Water Quality of Lake Powell and the Colorado River

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Colorado River Ecosystem Science Symposium
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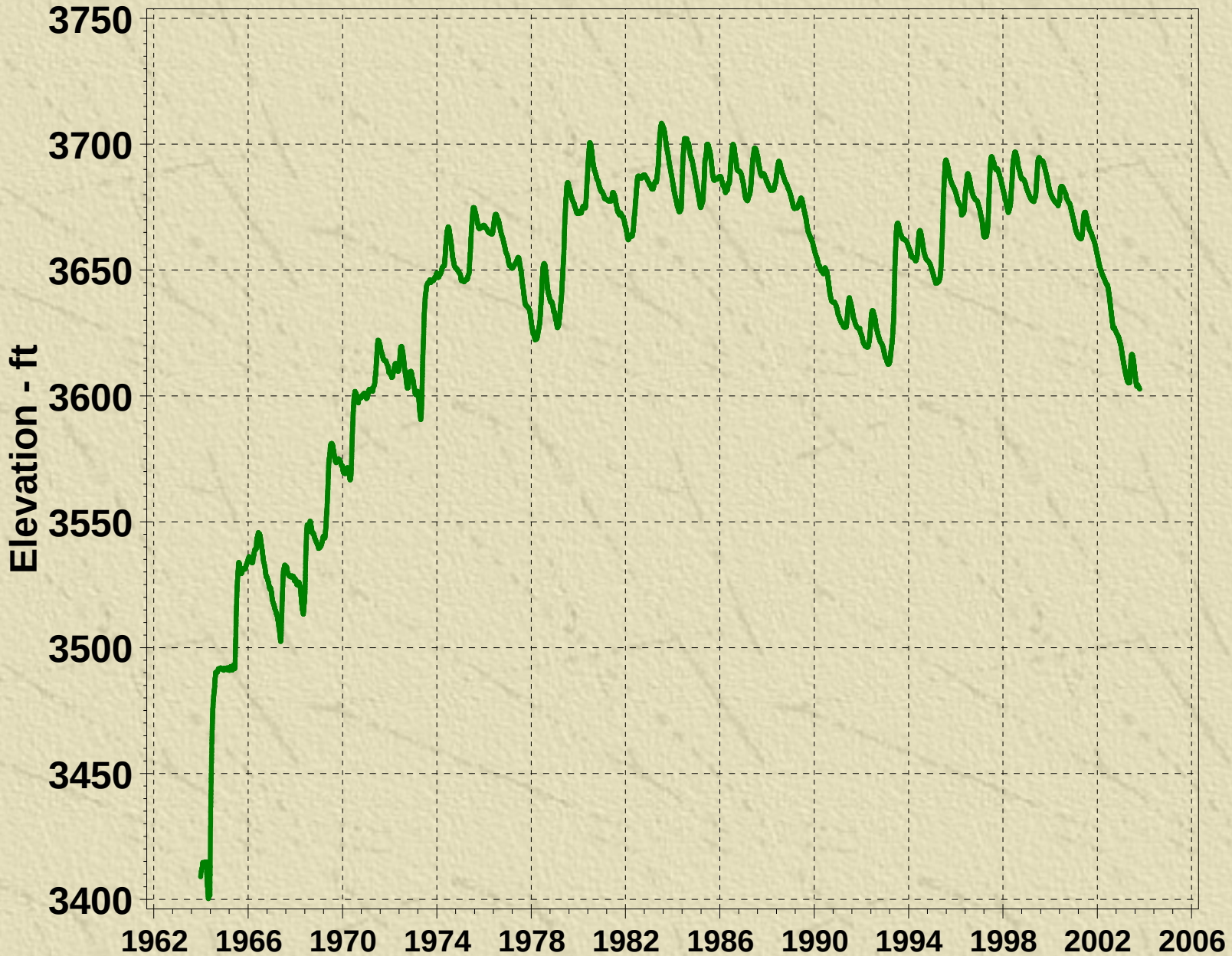
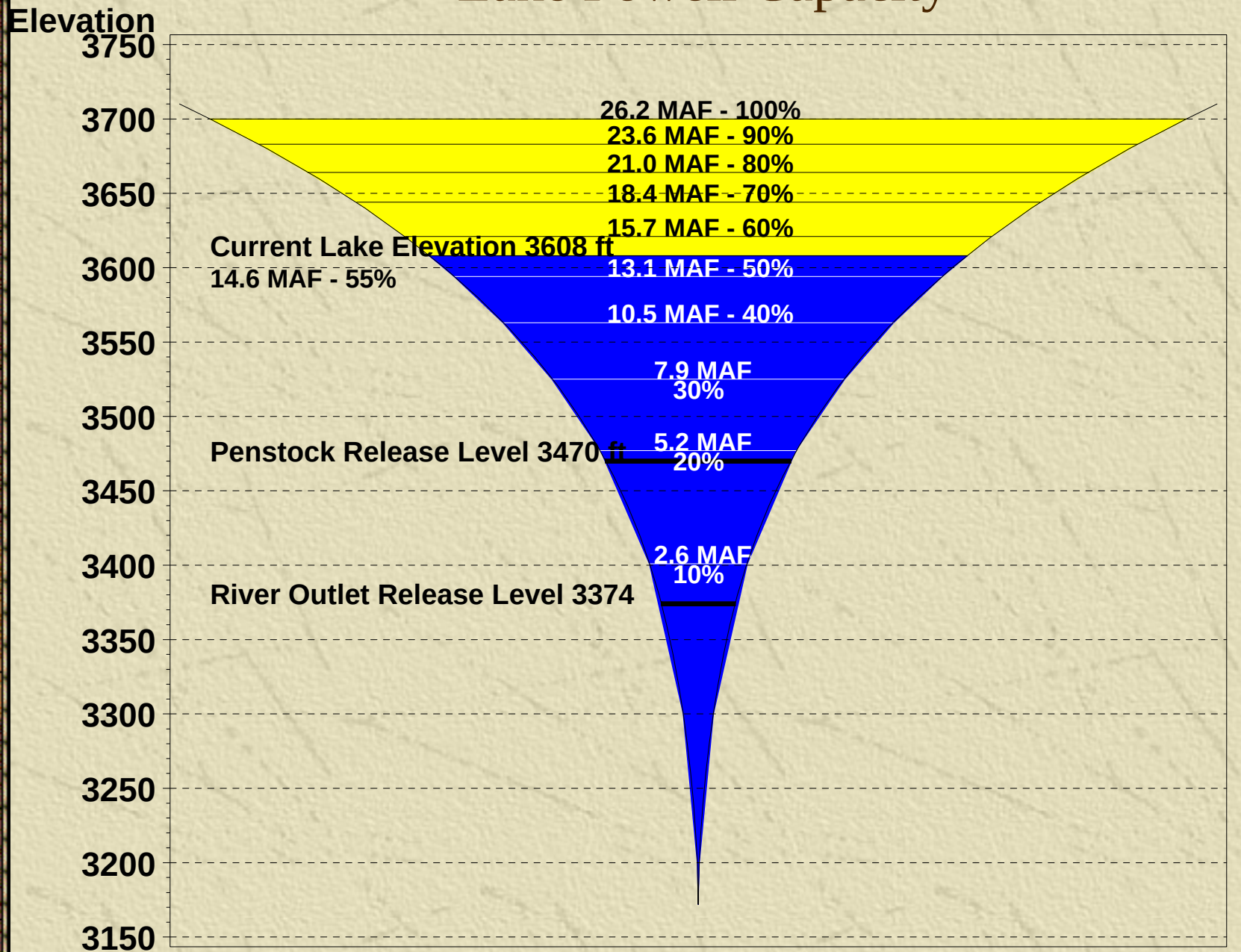
What's Going on in Lake Powell?

- Declining Reservoir Levels
  - Normal Pool Elevation - 3700 ft
  - Current Elevation – 3602.5 ft
  - Reported (April 2003) – 3605.1 ft
  - Reported High (June 2003) – 3616.2 ft
  - Projected Low (April 2004) – 3587.2 ft
  - Projected High (June 2003) – 3606.3 ft

