East Bay Municipal Utility District (EBMUD) Operations Model

Riverware User Group Meeting, March 2005

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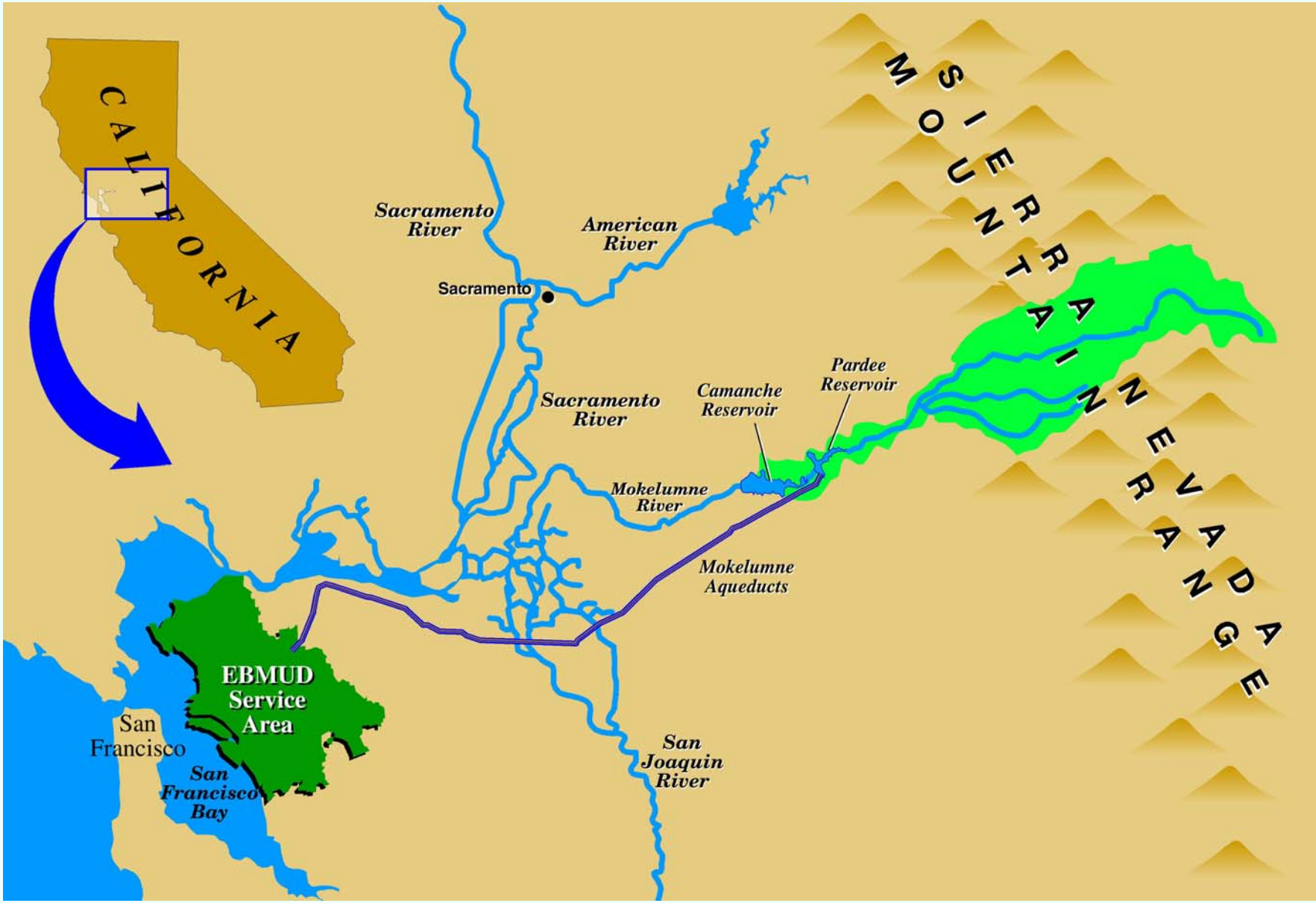
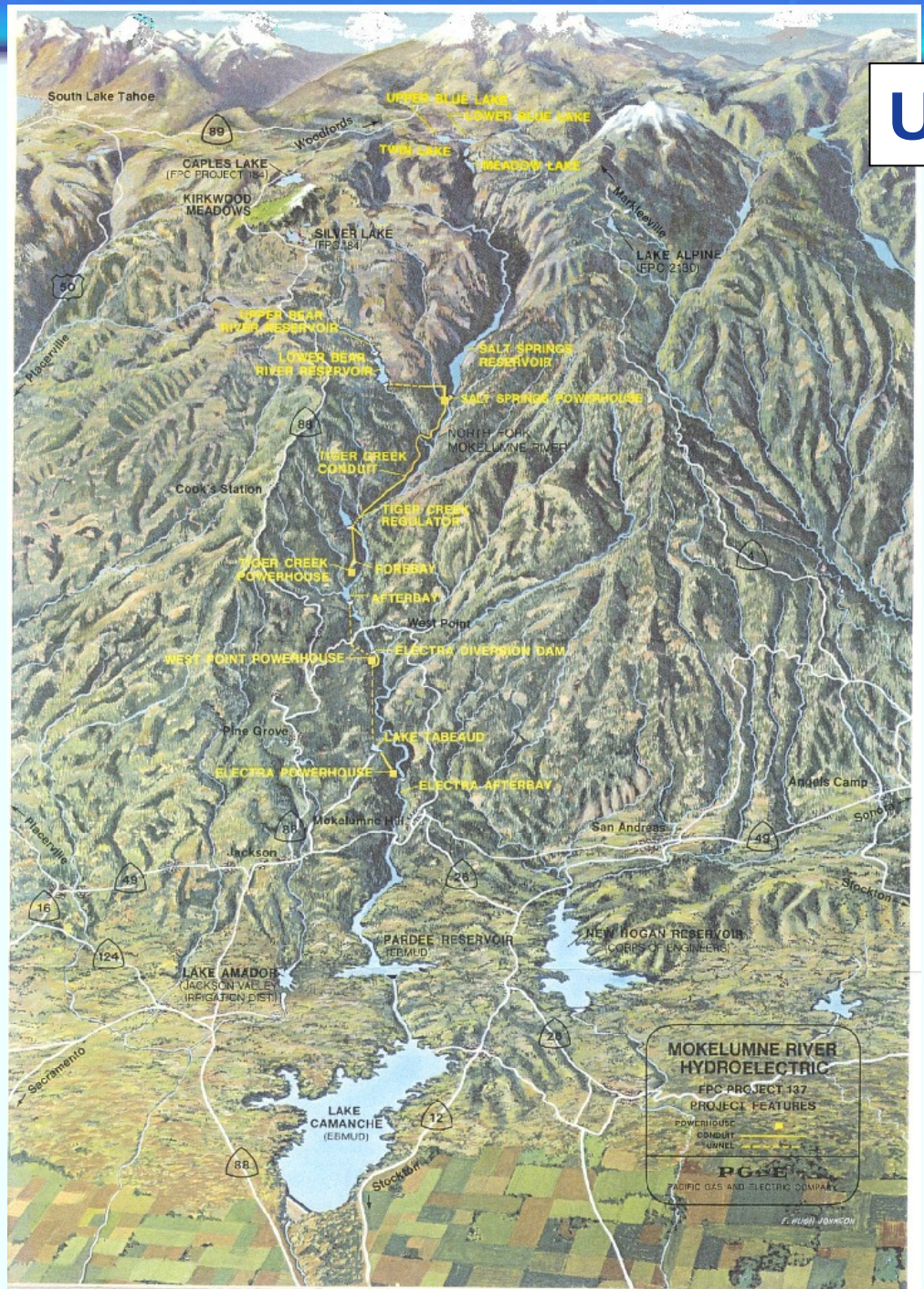
EBMUD Location



