation at gage; need to translate to elevation at intake

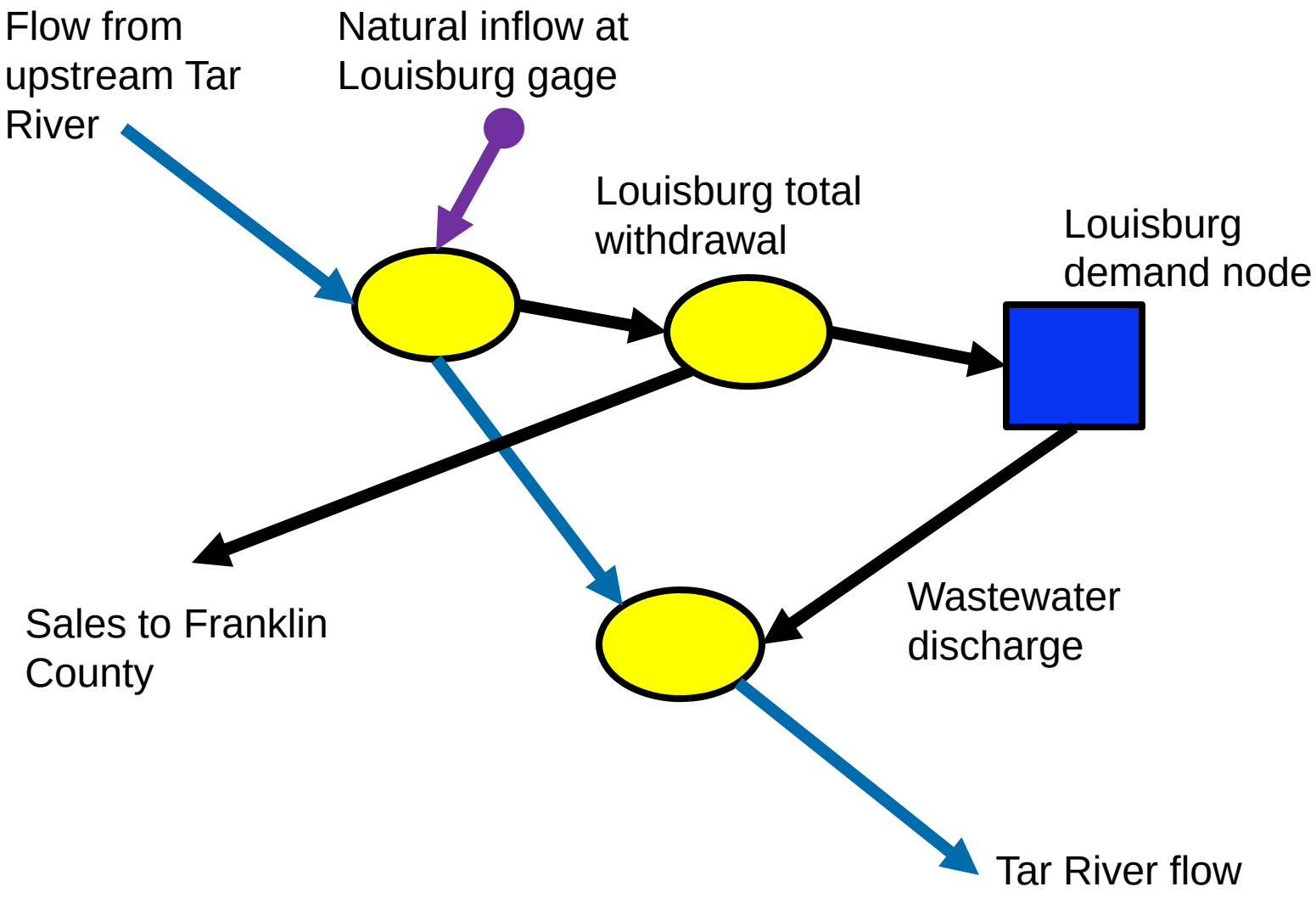
HYDROLOGICS

Louisburg System (from model)



HYDROLOGICS

Louisburg System - Simplified



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 86, 'Louisburg'

	Month	Day	Demand
▶	1	1	0.937
	1	31	0.937
	2	1	0.964
	2	29	0.964
	3	1	0.991
	3	31	0.991
	4	1	1.011
	4	30	1.011
	5	1	0.996
	5	31	0.996
	6	1	1.046
	6	30	1.046
	7	1	1.072
	7	31	1.072
	8	1	1.111
	8	31	1.111
	9	1	1.088
	9	30	1.088
	10	1	0.977
	10	31	0.977
	11	1	0.929
	11	30	0.929
	12	1	0.880
	12	31	0.880
*			

MGD Units

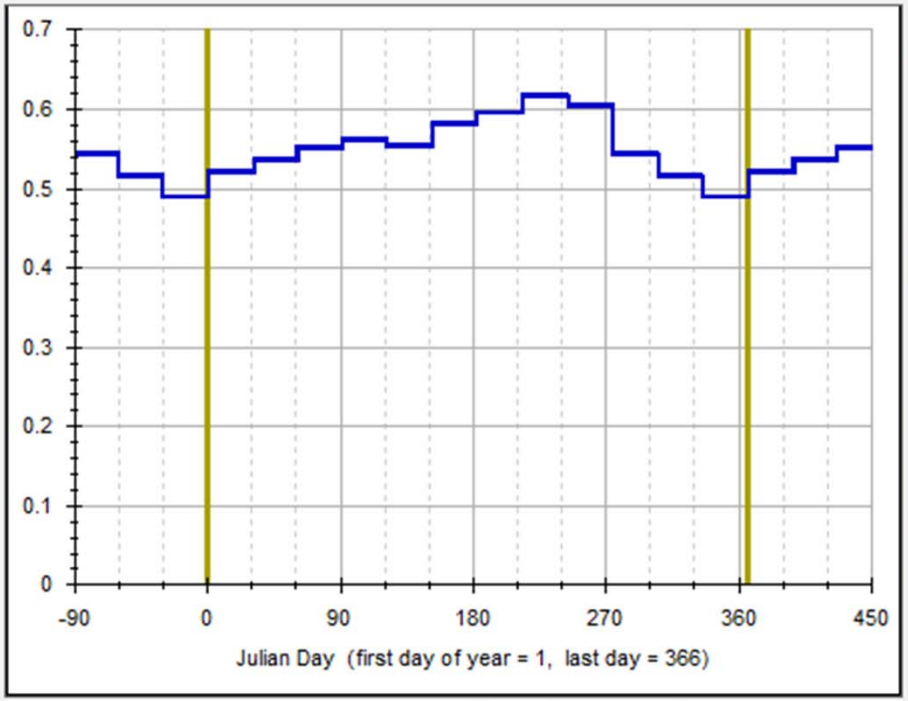
0.55500000 Multiplication Factor

Change Node

Import Data

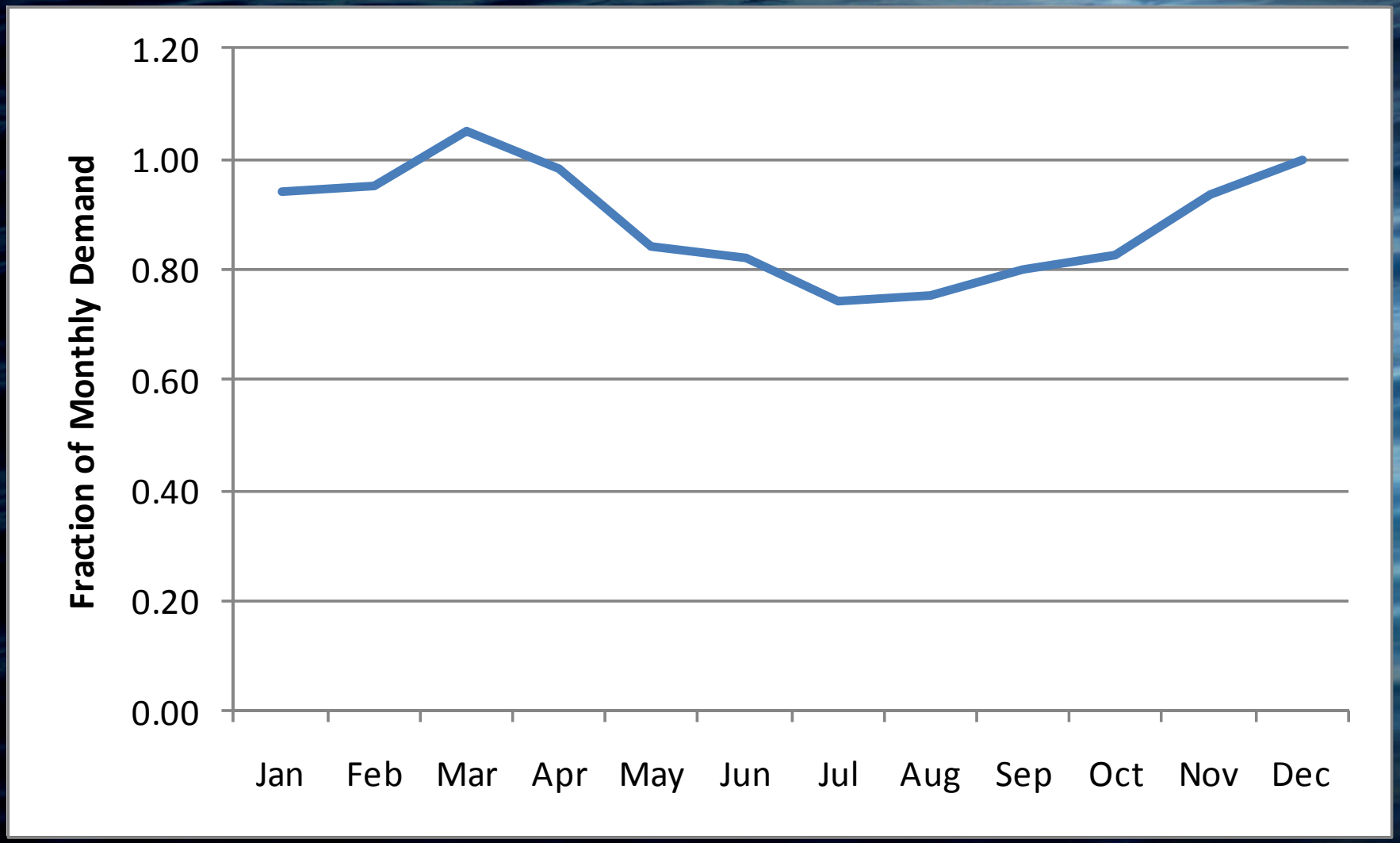
OK

Cancel



HYDROLOGICS

Wastewater Pattern

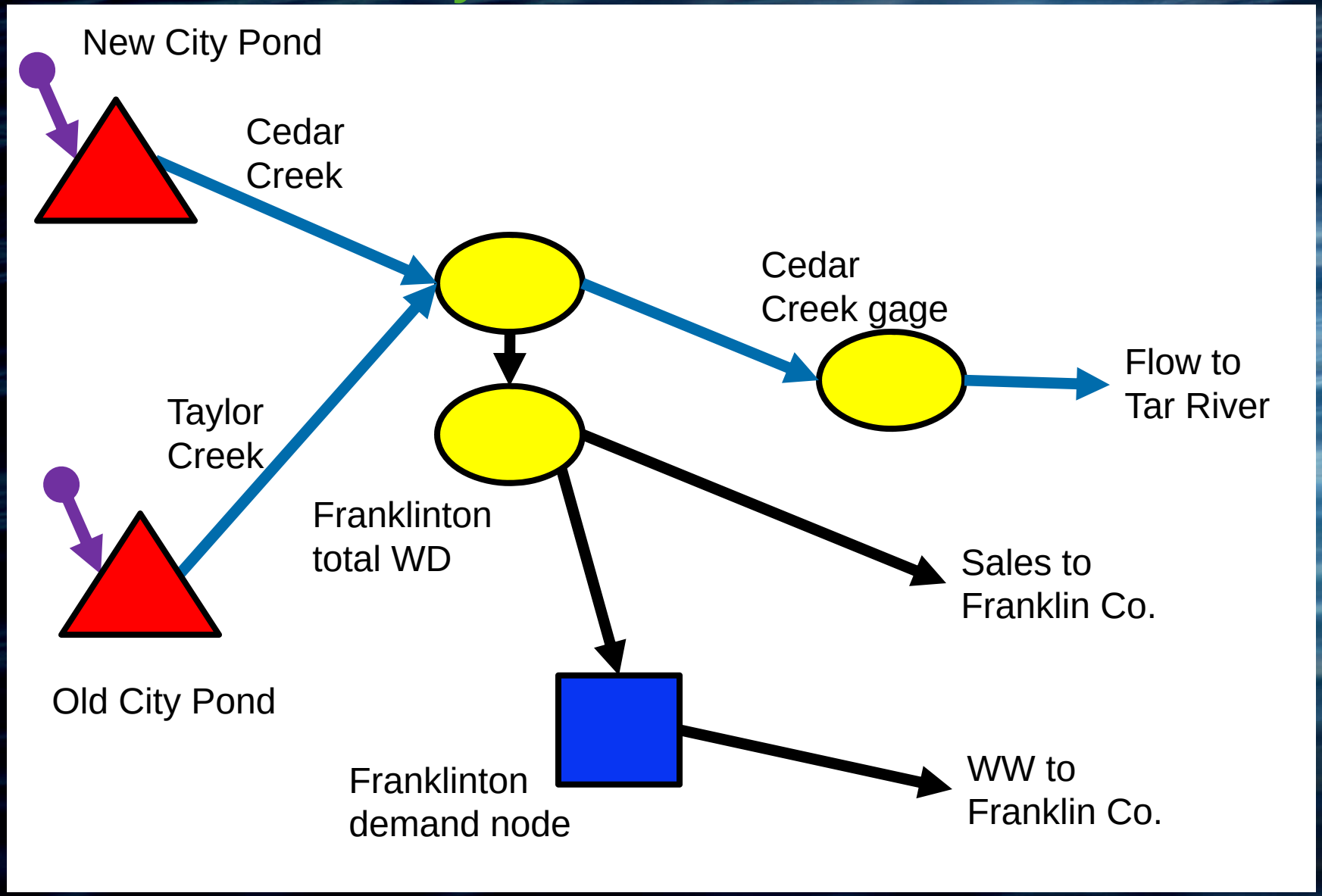


HYDROLOGICS

Franklinton

- Primary source – New City Pond
  - Secondary source – Old City Pond
- Sells water to Franklin County
- Sends WW to Franklin County
- Annual Average Demand = 0.32 MGD
  - After sales to Franklin Co.
- Treatment capacity = 1 MGD
- Drought Plan
  - Stage 1 – Storage < 75%
    - 5% demand reduction
  - Stage 2 – Storage < 65%
    - 10% demand reduction
  - Stage 3 – Storage < 50%
    - 20% demand reduction
  - Stage 4 – Storage < 30%
    - 25% demand reduction
  - Stage 5 – Storage = 0%
    - Rationing

