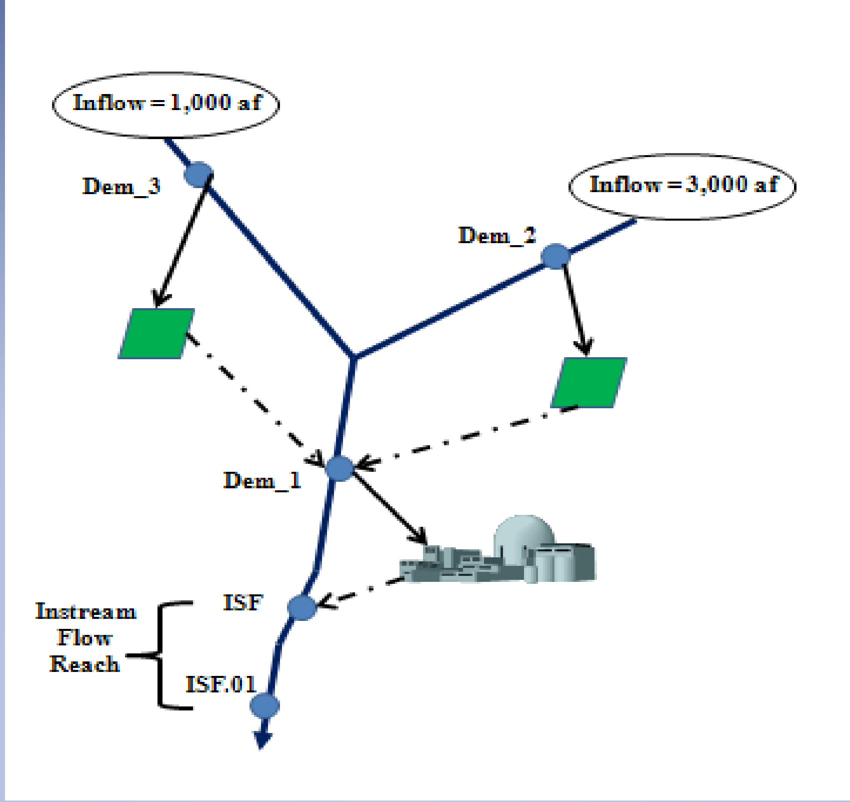
StateMod

Maintenance Training Session #1

April 24-25, 2014

Development History

Version	Year	Areas of Key Enhancements
1.	1986	Program developed for the Green Mountain Pump Back and Exchange Project
2. – 4.	1995	Baseflow module enhancement New reporting capabilities
5.	1996	Allow multiple replacement reservoirs Reoperate for non downstream return flows
6.	1996	Enhanced binary file reporting. New reporting capabilities
7.	1997	Treat Instream flows as a Reach Linked model capability
8.	1998	Daily simulation capability
9.	1999	Well simulation capability
10.	2001	Variable efficiency capability
11.	2006	Plan structure type added. New operating rule data that allow carrier losses, annual limits and on/off dates
12.	2007-2008	Irrigation Practice File is allowed to contain 4 water supply and irrigation method combinations (Expanded the ability to divert to and from plans.
13	2012	Finalized plan implementation and application to South Plate



Structure	Priority	Location	Demand	Ave. Eff	Immediate Return (%)
Dem_1	1	Dem_1	2,000 af	20	40
Dem_2	2	Dem_2	3,000 af	50	50
Dem_3	3	Dem_3	1,000 af	50	50
ISF_1	4	ISF_1 to ISF.01	65 cfs	0 (1)	100

Development Philosophy

- Keep it simple
  - Complexity is there if required
- Help the user
  - Check input data
  - Backward compatible
- Ability to construct input data in steps
  - Stream,
  - Diversions,
  - Reservoirs,
  - …
- Simplify data input
  - Quality in = quality out
  - Data groups
    - Structure
    - Water rights
    - Time series