Upcountry Watershed



Mokelumne River Watershed

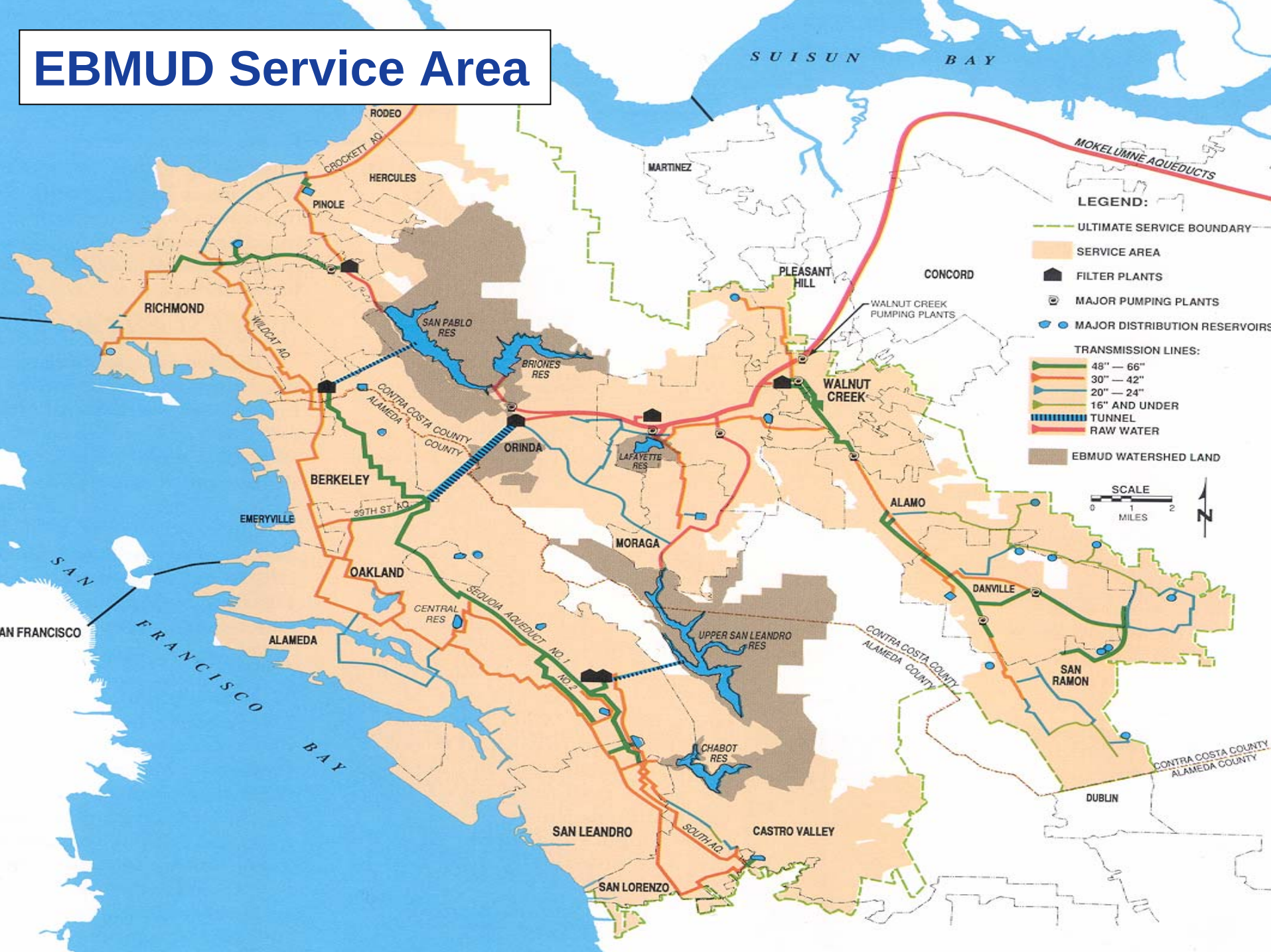
- Middle Sierra Nevada Region
- 577 square miles
- 740 TAF Avg True Natural Flow
- Pardee Reservoir (198 TAF)
- Camanche Reservoir (417 TAF)

So far this year:

- Precipitation 39" (118% of avg)
- Snowpack 90" (125% of avg)
- Power Fire

Power Fire 2004 (Upper Mokelumne Watershed)