Franklinton System



HYDROLOGICS

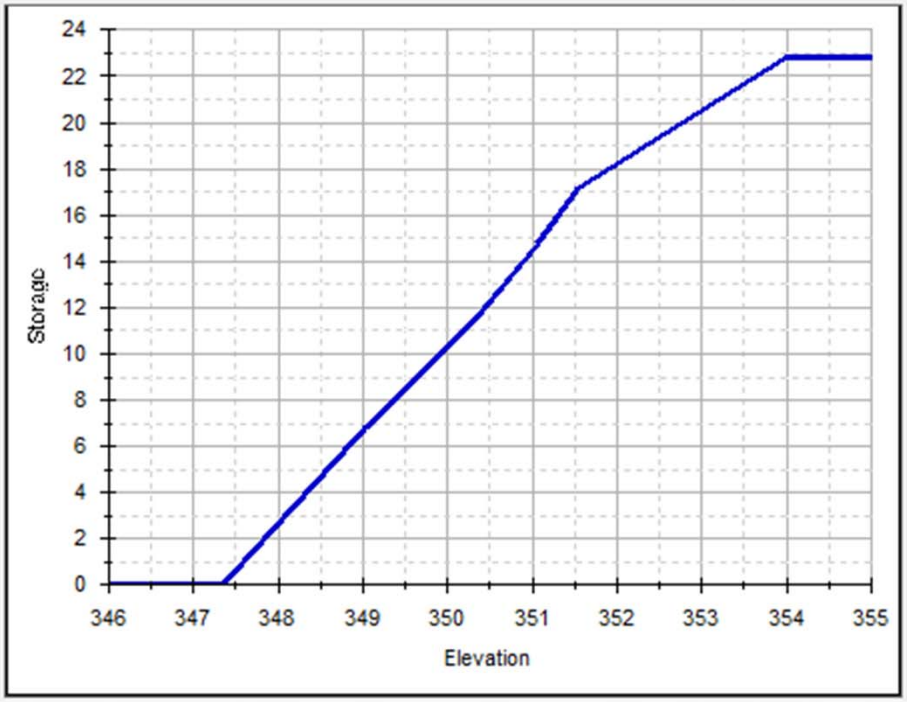
Stage-Storage Curve – New City Pond

Reservoir Storage-Area-Elevation at Node 60, 'Cedar Ck.'

	Elevation	Storage	Area
▶	347.340	0.000	0.000
	349.030	6.800	4.700
	350.290	11.400	7.900
	351.070	14.800	10.300
	351.520	17.100	11.900
	354.000	22.800	15.800
*			

	Units	X-Variable	Y-Variable
Elevation	FT	●	
Storage	MG		●
Area	acre	○	○

Change Node | Import Data | OK | Cancel



HYDROLOGICS

Stage-Area Curve – New City Pond

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	Elevation	Storage	Area
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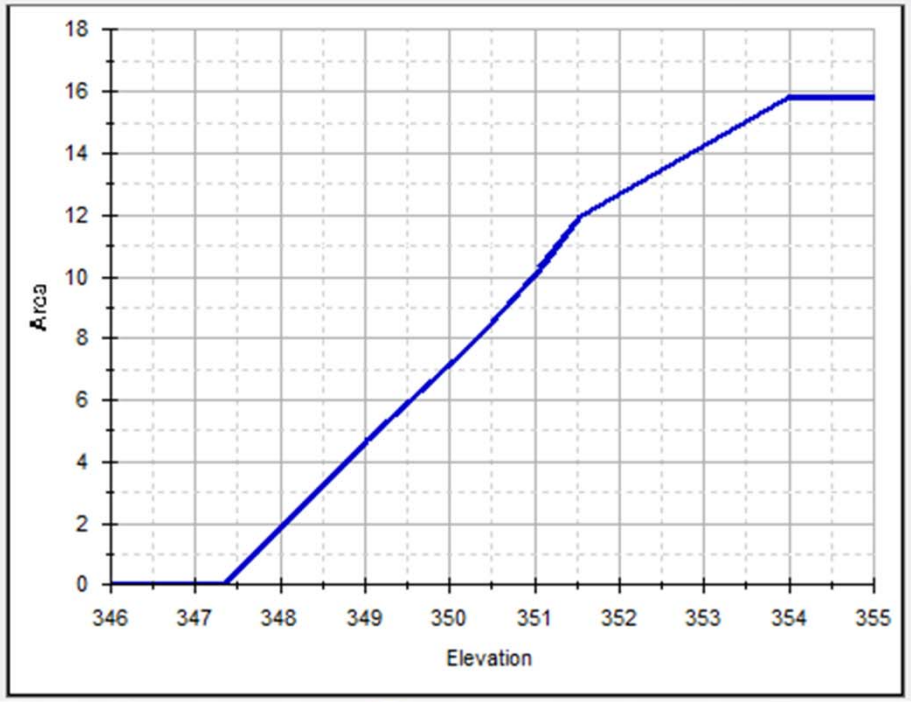
	351.520	17.100	11.900
	354.000	22.800	15.800
*			

	Units	X-Variable	Y-Variable
Elevation	FT	◉	
Storage	MG	○	○
Area	acre		◉

Change Node | Import Data | OK | Cancel



HYDROLOGICS

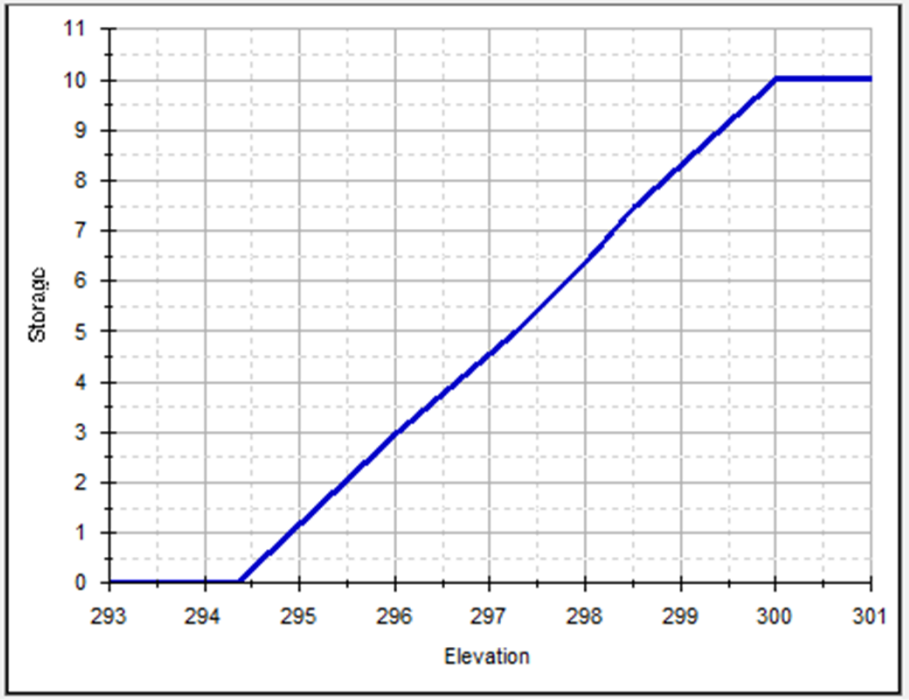
Stage-Storage Curve – Old City Pond

Reservoir Storage-Area-Elevation at Node 66, 'Old City Pond'

	Elevation	Storage	Area
▶	294.340	0.000	0.000
	296.030	3.000	2.100
	297.290	5.000	3.500
	298.070	6.500	4.500
	298.520	7.500	5.200
	300.000	10.000	6.900
*			

	Units	X-Variable	Y-Variable
Elevation	FT	●	
Storage	MG		●
Area	acre	○	○

Change Node | Import Data | OK | Cancel



HYDROLOGICS

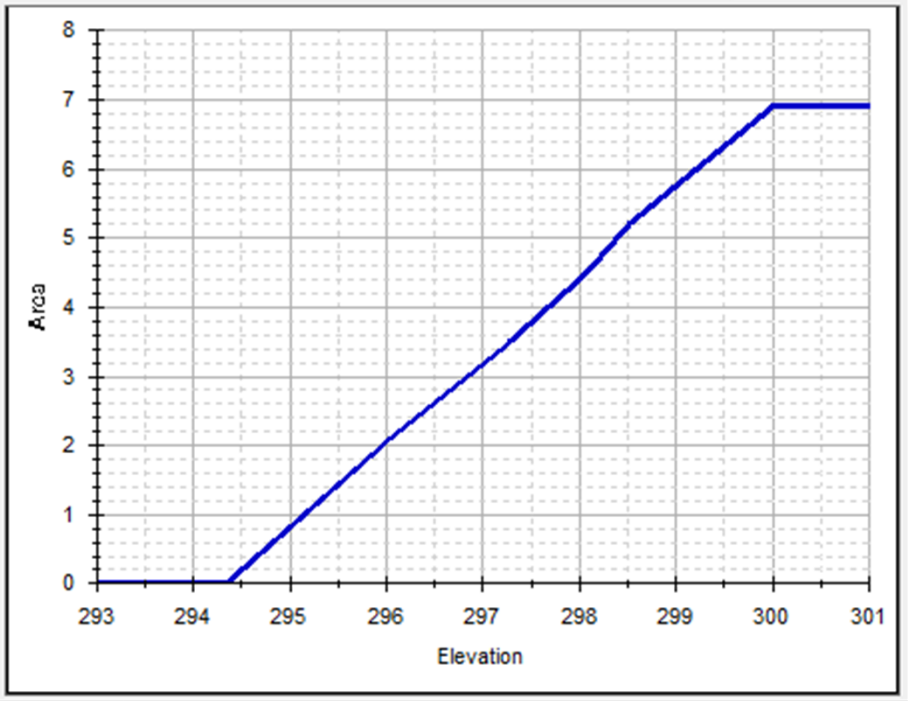
Stage-Area Curve – Old City Pond

Reservoir Storage-Area-Elevation at Node 66, 'Old City Pond'

	Elevation	Storage	Area
▶	294.340	0.000	0.000
	296.030	3.000	2.100
	297.290	5.000	3.500
	298.070	6.500	4.500
	298.520	7.500	5.200
	300.000	10.000	6.900
*			

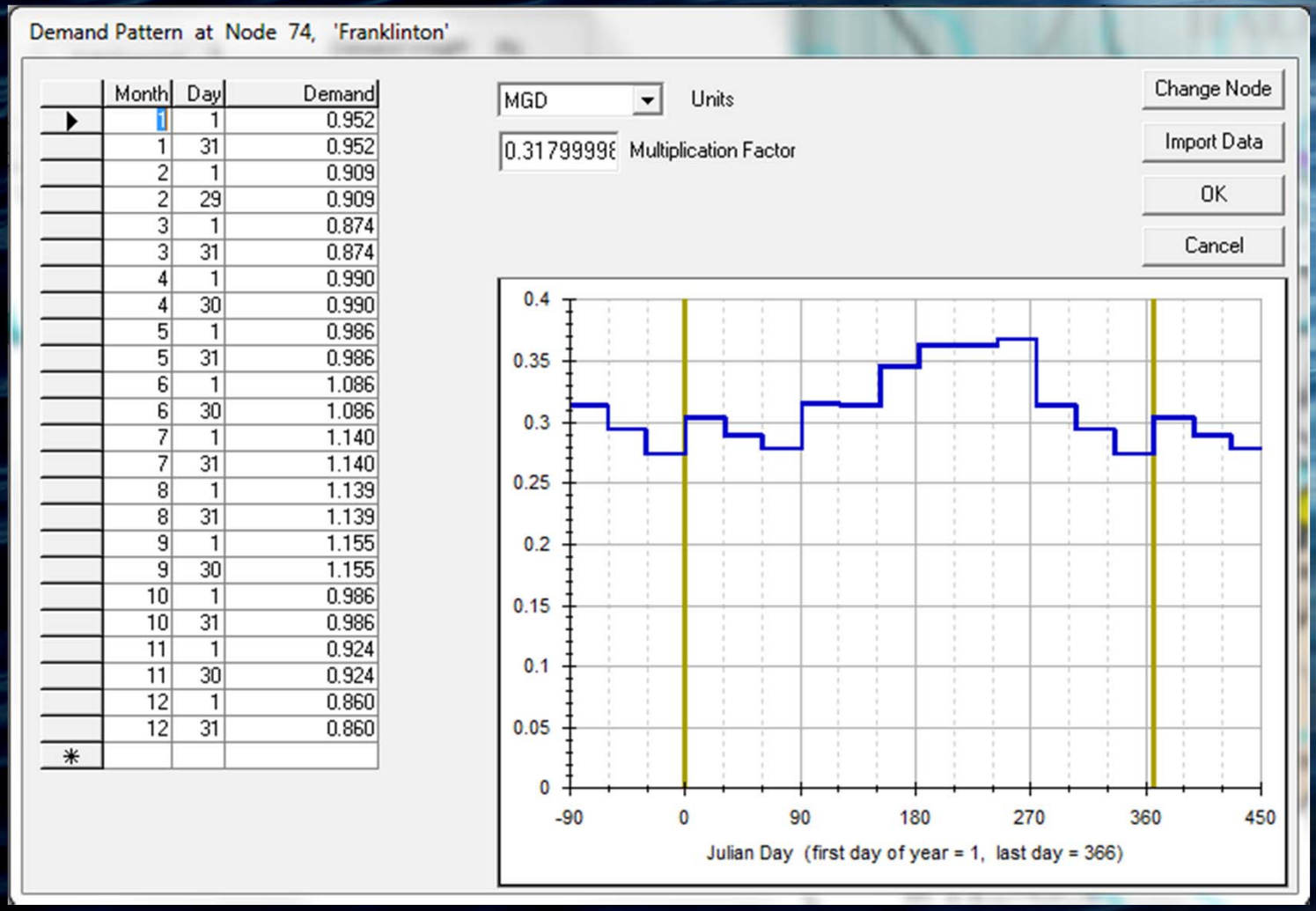
	Units	X-Variable	Y-Variable
Elevation	FT	●	
Storage	MG	○	○
Area	acre		●

