Effects of Future Water Demands and Climate Change on Fox River Water Availability

Vernon Knapp, Senior Hydrologist
Center for Watershed Science
Illinois State Water Survey
University of Illinois

This presentation will show the following results:

- The Fox River has the potential, if needed, to supply as much as 50% of new water demands.
- This potential is based on the increase of water initially withdrawn from groundwater and discharged to the river as effluent.
- Watershed modeling suggests that the potential effect of climate change on Fox River low flows is considerably less than the effects of effluents and withdrawals, and thus does not substantially alter the water supply potential of the river.

Primary factors affecting Fox River low flow availability

1. Water supply withdrawals (current withdrawals are Elgin and Aurora)
2. Effluent discharges
3. Climate change
4. Operation of Stratton Dam / Fox Chain of Lakes

Surface water models used in the analysis

- Fox River Surface Water Accounting Model – effects of changes in water withdrawals and effluent discharges
- Fox River Watershed Model (SWAT) – effect of potential climate change
- Results from a Chain of Lakes water budget model (1988) – sensitivity of lake outflow to changes in inflow

Why 3 models?

- The Surface Water Accounting Model, based on statistical flow relationships, is the most accurate for predicting streamflow frequency and the effects of withdrawals and discharges – but cannot determine impacts of climate change
- Watershed models can estimate relative impacts in flow from climate and land use change, but are not accurate predictors of flow amounts
- The Chain of Lakes water budget model provides simulation of the relationship between lake level, gate operation, and outflow

Fox River 2050 Demand Scenarios – Basic Assumptions

- No change from existing sources – except where noted. Elgin and Aurora withdraw from the Fox River, all other water supply comes from groundwater.
- No change in existing discharge locations: all water used in the Fox watershed is discharged to the river/tributaries after use
- Increases in effluent discharges are proportional to water use growth

2050 Scenarios – Change in Water Use (%)

Current Trends (CT), Less/More Resource Intensive (LRI / MRI)

	CT	LRI	MRI
Elgin	+82	+41	+117
Aurora	+25	-3	+49
Crystal Lake	+16	-10	+38
Oswego	+223	+151	+285
Kane County (Residual)	+145	+45	+229
Kendall County (Residual)	+804	+359	+1280
Lake County	+86	+45	+121
McHenry County (Residual)	+121	+39	+238
Waukesha County, WI	+132	(+45)	---
Walworth County, WI	+147	(+45)	---

2050 Climate Change Scenarios

Change from 1971-2000 Baseline Condition

Change in Temperature

Change in Precip

No Change (Baseline)	+ 3F Temp	+6F Temp
+ 5” Precip	+3F, +5”	+6F, +5”
– 5” Precip	+3F, – 5”	+6F, – 5”

+ Historical Climate Record from 1931-1960

What is the projected 2050 change in flow upstream of Stratton Dam?

- Low flow effluents to Fox River upstream of Stratton Dam:
  - Waukesha region – 12 mgd
  - Remainder of Wisconsin – 4 mgd
  - Illinois – 9 mgd
- One big question still is whether the Waukesha region will be permitted to use lake water
- If Waukesha is able to use lake water, it would reduce the amount of effluent discharged to the Fox River (–12 mgd)

Impact of Water Demand on Stratton Dam inflows

- Regardless of what happens with Waukesha, effluents from other communities upstream of Stratton Dam will continue to grow

NET CHANGE IN LOW FLOW BY 2050 (mgd)

	CT	LRI
Waukesha – groundwater	+28	+11
Waukesha to lake	+2	– 6

Impact of Climate Change on Stratton Dam inflows

CHANGE IN LOW FLOW (mgd)

