



Yuba River Development Project FERC Project 2246 Relicensing Water Balance/Operations Modeling



Wednesday, May 9, 2012

Meeting Objectives

- Review previous discussions
 - Model Platform
 - Hydrology
- Present Model Basics
 - Facilities
 - Schematic
 - Operational objectives
- Present operations modeling approach



Previous Discussion

- Use of MS Excel/VBA for modeling platform
- Hydrology
 - Period of Record: 10/1/1969-9/30/2010
 - Historical inflows
 - Synthetic accretions below inflows
- All input timeseries are stored in a single DSS file
- Output is written to a separate DSS file



Model Basics

- Model is coded to simulated one year at a time
- Can run as short as 2 days
- Last day of simulation must always be 9/30
- When running multiple years, it is possible for interim years to extend as much as 6 days beyond 9/30
 - Always ends on a Sunday due to power generation simulation module except for final year of simulation



Model Basics

■ Facilities

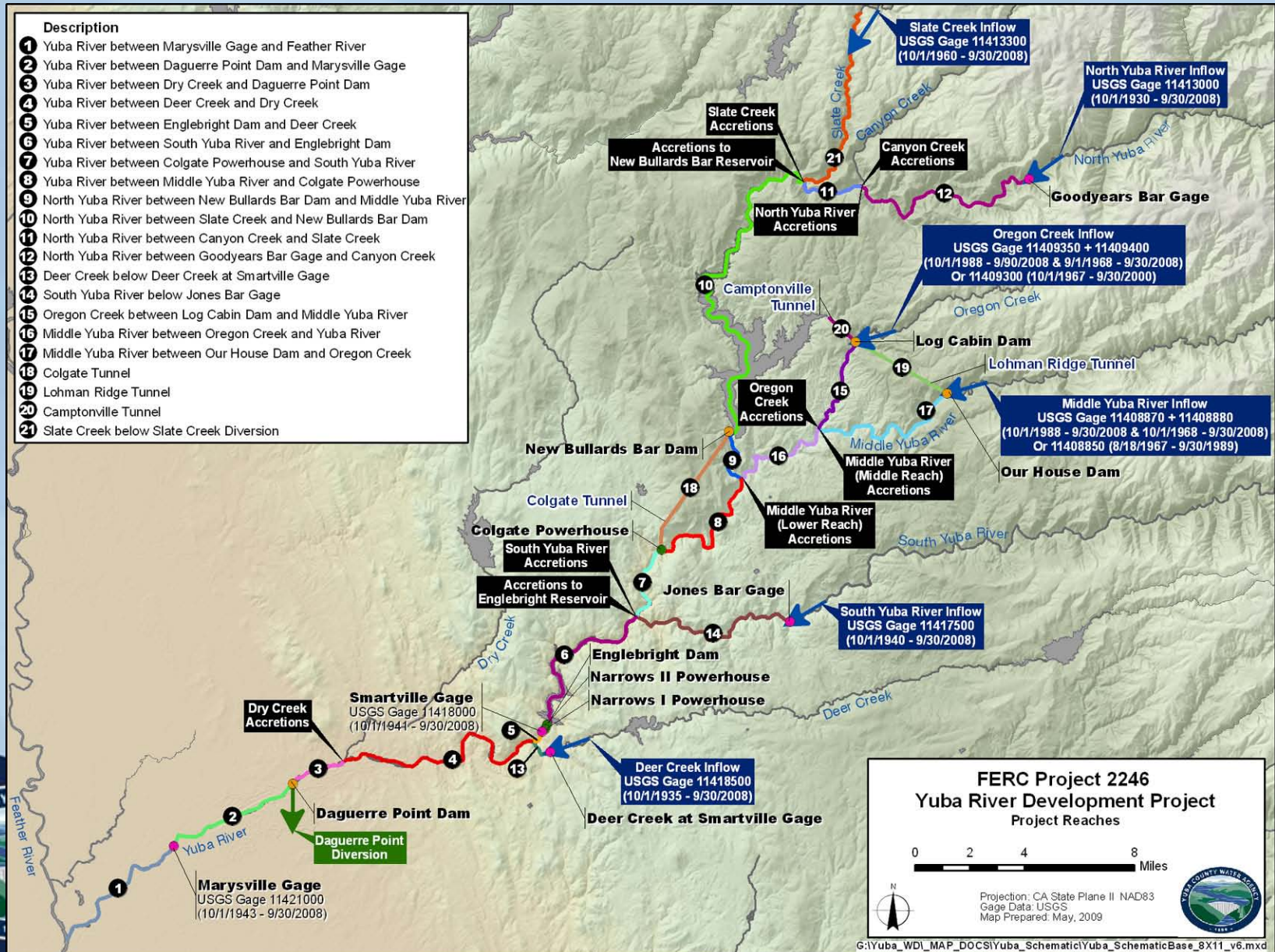
- New Bullards Bar Reservoir
- Fish Hydro
- Colgate Powerhouse
- Our House Dam
- Lohman Ridge Tunnel
- Log Cabin Dam
- Camptonville Tunnel
- Englebright Dam
- Narrows 1 and 2 powerhouses
- Daguerre Point Dam diversions