MODEL COMPONENTS

Key Components

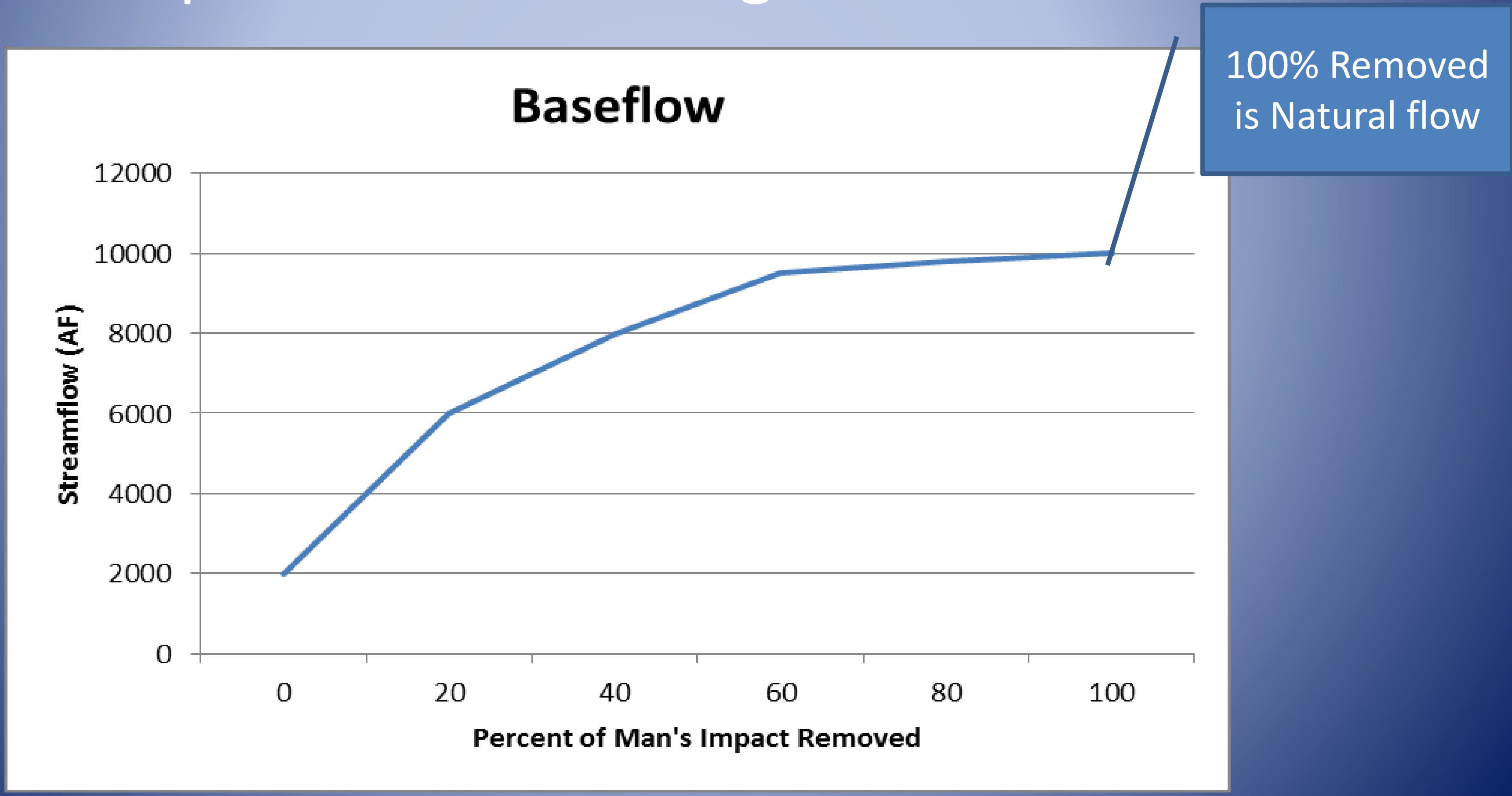
- Network System
  - Looks like the stream itself
- Prior Appropriation Doctrine
  - Modified Direct Solution Algorithm
- Structure Types
  - Diversion,
  - Instream flows,
  - Reservoirs,
  - Wells,
  - Plans

