



Real-Time Dam Fill Time and Outflow Prediction Software DAMFLOWV100

Carlos Carriaga, PhD, PE, CFM, Software Systems Engineer
Engineering Application Development and River Mechanics Branch
Engineering Division, FCDMC

Bing Zhao, PhD, PE, Branch Manager
Engineering Application Development and River Mechanics Branch
Engineering Division, FCDMC

2018 ASFP Annual Conference

Phoenix, Arizona
June 17-21, 2018



ACKNOWLEDGMENTS

Pramita Chitrakar, PE, CFM

Civil Engineer

EADRM Branch, Engineering Division
FCDMC

Shimin Li, Ph.D., PE

Senior Civil Engineer

EADRM Branch, Engineering Division
FCDMC

Denis Liu

Former Software Systems Engineer

EADRM Branch, Engineering Division
FCDMC

Michael Potucek

Associate Engineer

EADRM Branch, Engineering Division
FCDMC

Venkatraman Radhakrishnan

Former Intern

EADRM Branch, Engineering Division
FCDMC

Gajendra Shrestha, PE, CFM

Civil Engineer

EADRM Branch, Engineering Division
FCDMC

Raj Shrestha, PE, CFM

Software Systems Engineer

EADRM Branch, Engineering Division
FCDMC

Scott Vogel, P.E.

Chief Engineer/General Manager

Engineering Division Manager
FCDMC

Stephen D. Waters

Branch Manager

Flood Warning Branch, Engineering Division
FCDMC



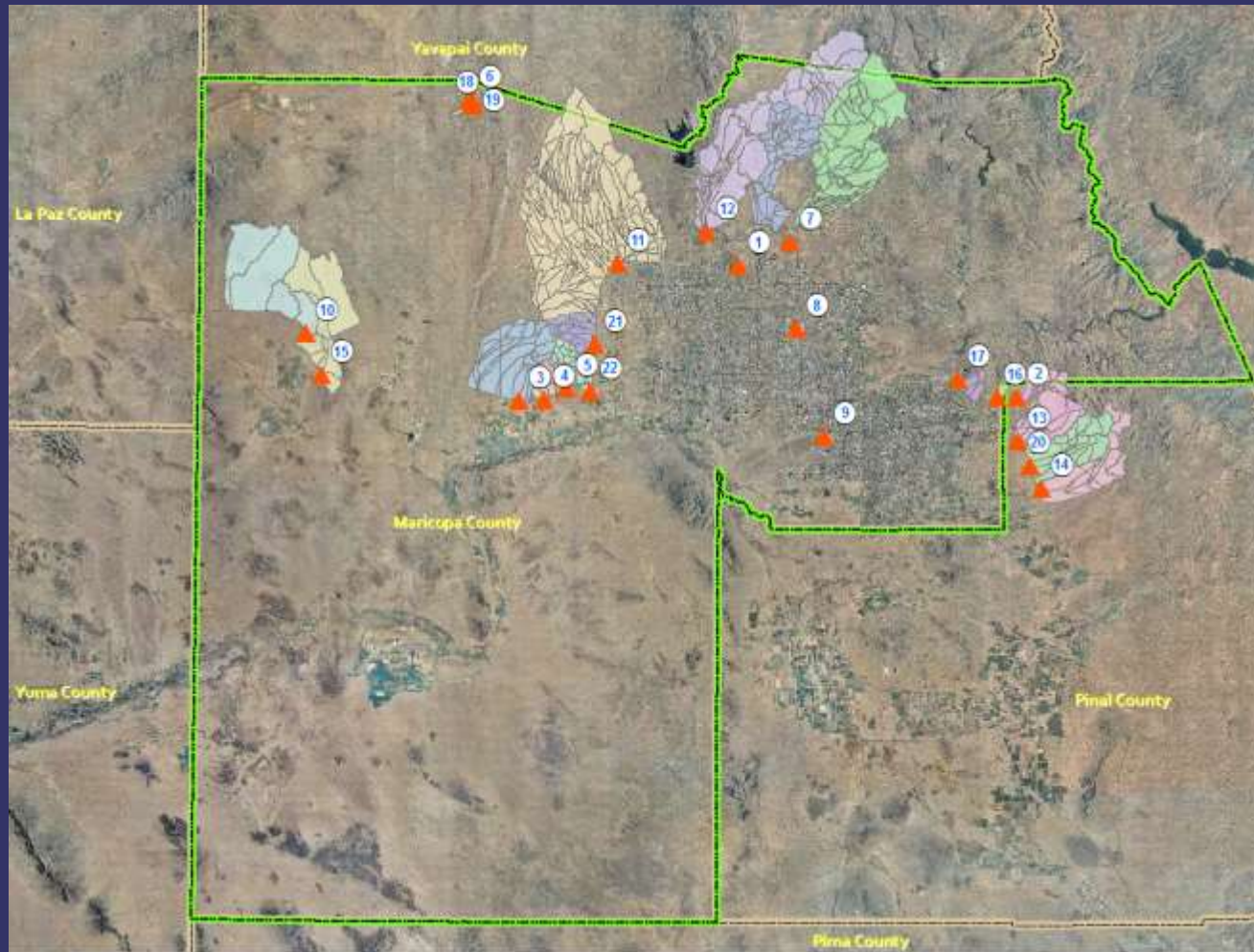
PRESENTATION OUTLINE

- ❖ **Background and Objective**
- ❖ **Analysis Components / Modules**
- ❖ **Fundamentals / Theory**
- ❖ **Capabilities and Features**
- ❖ **Quick Program Overview**