■ Hydrology

- North Yuba River
- Slate Creek
- Middle Yuba River
- Oregon Creek
- South Yuba River
- Deer Creek
- Dry Creek
- Intervening accretions



Model Schematic



Operational Objectives

- Minimum flow requirements
 - Below New Bullards Bar Dam
 - Below Our House Dam
 - Below Log Cabin Dam
 - At Smartsville
 - At Marysville
- Flood Management Objectives
 - New Bullards Bar flood pool management
 - Flow below New Bullards Bar Dam
 - Flow at Marysville
- Reservoir Storage
- Water Supply
 - Deliveries from Daguerre Point Dam
- Fisheries Protection
 - Ramping rates below Englebright Dam
 - Flow stability below Englebright
 - Spill avoidance at Englebright
- Power Generation
 - At Colgate Powerhouse
 - At Narrows 1 and 2 powerhouses
- Physical Constraints
- Carryover Storage



Diversions

- Diversion locations
 - OHD/Lohman Ridge Tunnel
 - LCD/Camptonville Tunnel
 - NBB/Colgate Penstock
 - Daguerre Point Dam
- Basic approach
 - Ensure downstream flow requirements are met before diversions
 - Divert up to capacity
 - Remaining flow released to river



Agricultural Deliveries

- Synthetic demands developed
 - Historical deliveries were not usable
 - Highly variable historical deliveries
 - Districts coming on line at different times
 - Historical groundwater substitution transfers
 - Changing cropping patterns/irrigation methods
- Demand developed based on:
 - Historical land use (2005)
 - DWR applied water rates (Wet – 1999, Dry – 2001)
 - Historical daily district delivery patterns (2003-2007)
 - Loss and reuse rates based on estimates
 - Checked against recent historical deliveries
- Two timeseries for each district: Wet year/Dry year
- Future level of development assumes full Wheatland WD build-out



New Bullards Bar Operation Curves

- FERC minimum pool : 234,000 AF
 - Absolute minimum storage
- Target line + buffers
 - Used to “push” water out when operations for minimum flows would result in high storage
 - Based on historical operations
 - Buffers allow for gradual changes/smooth releases
 - If predicted storage would be above upper buffer, releases are at maximum Colgate capacity
 - Avoid spilling Englebright, if possible
 - If predicted storage would be below lower buffer, releases are for minimum requirements
 - Linear interpolation in between