Operating Modes

1. Baseflows
   – Create streamflow without man's impact
   – 100% is natural, <100% is baseflow
2. Simulate
   – Calibrate to history
   – Simulate future conditions
3. Report
   – Standard reports
   – Detailed as needed
4. Data check
   – Verify input data

Baseflow

- Create streamflow without man's impact
  - 100% is natural, <100% is baseflow
- Can operate with missing data



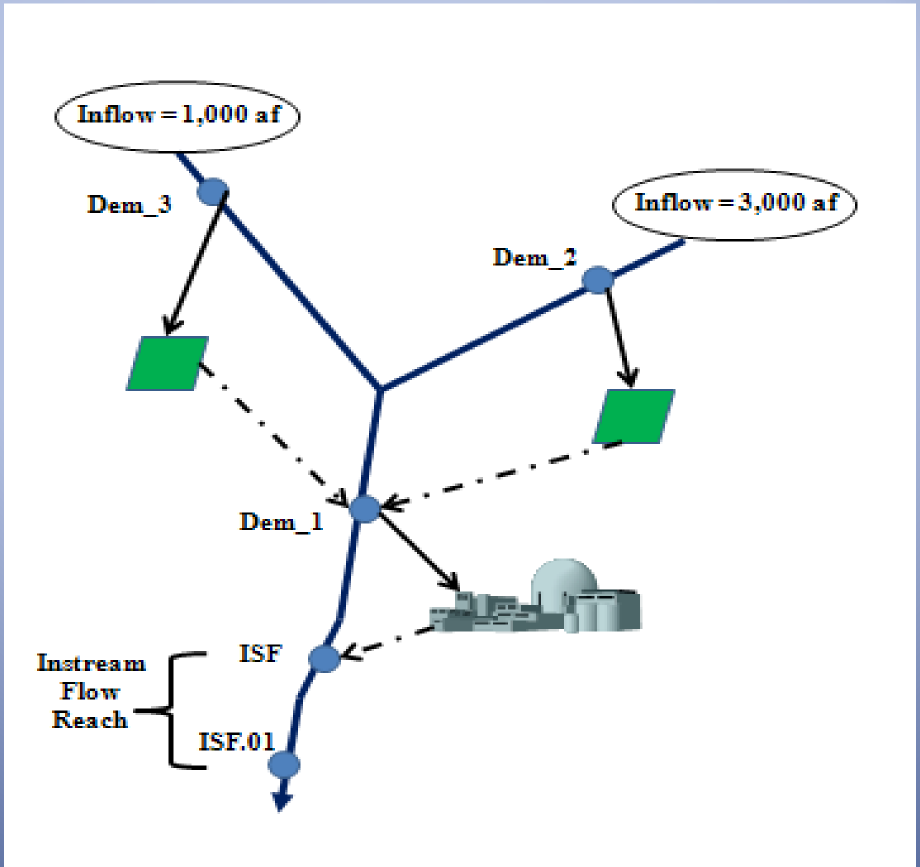
Gaged Baseflow

1. Gaged (Qg) = Qg + D – R – S + E

Baseflow Calculation			
Item	**Ex 1**	**Ex 2**	**Ex 3**
Gaged	1,000	1,000	1,000
Diversion (-)	500	500	500
Return Flow (-)	200	0	400
Storage Increase (-)	210	-490	1490
Evaporation Loss (+)	10	10	10
Baseflow	**1,100**	**2,000**	**-380**

Un-gaged Baseflow

- FlowX = gaged portion + ungaged portion
  - Gaged = (FlowB(1)*coefB(1) + FlowB(2)*coefB(2)+ ....)
  - Ungaged = pf * (FlowG(1)*coefG(1) + FlowG(2)*coefG(2)+ ..
- FlowX = 1,000*1.0 + 3,000*1.0 + 0.70*(6,000*1 – 1,000*1-3000*1)



Simulate (Stream Allocation)

