# Jordan River DO Linkage Symposium
# Physical Limitations – DO Solubility and Reaeration

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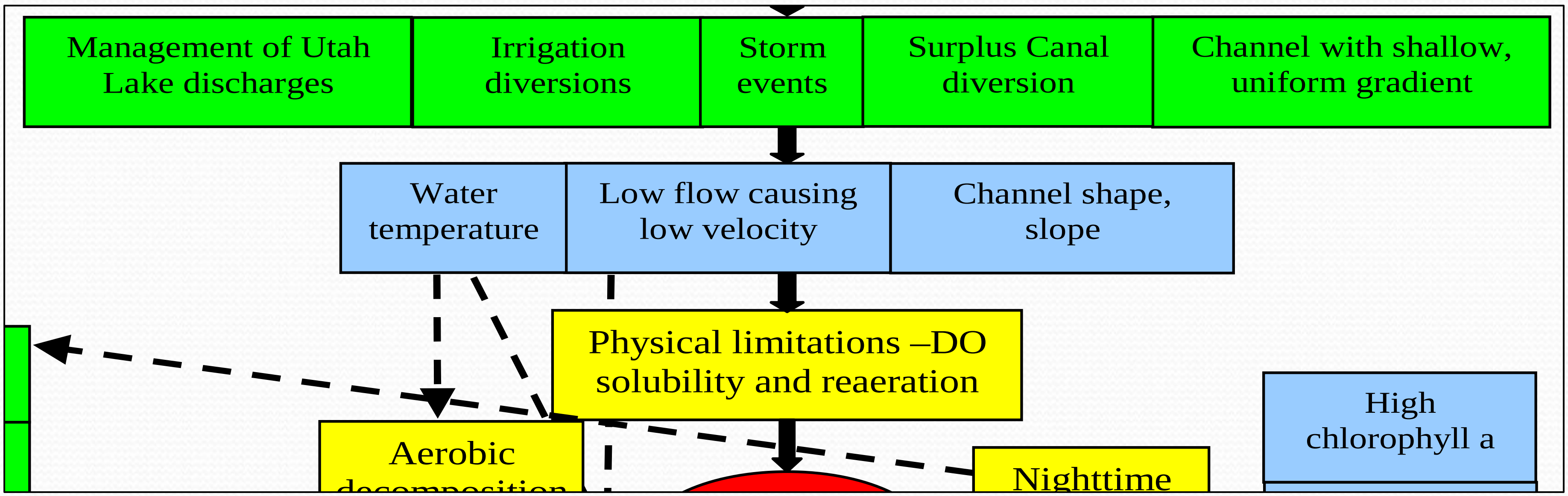
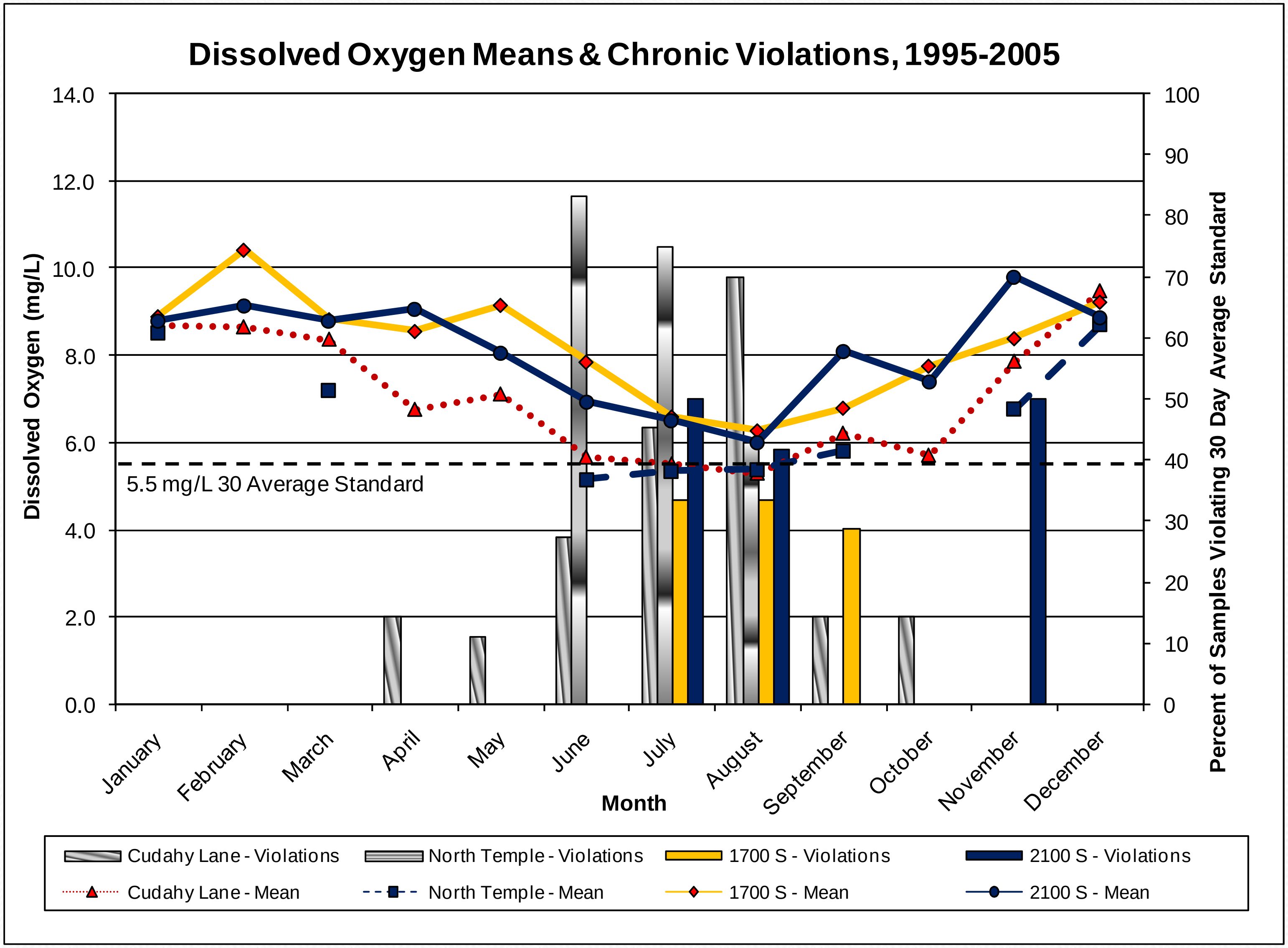
# Physical Processes