Change Node | Import Data | OK | Cancel



HYDROLOGICS

Demand Pattern

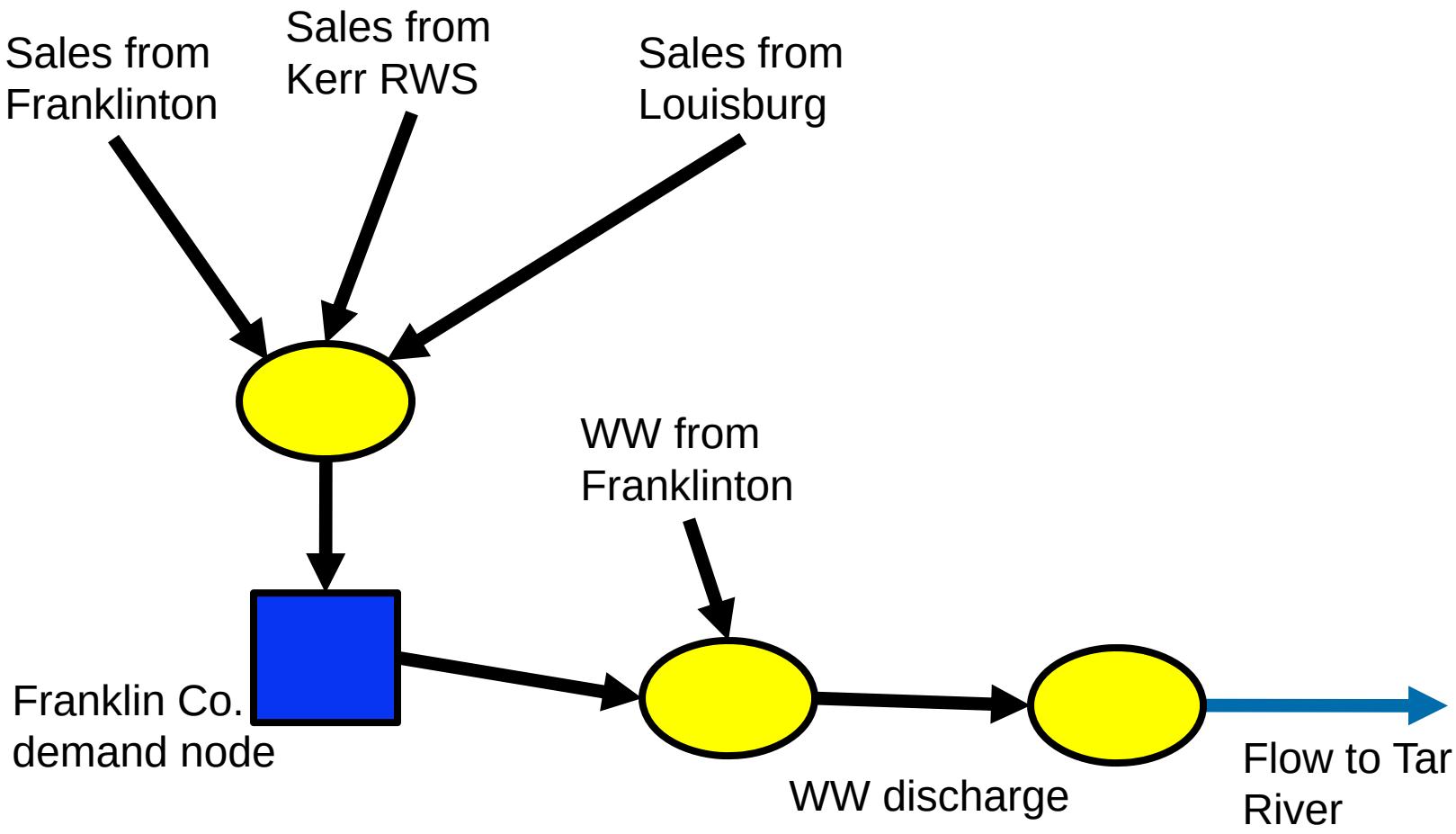


HYDROLOGICS

Franklin County

- Primary source – Kerr RWS
  - Secondary sources – Franklinton and Louisburg
- Also treats Franklinton wastewater
- Annual Average Demand = 2.4 MGD
  - 79% from Kerr RWS (3 MGD contract)
  - 13% from Franklinton (0.35 MGD contract)
  - 8% from Louisburg (0.08 MGD contract)
- Drought Plan
  - Follows Kerr RWS triggers
    - Not currently available from RRBROM

Franklin County System



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 76, 'Franklin Co. Demand'

	Month	Day	Demand
▶	1	1	0.940
	1	31	0.940
	2	1	0.868
	2	29	0.868
	3	1	0.822
	3	31	0.822
	4	1	0.944
	4	30	0.944
	5	1	1.123
	5	31	1.123
	6	1	1.136
	6	30	1.136
	7	1	1.090
	7	31	1.090
	8	1	1.144
	8	31	1.144
	9	1	1.083
	9	30	1.083
	10	1	1.023
	10	31	1.023
	11	1	0.947
	11	30	0.947
	12	1	0.881
	12	31	0.881
*			

MGD Units

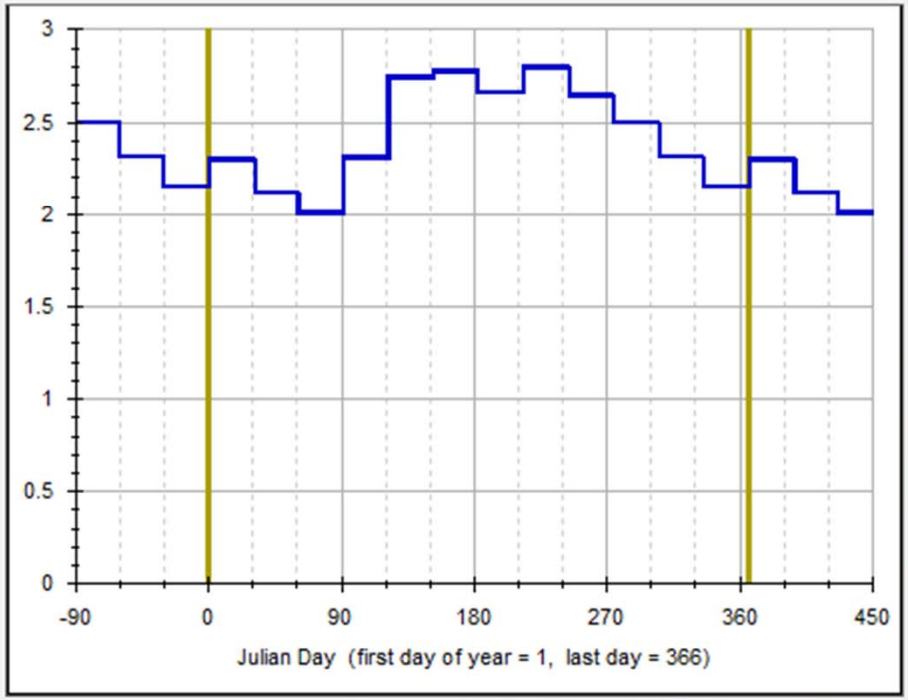
2.44000005 Multiplication Factor

Change Node

Import Data

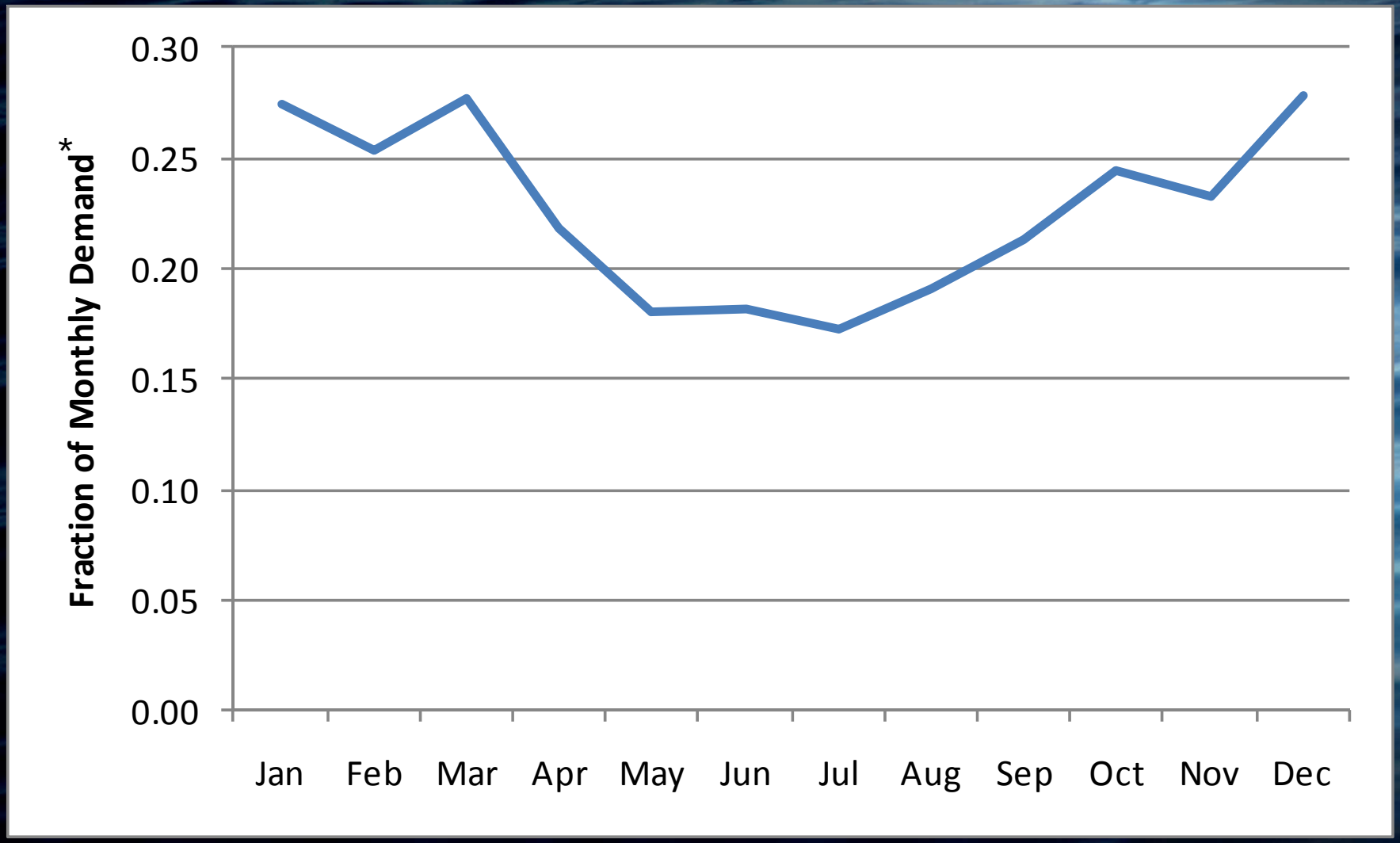
OK

Cancel



HYDROLOGICS

Wastewater Pattern



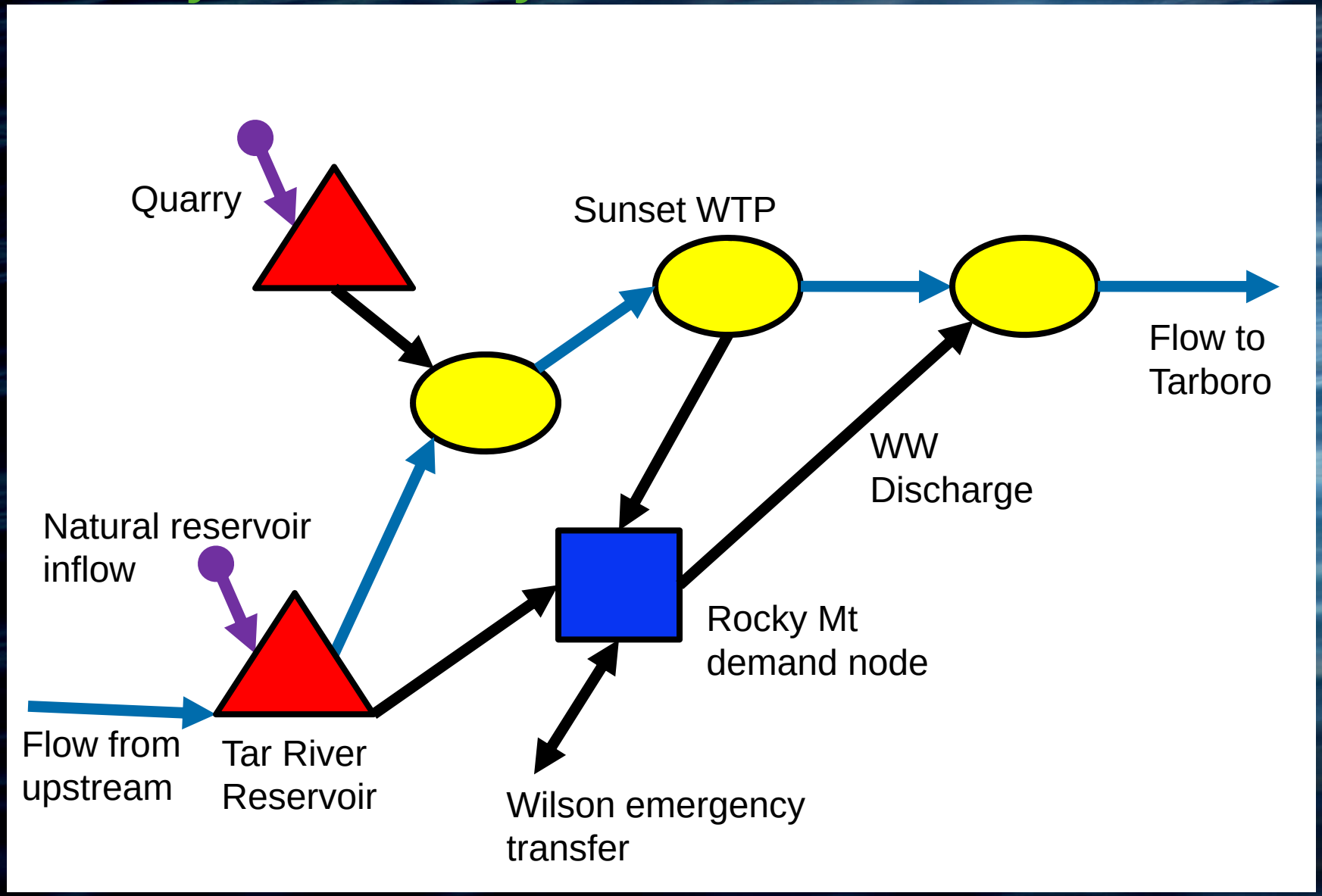
* Demand includes Franklinton & Franklin Co.