Lake Powell Surface Elevation

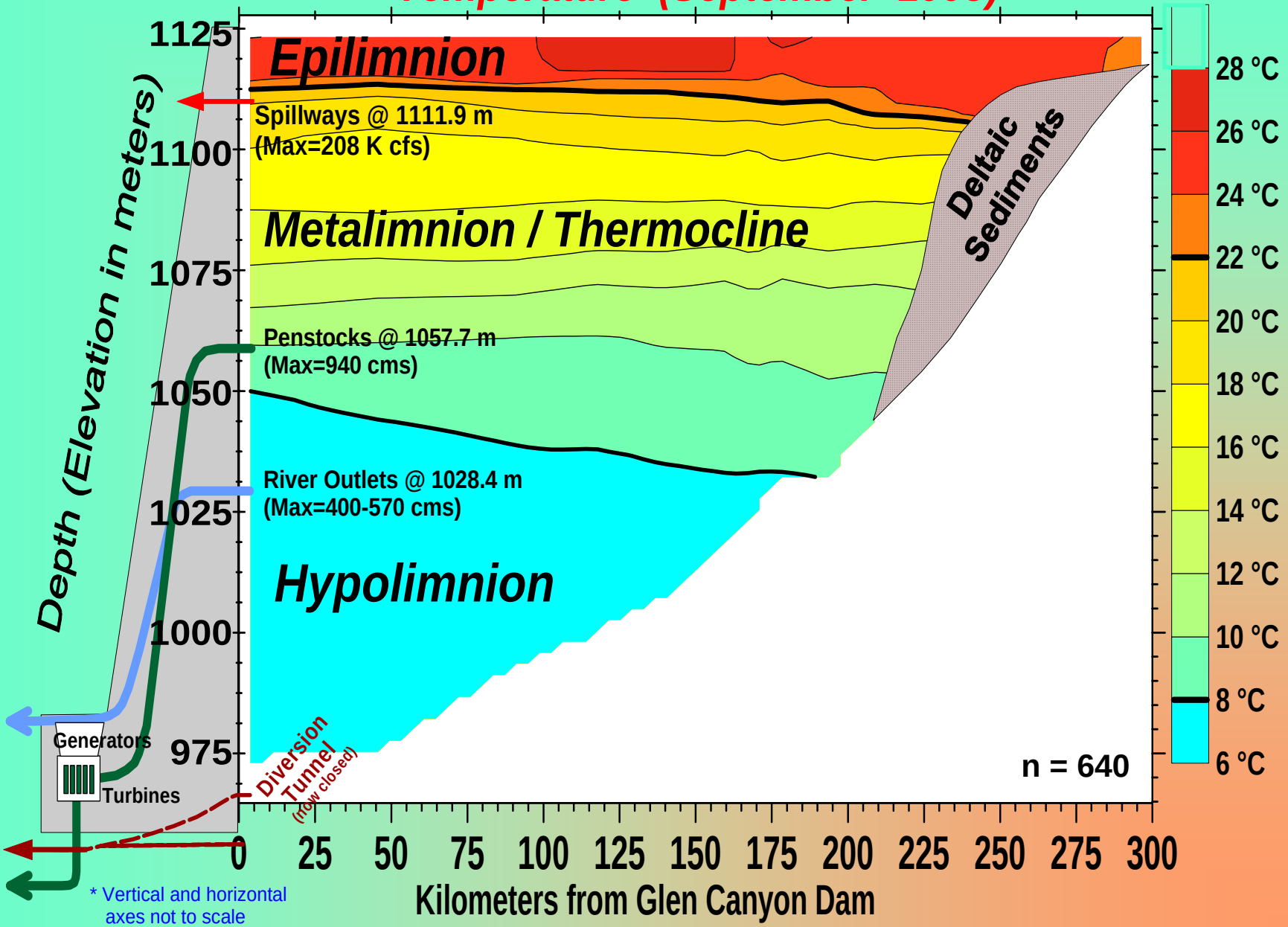


Lake Powell Capacity



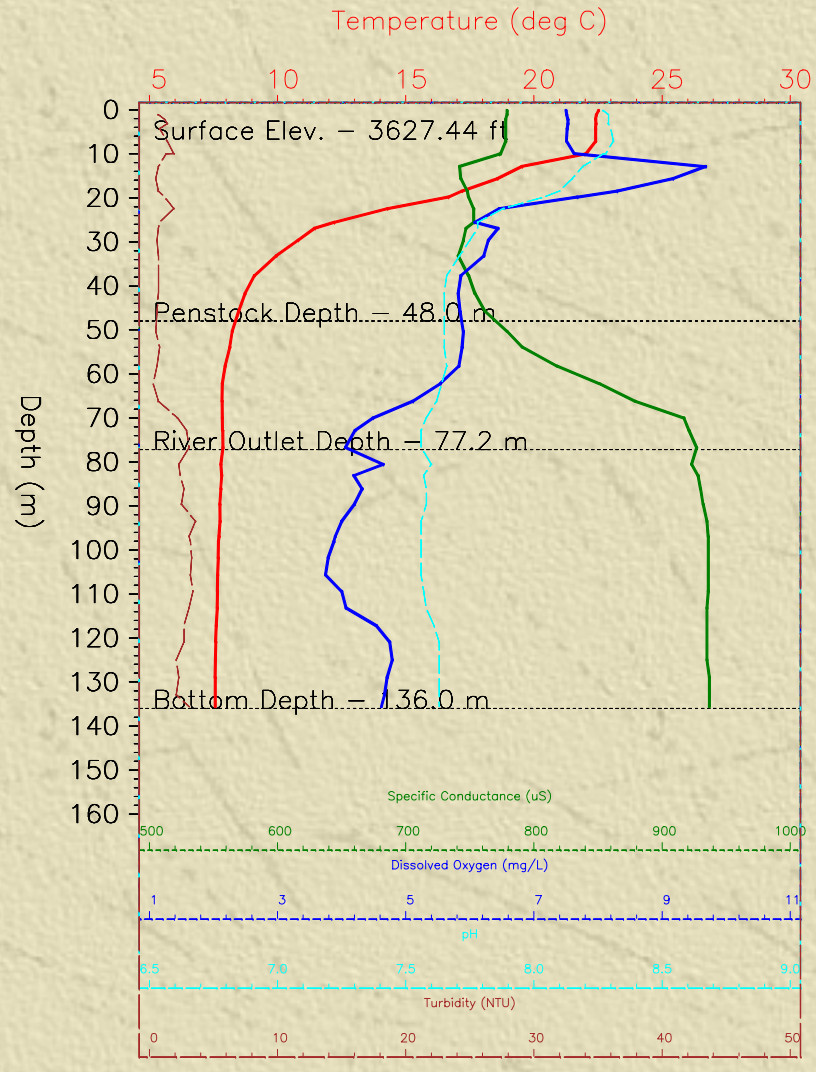
Cross Section through Lake Powell *

Temperature (September 1995)



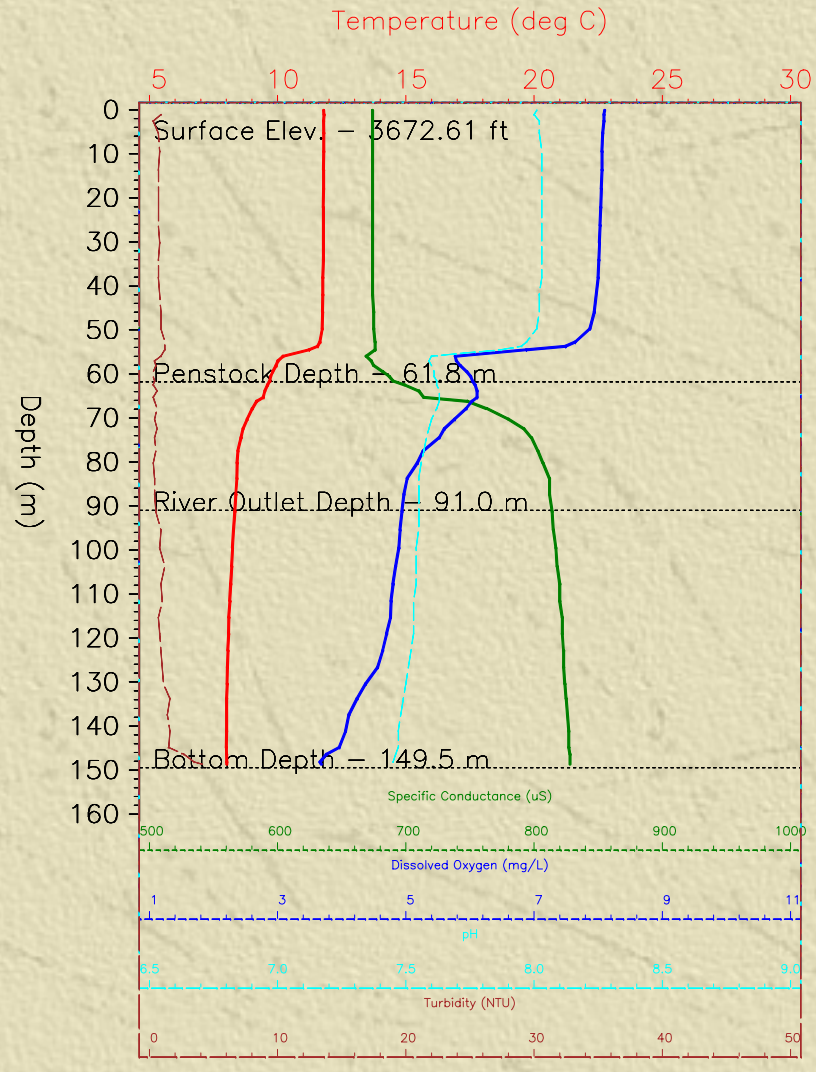
* Vertical and horizontal axes not to scale