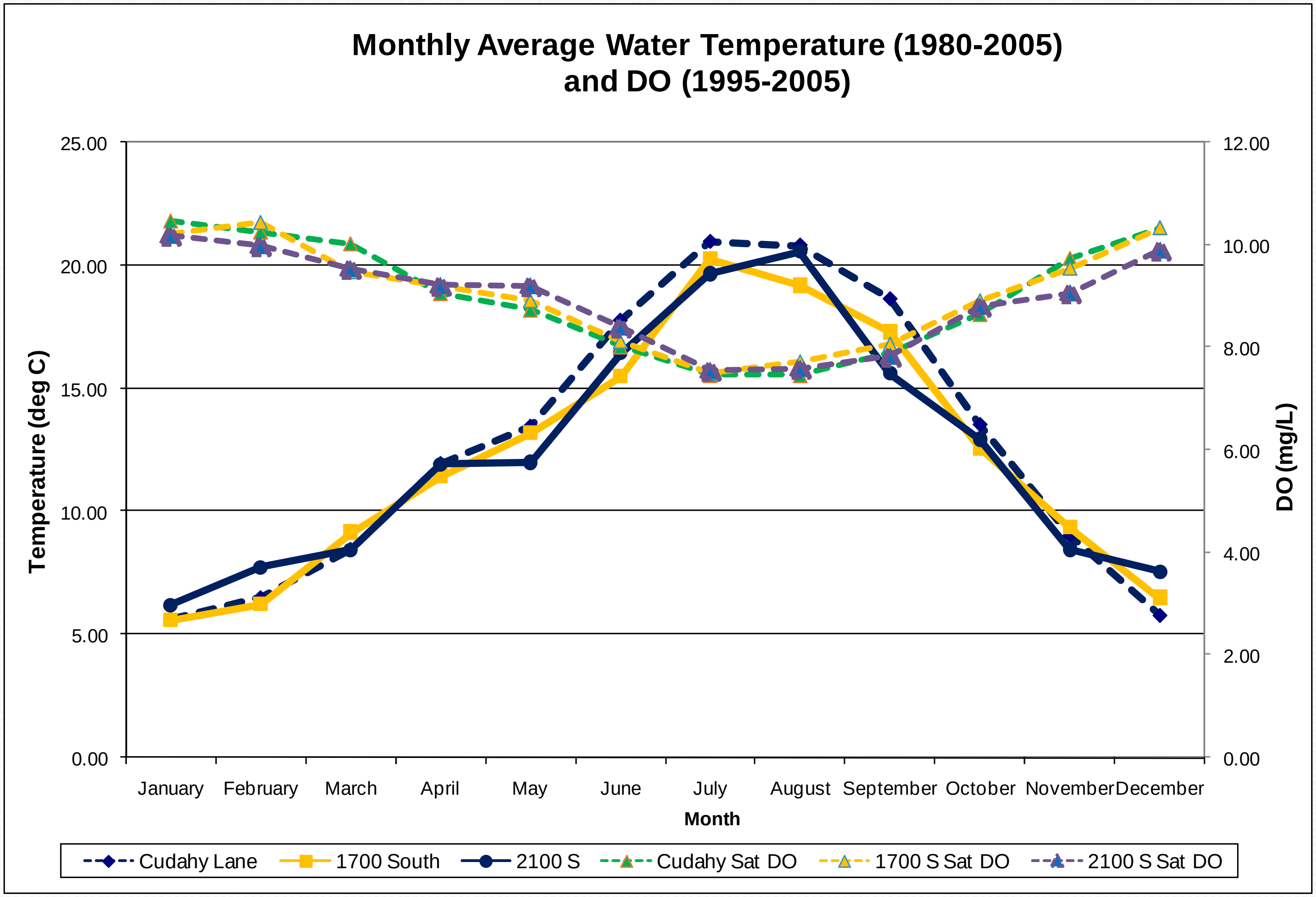

Reaeration function of:

- Temperature, pressure, (salinity)
- Turbulence – channel morphology and flow

# Season Pattern in DO Violations



# Seasonal Water Temperature and Saturated DO




Sat DO:
10.6 mg/L
@ 5.5 °C