1. Water availability is determined for network
2. The most senior water right is identified
3. Allocate diversion using the MDSA
   - Min (available flow, demand, water right, capacity, other)
4. Downstream flows are adjusted
5. Return flows for future time periods are stored
6. Well depletions for future time periods are stored
7. Check for need to need to reoperate
   - If yes, go back to step 2 and repeat with the most senior water right
8. Repeated by priority for each successive direct, instream, storage, well and operational water right.
9. The process is repeated for each month or day of the study period

Report

1. Standard
   - Network *.xdd
   - Diversion & well *.xss
   - Reservoir output: *.xre
   - Well output: *.xwe
   - Plan output: *.xpl
   - Operating Rule Info: *.xop
   - Instream Reach Info: *.xir
   - Structure Summary: *.xss
   - Call (Control) Summary: *.xca

2. Detailed
   - Water Balance *.xwb
   - Diversion comparison *.xdc
   - CU summary *.xcu
   - …

Data Check

1. Read input data
2. Standard Reports
   - Base flow (*.xbc)
     - Compare gaged to ungaged flow
   - Direct demand (*.xcd)
   - Instream Demand (*.xci)
   - Well Demand (*.xcw)
   - Water Right List (*.xwr)
   - Output Request (*.xou)

FEATURES

Features

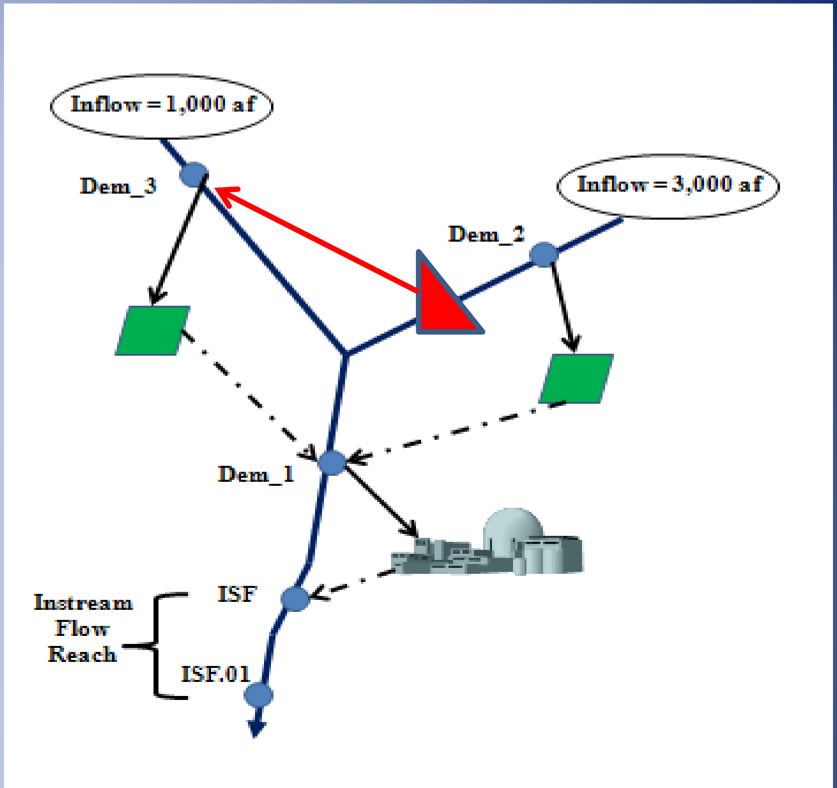
- Modified Direct Solution Algorithm MDSA)
  - Include immediate return flows w/o iteration
  - Reoperates if new water is added to system
- Daily or Monthly
- Variable efficiency
- Soil accounting
- Wells
- Plans
- Operating rules

Modified Direct Solution Algorithm

- In summary:
  - Direct Solution Algorithm (see handout):
    - For every node downstream:
    - Divert = min(demand, water right, capacity, available flow
    - If available flow limits:
    - Divert = Available Flow / (1.00-efficiency) * (return (0))
  - Modified Direct Solution Algorithm (see handout)
  - Allow variable efficiency and soil accounting
    - Requires Consumptive Water Requirement (CIR) data
    - Requires maximum efficiency data