Glen Canyon Dam Forebay 9/18/02



Late Summer Stratification

Glen Canyon Dam Forebay 12/7/2002

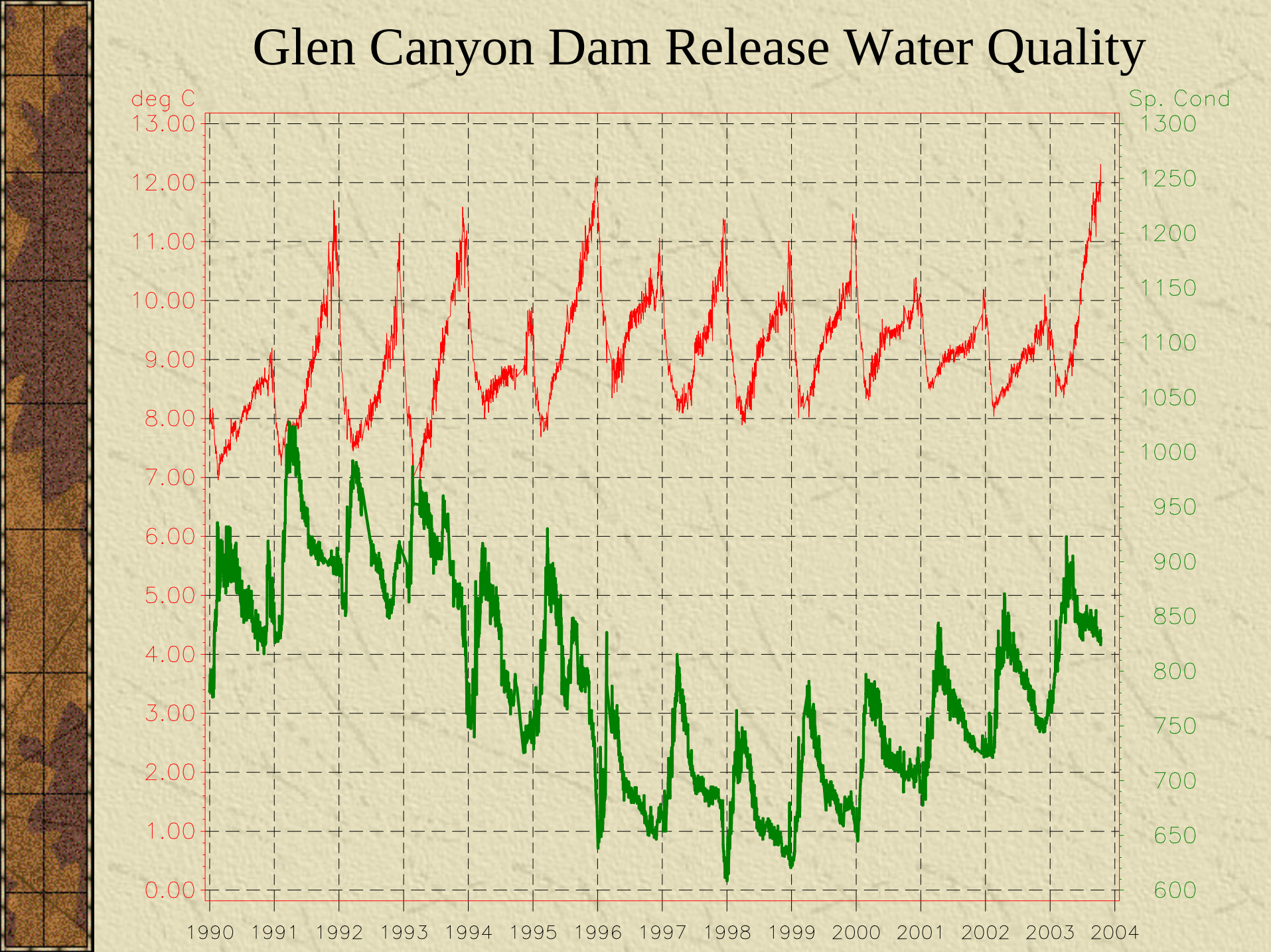


Early Winter Mixing

Glen Canyon Dam Release Water Quality

- Warmest temperature/lowest salinity released in late December – epilimentic withdrawal
- Followed shortly afterwards (Feb-Mar) by coldest temperature/highest salinity – hypolimnetic influence

Glen Canyon Dam Release Water Quality

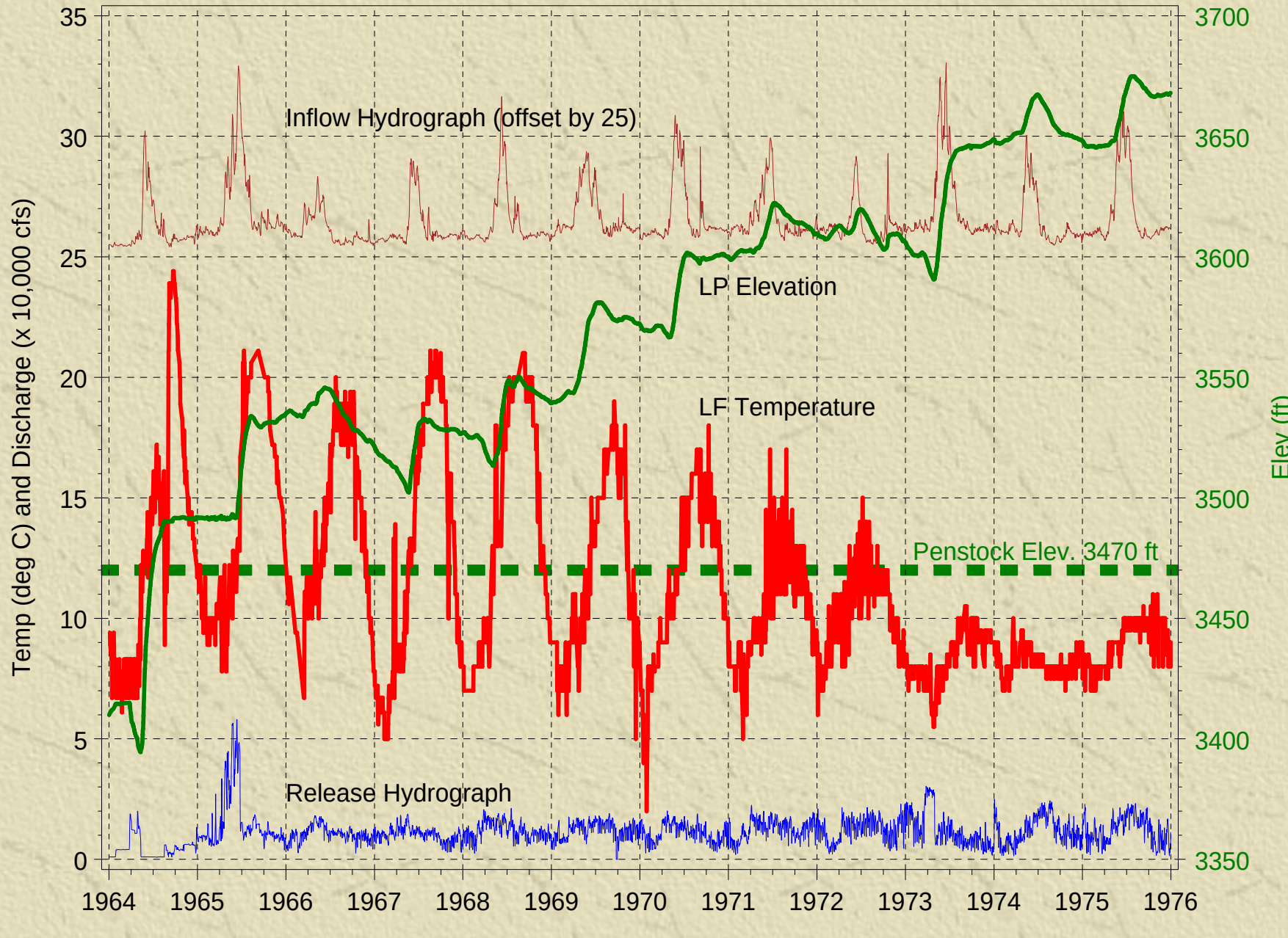


Effects of Low Reservoir Levels

- Lowest levels since 1973 – 3602.5 ft
- Warmest temperatures since 1973
  - 12 deg C (54 deg F)
  - 14 deg C in 2004?
- Sediment resuspension & O_2 demand
- Waterfalls on San Juan – Hite next?