7.7 mg/L
@ 20.5 °C

# DO Deficit All Seasons

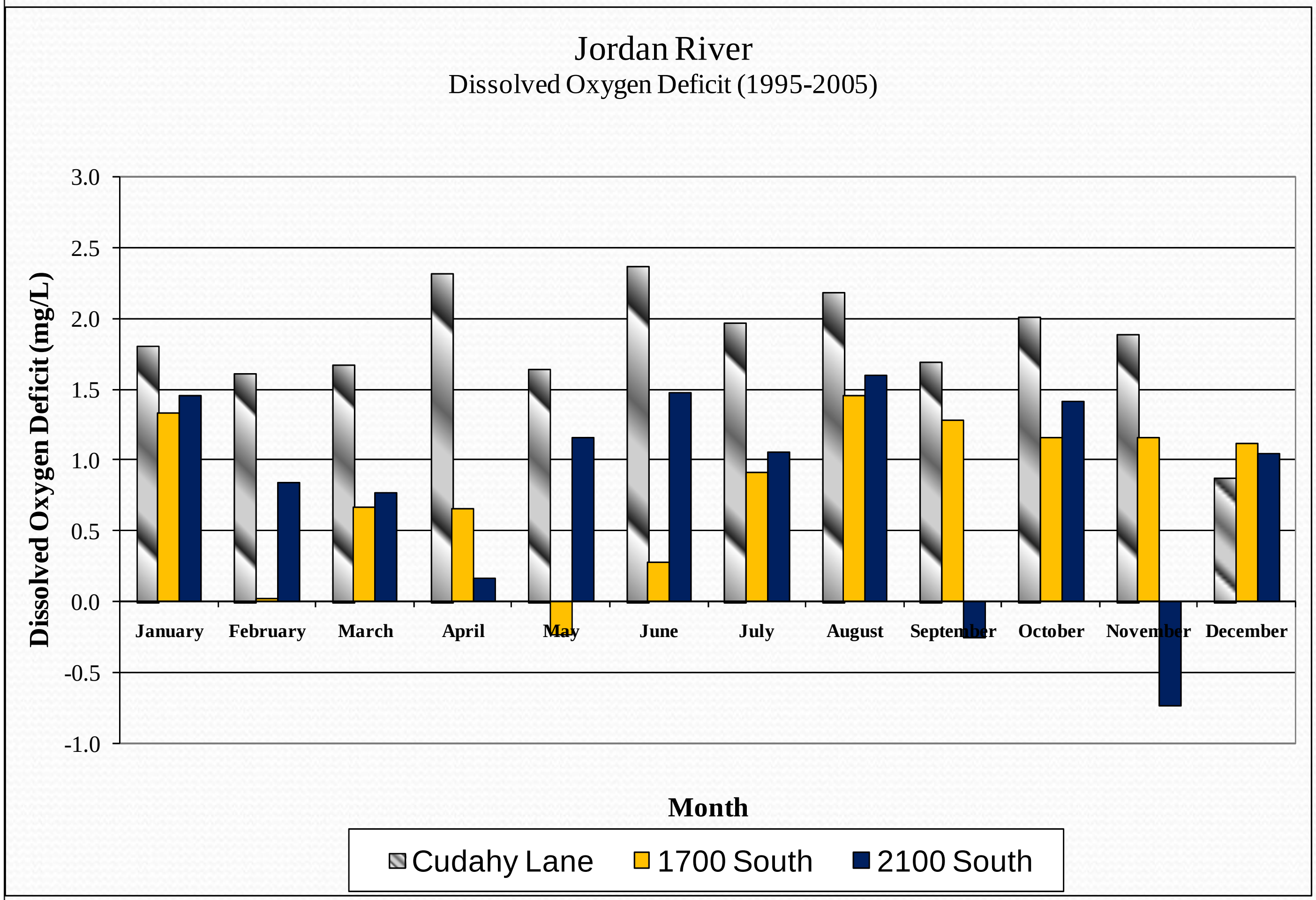
**Table 4.3. Deficit in DO between saturated and observed mean concentrations by month for the lower Jordan River 1980-2005 (mean of 2100 South, 1700 South, Cudahy Lane)[1].**