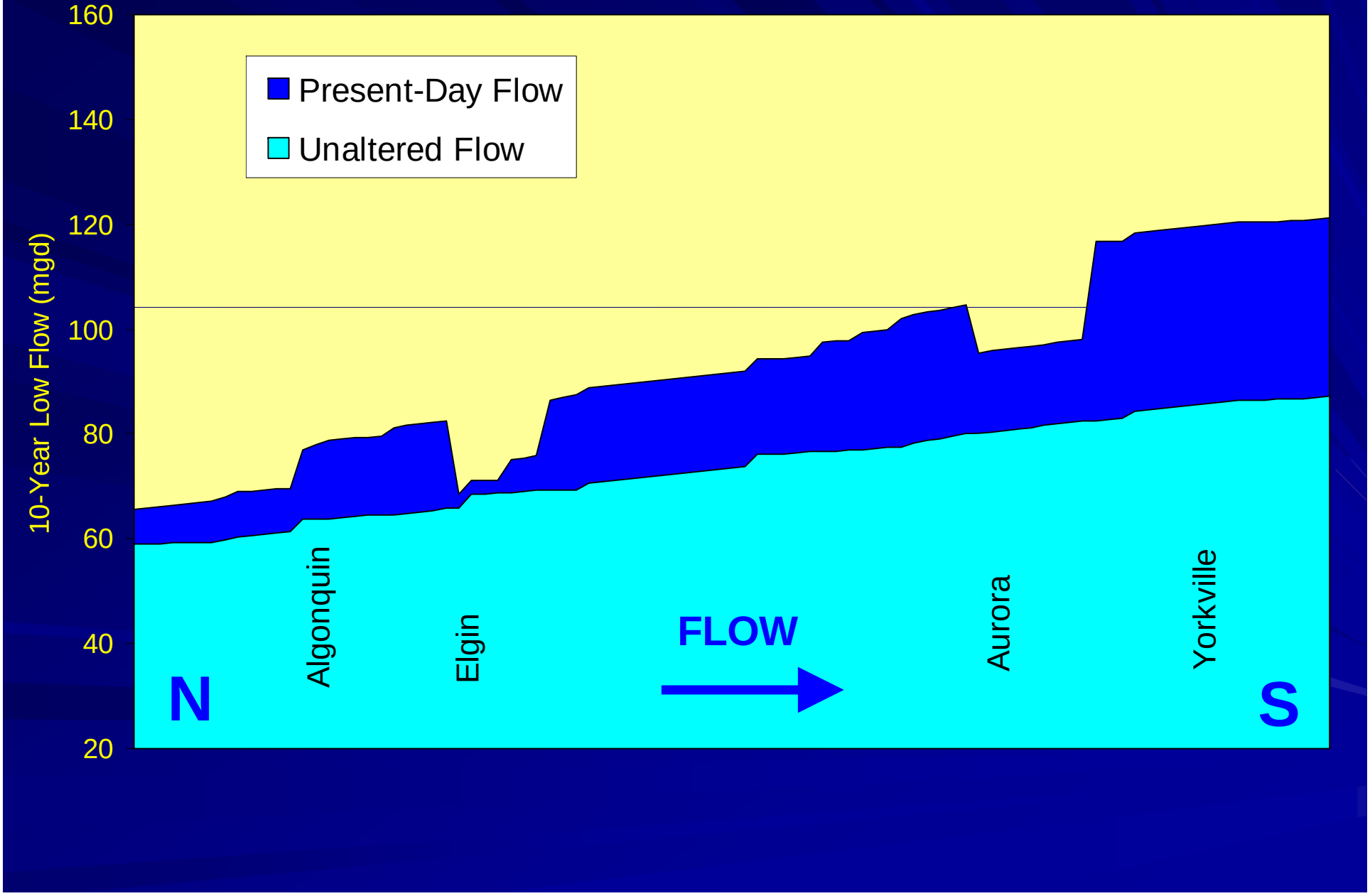
	No Temp Change	+ 3F Temp	+6F Temp
No Precip Change	0	– 4	– 6
+ 5” Precip	+ 7	+ 2	– 4
– 5” Precip	– 4	– 6	– 8