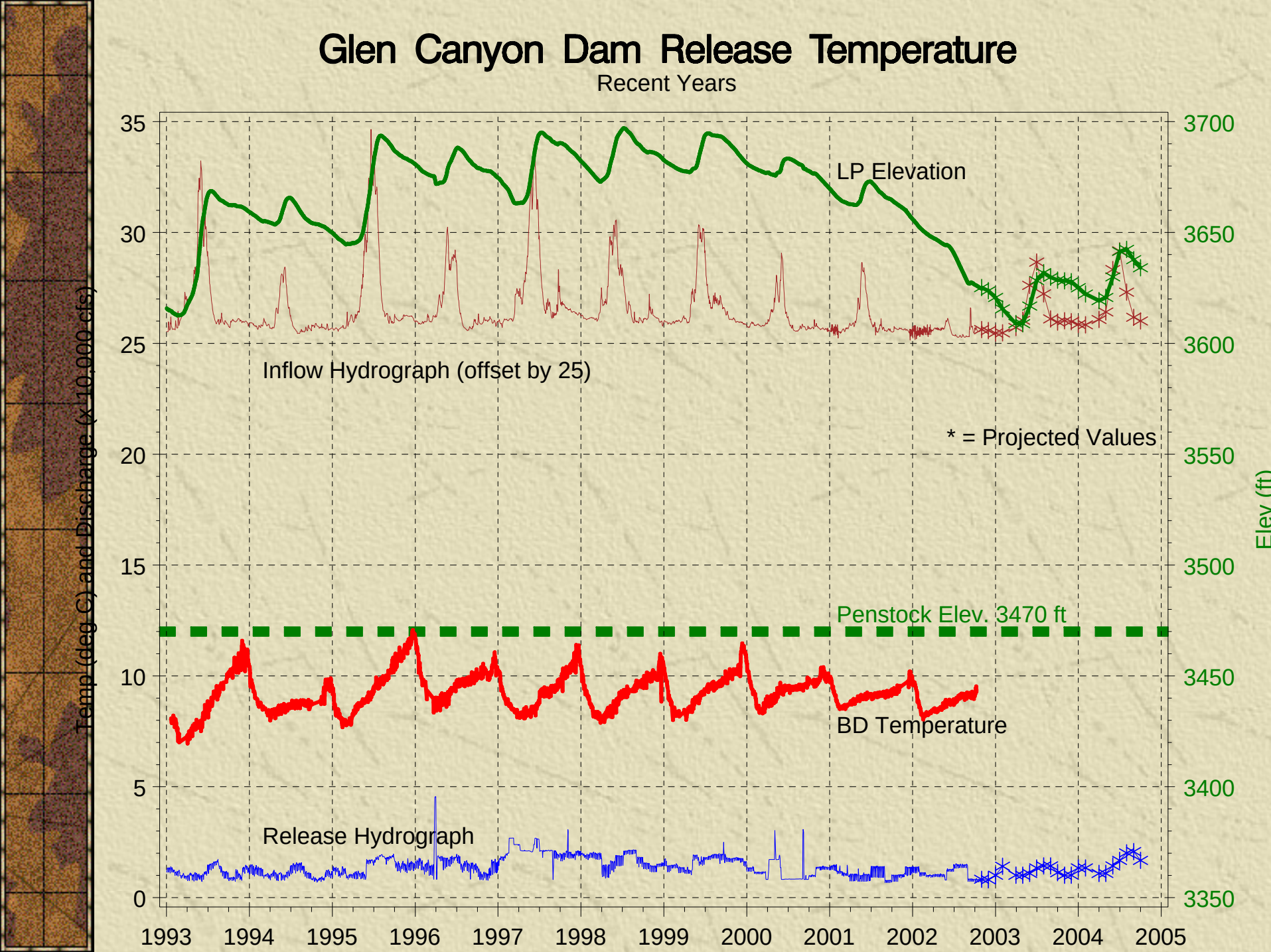
Lees Ferry Daily Temperature

Lake Powell Initial Filling Stage



Filling Period 1964-1976

- Summer withdrawals from epilimnion
  - Ended with filling to 3645 ft. in 1973
- Maximum temperatures in September
  - Due to epilimnetic withdrawal
- Maximum temperatures reduced as reservoir filled
- High inflows in 1973 raised surface elevation away from penstock levels


Glen Canyon Dam Release Temperature
Recent Years
LP Elevation
Inflow Hydrograph (offset by 25)
* = Projected Values
Penstock Elev. 3470 ft
BD Temperature
Release Hydrograph
Temp (deg C) and Discharge (x 10,000 cfs)
Elev (ft)
35
30
25
20
15
10
5
0
3700
3650
3600
3550
3500
3450
3400
3350
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

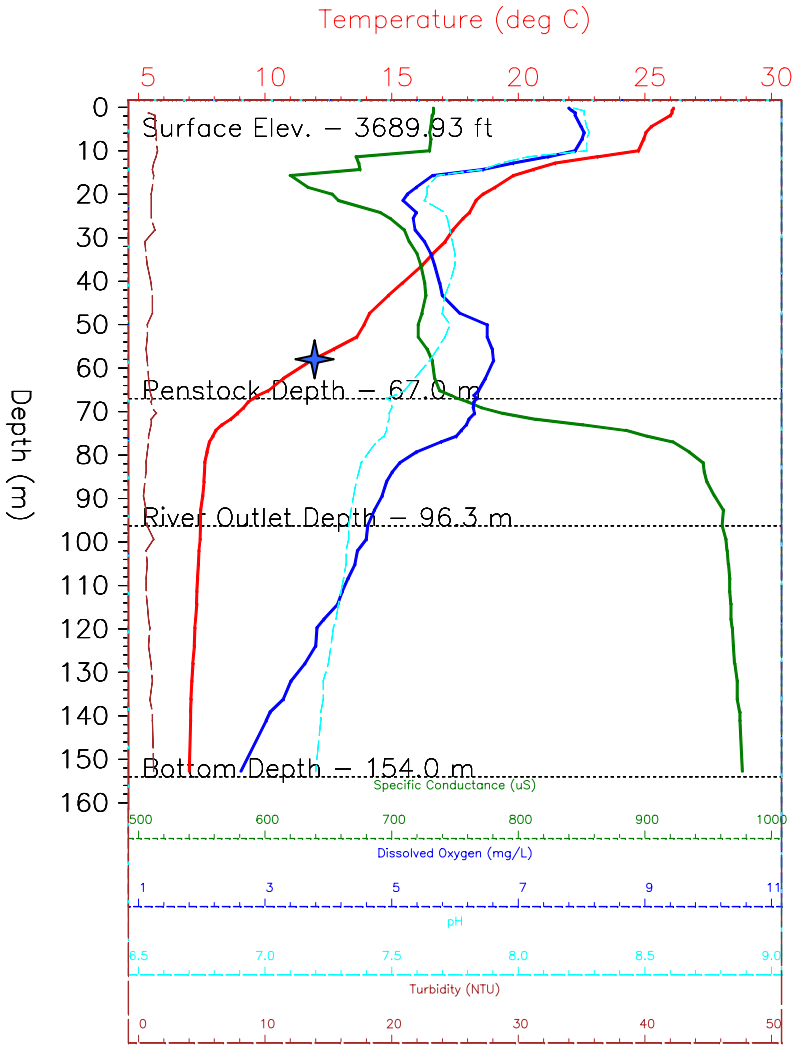
Current Conditions 1993-2003

- Summer withdrawals from hypolimnion
- Maximum temperatures in December
  - Due to convective mixing of epilimnion
- Maximum winter temperatures affected by previous spring runoff volume

Factors Affecting Possibility of Warm Water Release

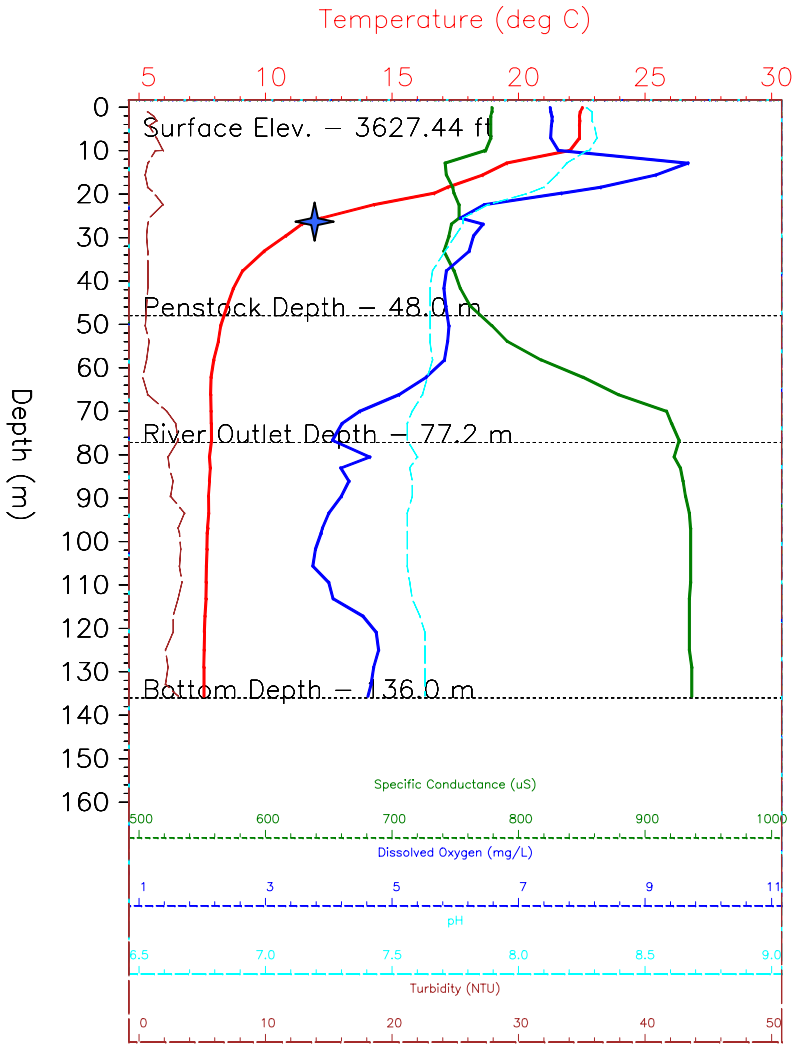
- Reservoir elevation
  - Proximity of thermocline to penstock depth
- Antecedent Hydrology
  - High runoff causes thick layer of warm water near dam (closer to penstocks)
- Timing
  - Maximum warming at depth occurs August-September