| Month | Mean Temp °C | Mean Saturated DO Concentration (mg/L) | Mean Actual DO Concentration (mg/L) | Deficit in DO (mg/L) |
|---|---|---|---|---|
| **Jan** | 5.9 | 10.6 | 9.0 | **1.68** |
| **Feb** | 7.0 | 10.3 | 9.2 | **1.19** |
| **Mar** | 8.9 | 9.9 | 8.5 | **1.34** |
| **Apr** | 11.7 | 9.2 | 7.8 | **1.45** |
| **May** | 13.0 | 9.0 | 7.6 | **1.39** |
| **Jun** | 16.8 | 8.3 | 6.8 | **1.50** |
| **Jul** | 20.5 | 7.7 | 5.5 | **2.16** |
| **Aug** | 20.5 | 7.7 | 5.7 | **1.97** |
| **Sep** | 17.4 | 8.2 | 6.4 | **1.75** |
| **Oct** | 13.4 | 8.9 | 7.3 | **1.58** |
| **Nov** | 9.1 | 9.8 | 8.1 | **1.73** |
| **Dec** | 6.7 | 10.4 | 9.0 | **1.41** |

[1] Calculated at typical atmospheric pressures in the Salt Lake Valley and accurate for the observed average salinity of less than 1280 mg/L (Cirrus 2007).

DO 1.2 – 2.2 mg/L below saturated

# DO Deficit All Seasons




- DO deficit in all seasons
- DO Deficit increases from 2100 South to Cudahy Lane

| | Number Temp Measurements 1995-2005 | | |
|---|---|---|---|
| **Month** | **2100 South** | **1700 South** | **Cudahy Lane** |
| January | 8 | 6 | 10 |
| February | 5 | 12 | 6 |
| March | 5 | 7 | 10 |
| April | 5 | 11 | 8 |
| May | 10 | 9 | 9 |
| June | 10 | 10 | 11 |
| July | 10 | 7 | 11 |
| August | 12 | 3 | 10 |
| September | 2 | 7 | 6 |
| October | 6 | 6 | 7 |
| November | 2 | 6 | 7 |
| December | 2 | 6 | 3 |

| | Number DO Measurements 1995-2005 | | |
|---|---|---|---|
| **Month** | **2100 South** | **1700 South** | **Cudahy Lane** |
| January | 8 | 6 | 10 |
| February | 5 | 12 | 6 |
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| May | 9 | 9 | 9 |
| June | 10 | 10 | 11 |
| July | 10 | 7 | 11 |
| August | 12 | 3 | 10 |
| September | 2 | 7 | 7 |
| October | 6 | 6 | 7 |
| November | 2 | 5 | 7 |
| December | 2 | 6 | 3 |