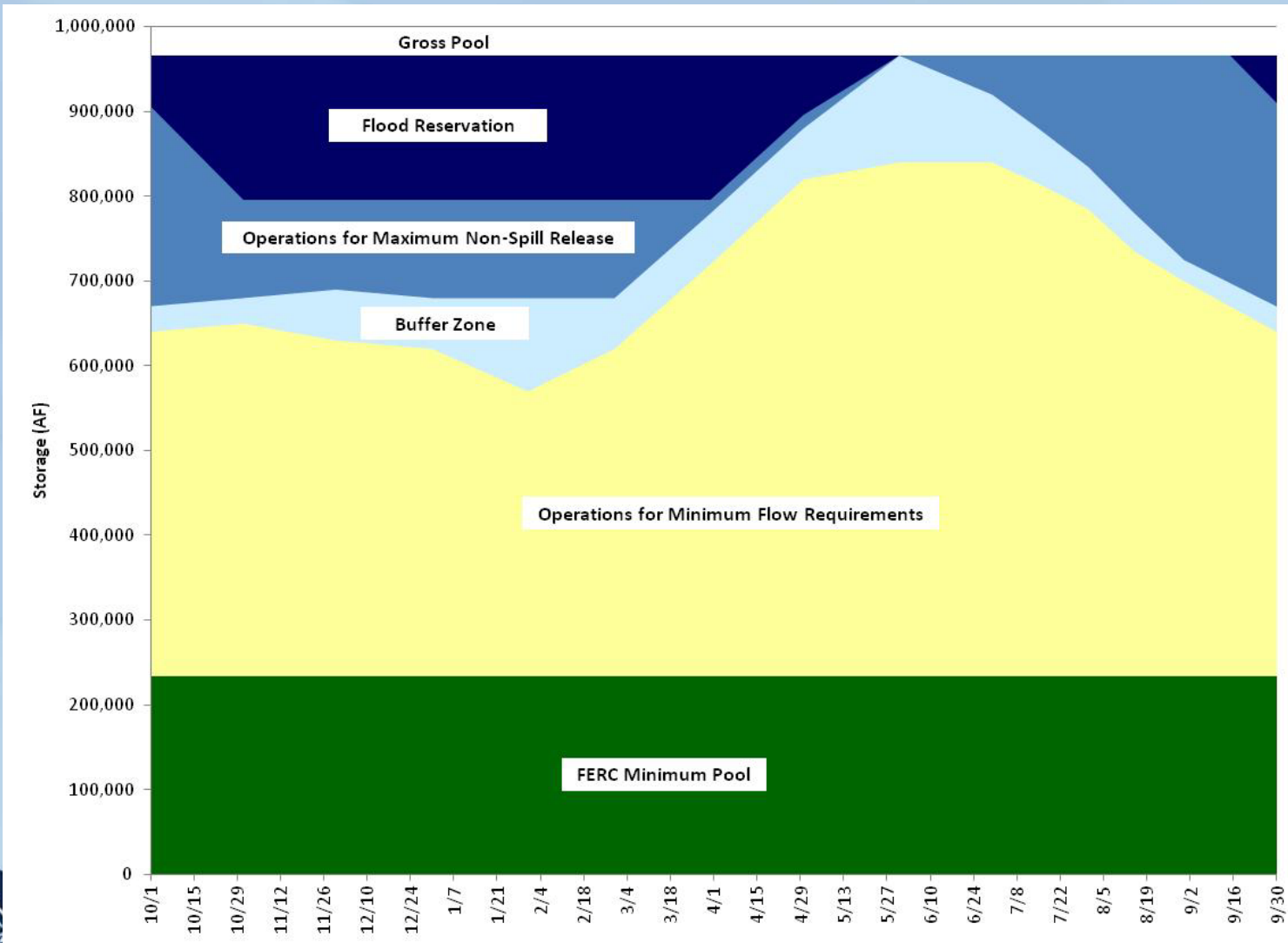


New Bullards Bar Operation Curves (Cont'd)

- USACE flood pool
 - Defined in 1972 New Bullards Bar Reservoir Reservoir Regulation for Flood Control
 - If predicted storage exceeds flood pool:
 - Release maximum possible flow based on previous day's elevation
- Gross Storage: 966,103 AF
- Carryover storage target
 - Based on:
 - Meeting flow requirements for a Schedule 6 (or other dry year) year-type
 - Providing 50% of agricultural deliveries in following year
 - In case of a 99% exceedance drought
 - Agricultural shortages applied ONLY if predicted storage is below carryover storage target



Example of Reservoir Operation Lines



General Model Output

- Daily flows in all reaches
- Reservoir storage and targets
- Generation
- Agricultural deliveries, shortages, allocations
- Year-types and indices
- Flags/codes describing operational drivers



Operational Modeling Approach

- Description of:
 - Sequence of simulation
 - General modules
 - Considerations taken for operational decisions



Log Cabin and Our House Dams

- Straightforward operations
- Meet minimum flow
 - Buffer included
- Divert to tunnel capacity
 - To Oregon Creek
 - To New Bullards Bar Reservoir
- Balance remains in Middle Yuba River/Oregon Creek



Compute Hydrologic Index

- Currently coded for either NYI or YRI
- North Yuba Index
 - Assumes perfect foresight of inflows
 - Uses previous year's end-of-September NBB storage
 - Changes on April 1
- Yuba River Index
 - Pre-processed based on historical full-natural flows
 - Changes on April 1



Determine Flow Requirements

- Currently set up for Marysville and Smartsville
- Uses lookup tables with hydrologic year-type and date
- Filled in for full simulation year

Determine Agricultural Demand

- Agricultural demand applied for calendar year
- Pre-processed based on current water year's hydrologic Yuba River Index (binary-wet/dry)



Identify Controlling Lower Yuba River Flow

- Release from Englebright either:
 - Smartville flow requirement
 - Marysville flow requirement + Daguerre Point Dam diversions – Dry Creek inflow – Deer Creek inflow
 - Whichever is greater

Identify Minimum New Bullards Bar Reservoir Release

- Ensure no change in Englebright storage, release:
 - Englebright Release – South Yuba River Inflow – Middle Yuba River inflow - Accretions