Forebay Profile – September 12, 1995



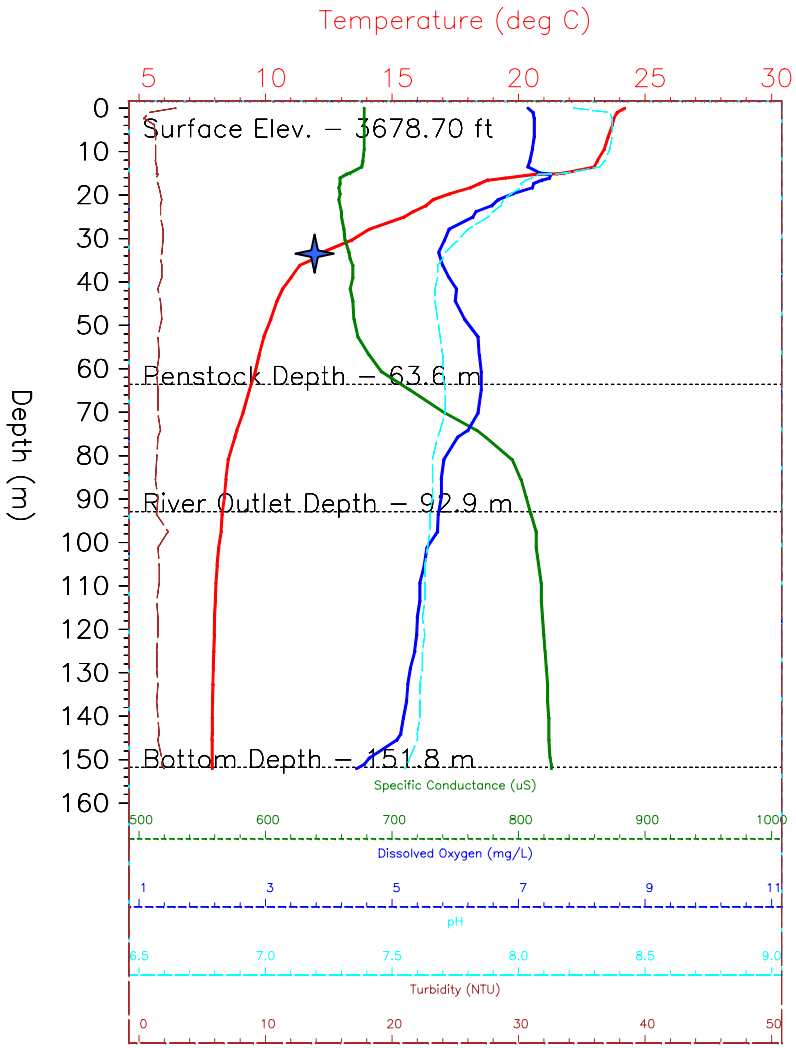
- Apr-Jul runoff 10.62 MAF
- **Highest** runoff volume since 1986
- Very thick epilimnion
- 12°C water at 59 m
- 1995 conditions at 2002 lake levels would have resulted in ~14°C releases

Forebay Profile – September 18, 2002



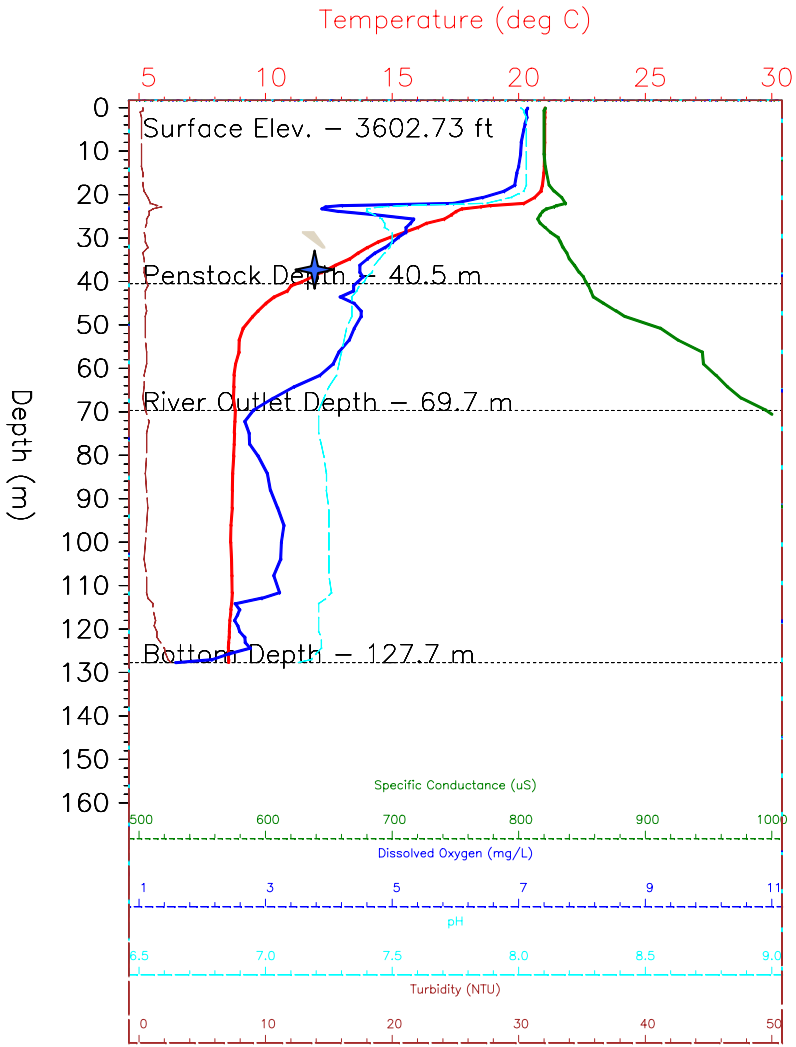
- Apr-Jul runoff 1.45 MAF
- **Lowest** runoff volume on record
- Very thin epilimnion
- 12°C water at 27 m

Forebay Profile – September 13, 2000



- Apr-Jul runoff 4.62 MAF
- **Intermediate** runoff volume
- Similar to 1972 runoff
  - 4.06 MAF in 1972
  - Last year of warm release
- Similar to projected 2003 runoff of 5.67 MAF
- 12°C water at 35 m ✦

Forebay Profile – October 22, 2003



- Apr-Jul runoff 3.91 MAF
- **Lowest** reservoir elevation since 1973
- Very thin epilimnion
- 12°C water at 39 m

What are Chances of Warm Water Release in 2003?

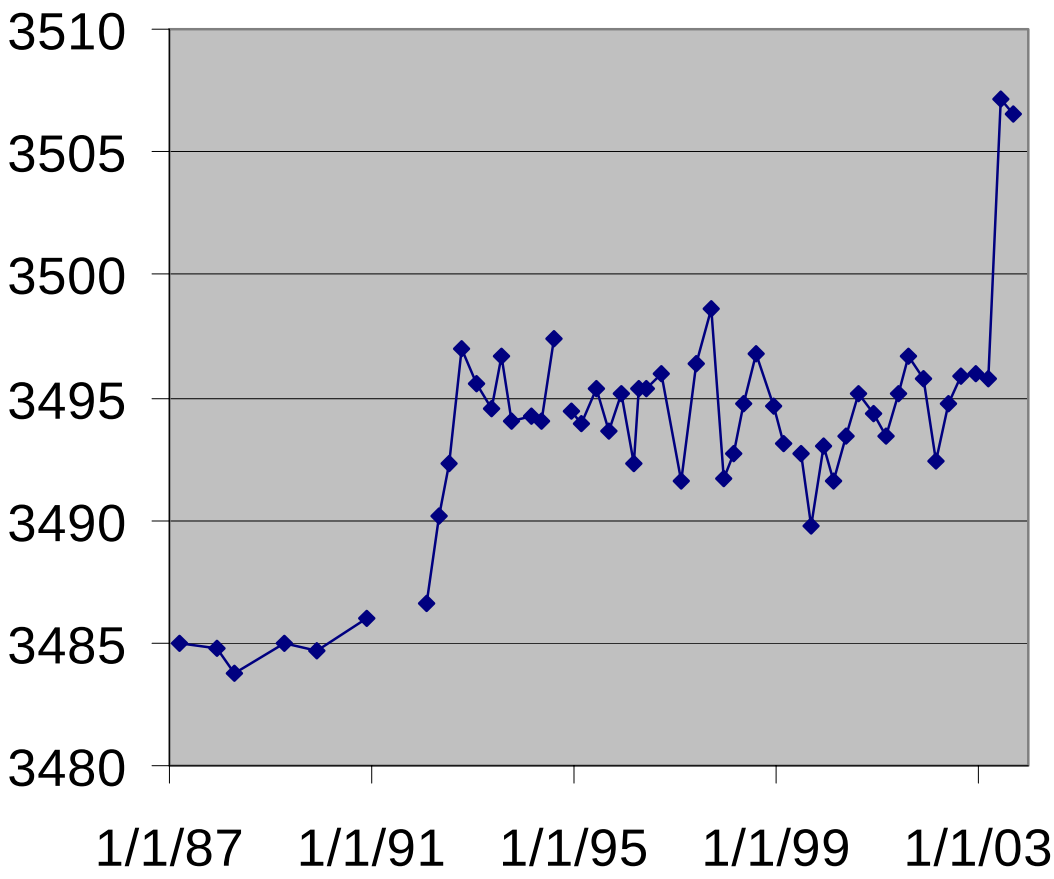
- Probably LOW based on projected elevation and runoff
- Current projections (March 2003):
  - 3.95 MAF runoff (moderate)
    - 12°C water expected at 30-35 meters
  - Reservoir elevation of 3609 ft by Sept. 2003
    - Penstock depth of ~42 meters
  - Higher runoff could warm to greater depths
    - But could raise thermocline away from penstocks
  - Lower runoff could bring thermocline lower
    - But would not allow as much warming at depth