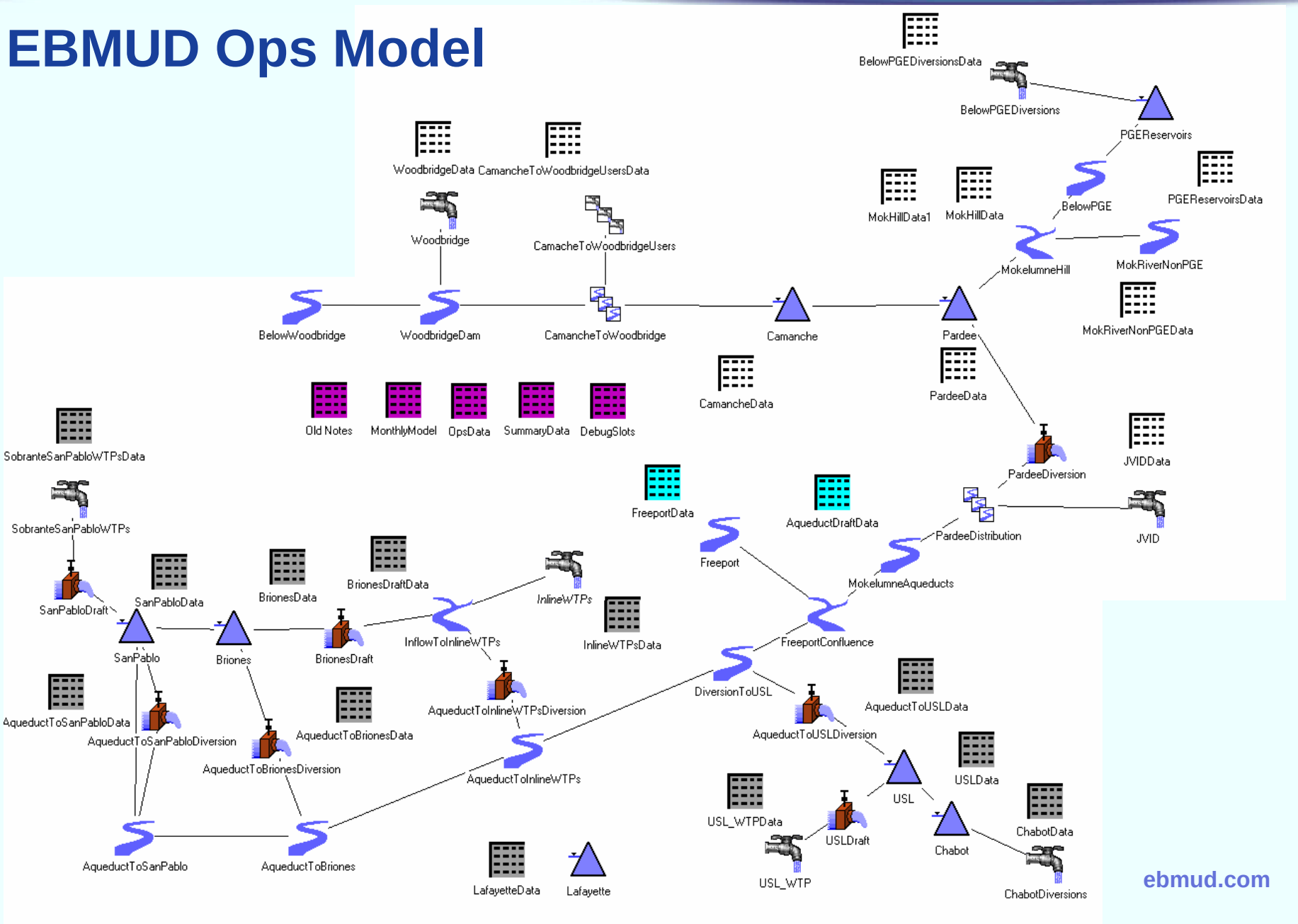
EBMUD Service Area

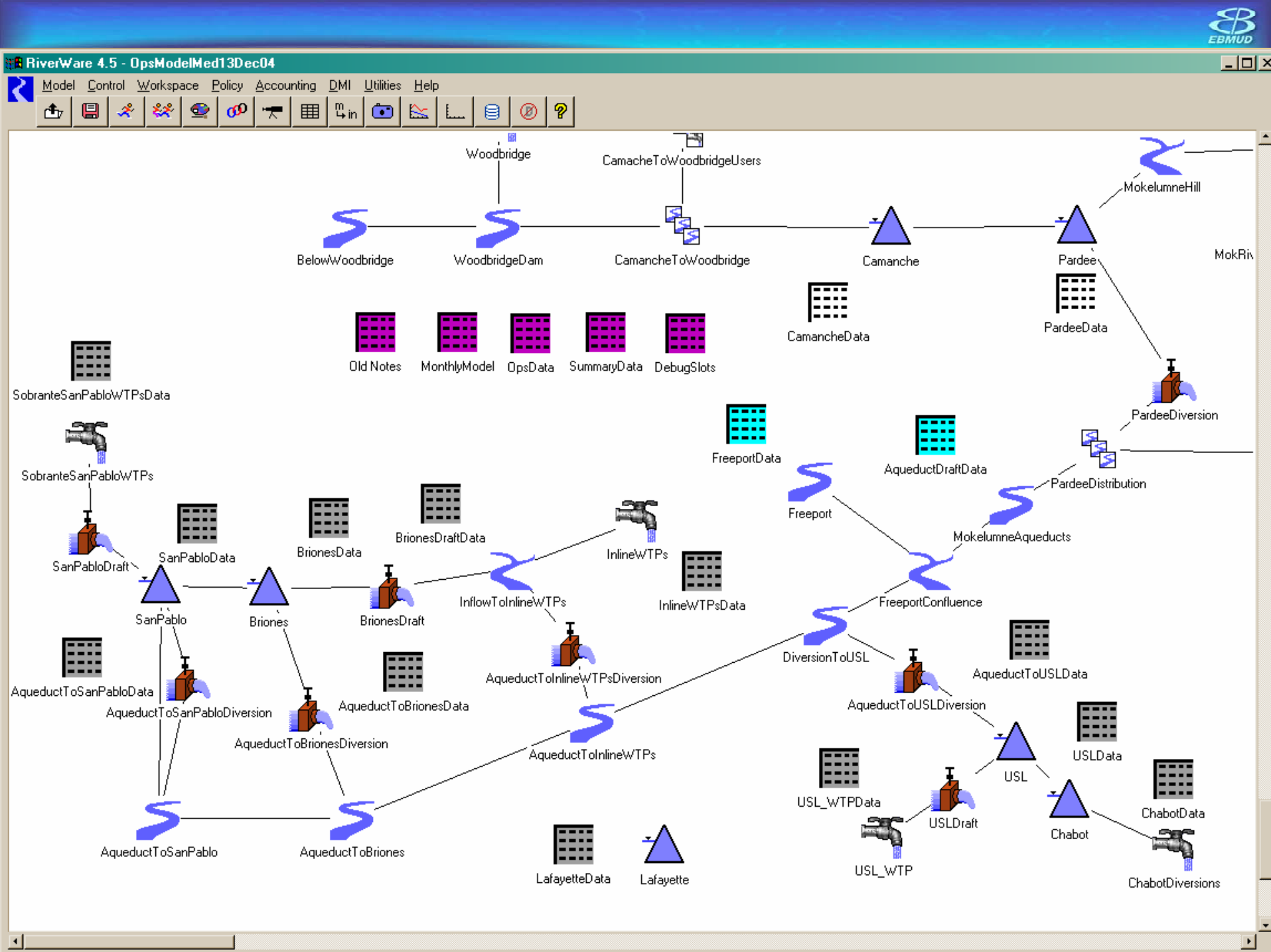


Riverware Modeling

- Upcountry Operations
  - Water Rights (downstream, pumped from reservoirs)
  - Instream Fish Flows
  - Water quality (Temperature, DO management)
  - Flood Control
- Local Operations
  - 180-Day Standby Storage
  - Flood Protection
  - Pumping Costs
  - Water Quality
  - Recreation