1931-1960 Historical Period – 3 mgd

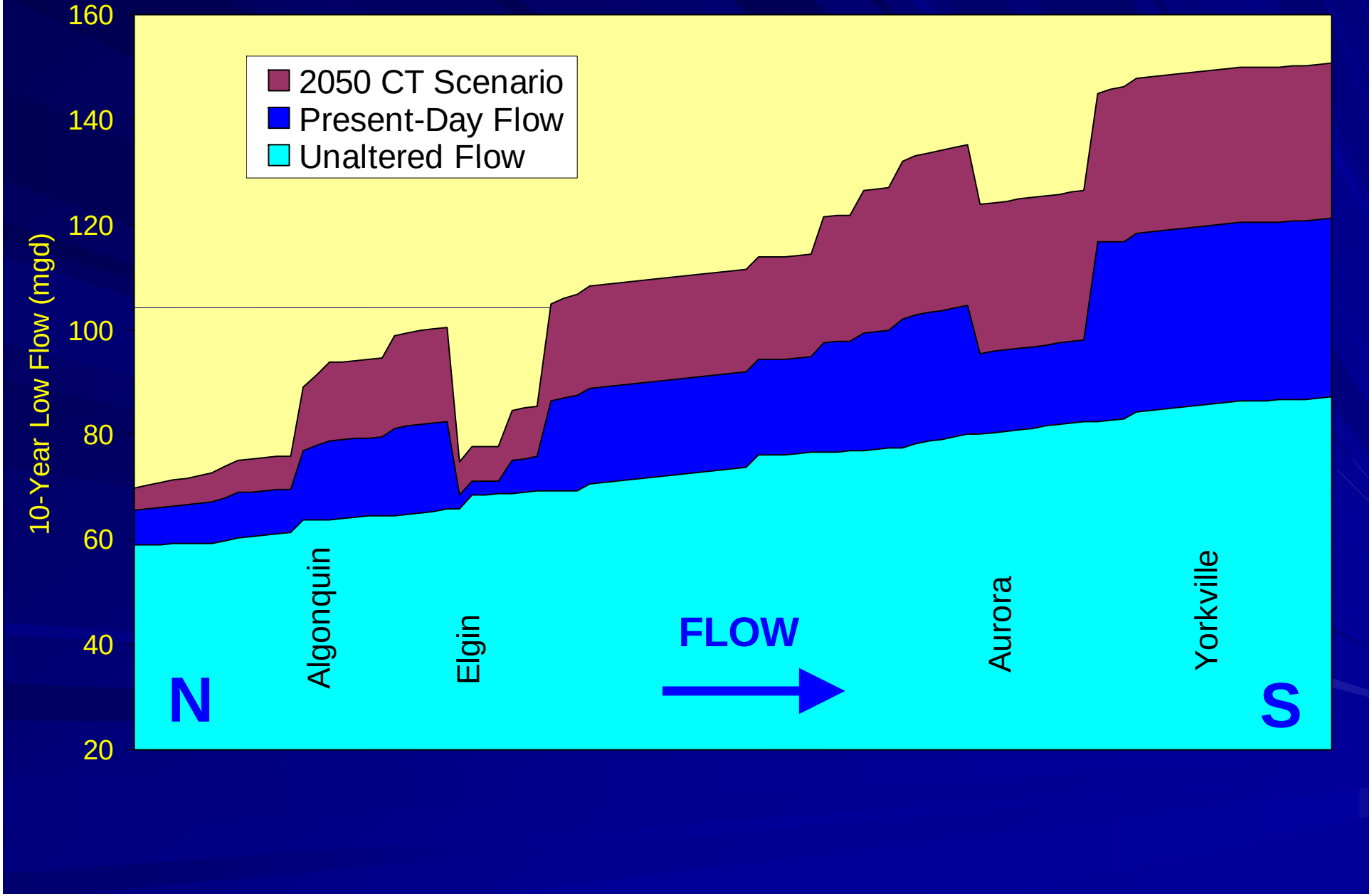
Net change in low flow released from Stratton Dam

- Inflows changes resulting from climate change alone would probably not be sufficient to bring about a change in Stratton Dam operation
- Conservative assumption: Waukesha will switch to Lake Michigan water with effluents piped back to the lake – with likely no net change to Stratton Dam low flow releases
- But, if Waukesha continues to discharge effluents to the Fox River, the increase in low flows could likely lead to an increase in minimum flow releases from Stratton Dam