Colorado River at Hite Marina - 9/18/03

Colorado River at Hite Marina - 3/9/03

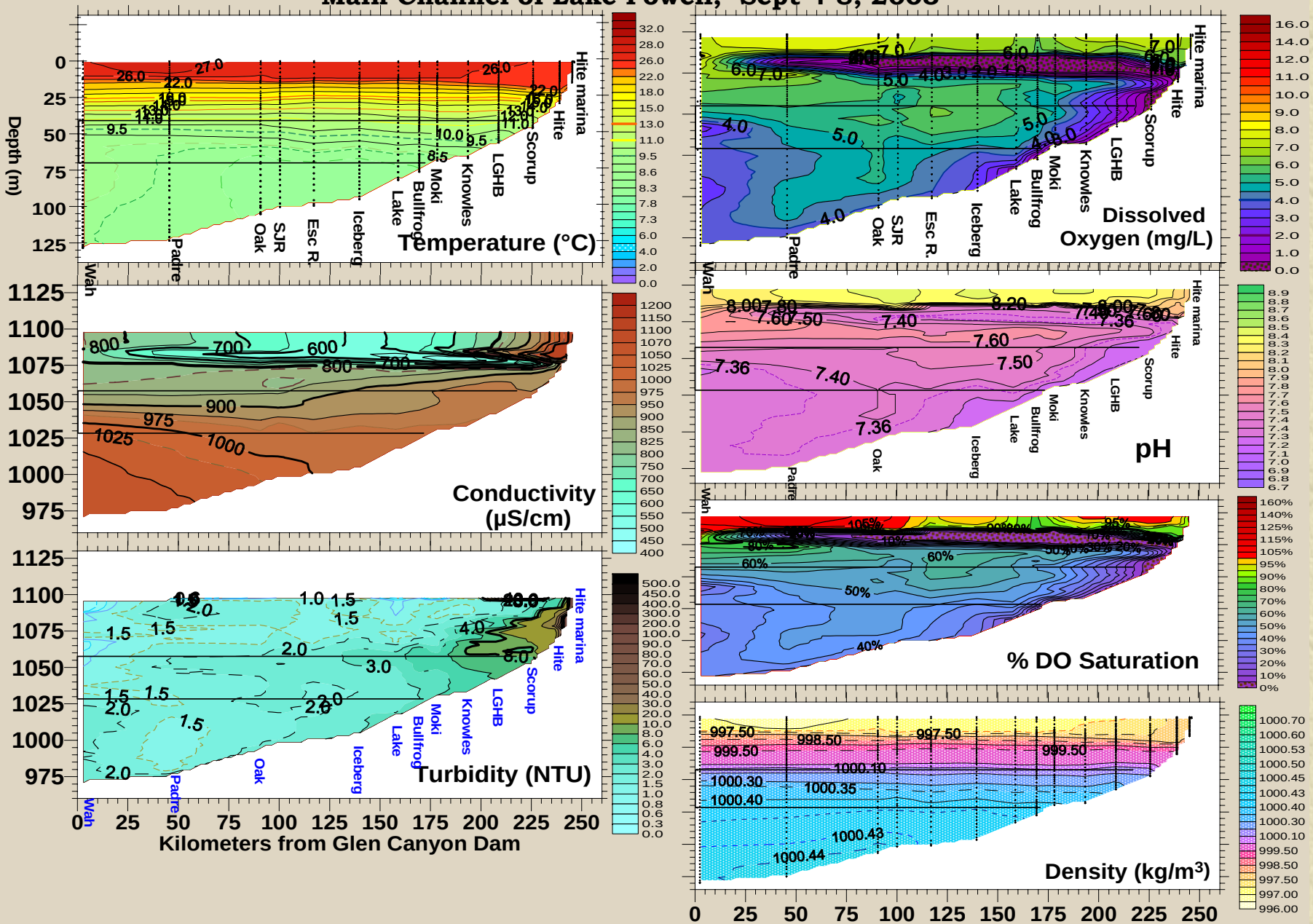
Sediment aggradation from deltaic resuspension

Hite Crossing Bottom Elevations



- Long-term site at old Hite Crossing, about 6 miles downstream of Hite Marina
- Site aggraded with low reservoir levels in 1992 and again in 2003 due to deltaic resuspension

Main Channel of Lake Powell, Sept 4-8, 2003



Temperature (°C), conductivity (µS/cm), turbidity (ntu), dissolved oxygen (mg/L), pH, and dissolved oxygen saturation (%) and density (kg/m3, calculated) in the main channel of Lake Powell, Sept. 4-8, 2003. Penstock elevation is at 1057.7 m (-42.7 m), river outlet at 1028.4 m. Reservoir elevation is 1098.5 m /3603.7 ft above sea level. Profile measurements indicated by dots on temperature plot, sample points indicated by "+".

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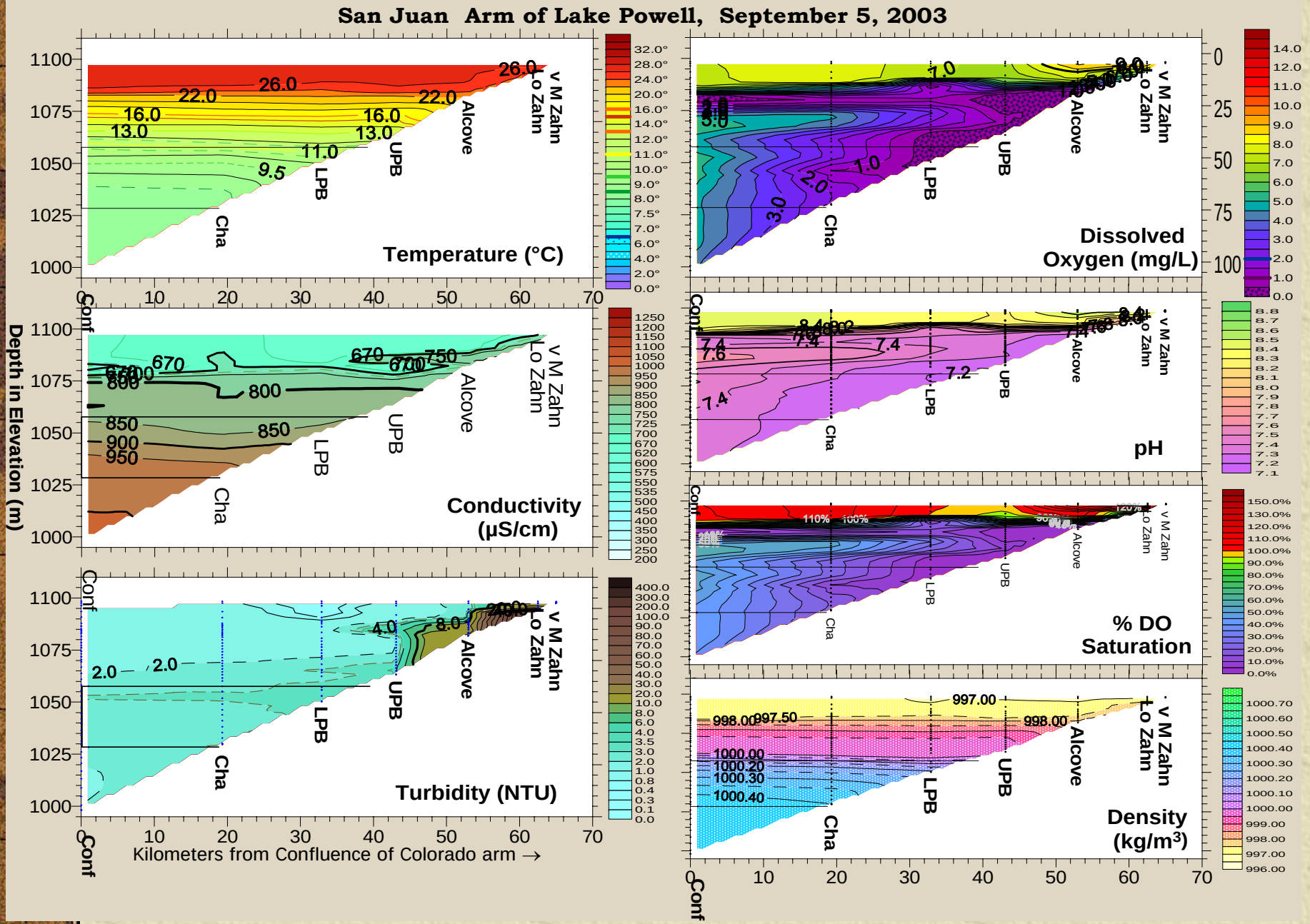

Temperature (°C), conductivity (µS/cm), turbidity (NTUs), dissolved oxygen (mg/L), pH, % DO saturation and density (kg/m\up30 \fs70 3\dn45 \fs150) in the San Juan arm of Lake Powell, September 5, 2003. Elevation of lake is1098.5 m (3604.0 ft) above sea level.