# Reaeration

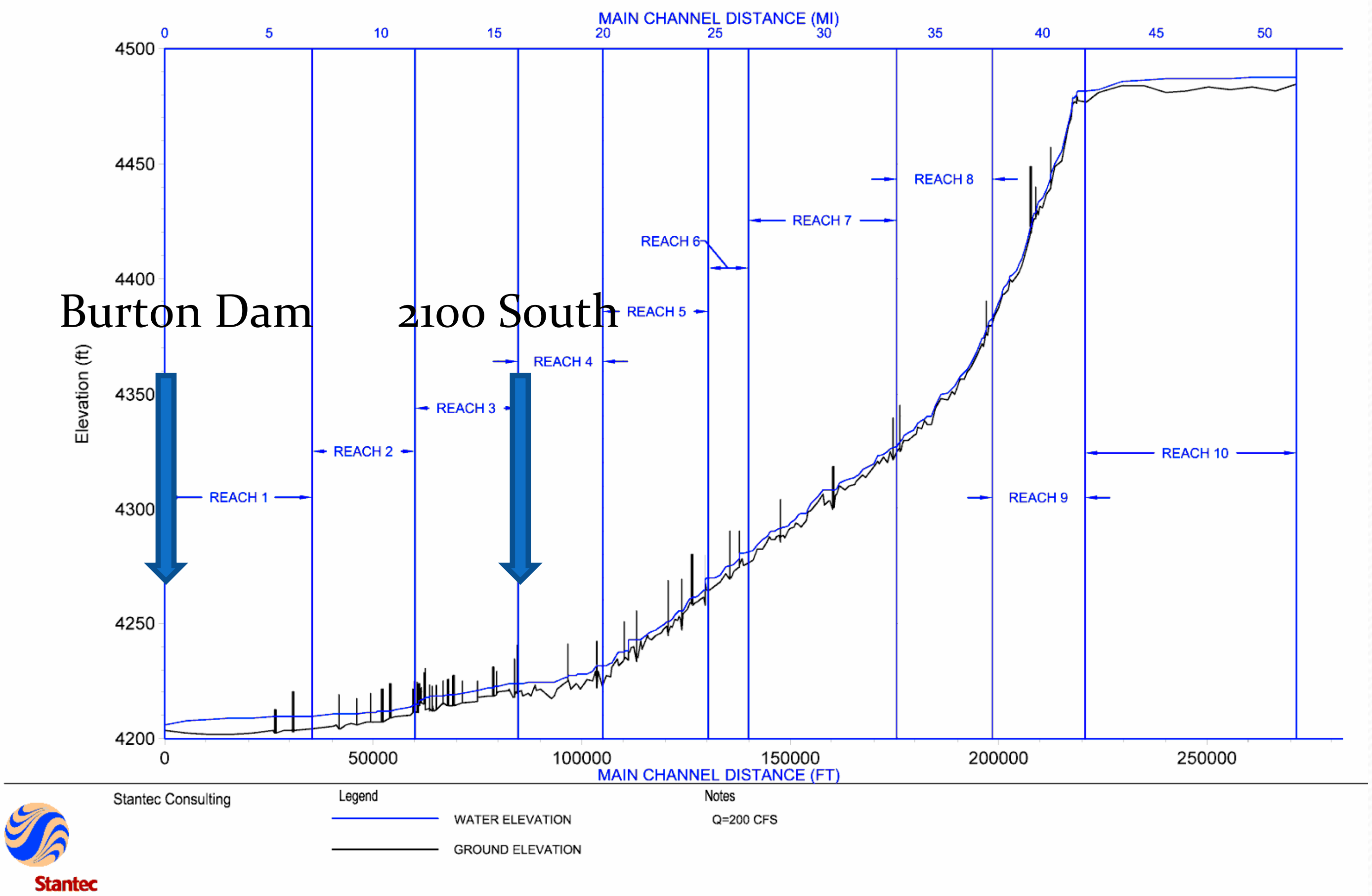
- Moves DO toward saturated concentrations
- Reaeration = function of:
  - Velocity
  - Channel Characteristics
- Difficult to measure
- Equations from QUAL2K provided by Chapra et al. (2007); Internal (O'Connor-Dobbins) formula for typical depths in lower Jordan River, where:

  k = reaeration rate at 20°C in mg/L/day
  U = mean water velocity (m/s)
  H = mean depth (m)