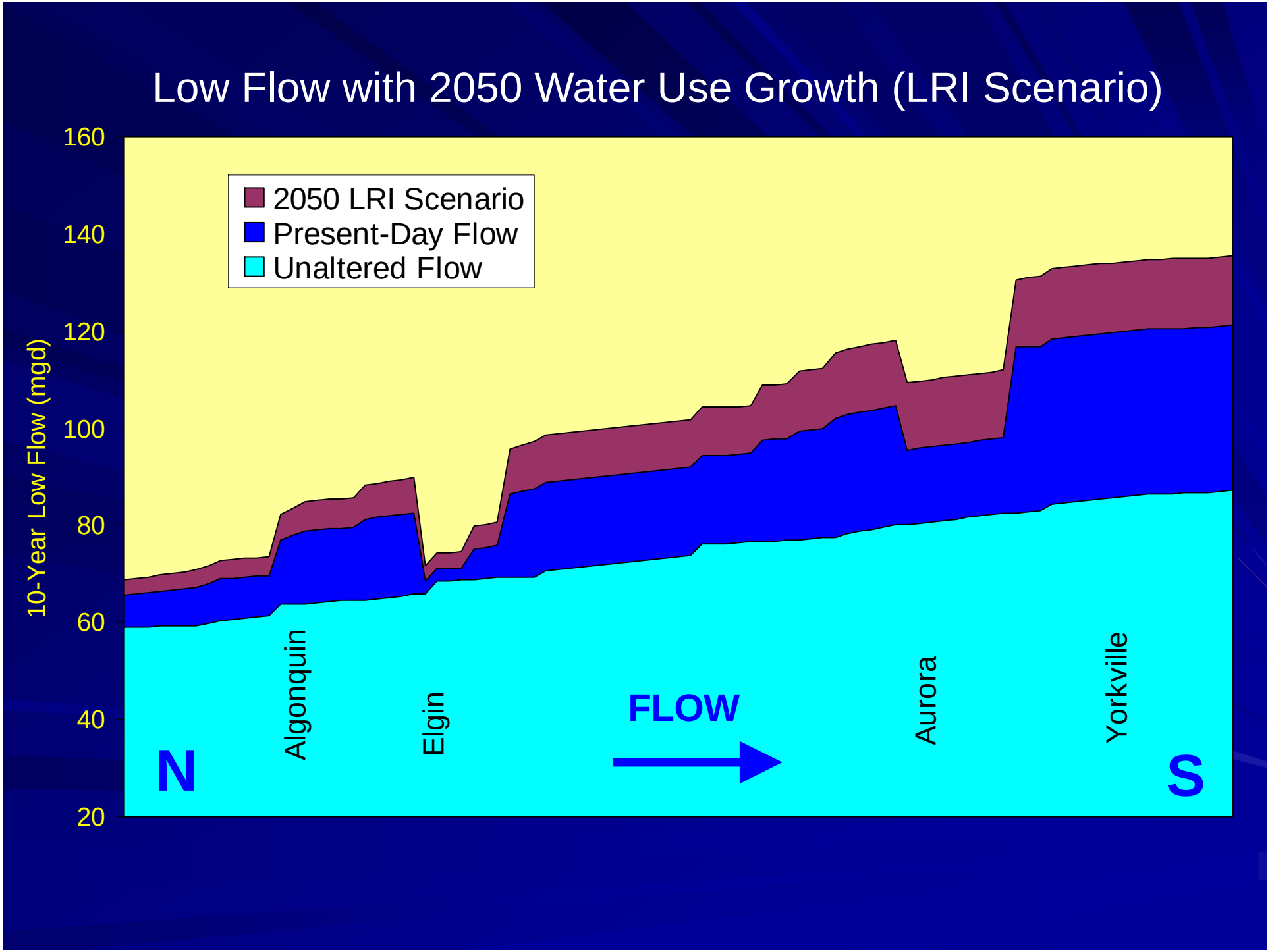
Change in Low Flow Amount on the River (North to South)



Low Flow with 2050 Water Use Growth (Current Trends)



Low Flow with 2050 Water Use Growth (LRI Scenario)



Cumulative Impact on Low Flows at Yorkville

- Impacts of Effluent Discharges and Increased Withdrawals at Elgin & Aurora:
  - + 29 mgd (CT scenario)
  - + 14 mgd (LRI scenario)
- Impacts of Climate Change Scenarios (mgd):