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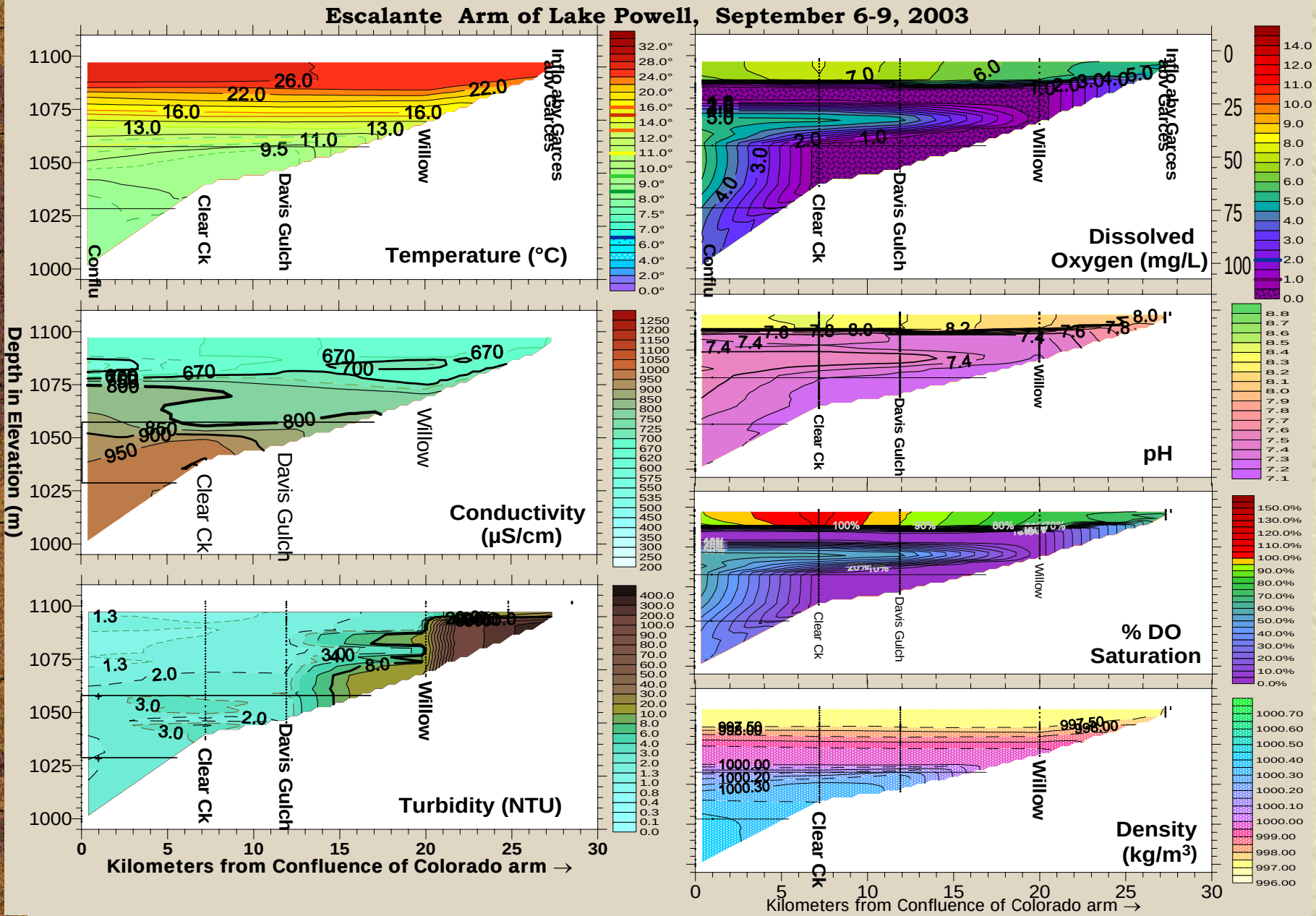

Temperature (°C), conductivity (µS/cm), turbidity (NTUs), dissolved oxygen (mg/L), pH, DO saturation and density (kg/m3) in the Escalante arm of Lake Powell, September 6-9, 2003. Elevation of lake is1098.5 m (3604 ft) above sea level.

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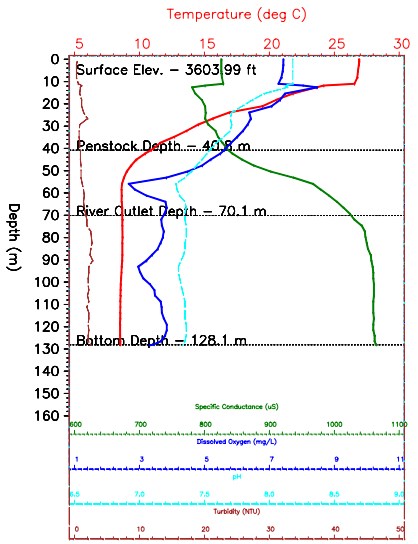
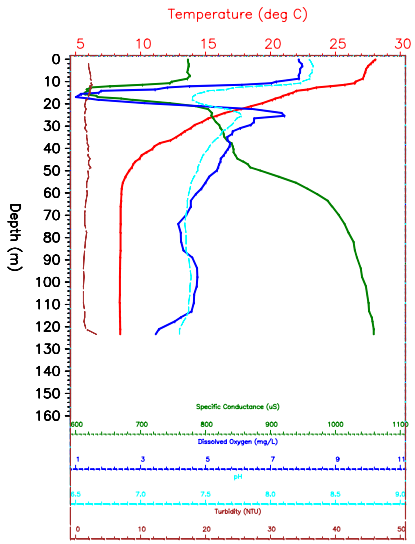
Progressive Metalimnetic Oxygen Deficit – September 2003