EBMUD Ops Model

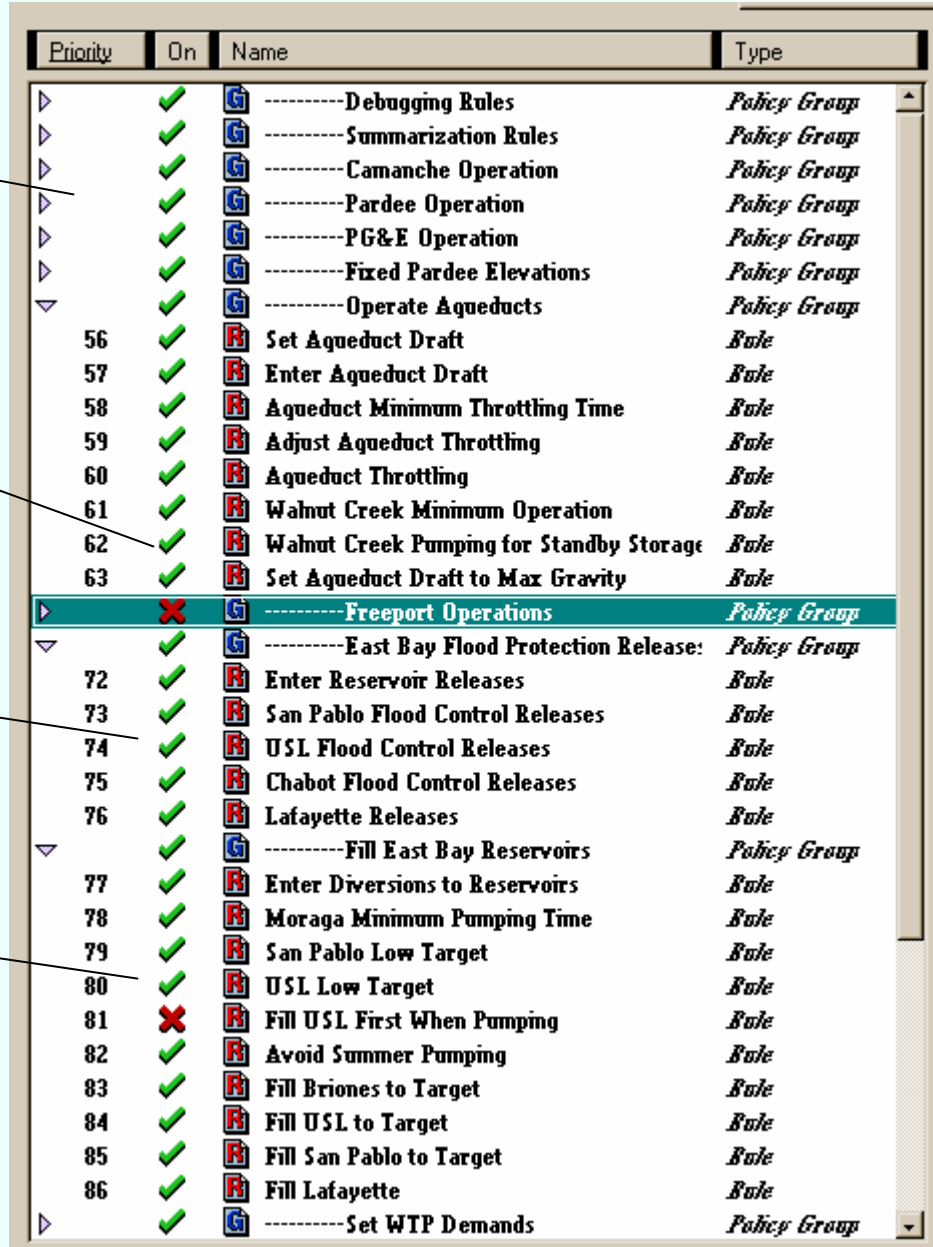



RiverWare 4.5 - OpsModelMed13Dec04
Model Control Workspace Policy Accounting DMI Utilities Help
Woodbridge
CamacheToWoodbridgeUsers
MokelumneHill
BelowWoodbridge
WoodbridgeDam
CamancheToWoodbridge
Camanche
Pardee
MokRiv
CamancheData
PardeeData
Old Notes
MonthlyModel
OpsData
SummaryData
DebugSlots
SobranteSanPabloWTPsData
PardeeDiversion
FreeportData
AqueductDraftData
SobranteSanPabloWTPs
PardeeDistribution
Freeport
SanPabloDraft
SanPabloData
BrionesData
BrionesDraftData
InlineWTPs
MokelumneAqueducts
SanPablo
Briones
BrionesDraft
InflowToInlineWTPs
InlineWTPsData
FreeportConfluence
AqueductToSanPabloData
AqueductToSanPabloDiversion
AqueductToBrionesData
AqueductToInlineWTPsDiversion
DiversionToUSL
AqueductToUSLData
AqueductToUSLDiversion
AqueductToBrionesDiversion
AqueductToInlineWTPs
USLData
USL_WTPData
USL
USLDraft
ChabotData
Chabot
AqueductToSanPablo
AqueductToBriones
LafayetteData
Lafayette
USL_WTP
ChabotDiversions

Operating Rules

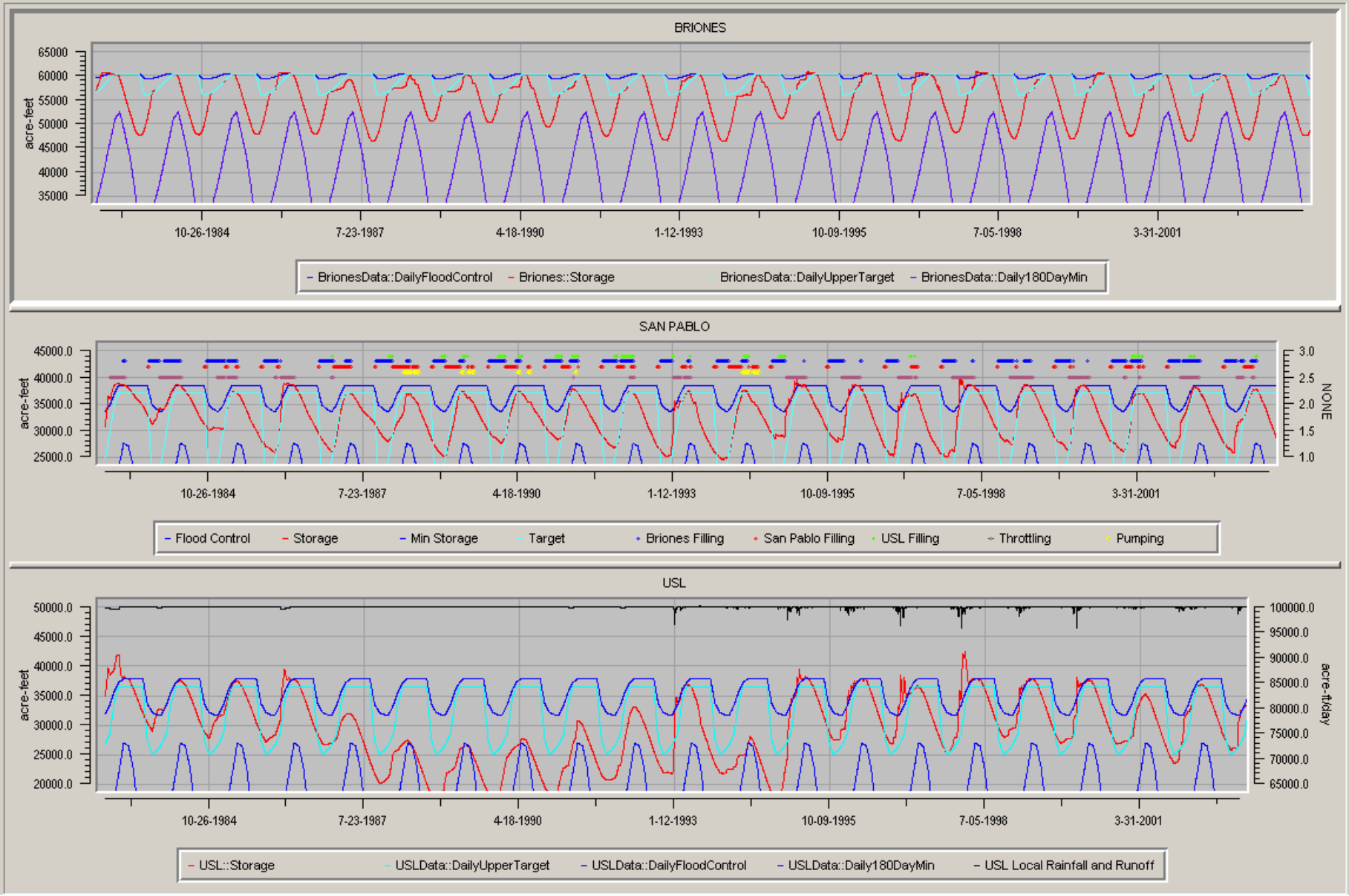
- Upcountry Rules
- Maintain 180-Day Standby Storage
- Flood protection
- Filling Priorities
- Outages/ Special Ops