HYDROLOGICS

Rocky Mount

- Primary source – Tar River Reservoir
  - 80 cfs minimum flow
  - Secondary source – Quarries
- Annual Average Demand = 10.2 MGD
- Treatment capacity
  - Tar River Plant = 18 MGD
  - Sunset Plant = 12 MGD
- Drought Plan
  - Stage 1 – June – October
    - Voluntary I, Min. flow reduced to 70 cfs
  - Stage 2 – 10% risk of 120 ft (reservoir elevation) in 12 weeks
    - Voluntary II, Min flow 70 cfs
  - Stage 3 – 15% risk of 118 ft in 8 weeks
    - 10% demand reduction, Min flow 60 cfs, 10 cfs pumped from quarries
  - Stage 4 – 20% risk of 116 ft in 6 weeks
    - 18% demand reduction, Min flow 50 cfs, 10 cfs pumped from quarries

Rocky Mount System



HYDROLOGICS

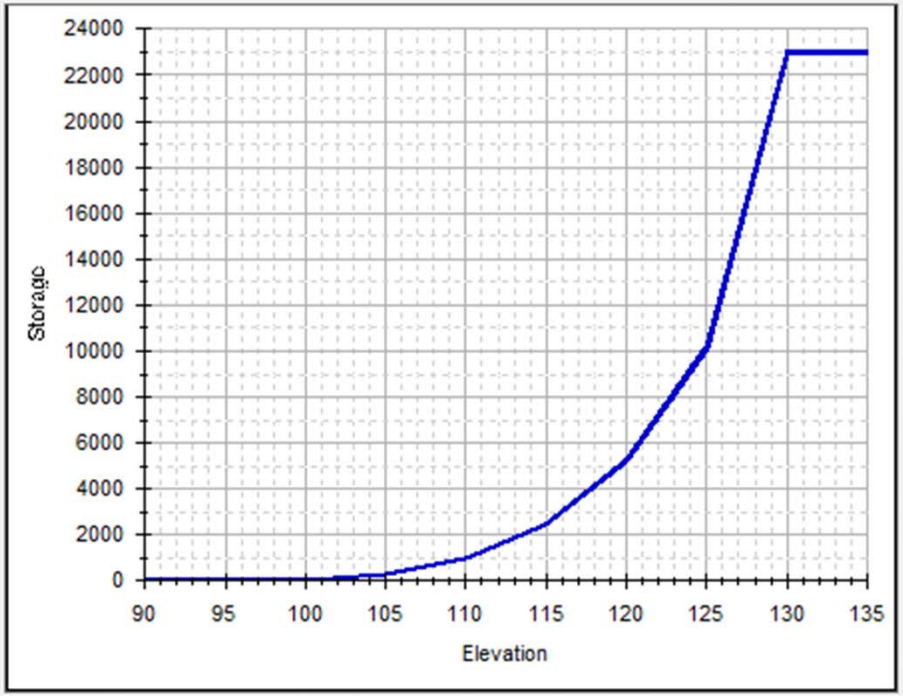
Stage-Storage Curve – Tar River Res.

Reservoir Storage-Area-Elevation at Node 120, 'Tar River Reservoir'

	Elevation	Storage	Area
▶	100.000	28.000	11.000
	105.000	279.000	89.000
	110.000	984.000	193.000
	115.000	2431.000	386.000
	120.000	5269.000	749.000
	125.000	10151.000	1203.000
	130.000	22930.000	2400.000
*			

	Units	X-Variable	Y-Variable
Elevation	FEET	◉	
Storage	AF		◉
Area	acre	○	○

Change Node | Import Data | OK | Cancel



HYDROLOGICS

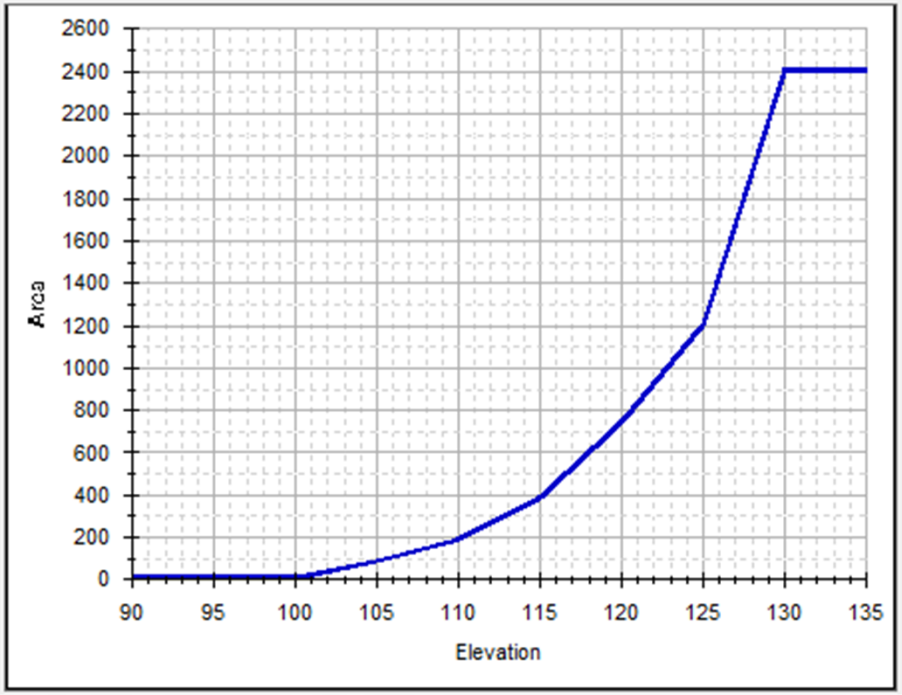
Stage-Area Curve – Tar River Res.

Reservoir Storage-Area-Elevation at Node 120, 'Tar River Reservoir'

	Elevation	Storage	Area
▶	100.000	28.000	11.000
	105.000	279.000	89.000
	110.000	984.000	193.000
	115.000	2431.000	386.000
	120.000	5269.000	749.000
	125.000	10151.000	1203.000
	130.000	22930.000	2400.000
*			

	Units	X-Variable	Y-Variable
Elevation	FEET	●	
Storage	AF	○	○
Area	acre		●

Change Node | Import Data | OK | Cancel



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 146, 'Rocky Mt. Demand'

	Month	Day	Demand
▶	1	1	0.936
	1	31	0.936
	2	1	0.932
	2	29	0.932
	3	1	0.918
	3	31	0.918
	4	1	0.949
	4	30	0.949
	5	1	1.027
	5	31	1.027
	6	1	1.136
	6	30	1.136
	7	1	1.135
	7	31	1.135
	8	1	1.114
	8	31	1.114
	9	1	1.017
	9	30	1.017
	10	1	0.998
	10	31	0.998
	11	1	0.953
	11	30	0.953
	12	1	0.887
	12	31	0.887
*			

MGD Units

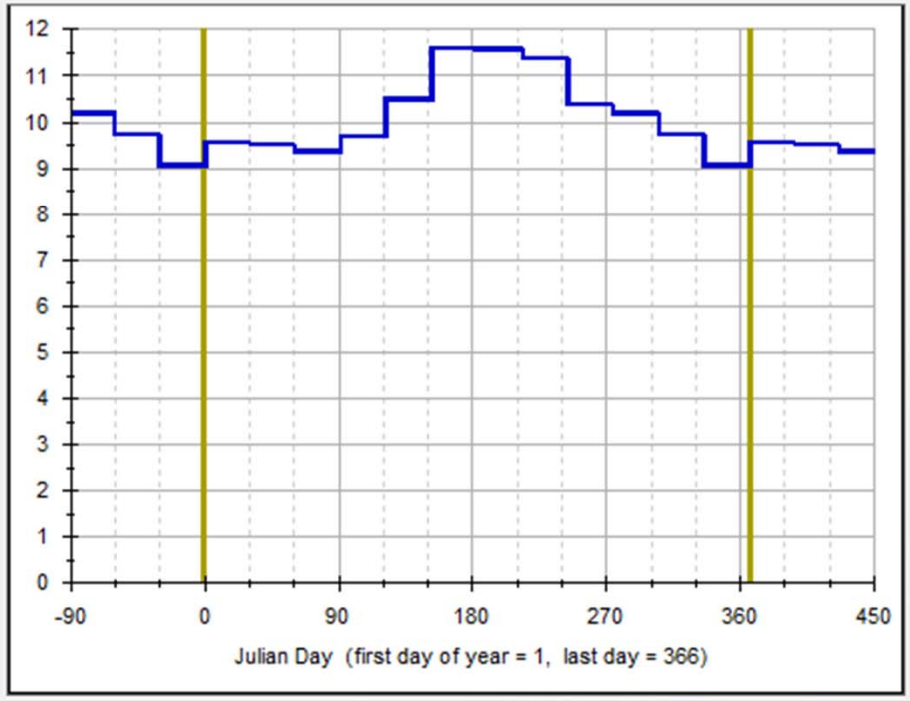
10.1990003 Multiplication Factor

Change Node

Import Data

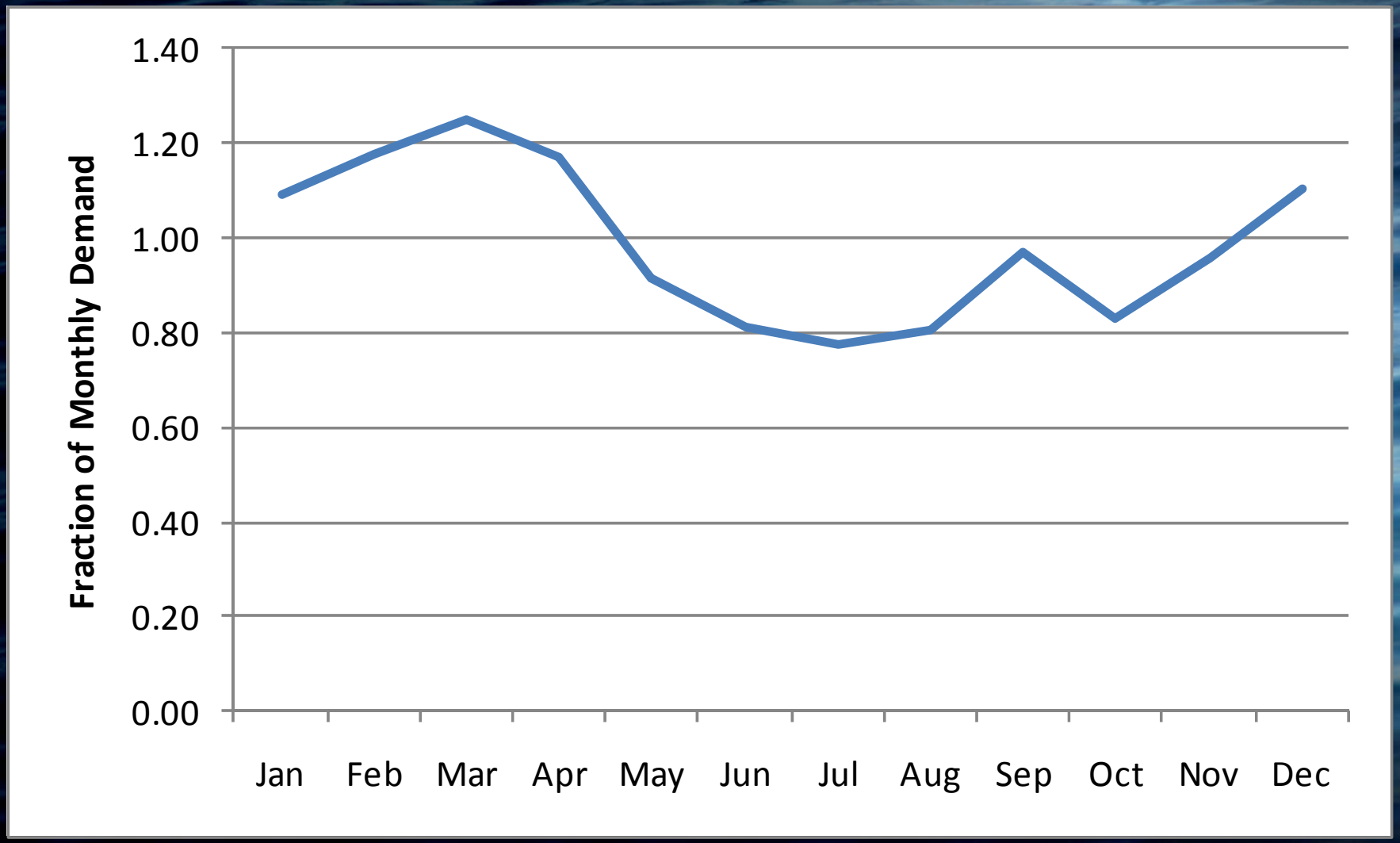
OK

Cancel



HYDROLOGICS

Wastewater Pattern

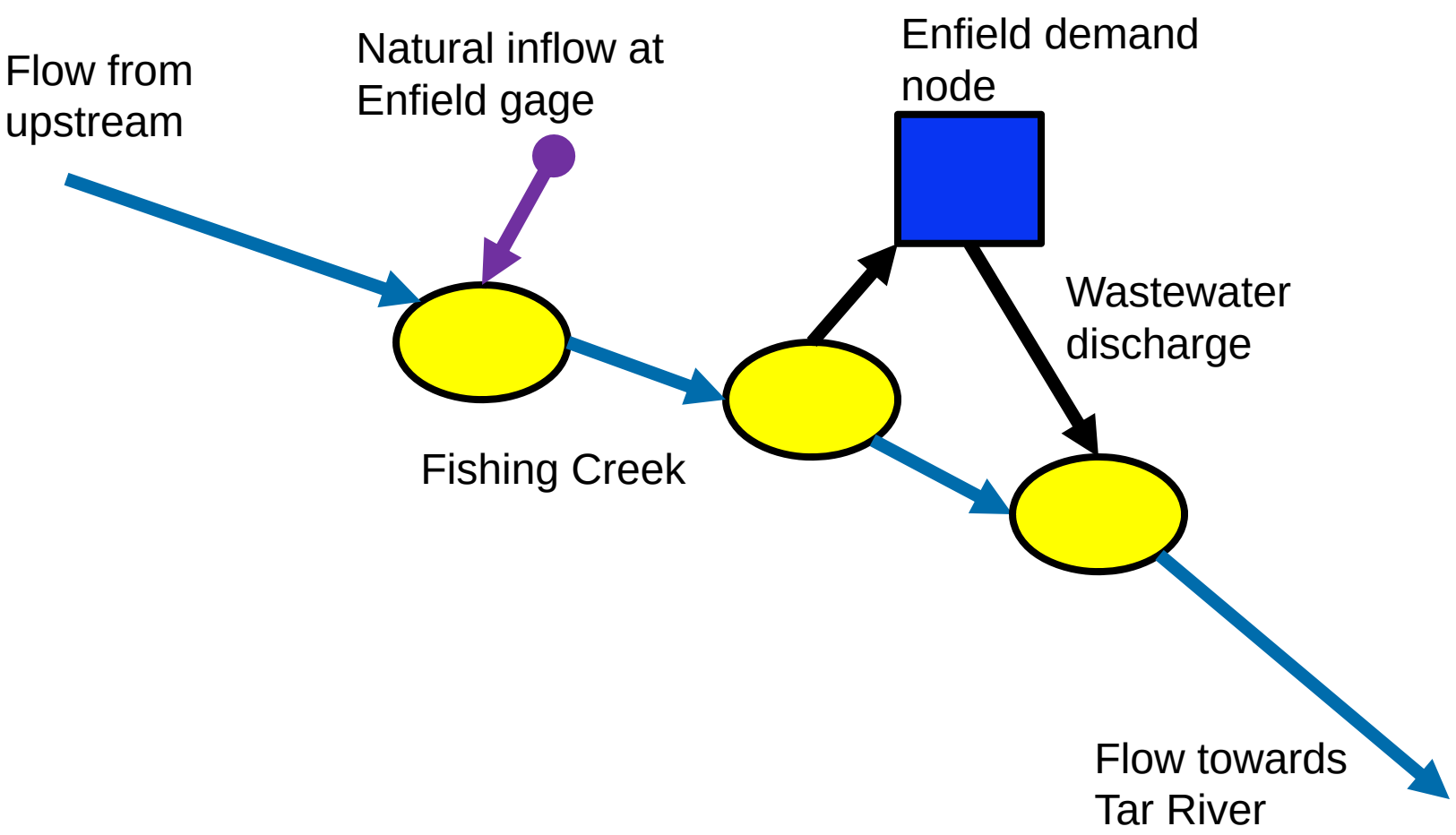


HYDROLOGICS

Enfield

- Primary source – Fishing Creek
- Annual Average Demand = 0.52 MGD
- Treatment capacity = 1 MGD
- Drought Plan
  - Stage 1 – 20% reduction in normal stream levels
    - Voluntary
  - Stage 2 – 40% reduction in normal stream levels
    - Mandatory
  - Stage 3 – 60% reduction in normal stream levels
    - Emergency
  - Used average monthly flows from period of record to define ‘normal stream levels’