Reoperation

- Check for new water
  - Reservoir releases
  - Non downstream returns
- Reoperate
  - Determine if a senior right can benefit from new water by repeating the water right loop
- Control
  - Off (testing)
  - On (simulate)
  - Reoperate when the sum of reservoir releases and non-downstream return flows exceed a specified value



Daily Operations

1. Build upon a monthly model
   - System understanding
2. Daily input options
   - Provide daily data for only those component where it is necessary or justified (e.g. streamflow but not reservoir targets)
3. Options
   - Daily data provided
   - Use a monthly average
   - Similar to another station
   - Connect monthly midpoints (demand)
   - Connect monthly end points (reservoir target)
4. No routing

Variable Efficiency

1. Major component to MDSA
2. Allows the efficiency of water use to vary from 0 to a maximum.
3. Soil moisture accounting may be included
4. Does not apply to reservoir releases
5. Data requirements
    1. Consumptive water requirement
    2. Maximum efficiency
        1. Sprinkler or
        2. Flood

Soil Accounting

1. Requires the variable efficiency option
2. Capacity = depth * area * capacity
3. Max diversion to storage is the minimum of soil capacity and diversion * efficiency
4. If area is reduced in a time step and soil capacity is exceeded the difference is a loss

Amount to Storage for various maximum efficiency values			
Given: Storage Capacity	200		
Item	Ex 1	Ex 2	Ex 3
Divert	1000	1000	1000
Max efficiency	40%	60%	70%
CIR	500	500	500
CU	400	500	500
Final soil storage	0	100	200

Wells

1. May be independent or tied to a diversion
2. Do not need to be in network
3. Demands
   - If independent, they are provided in the well demand file
   - If tied to a diversion, provided as a well demand (calibration) or as part of a diversion demand (simulate)
4. Well operations can cause the system to reoperate
5. If depletions exceed streamflow
   - Water is taken from groundwater storage
   - Groundwater storage is paid back in next time step
6. Can be tied to augmentation plans
7. Reported in two pieces:
   - From well (pumping this time step) and
   - Well Depletion (prior pumping)

Plans

1. Originated for wells
2. Expanded to include many complex features (see section 3.9 of documentation for descriptions)
   - Accounting
   - Reservoir reuse
   - Non reservoir reuse
   - Transmountain imports
   - Terms and conditions
   - Well augmentation
   - Recharge plan
   - Out of priority diversions
   - Release limit
   - Special well augmentation (designated basin, coffin wells, etc)

Operating Rules

1. Allow complex owner and water rights to be simulated
2. Began with 12 and have grown to 50
   – See section 4.13 of documentation
3. In general must know 3 things
   – Source of Water
     - Water right, reservoir, well, water right , plan
   – Destination of water
     - Diversion, reservoir, well, instream flow or plan
   – Delivery method
     - Stream or carrier
     - With or without losses
4. Special operating rules
   – Compacts, soil moisture, storage

Soil Accounting

1. Requires the variable efficiency option
2. Capacity = depth * area * capacity
3. Max diversion to storage is the minimum of soil capacity and diversion * efficiency
   - Water use efficiency includes soil storage
4. If area is reduced in a time step and soil capacity is exceeded the difference is a loss

Amount to Storage for various maximum efficiency values			
Given: Storage Capacity	200		
Item	Ex 1	Ex 2	Ex 3
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Water Balance

1. Stream Inflow
   - Return
   - To/From GW Storage
   - Total In
2. Stream Outflow
   - From river by well
   - Well Depletion
   - Reservoir Evaporatoin
   - Stream Output
   - Total Out
3. Delta (In – Out)
4. Other
   - CU
   - Loss
   - Pumping
   - Salvage

Documentation

1. Acknowledgment
2. Introduction
3. Model description
4. Input data
5. Output data
6. Model operation
7. Technical notes
    1. Describes various technical issues
8. Frequently asked questions
9. Supporting utilities
10. Discontinued but supported files