Determine if Additional Releases are Needed from New Bullards Bar Reservoir

- Compute New Bullards Bar Reservoir storage with
 - North Yuba River inflows
 - Camptonville Tunnel inflows
 - Accretions
 - Minimum required release for lower Yuba River needs
- If resulting storage would be within target operating line buffer range, additional releases would be required



Target Operating Line Operations

- Target operating line and buffers developed through experience
- Storage from operations for lower Yuba River requirements compared against buffer zones
 - Top of buffer zone represents full Colgate release
 - Bottom of buffer zone represents minimum release
 - Linearly interpolated between these extremes for intermediary storage conditions
 - Avoids dramatic “jumps” at transitions
 - Reduced Colgate releases if buffer zone releases would result in spills at Englebright
- If anticipated storage would exceed flood pool, releases based on maximum release for previous day’s elevation.
 - Considers flood control limitations below NBB dam and in Marysville



Englebright Storage Not Typically Operated

- Under normal simulation, Englebright storage is maintained day-to-day
- Simulated reservoir water surface variations for:
 - Power generation
 - Freshet management
 - To be further discussed later



Agricultural Diversion Shortages

- Shortages applied if carryover storage cannot be met.
- Carryover storage determined by computing volume of storage needed to provide 50% of deliveries and dry-year lower Yuba River flow requirements at risk with 99% exceedance (1:100 year drought) inflows
 - Currently uses Schedule 6 flows for carryover storage
 - Schedule 6 designed to occur in 1:100 to 1:20 year recurrence
- Model iterates, if needed, to ensure end-of-year storage is at target level
 - No shortages when Smartsville flow requirements are controlling
- Reductions limited to 50%
 - Storage is allowed to drop to FERC minimum pool if 50% shortages are insufficient to meet carryover storage requirement
 - Releases would equal inflows once FERC minimum pool is reached.
 - Agricultural diversions only allowed after minimum required flows were met.



Power Generation Calculation

- Based on empirical data
 - 10+ years of hourly generation at Colgate and Narrows 2 powerhouses
 - Filtered for reasonableness
 - Efficiency $>20\%$, $<120\%$
 - Flows <600 cfs, $>3,500$ cfs excluded
 - Huge resulting data sets
 - $>100,000$ points for Narrows 2
 - $>50,000$ points for Colgate
 - Normalized to maximum gross head using affinity laws
- Lookup tables relating maximum gross head to generation and flow
- Recomputed for simulated gross head and flow
- Narrows 1 based on similar information from PG&E



Special Operational Considerations

- Englebright freshet management
- Englebright flow stability
- Power operations
- Narrows 1 / 2 powerhouse split



Englebright Freshet Management

- Small events on Middle and South Yuba Rivers
- Assumes 4-day forecasting (user defined variable)
- Colgate releases are reduced in response to forecasted increases in Middle and South Yuba flows (for flows in excess of combined Narrows capacity)
- Englebright Reservoir releases would remain at previously computed rate
- Englebright Reservoir elevation would decrease (down to minimum recreation level)
- Inflows would be captured, stored, and released when possible



Englebright Flow Stability

- Defined in FERC Amendment for Narrows 2 Bypass
- Based on maximum (non-flood) 5-day average flow below Englebright for September 15 – March 31
 - Minimum flow limited to 55% of max for September 15-October 31
 - Minimum flow limited to 65% of max for November 1-March 31
- Maximum of 70% daily reduction



Power Operations Module

- Allows for reshaping of weekly Colgate releases
 - Preserves volume of releases
 - Does not change Englebright release
- Englebright Reservoir levels allowed to fluctuate within operable range (516-527 ft above mean sea level)
- Colgate releases are reshaped to reflect potential power generation pricing
 - Weekday vs weekend generation?
 - Limited by available storage in Englebright and Colgate capacity



Narrows 1-2 Flow Split

- Two Modes:
 - No split (maximum efficiency)
 - Eng release of 0-730 cfs: All Narrows 1
 - Eng release of 730-900 cfs: Narrows 1 + bypass
 - Eng release of 900-3,400 cfs: Narrows 2
 - Eng release of 3,400-4,130 cfs: Narrows 1 + 2
 - Current Operations (Renewable energy credit from N1)
 - Eng release of 0-730 cfs: All Narrows 1
 - Eng release of 730-900 cfs: Narrows 1 + bypass
 - Eng release of 900-1,630 cfs: Narrows 1 + Narrows 2 min
 - Eng release of 1,620-4,130 cfs: Narrow 1 max + Narrows 2



Next Meeting (6/14)

- Running the model
 - User interface
 - Where various code can be found
 - Common causes of errors
- Validation Report
- Model and Base Case Report