Riverware Rules

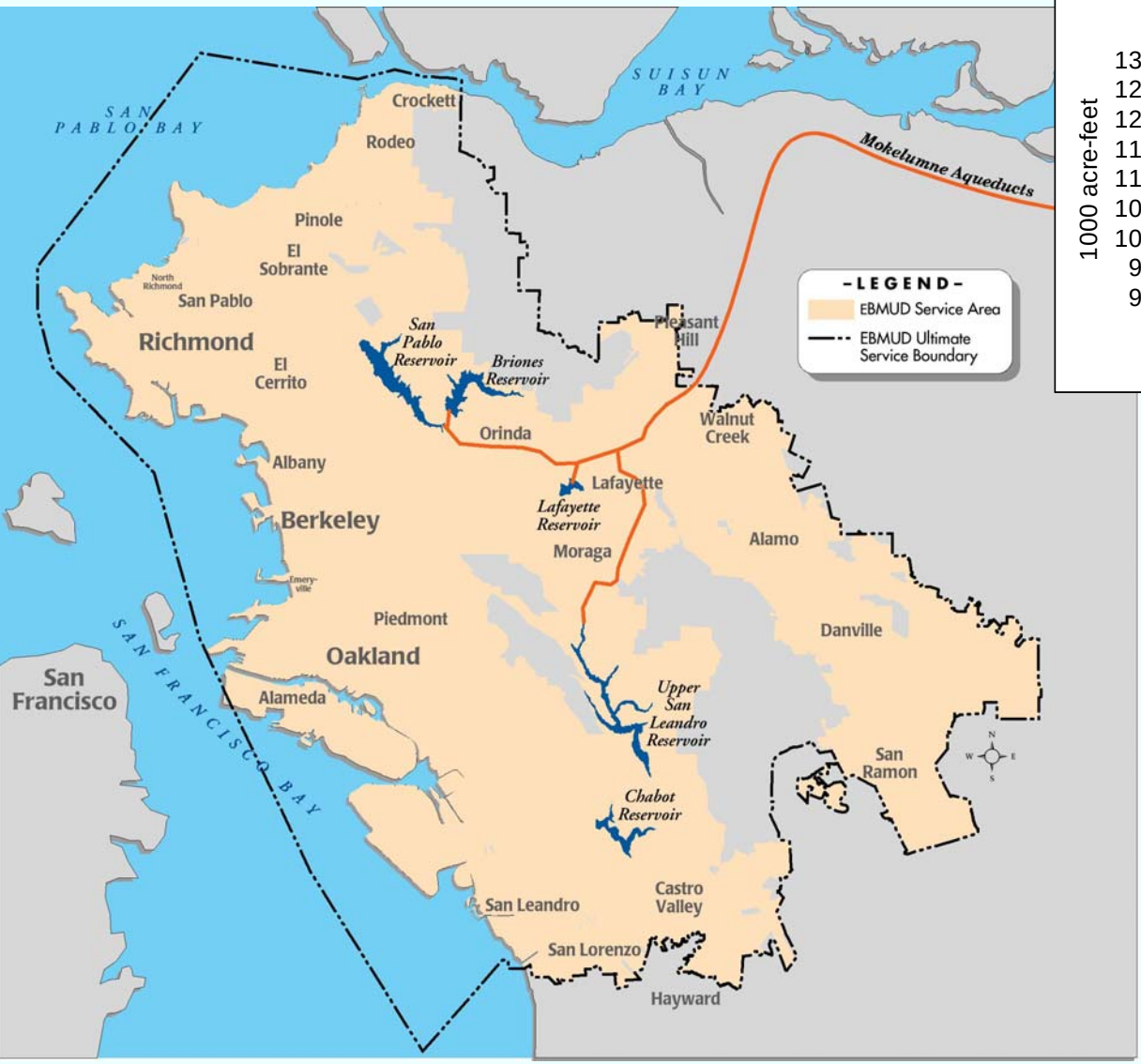


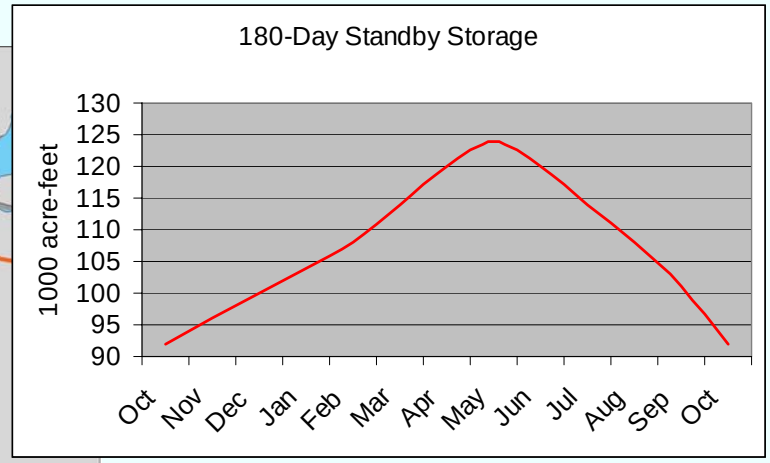
Priority	On	Name	Type
	✓	----------Debugging Rules	Policy Group
	✓	----------Summarization Rules	Policy Group
	✓	----------Camanche Operation	Policy Group
	✓	----------Pardee Operation	Policy Group
	✓	----------PG&E Operation	Policy Group
	✓	----------Fixed Pardee Elevations	Policy Group
	✓	----------Operate Aqueducts	Policy Group
56	✓	Set Aqueduct Draft	Rule
57	✓	Enter Aqueduct Draft	Rule
58	✓	Aqueduct Minimum Throttling Time	Rule
59	✓	Adjust Aqueduct Throttling	Rule
60	✓	Aqueduct Throttling	Rule
61	✓	Walnut Creek Minimum Operation	Rule
62	✓	Walnut Creek Pumping for Standby Storage	Rule
63	✓	Set Aqueduct Draft to Max Gravity	Rule
	✗	----------Freeport Operations	Policy Group
	✓	----------East Bay Flood Protection Releases	Policy Group
72	✓	Enter Reservoir Releases	Rule
73	✓	San Pablo Flood Control Releases	Rule
74	✓	USL Flood Control Releases	Rule
75	✓	Chabot Flood Control Releases	Rule
76	✓	Lafayette Releases	Rule
	✓	----------Fill East Bay Reservoirs	Policy Group
77	✓	Enter Diversions to Reservoirs	Rule
78	✓	Moraga Minimum Pumping Time	Rule
79	✓	San Pablo Low Target	Rule
80	✓	USL Low Target	Rule
81	✗	Fill USL First When Pumping	Rule
82	✓	Avoid Summer Pumping	Rule
83	✓	Fill Briones to Target	Rule
84	✓	Fill USL to Target	Rule
85	✓	Fill San Pablo to Target	Rule
86	✓	Fill Lafayette	Rule
	✓	----------Set WTP Demands	Policy Group