Enfield System



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 226, 'Enfield Demand'

	Month	Day	Demand
▶	1	1	1.014
	1	31	1.014
	2	1	1.008
	2	29	1.008
	3	1	0.920
	3	31	0.920
	4	1	0.937
	4	30	0.937
	5	1	0.985
	5	31	0.985
	6	1	1.033
	6	30	1.033
	7	1	1.051
	7	31	1.051
	8	1	1.060
	8	31	1.060
	9	1	1.033
	9	30	1.033
	10	1	1.018
	10	31	1.018
	11	1	0.971
	11	30	0.971
	12	1	0.971
	12	31	0.971
*			

MGD Units

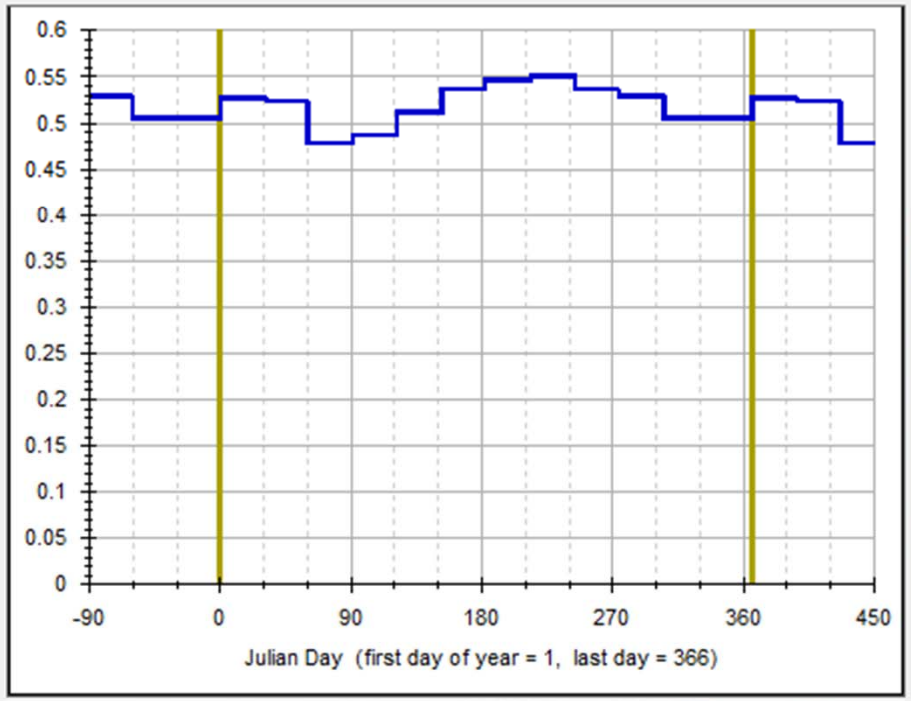
0.51899999 Multiplication Factor

Change Node

Import Data

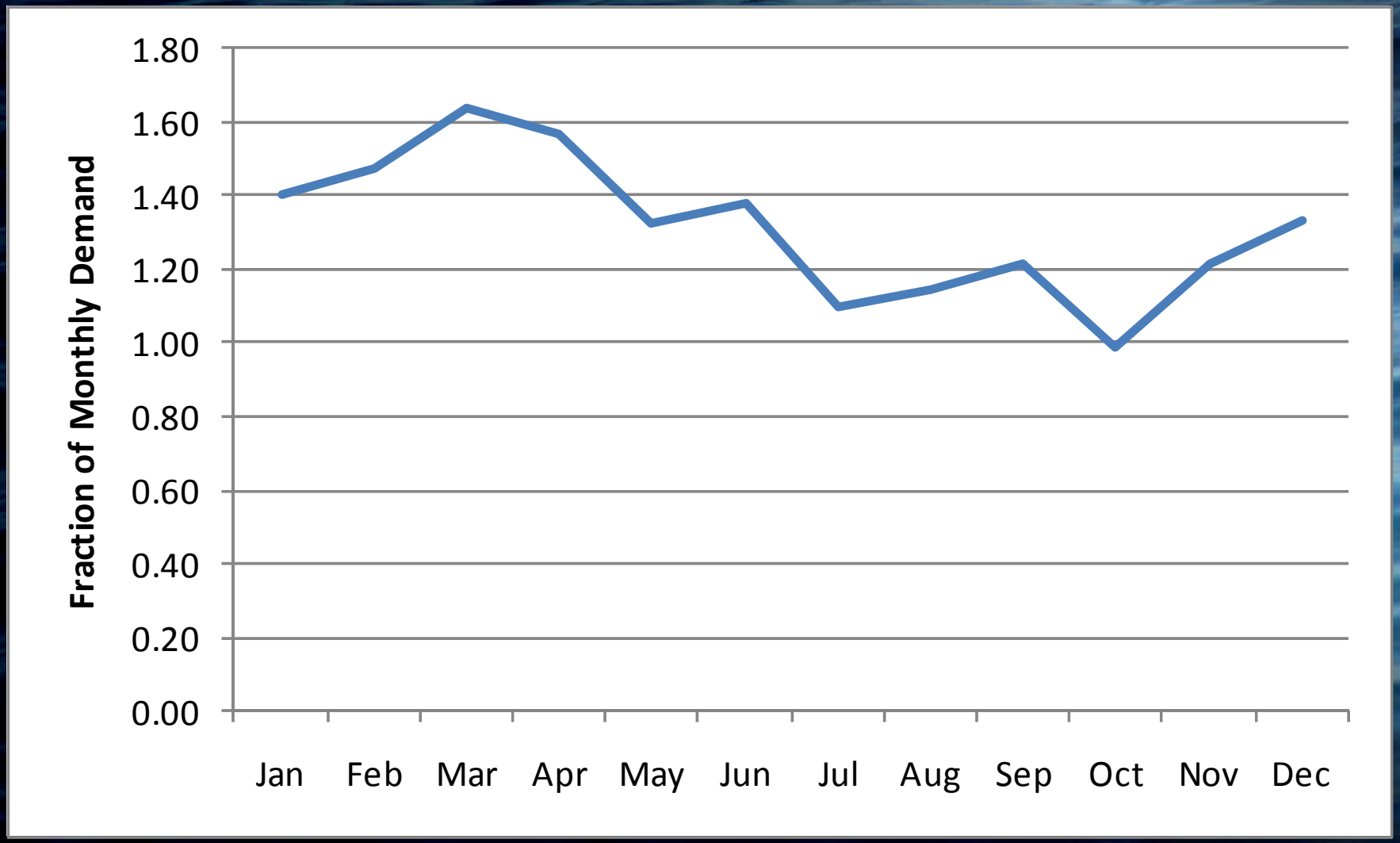
OK

Cancel



HYDROLOGICS

Wastewater Pattern

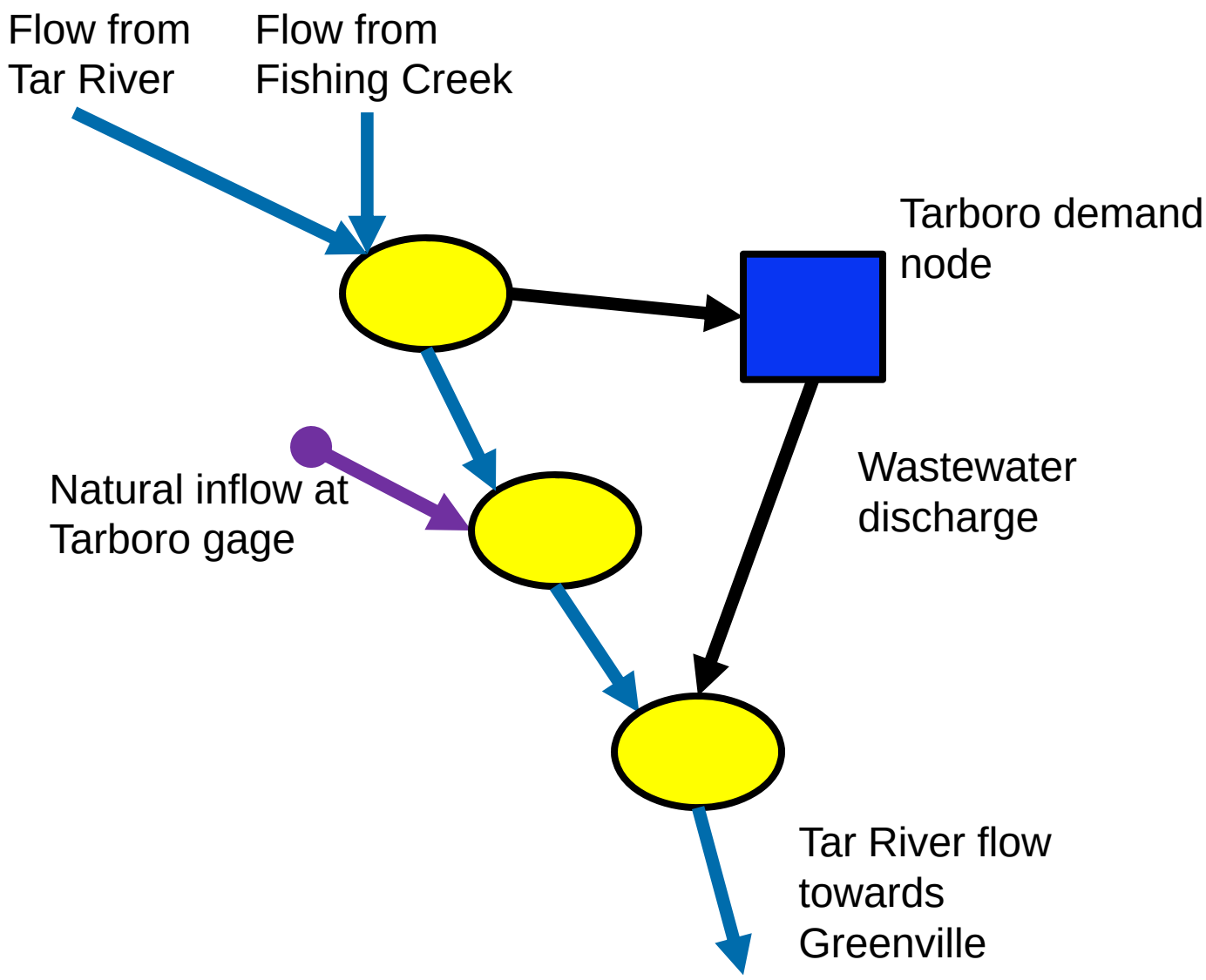


HYDROLOGICS

Tarboro

- Primary source – Tar River
- Annual Average Demand = 2.8 MGD
- Treatment capacity = 6 MGD
- Drought Plan
  - Stage 1 – Flow < 70 cfs for 7 days
    - Voluntary
  - Stage 2 – Flow < 50 cfs for 7 days
    - Mandatory
  - Stage 3 – Flow < 40 cfs for 7 days
    - Emergency
  - Stage 4 – Flow < 30 cfs for 7 days
    - Crisis

Tarboro System



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 296, 'Tarboro'

	Month	Day	Demand
▶	1	1	0.911
	1	31	0.911
	2	1	0.899
	2	29	0.899
	3	1	0.901
	3	31	0.901
	4	1	0.965
	4	30	0.965
	5	1	1.094
	5	31	1.094
	6	1	1.166
	6	30	1.166
	7	1	1.072
	7	31	1.072
	8	1	1.073
	8	31	1.073
	9	1	1.001
	9	30	1.001
	10	1	0.995
	10	31	0.995
	11	1	0.949
	11	30	0.949
	12	1	0.973
	12	31	0.973
*			