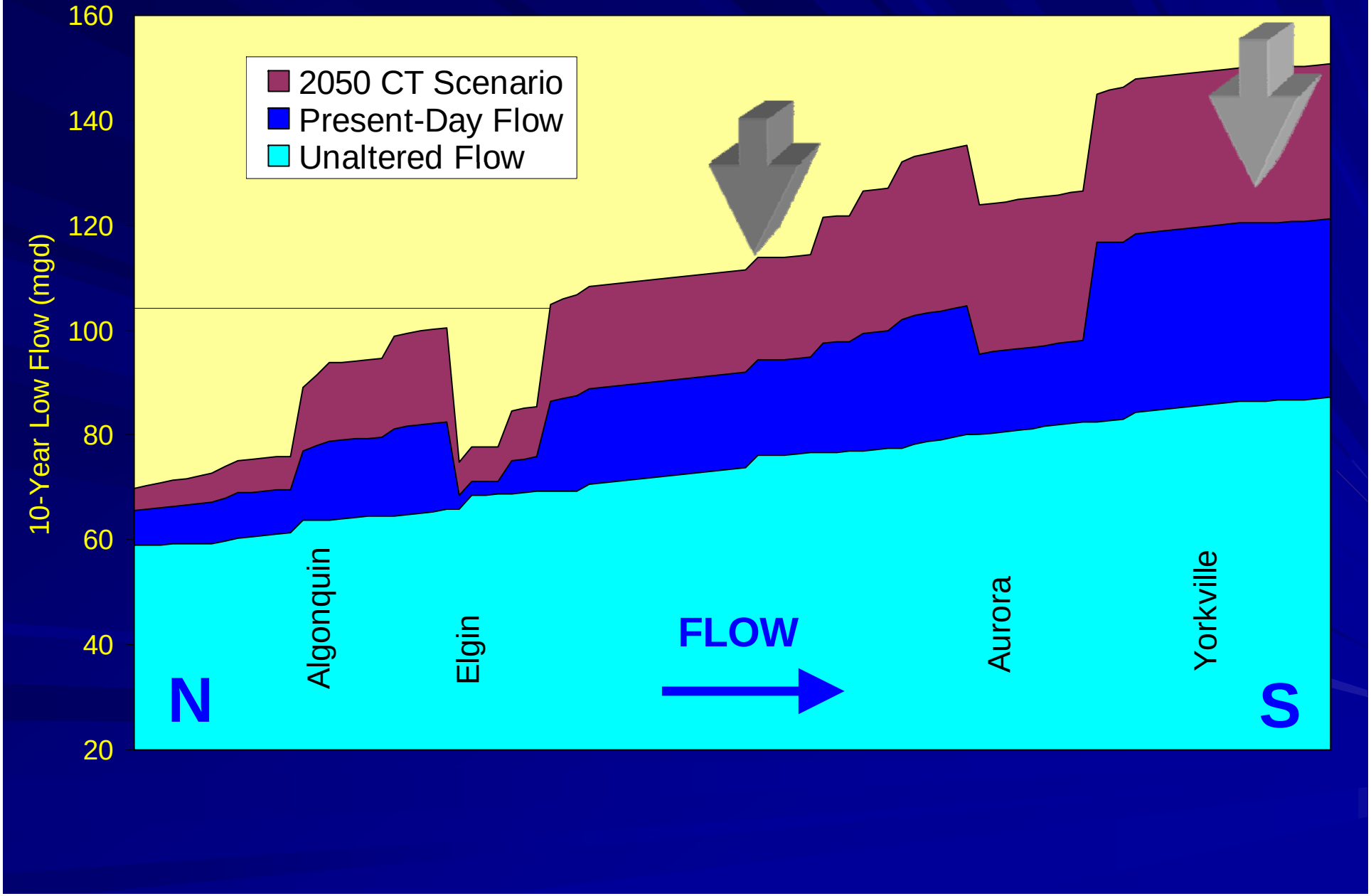
	No T Change	+3F Temp	+6F Temp
No precip change	0	–3	–5
+ 5” Precip	+10	+3	0
– 5” Precip	–4	–7	–9

If low flows in the Fox River are expected to increase, would additional flow be available for water supply?