EBMUD 1983-2003 Daily Operations



Standby Storage Calculation





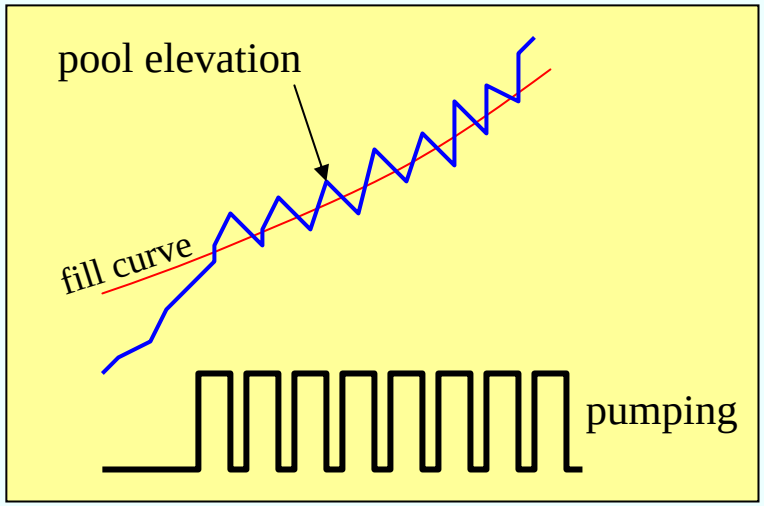
- Problem
  - Compute at each timestep
  - Required mini-simulation of reservoir drawdowns = long model runs
- Solution
  - Compute in Excel using VBA
  - Create 2D lookup table
  - Storage Index and Required Storage

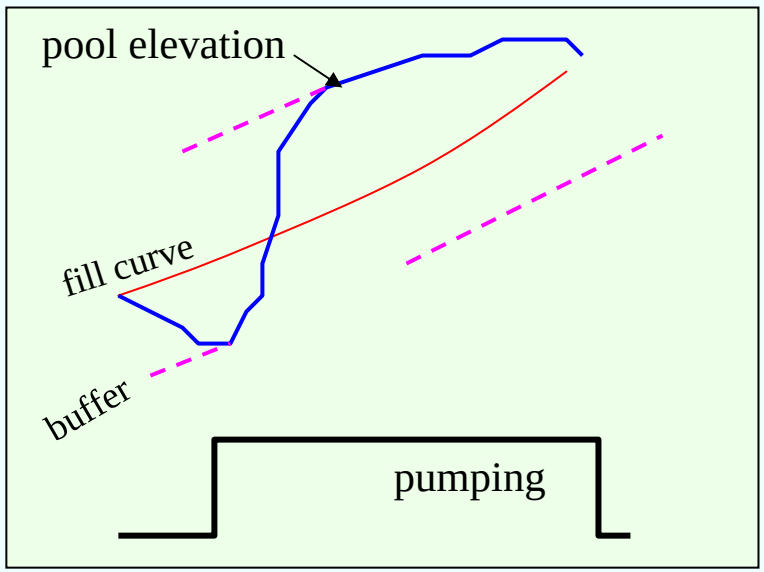
Storage Index	Req'd Storage
285235001	96500
285235032	98000

San Pablo Storage | USL Storage | Julian Day

ebmud.com

Pumping/ Throttling





- "Natural fill curve" determines pumping.
  Below curve, reservoirs request water.
  Above curve, reservoirs stop requests.
  Rule causes oscillations about curve

- Added buffer function

  IF (res.pool < curve + buffer)
  THEN pump

  buffer = IF(pumping)
  THEN + 0.5 feet
  ELSE -0.5 feet

- Add minimum time for pumping and throttling

SCT for smoothing operations changes

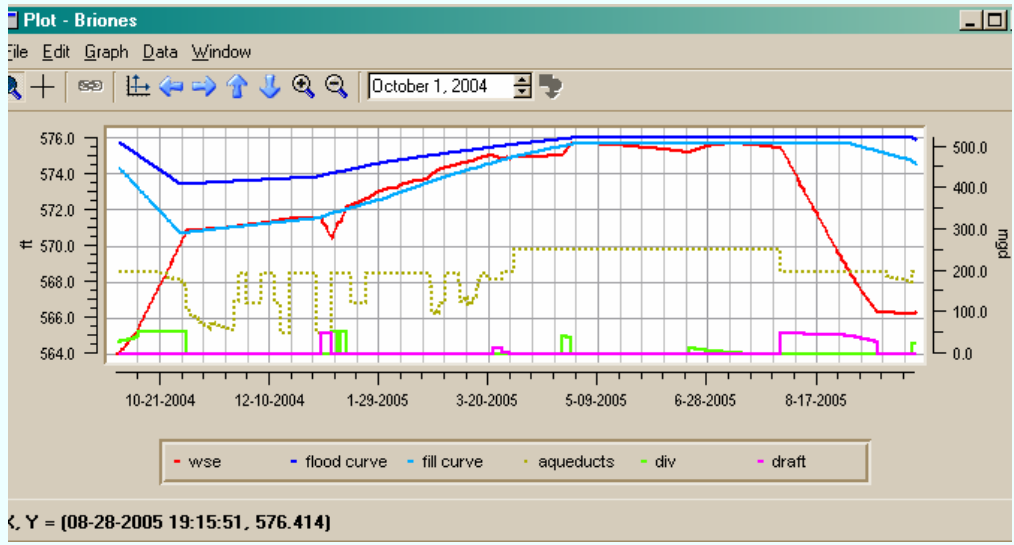
SCT InputOverrides.sct (OpsModeldud)

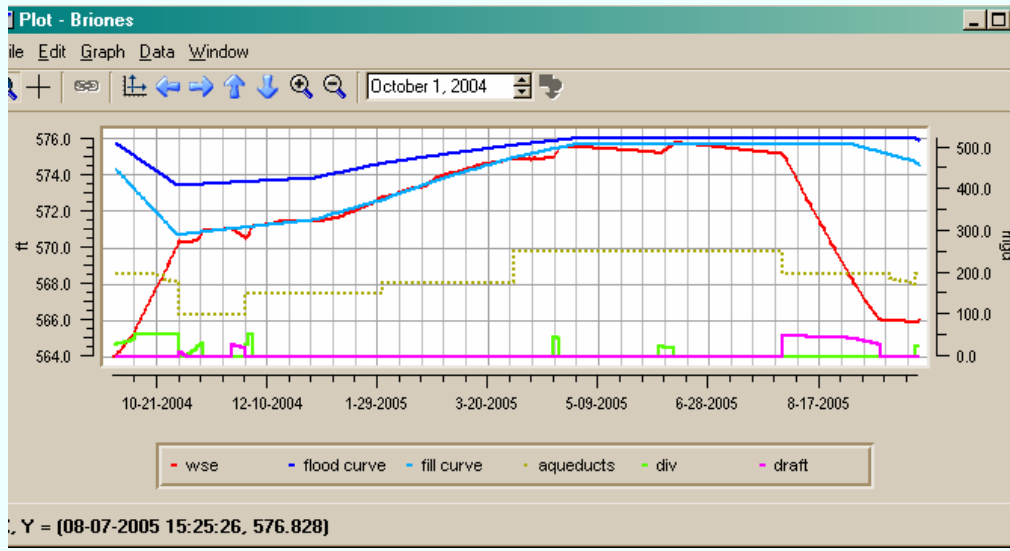
File Edit Slots TimeSteps View Run

NaN mgd October 1, 2004

	Timestep		DRAFT mgd [Ave]	InputDRAFT mgd [Last]	Pardee .Outflow cfs [Last]	InputPardee cfs [Sum]	Camanche .Outflow cfs [Last]	InputCamanc cfs [Sum]
▶	10/31/04 24:00	Sun	192.44	NaN	NaN	0.00	NaN	0.00
▶	11/30/04 24:00	Tue	100.00	100.00	NaN	0.00	NaN	0.00
▶	12/31/04 24:00	Fri	150.00	150.00	NaN	0.00	NaN	0.00
▶	1/31/05 24:00	Mon	150.00	150.00	NaN	0.00	NaN	0.00
▶	2/28/05 24:00	Mon	175.00	175.00	NaN	0.00	NaN	0.00
▶	3/31/05 24:00	Thu	175.00	175.00	NaN	0.00	NaN	0.00
▶	4/30/05 24:00	Sat	250.00	250.00	NaN	0.00	NaN	0.00
▶	5/31/05 24:00	Tue	250.00	250.00	NaN	0.00	NaN	0.00
▶	6/30/05 24:00	Thu	250.00	250.00	NaN	0.00	NaN	0.00
▶	7/31/05 24:00	Sun	250.00	250.00	NaN	0.00	NaN	0.00
▶	8/31/05 24:00	Wed	197.38	NaN	NaN	0.00	NaN	0.00
▶	9/30/05 24:00	Fri	190.35	NaN	NaN	0.00	NaN	0.00
▶	10/1/05 24:00	Sat	197.38	NaN	NaN	0.00	NaN	0.00