MGD Units

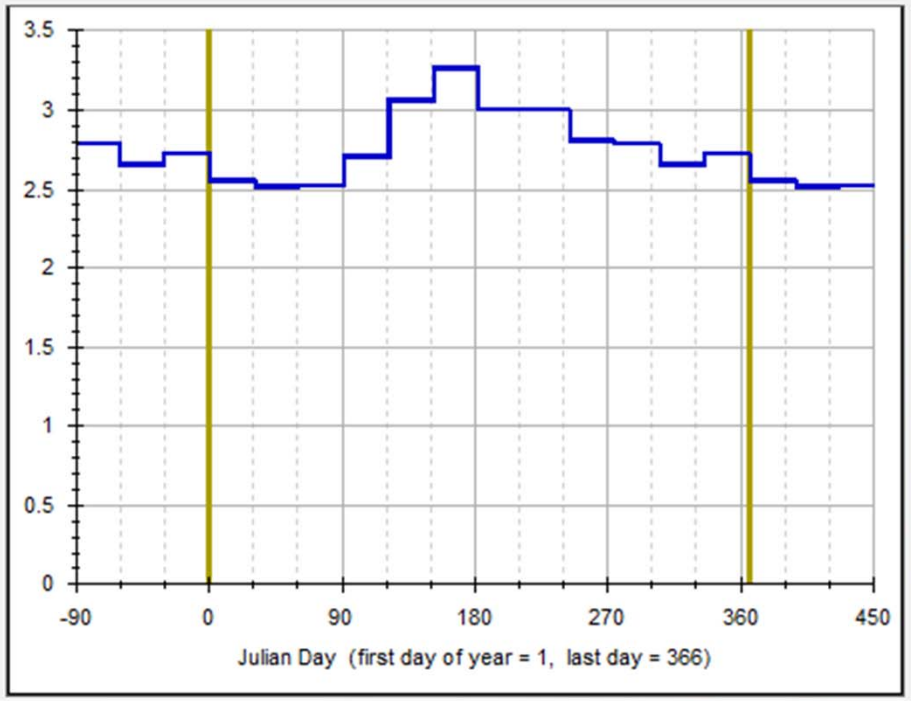
2.79699993 Multiplication Factor

Change Node

Import Data

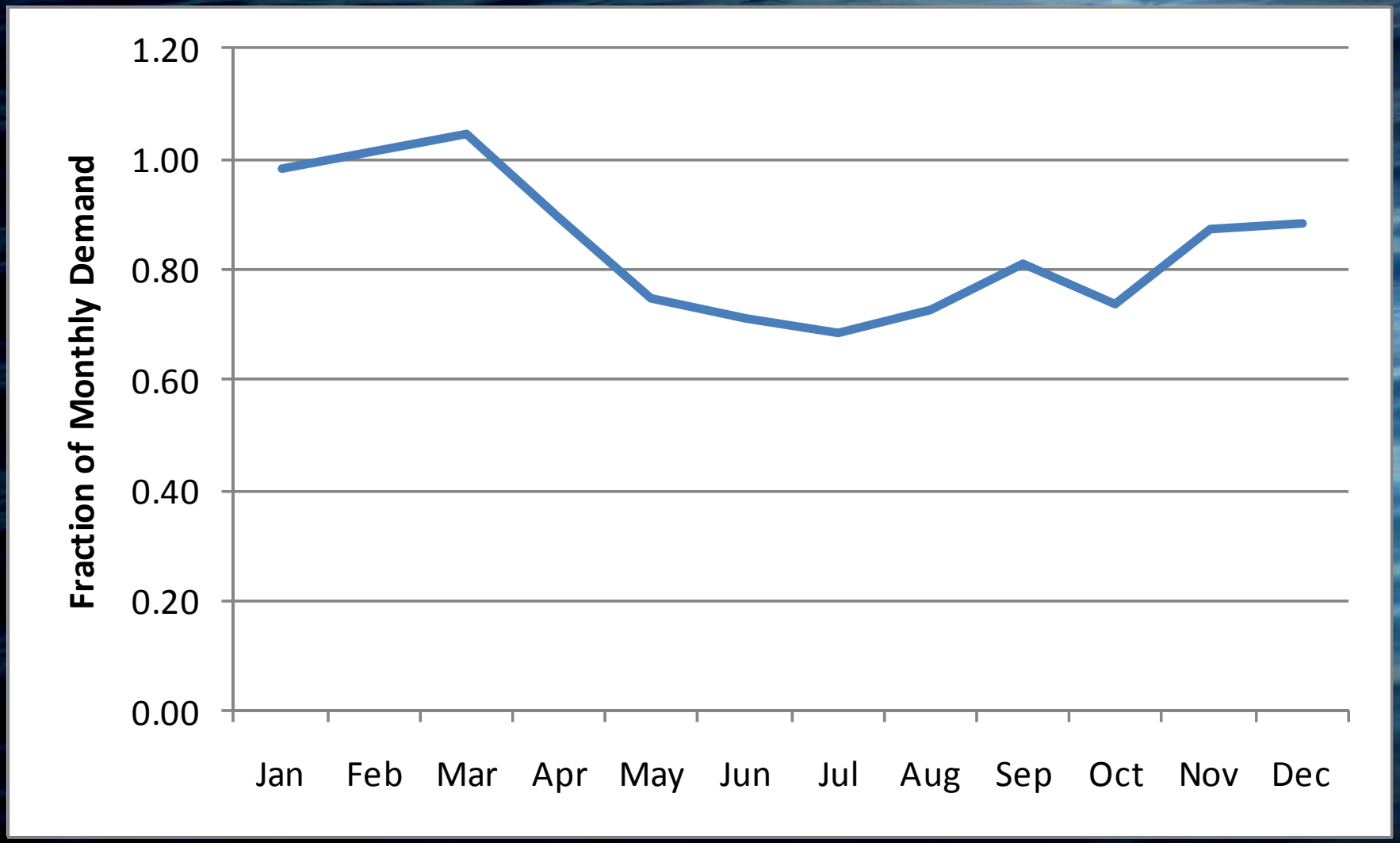
OK

Cancel



HYDROLOGICS

Wastewater Pattern

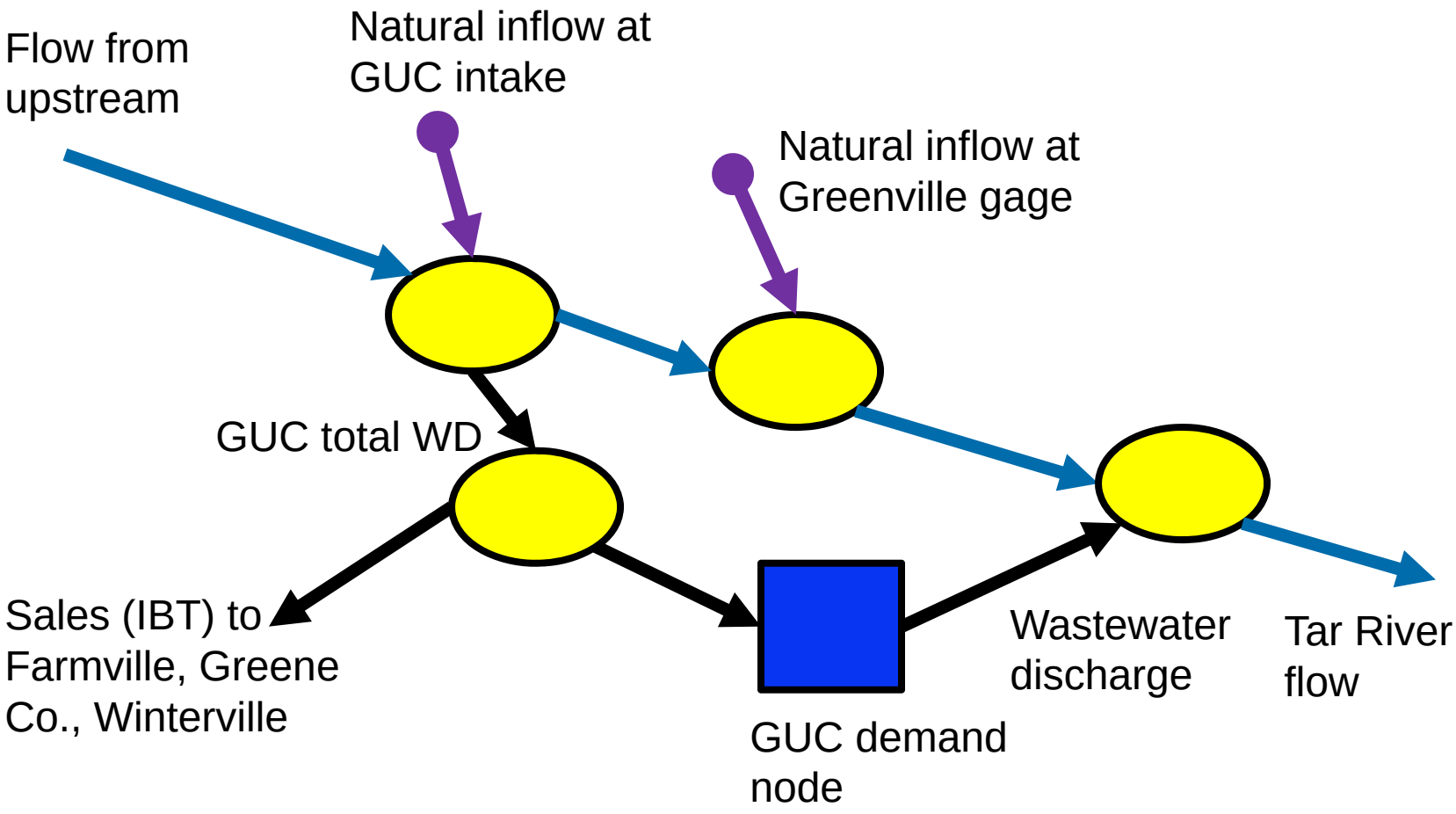


HYDROLOGICS

Greenville

- Primary source – Tar River
- Sells water (IBTs)
  - Greene Co.
  - Farmville
  - Winterville
- Annual Average Demand = 13.7 MGD
- Treatment capacity = 22.5 MGD
- Drought Plan
  - Stage 1 – Intake <= -2.0 ft msl
    - Water Shortage Alert
  - Stage 2 – Intake <= -2.5 ft msl
    - Water Shortage Warning
  - Stage 3 – Intake <= -3.5 ft msl
    - Water Shortage Danger
  - Stage 4 – Flow < 30 cfs for 7 days
    - Danger
  - Cannot convert flow to stage due to tidal influence

Greenville System



HYDROLOGICS

Demand Pattern

Demand Pattern at Node 392, 'GUC Demand'

	Month	Day	Demand
▶	1	1	0.915
	1	31	0.915
	2	1	0.922
	2	29	0.922
	3	1	0.909
	3	31	0.909
	4	1	1.000
	4	30	1.000
	5	1	1.035
	5	31	1.035
	6	1	1.083
	6	30	1.083
	7	1	1.086
	7	31	1.086
	8	1	1.114
	8	31	1.114
	9	1	1.060
	9	30	1.060
	10	1	1.019
	10	31	1.019
	11	1	0.954
	11	30	0.954
	12	1	0.903
	12	31	0.903
*			

MGD Units

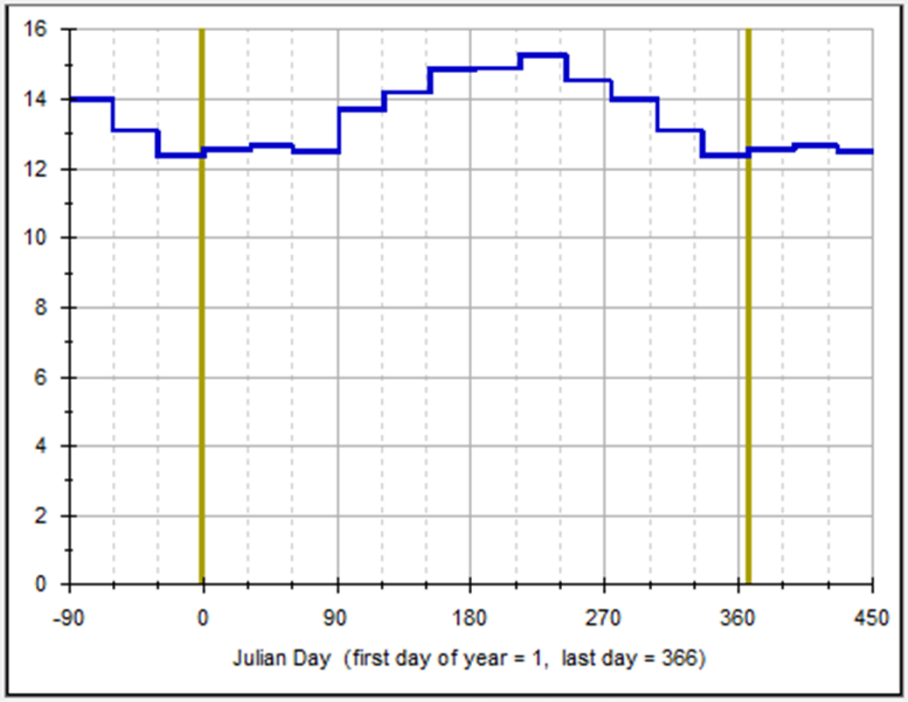
13.6990003 Multiplication Factor

Change Node

Import Data

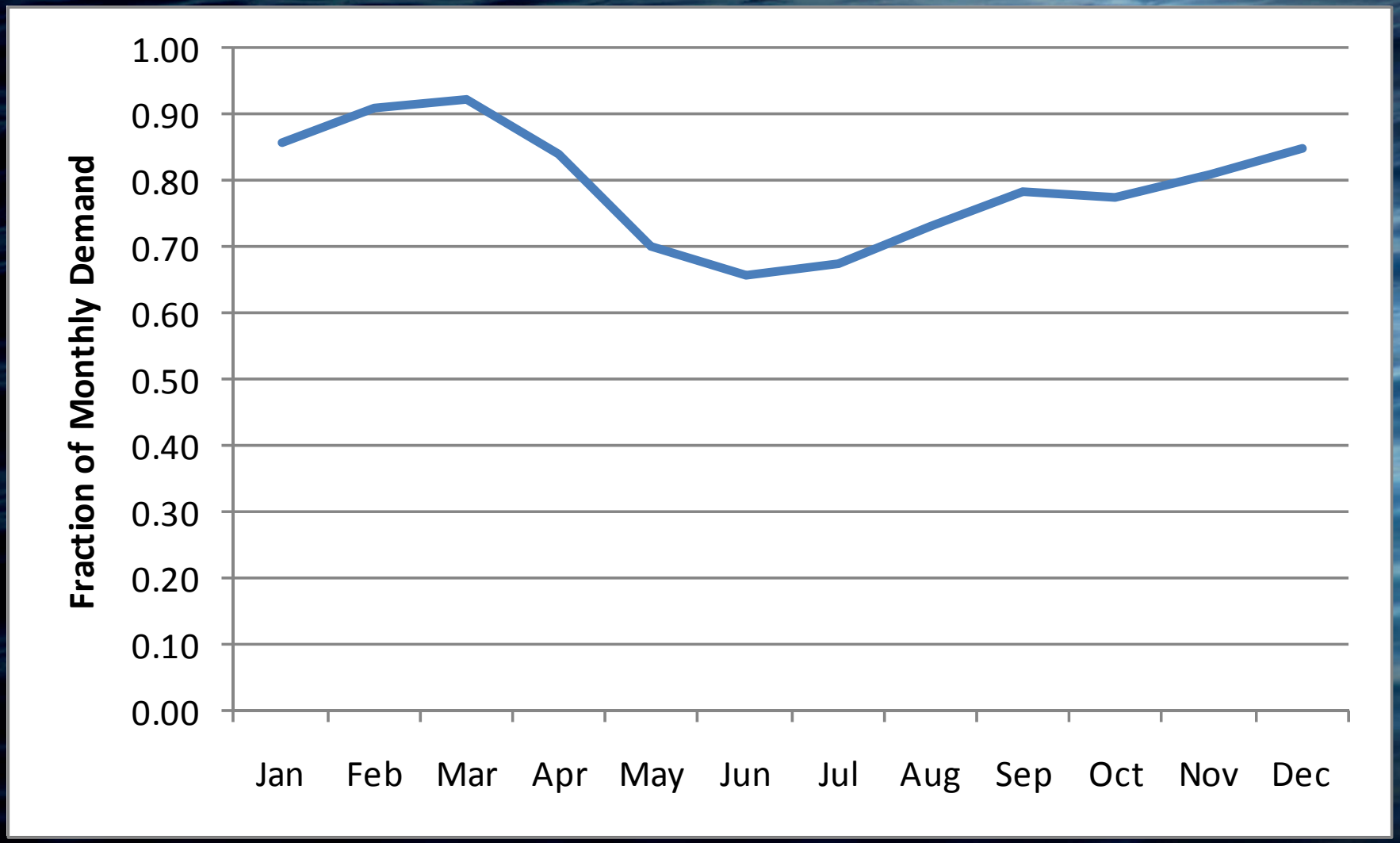
OK

Cancel



HYDROLOGICS

Wastewater Pattern



HYDROLOGICS

Summary of Basin Demands

Utility	2010 Average Annual Demand (MGD)
Louisburg	0.56
Franklinton	0.32
Franklin Co.	2.44
Rocky Mount	10.2
Enfield	0.52
Tarboro	2.80
Greenville	13.7