$$k_h(20) = 3.93\frac{U^{0.5}}{H^{1.5}}$$

**Note that increasing depth has greater impact than increasing velocity:**

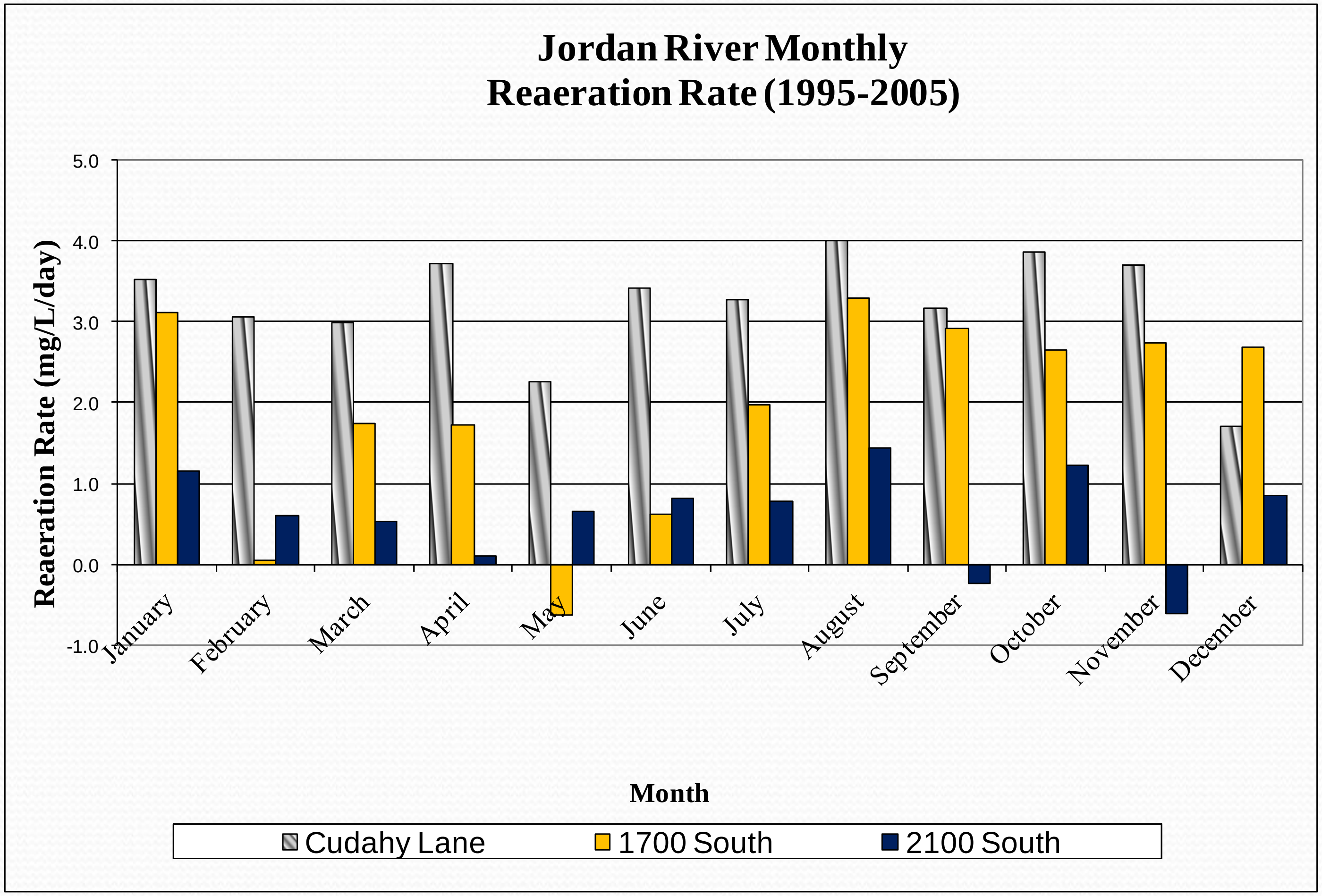
# Gradient below 2100 South




Low gradient and low flow (shallow depth) =
low velocity =
low turbulence =
low reaeration

(...and settling of suspended matter)

# Reaeration Rates in Lower Jordan River




- Higher downstream (shallow, greater deficit)
- Rates = 2 – 4 mg/L/day in summer…
- … 0.8 – 1.6 mg/L in the 0.4 days from 2100 South to Cudahy Lane or 1.7 – 3.4 mg/L in 0.85 days to Burton Dam.

# Conclusions

- DO is not usually saturated in lower Jordan River (although some supersaturated measurements do occur in summer) – deficit in all seasons.
- Reaeration should be moving it toward saturation – even at these flows – but deficit increases downstream.
- Therefore, some other process(es) must be consuming DO faster than reaeration can restore it.