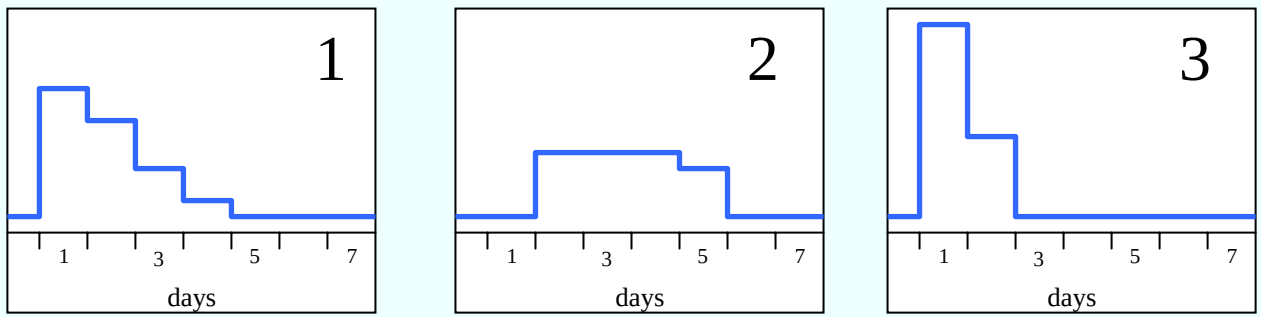
AqueductDraftData.InputDraft -- 0.00 []
0 values [mgd]





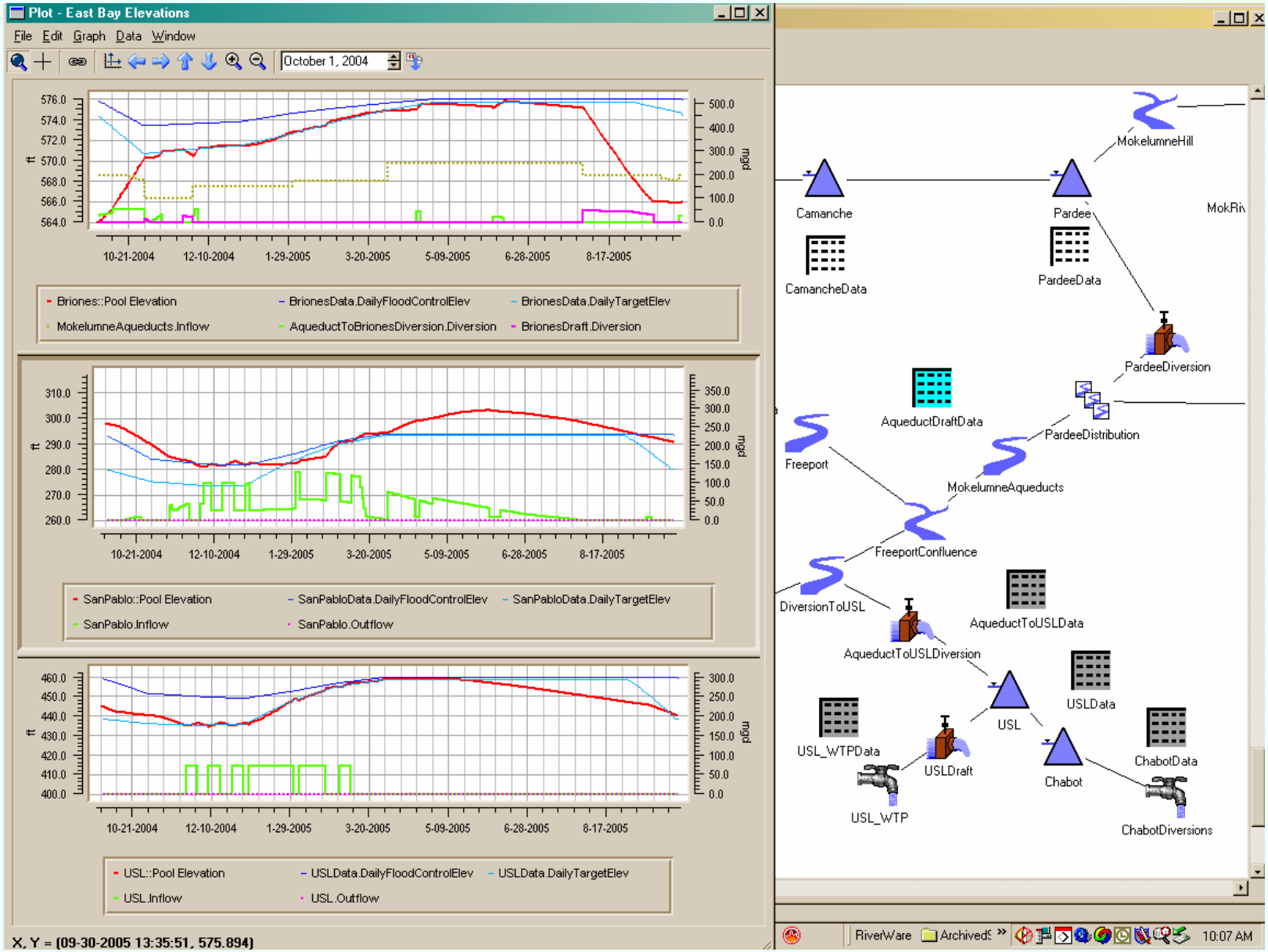
Hydrology Input

- Input daily local rainfall/ runoff volumes
- 10%, 50%, 90% local hydrology for long-term studies
- Add slots for short term hydrology
- Prescribe zero local inflow, 10/50/90 hydrology, or storm hydrograph