Additional Basin Wastewater Returns

Utility	2010 Average Annual Return (MGD)
Bunn	0.09
Spring Hope	0.09
Hospira	0.74
EdgeGen	0.12
Pinetops	0.24
Macclesfield	0.03
Oxford	1.68
Warrenton	0.49
Littleton	0.07
Scotland Neck	1.03

Transfers To / From the Basin

Transfer	2010 Average Annual Transfer (MGD)	Max Transfer Capacity (MGD)
Kerr RWS* (to Oxford, Franklin Co., Warrenton)	4.1	11.0 (contractual)
Halifax* (to Littleton, Scotland Neck	1.1	1.075 (contractual)
Wilson to/from Rocky Mount	Emergency only	3.5 MGD (pipe capacity)
Greenville IBT (to Greene Co., Farmville, Winterville)	2.3	13.5 (max day IBT)

* The Tar model only accounts for the amount of the transfer that is ultimately discharged as WW into the Tar Basin

2060 Demand Projections

Summary of Basin Demands

Utility	2010 Average Annual Demand (MGD)	2060 Average Annual Demand (MGD)
Louisburg	0.56	0.90
Franklinton	0.32	0.47
Franklin Co.	2.44	11.4
Rocky Mount	10.2	15.1
Enfield	0.52	0.56
Tarboro	2.80	4.92
Greenville	13.7	18.5

Additional Basin Wastewater Returns

Utility	2010 Average Annual Return (MGD)	2060 Average Annual Return (MGD)
Bunn	0.09	0.13
Spring Hope	0.09	0.23
Hospira	0.74	0.74
EdgeGen	0.12	0.12
Pinetops	0.24	0.23
Macclesfield	0.03	0.03
Oxford	1.68	1.74
Warrenton	0.49	0.45
Littleton	0.07	0.07
Scotland Neck	1.03	0.56

Transfers To / From the Basin

Transfer	2010 Average Annual Transfer (MGD)	2060 Average Annual Transfer (MGD)
Kerr RWS* (to Oxford, Franklin Co., Warrenton)	4.1	11.2
Halifax* (to Littleton, Scotland Neck	1.1	0.6
Wilson to/from Rocky Mount	Emergency only	Emergency only
Greenville IBT (to Greene Co., Farmville, Winterville)	2.3	5.1

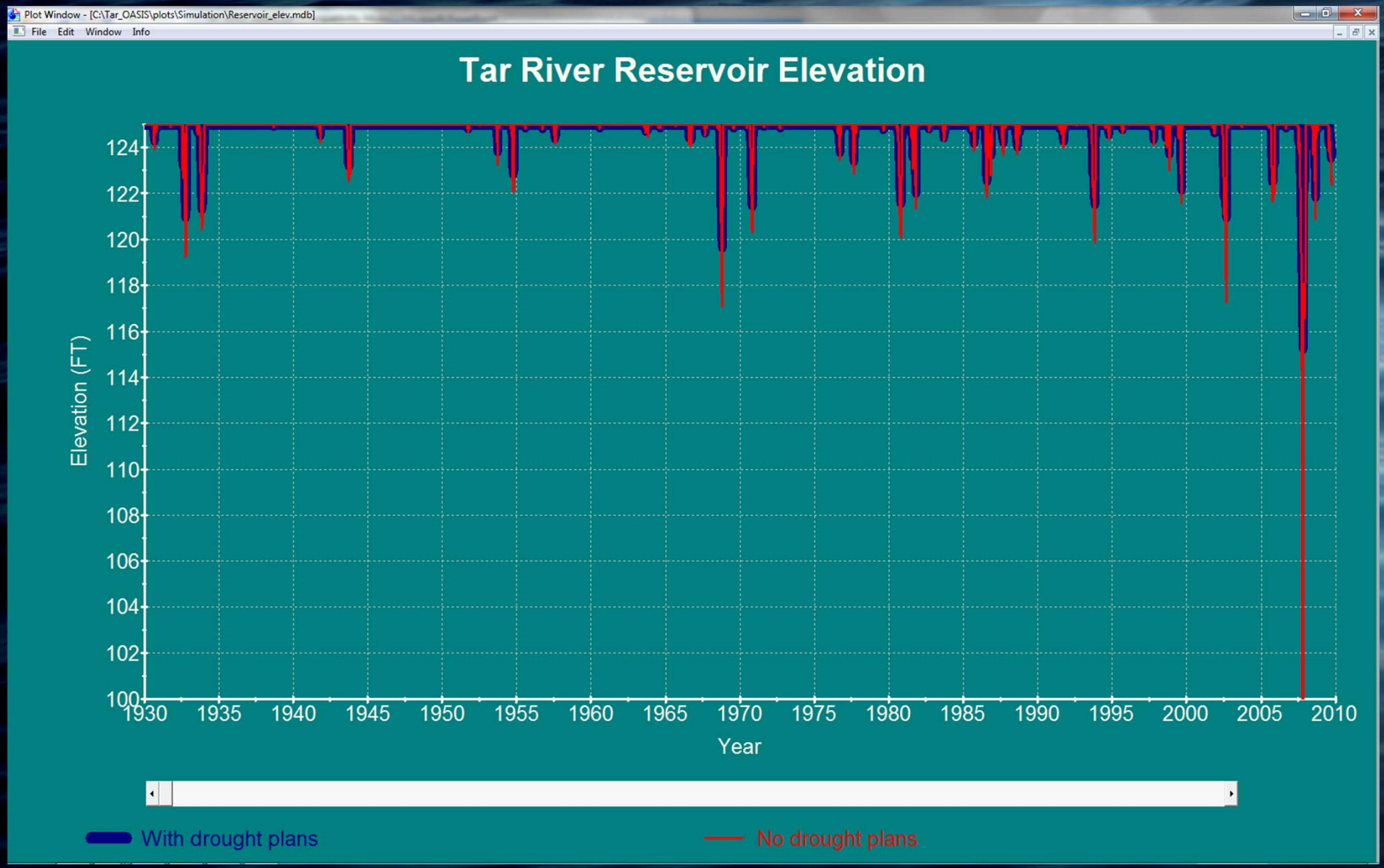
* The Tar model only accounts for the amount of the transfer that is ultimately discharged as WW into the Tar Basin

HYDROLOGICS

Assessing Impact of Drought Plans

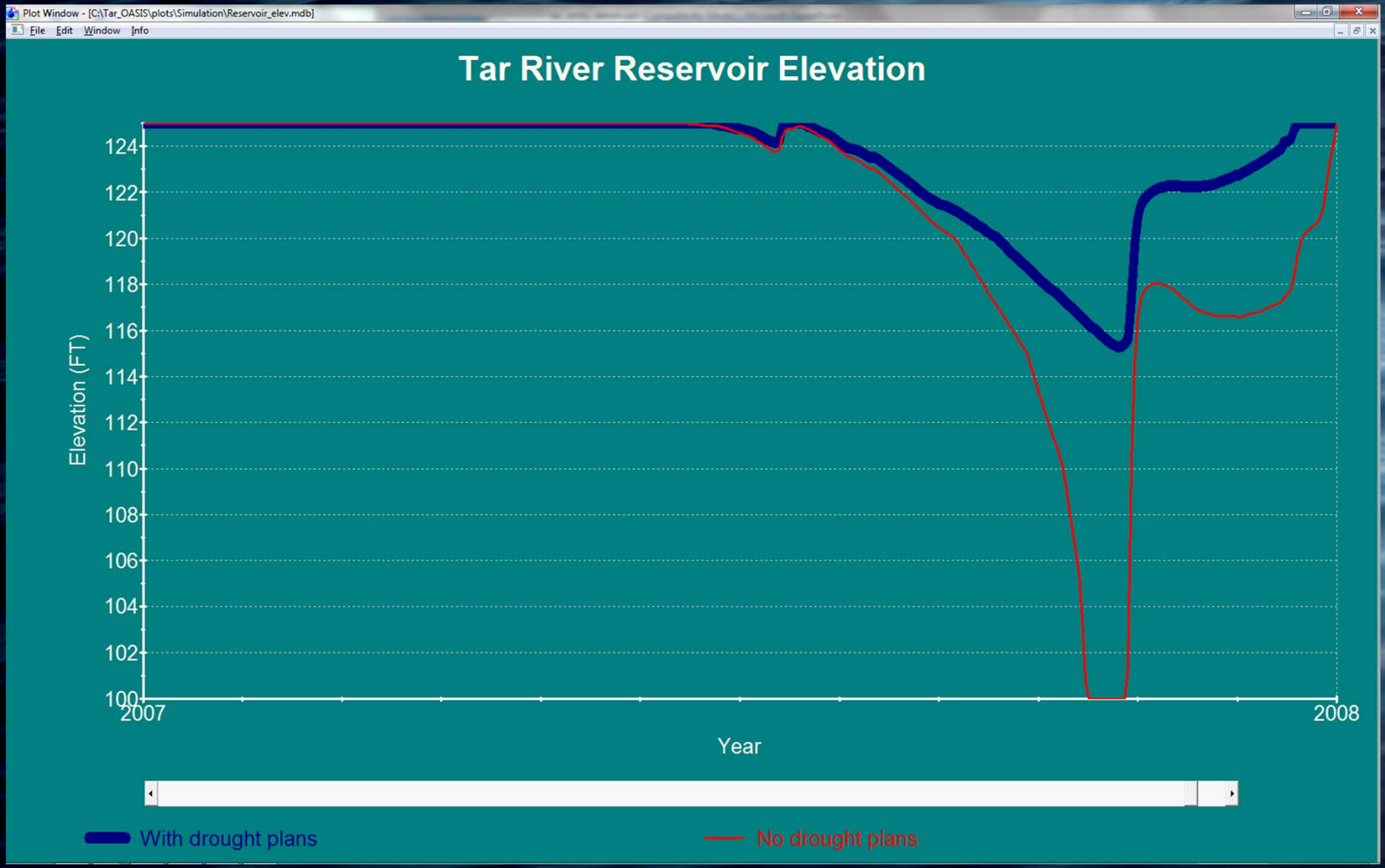
- Compare flow and reservoir storage with and without drought plans
- Analyze trigger activation frequency and duration
- Focus is on current demand levels

Impact of Drought Plans



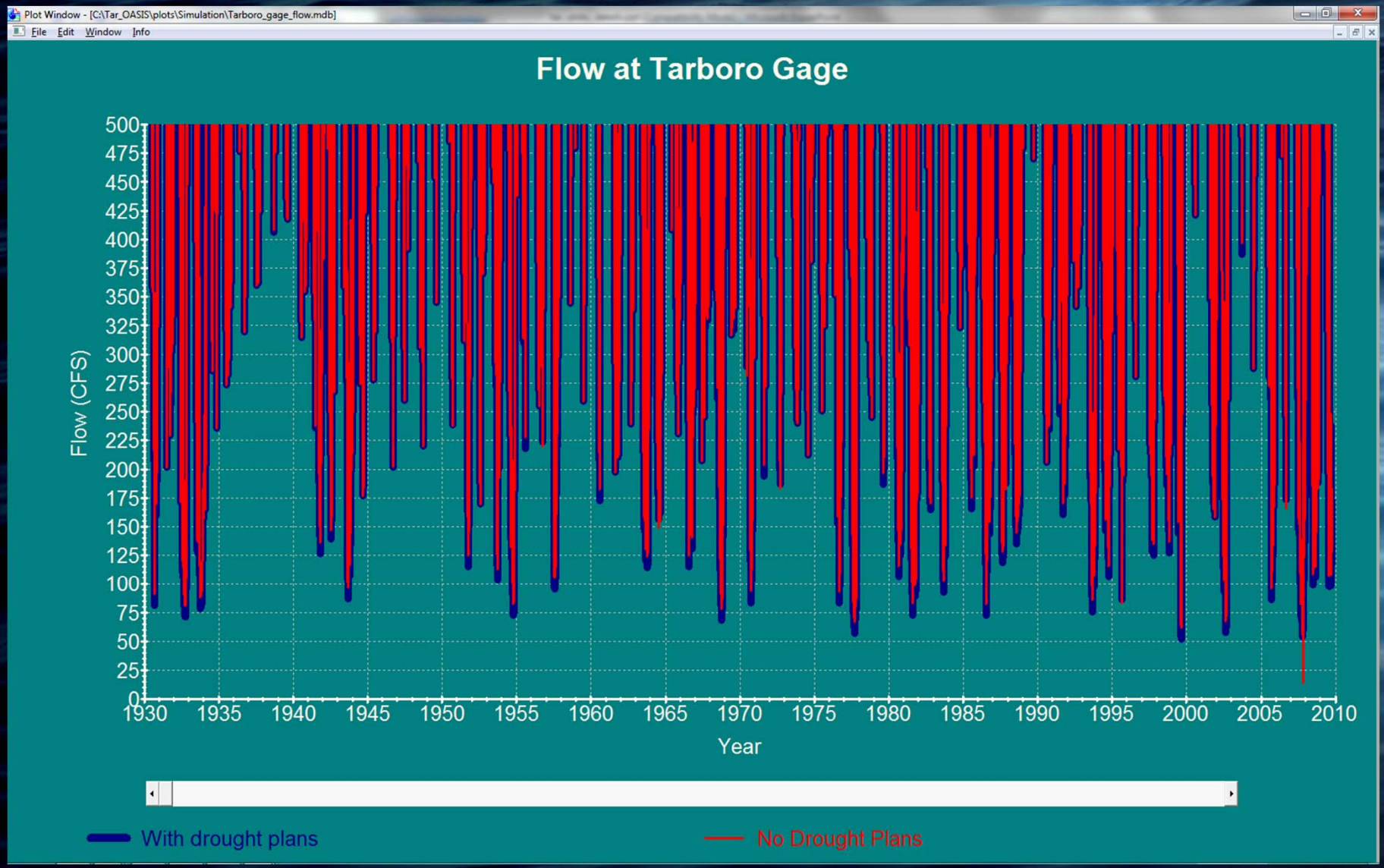
HYDROLOGICS

Impact of Drought Plans (cont'd)