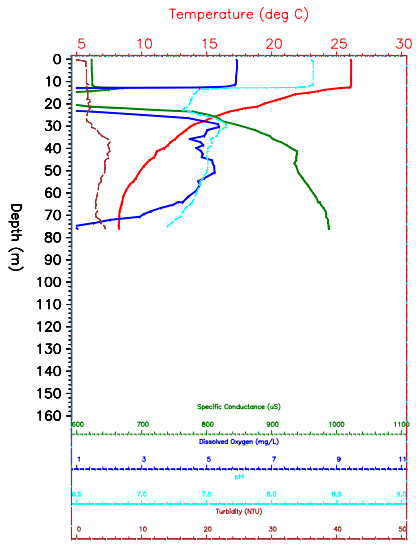
Wahweap



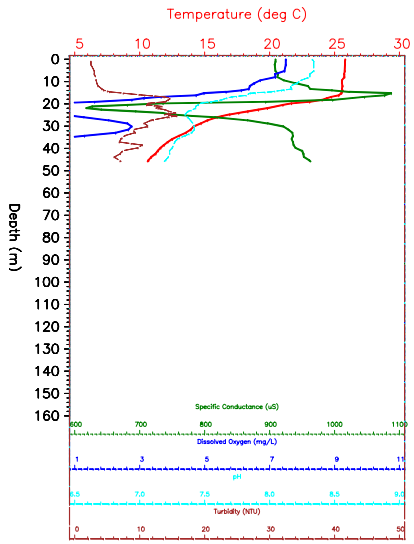
Padre Bay



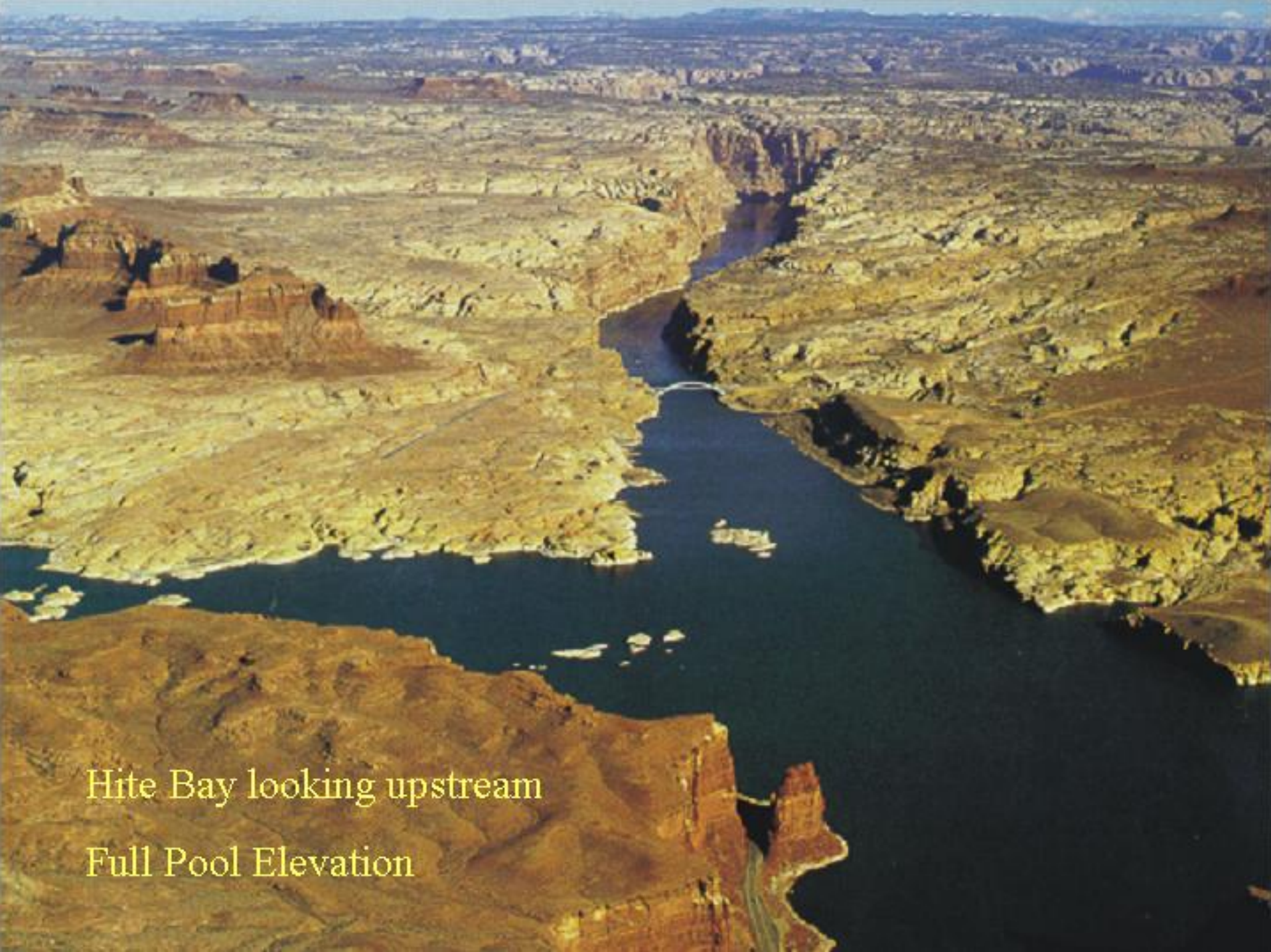
Bullfrog



Scorup



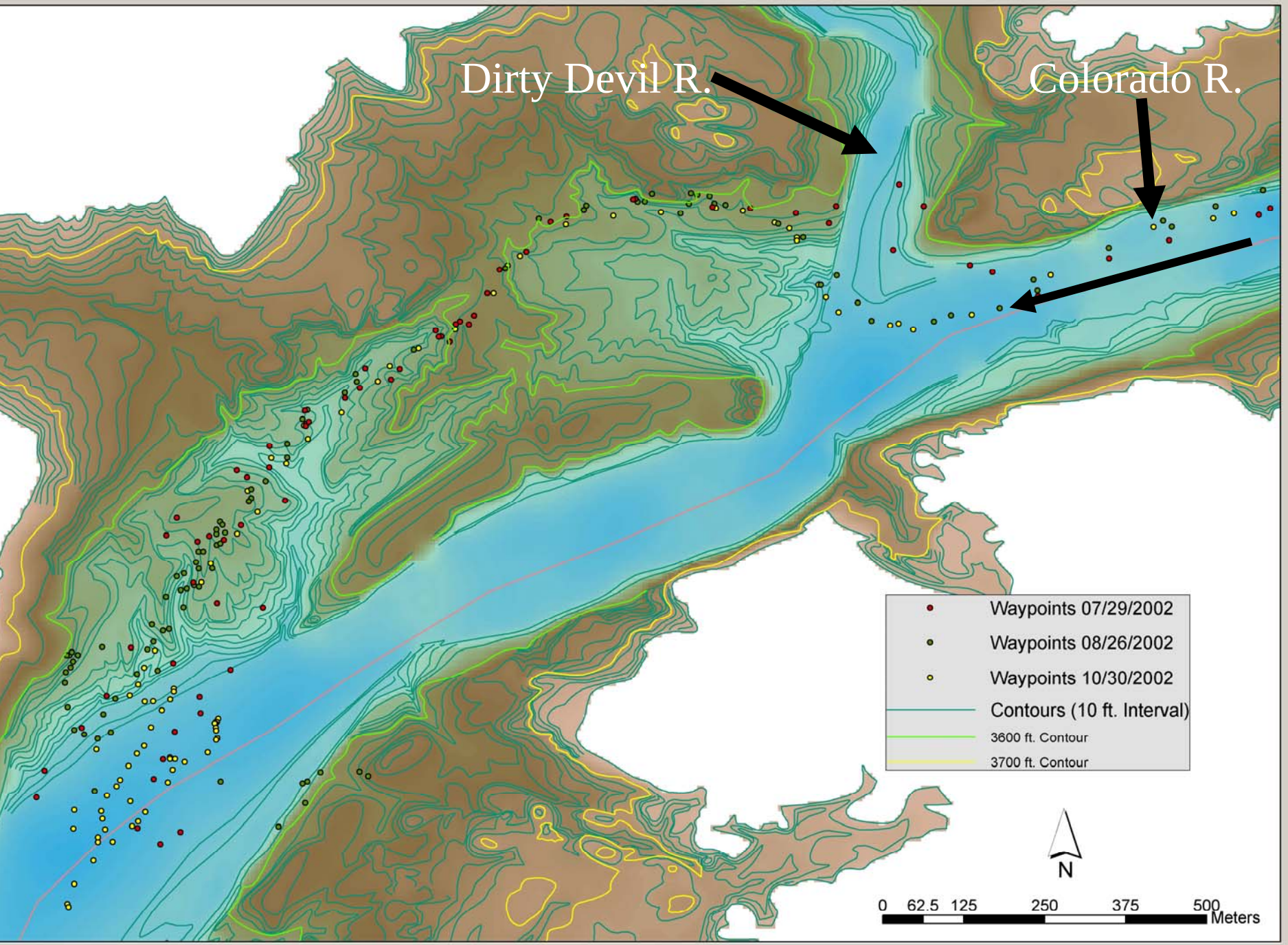

Lake Powell
~1973

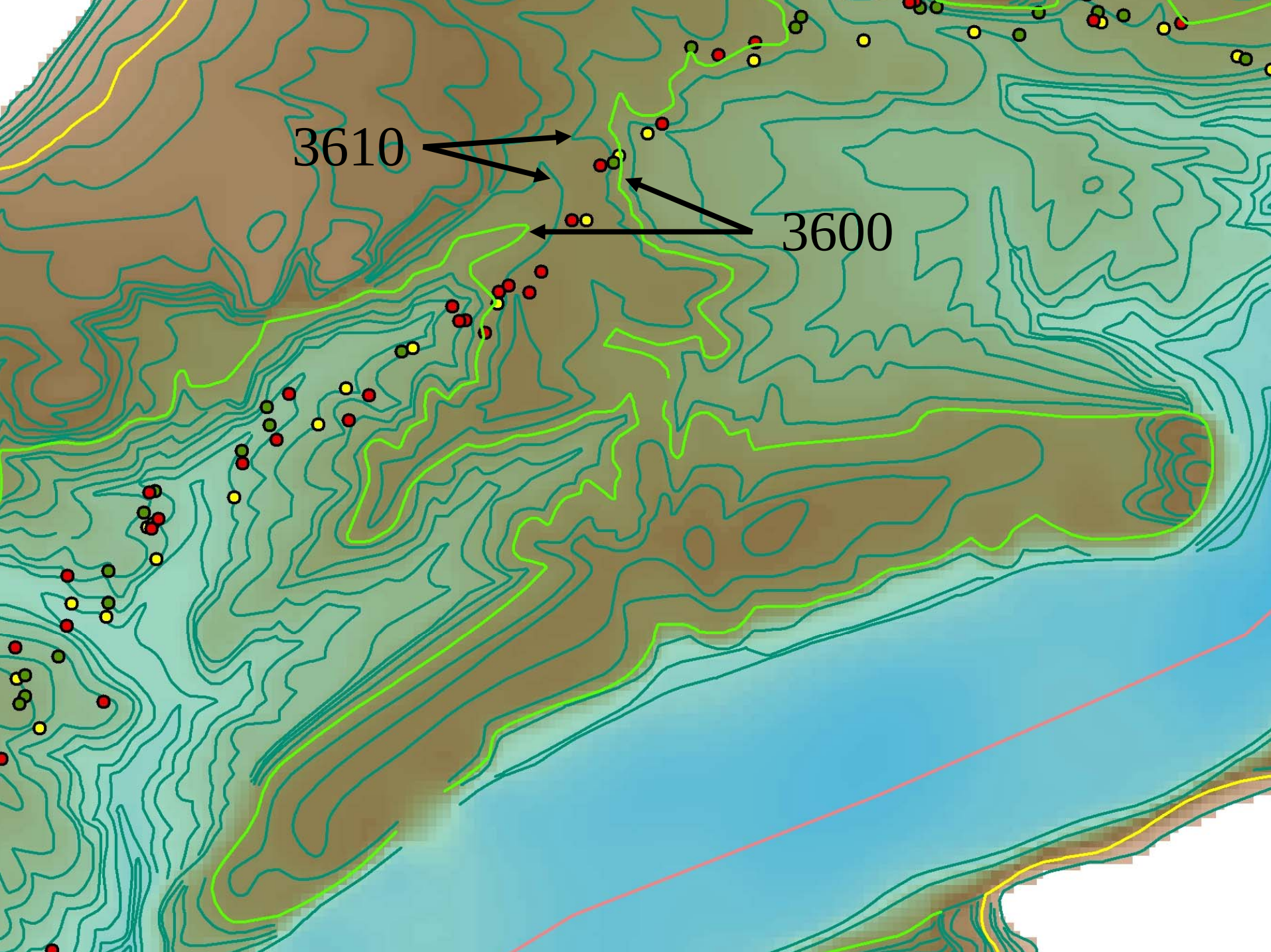

Hite Bay looking upstream
Full Pool Elevation


Lake Powell
7/26/2002


Dirty
Devil
Colorado
River
Bridge
Hite
Lake Powell
10/30/2002


Lake Powell
03/09/2003


Dirty Devil R.
Colorado R.
Waypoints 07/29/2002
Waypoints 08/26/2002
Waypoints 10/30/2002
Contours (10 ft. Interval)
3600 ft. Contour
3700 ft. Contour
N
0 62.5 125 250 375 500
Meters


3610
3600

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