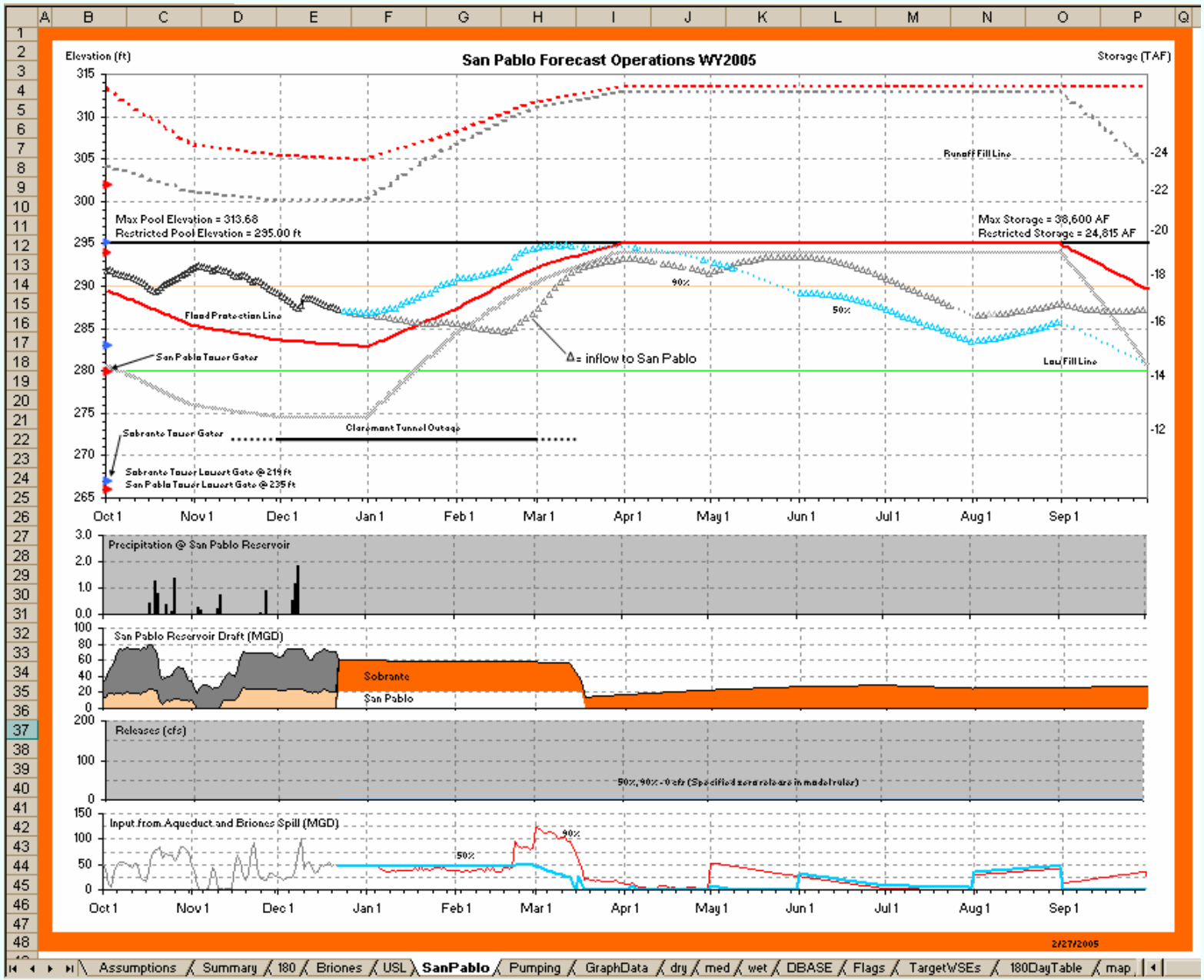


short-term hydrology

Output (RW)


Plot - East Bay Elevations
File Edit Graph Data Window
October 1, 2004
ft
mgd
10-21-2004
12-10-2004
1-29-2005
3-20-2005
5-09-2005
6-28-2005
8-17-2005
Briones::Pool Elevation
BrionesData.DailyFloodControlElev
BrionesData.DailyTargetElev
MokelumneAqueducts.Inflow
AqueductToBrionesDiversion.Diversion
BrionesDraft.Diversion
SanPablo::Pool Elevation
SanPabloData.DailyFloodControlElev
SanPabloData.DailyTargetElev
SanPablo.Inflow
SanPablo.Outflow
USL::Pool Elevation
USLData.DailyFloodControlElev
USLData.DailyTargetElev
USL.Inflow
USL.Outflow
X, Y = (09-30-2005 13:35:51, 575.894)
MokelumneHill
Camanche
Pardee
MokRiv
CamancheData
PardeeData
PardeeDiversion
AqueductDraftData
PardeeDistribution
Freeport
MokelumneAqueducts
FreeportConfluence
DiversionToUSL
AqueductToUSLData
AqueductToUSLDiversion
USLData
USL
USL_WTPData
USLDraft
Chabot
ChabotData
USL_WTP
ChabotDiversions
RiverWare
Archived
10:07 AM

Output (Excel)



Development needs (2004)

East Bay Municipal Utility District
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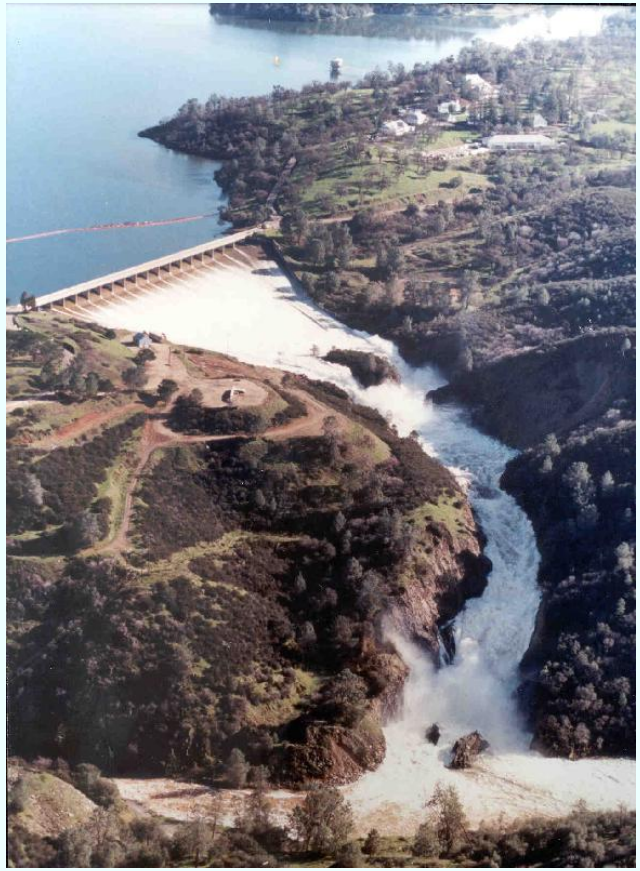
1) Sum Periodic Slot Function
2) MGD unit recognized in RPL
3) Function tracker - list calls to/from each function
4) Function name auto updating (change function name updates in all rules/functions)
5) User-specified icons for objects
6) Scaleable & printable workspace view
7) WQ support/ development (Temp, DO)
8) Switch output - input between runs in MRM
9) Output DMI in MRM
10) Notes object in slot
11) SCT -change cell/ font size
12) List of all recognized DATETIME values in RPL
13) Scalar slot
14) Function that retrieves what rule # set a particular slot value at any timestep
15) Function that counts how many times a rule has fired for a given time range
16) Parse error in ruleset loading if there is a " " in the rule/function description
17) Weekly/ monthly/ daily time series rule execution function. E.g. if "Every 3 days" or if "Saturday" then calc release differently
18) Scroll with arrow keys/ pgup-pgdown in all screens
19) Zooming in tightly into dense time series takes too long/ causes freezup.
20) Warning for user when run starts with plot screen open.
21) Slots added to MRM output should be tacked on to end of output, not inserted at unpredictable points
22) Copy/ Paste slots in same model
23) Configuration of slot defaults should be in main workspace screen

Development needs (2005)

- Graphing improvements (user-specified x-axis intervals)
- Cut and paste from Excel and other applications
- Import/query from external database files to fill slots
- Write and run scripts inside GUI
- Flag slots/ timesteps with manual Inputs

Questions



Pardee Reservoir – 1997