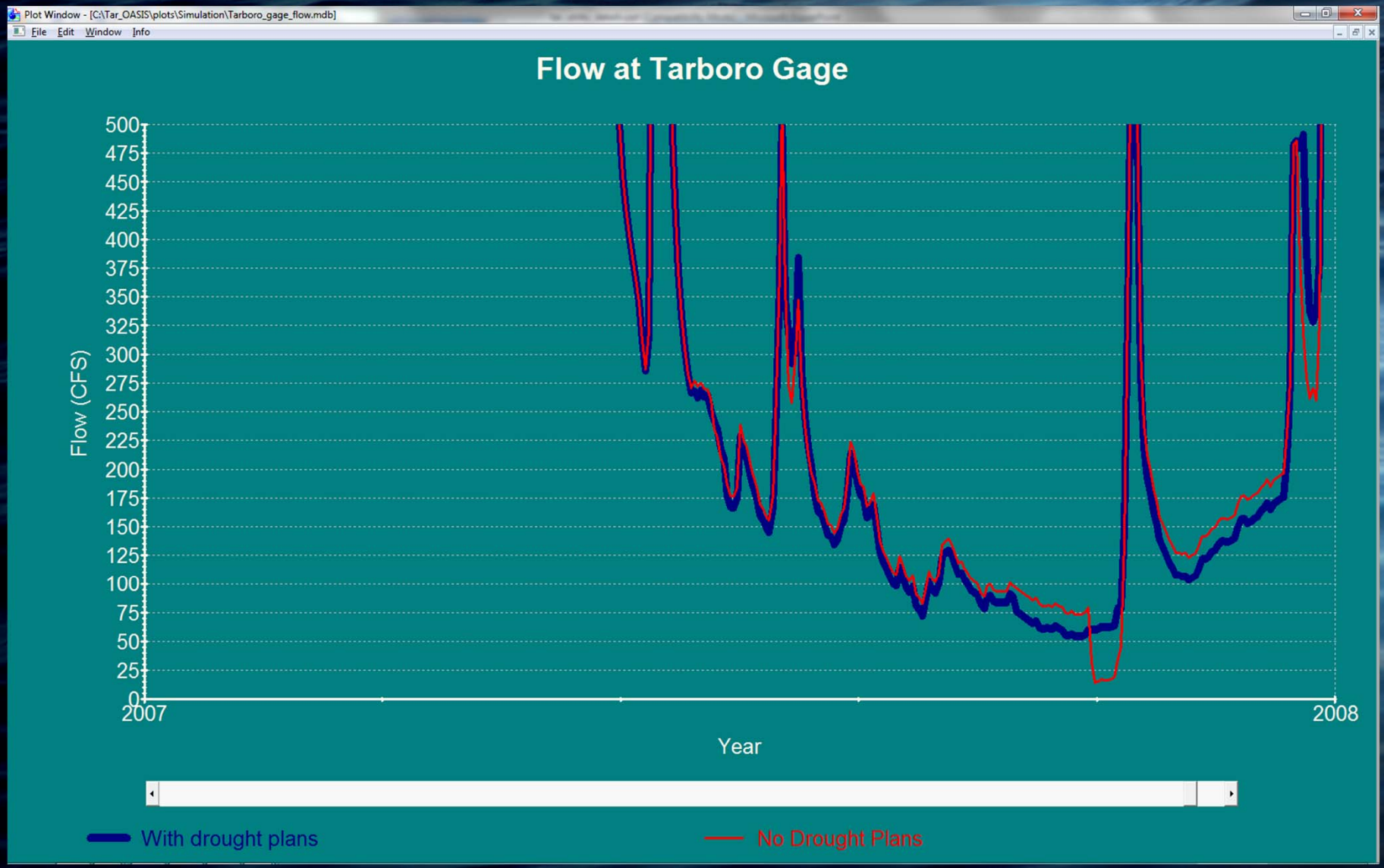
HYDROLOGICS

Impact of Drought Plans (cont'd)



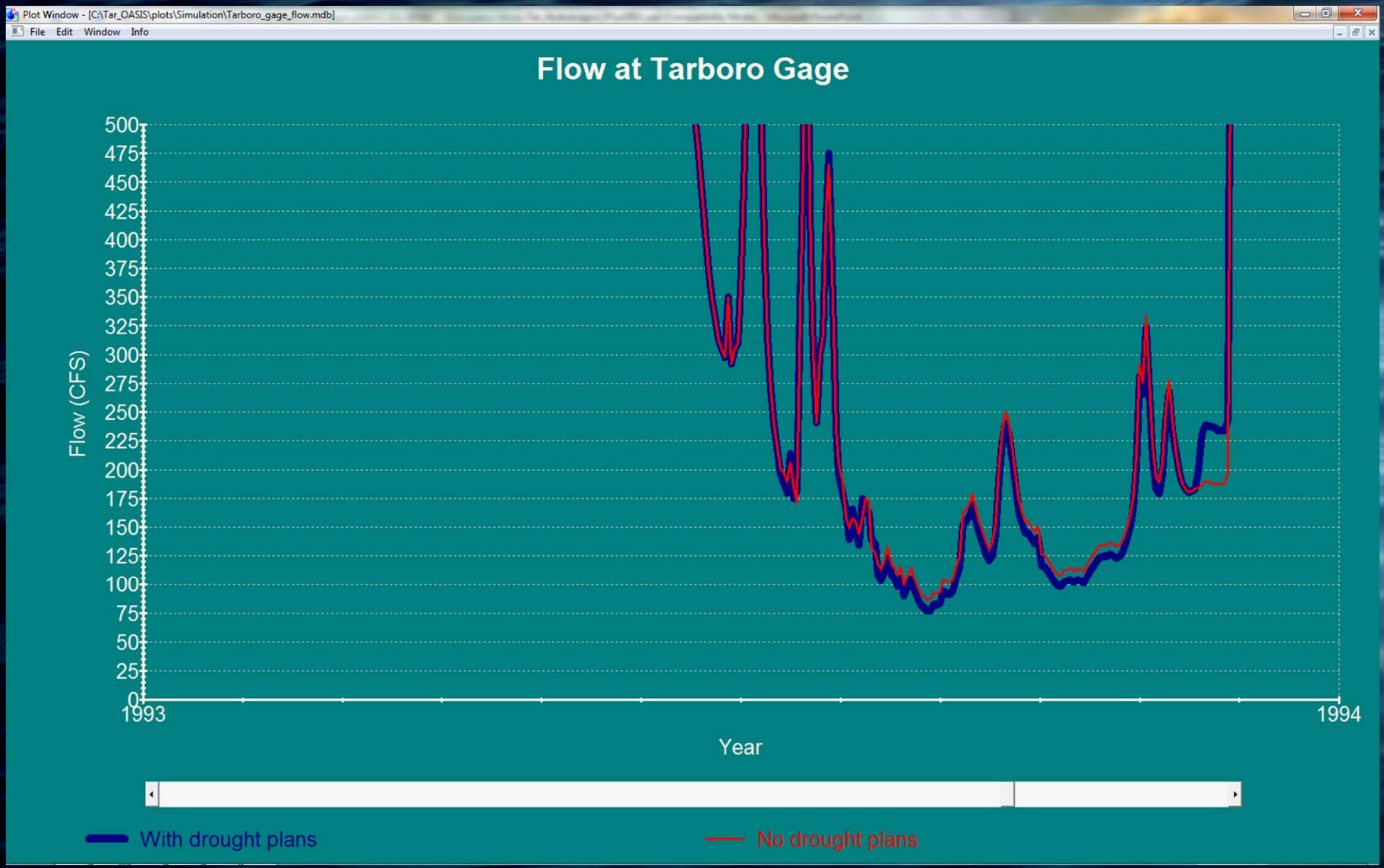
HYDROLOGICS

Impact of Drought Plans (cont'd)



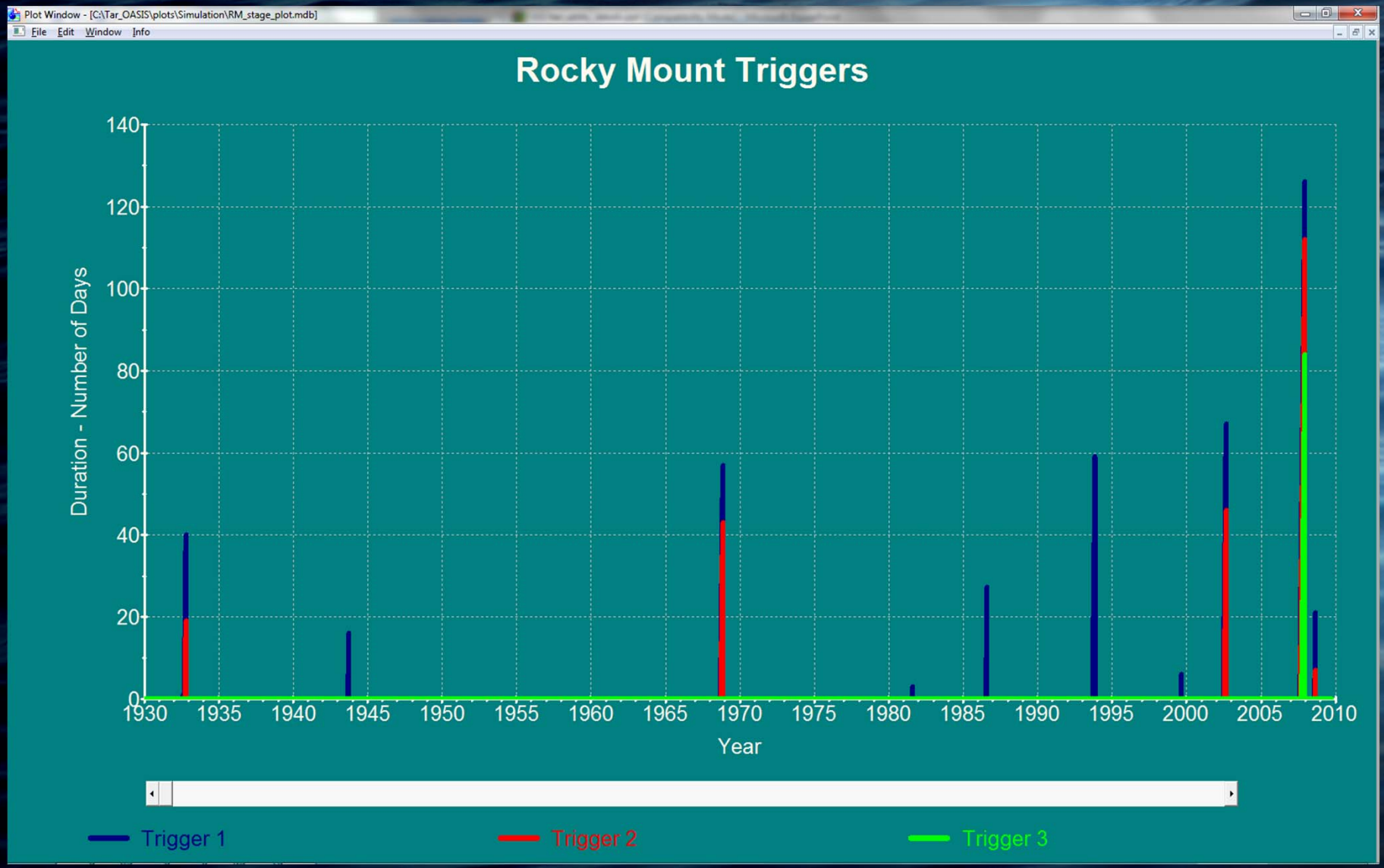
HYDROLOGICS

Impact of Drought Plans (cont'd)



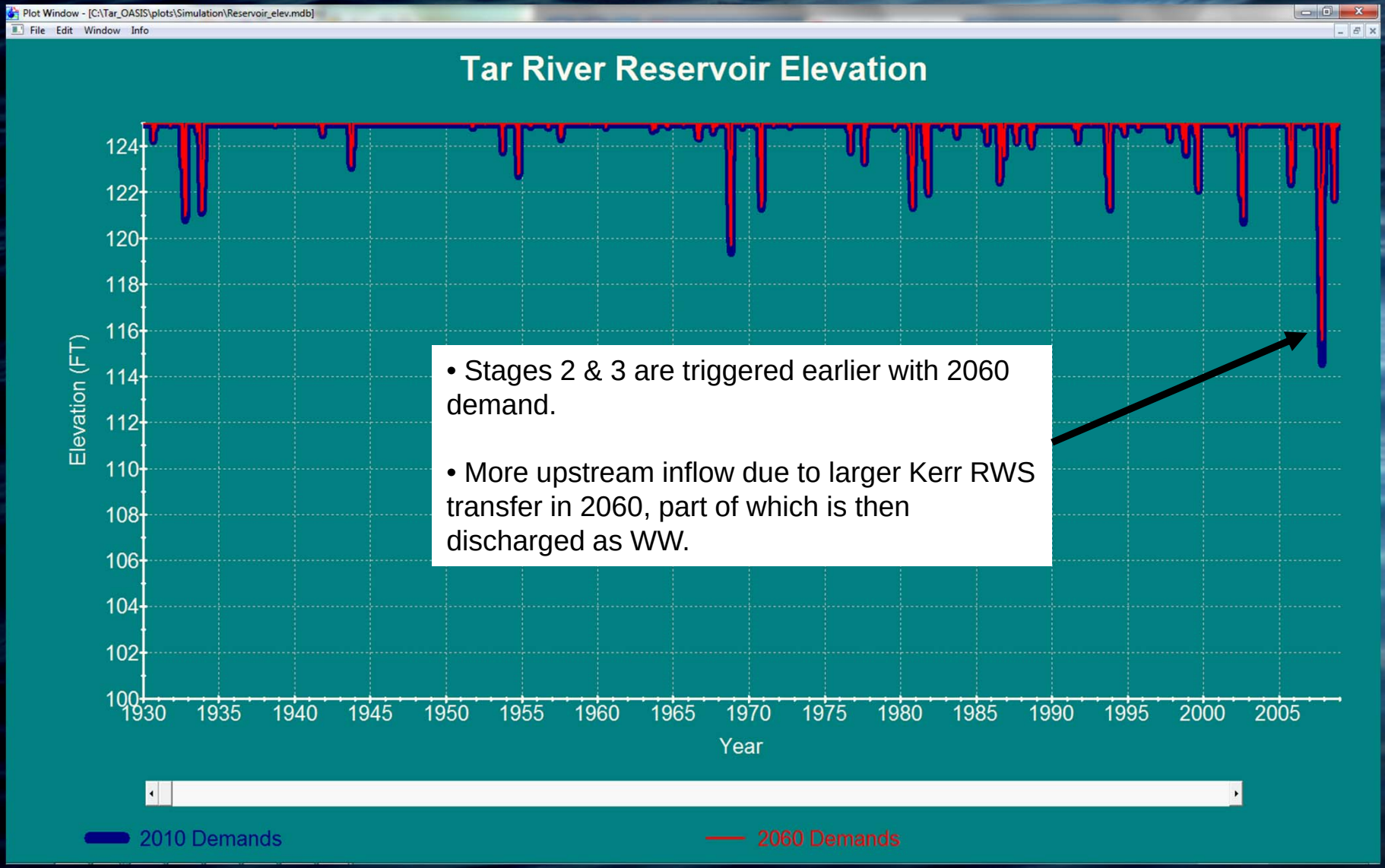
HYDROLOGICS

Drought Plan Activation Frequency & Duration



HYDROLOGICS

Impact of Future Demands



HYDROLOGICS