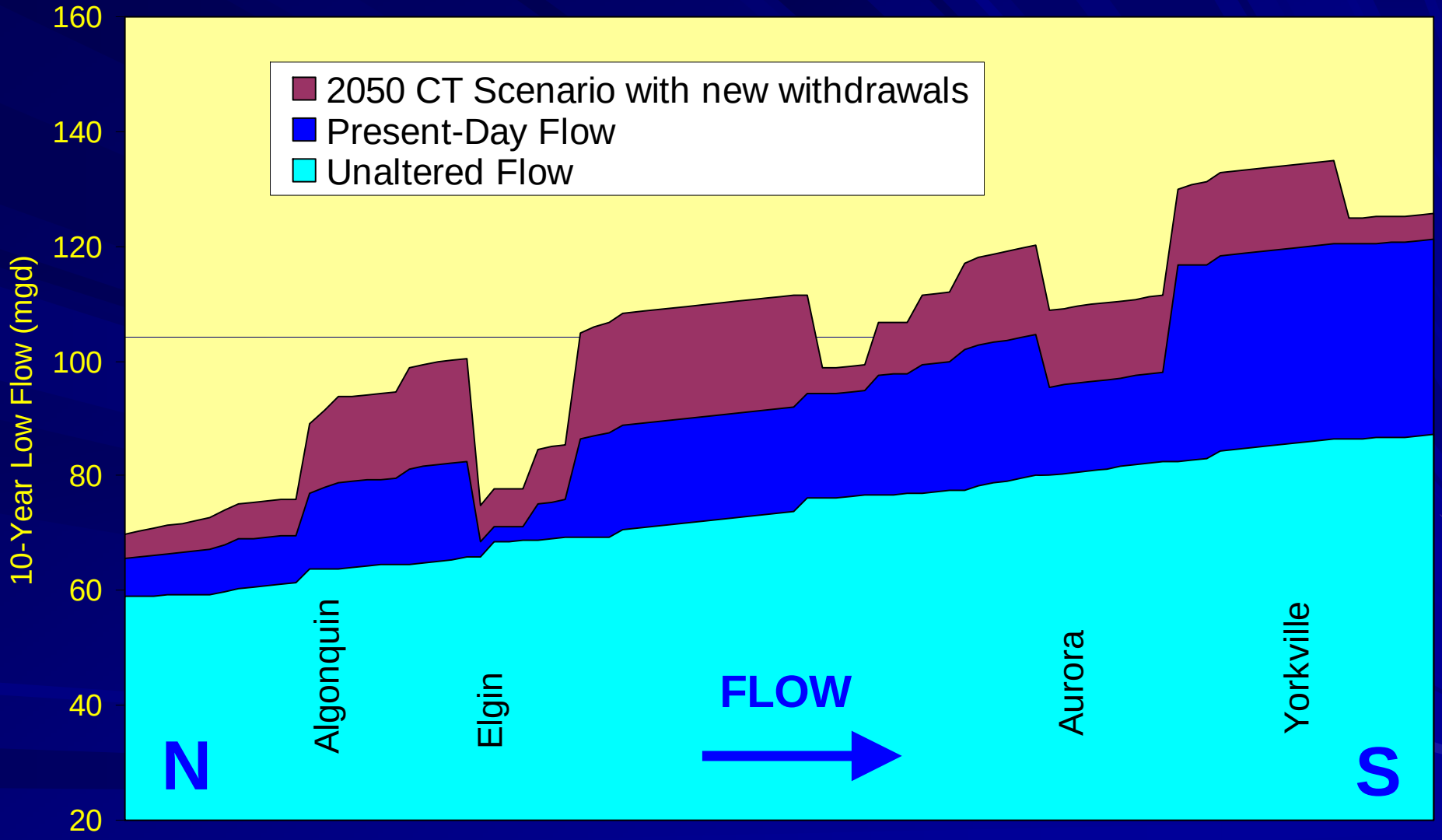
ASSUMPTIONS:

- Fox River protected flows are kept at current (2008) levels – needing agreement from IDNR
- Withdrawals at locations where 10mgd could be withdrawn and still allow the protected flow level to be maintained (10 mgd is suggested as a threshold for being able to economically provide needed water treatment)

Example Locations for New Withdrawals (CT Scenario)



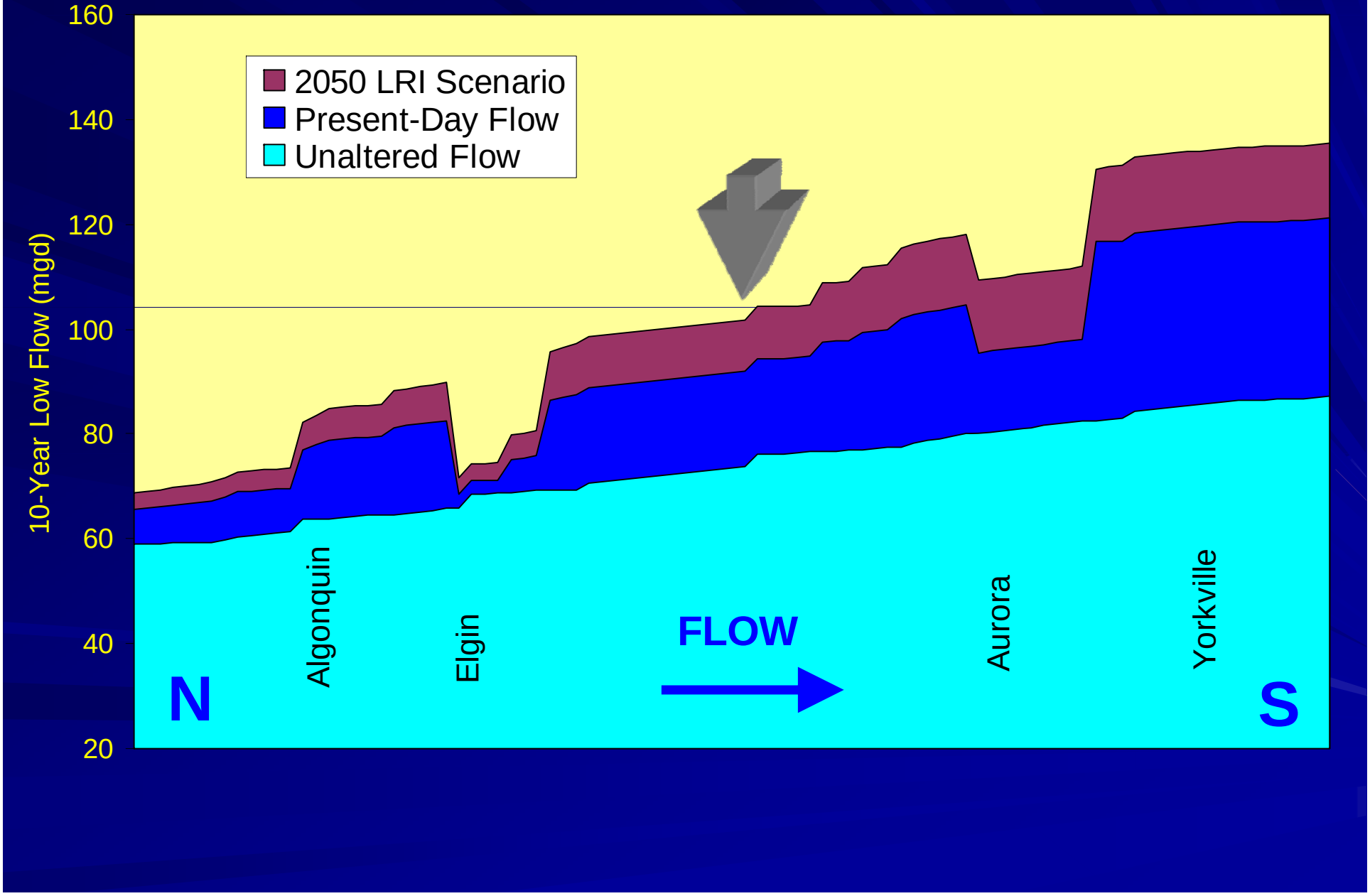
Low Flow with 2 Additional Withdrawals (CT Scenario)



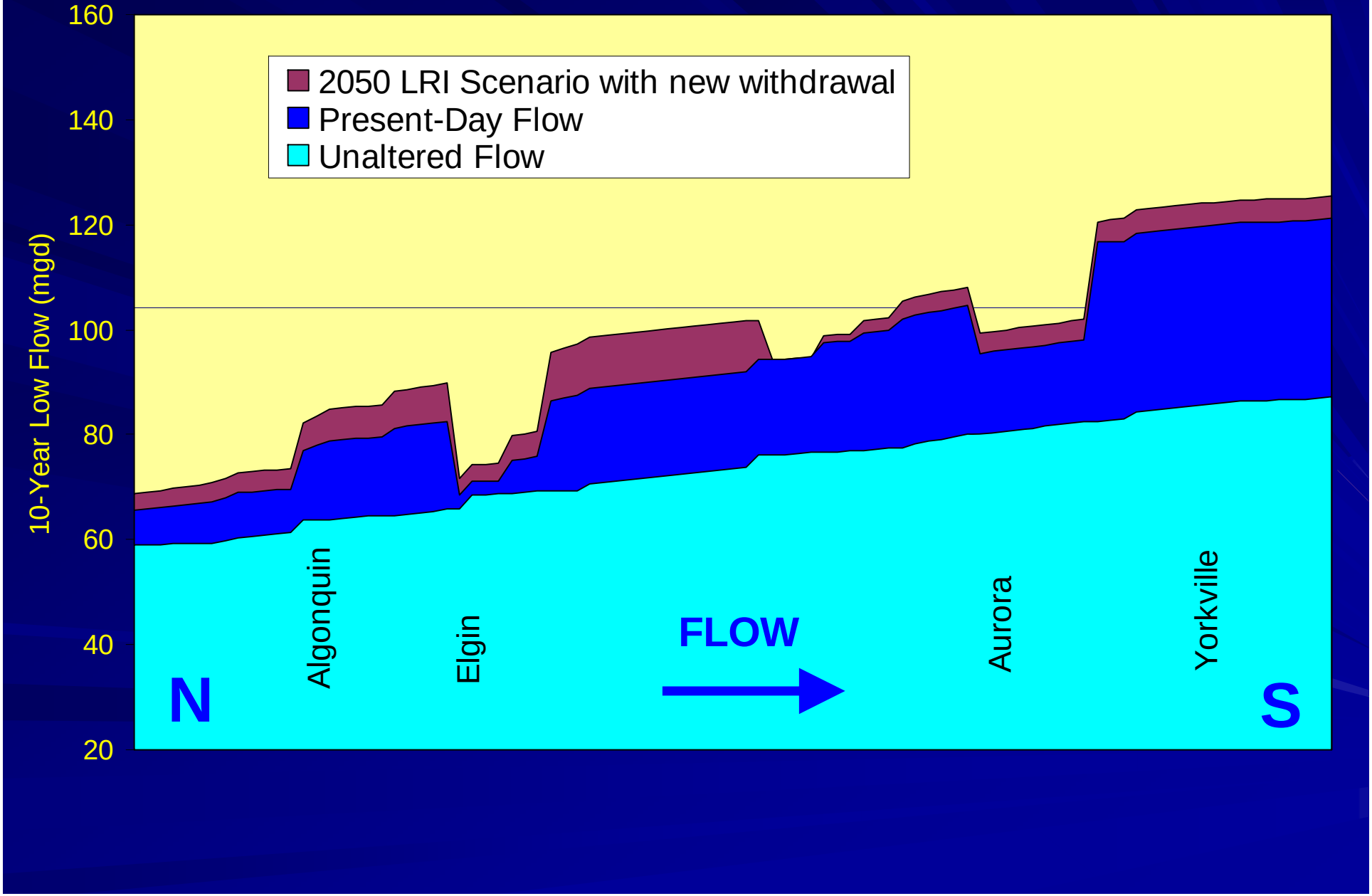
CT Scenario

- Total 2050 projected water use increase in Kane & Kendall Counties (all communities) = 67 mgd
- Elgin and Aurora growth accounts for 15 mgd of this amount
- Assuming no change in climate, new river withdrawals (for example near St. Charles and Yorkville) could collectively support an additional 25-30 mgd
- Thus, increases in surface water withdrawals (40-45 mgd) could provide over half of total growth

Example Location for New Withdrawal (LRI Scenario)



Low Flow with Additional Withdrawal (LRI Scenario)



LRI Scenario

- Total 2050 projected water use increase in Kane and Kendall Counties = 25 mgd
- Elgin and Aurora growth accounts for 5 mgd of this amount
- Assuming no change in climate, new river withdrawals near either St. Charles or Yorkville could potentially support an additional 10 mgd
- Thus, increases in surface water withdrawals (15 mgd) could provide over half of total growth

Other Issues/Options

- River withdrawals as water reuse (the value of effluent)
- Conventional types of water use would reduce the amount of flow returning to the river
- This analysis does not consider water quality. As the proportion of effluent increases in the river, can the river assimilate the effluent?
- If Waukesha continues to increase its effluent to the Fox River, it could potentially provide an opportunity for additional river withdrawal upstream of Elgin.
- River withdrawals supplemented by off-channel storage are always an option

Extension to other parts of NE Illinois?

- Even with a large increase in effluents, the Fox River still contains a high amount of natural low flow
- In contrast, low flows in rivers such as the DesPlaines are almost 100% effluent.
- The Kankakee River has the highest natural low flow in NE Illinois, but has not yet experienced the same level of development
- Thus, these results are primarily applicable to just the Fox River

Summary

- Low flows in the Fox River will continue to increase as a result of growth in population and water use
- Potential climate change may cause modest changes in low flow but not alter the overall increasing trend
- If Fox River protected low flow levels remain fixed, there is the potential for new river withdrawals that, if needed, could supply as much as half of new growth.