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

22 Flood Control District Dams



- (1) Adobe Dam
- (2) Apache Junction Dam
- (3) Buckeye FRS #1
- (4) Buckeye FRS #2
- (5) Buckeye FRS #3
- (6) Casandro Dam
- (7) Cave Buttes Dam
- (8) Dreamy Draw Dam
- (9) Guadalupe FRS
- (10) Harquahala FRS
- (11) McMicken Dam
- (12) New River Dam
- (13) Powerline FRS
- (14) Rittenhouse FRS
- (15) Saddleback FRS
- (16) Signal Butte FRS
- (17) Spook Hill FRS
- (18) Sunny Cove Dam
- (19) Sunset Dam
- (20) Vineyard FRS
- (21) White Tanks FRS #3
- (22) White Tanks FRS #4

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Adobe Dam Facts



Year Built:	1982
Drainage Area:	87.3 sq. mi.
Rivers:	Skunk Creek & New River
Dam Height:	65.3 ft
Dam Length:	2.1 miles
Cap. @ Spillway Crest Elev:	18,775 ac-ft
D/S Area:	Residential Area



The 2.1-mile Adobe Dam showing D/S Residential Area

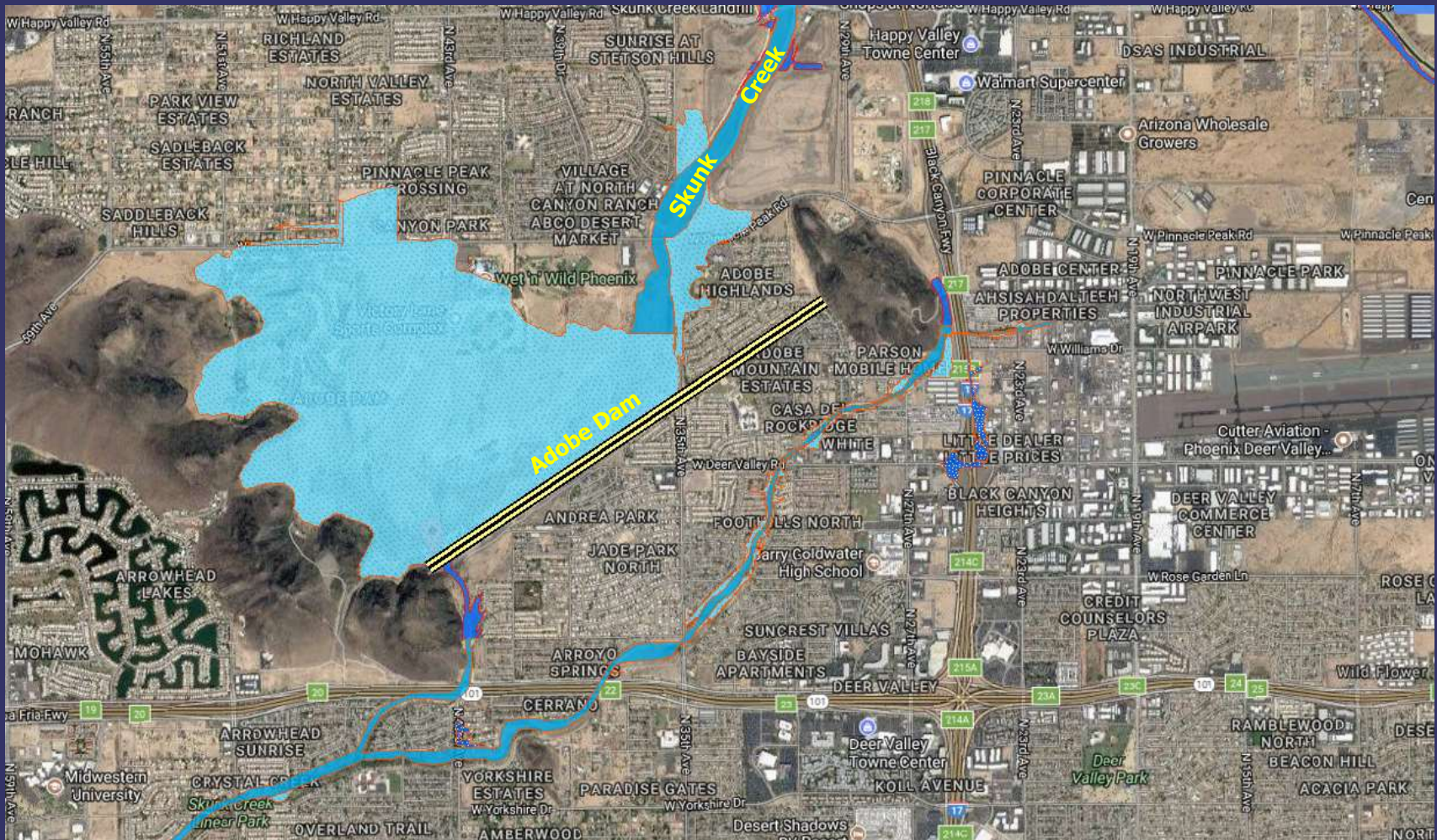
2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Adobe Dam Facts



The 2.1-mile Adobe Dam showing D/S Residential Area

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



BACKGROUND AND OBJECTIVE

- ☐ **Flood Modeling during Flood Exercises (EOC, AOC) since 1997**
- ☐ **Real-time Hydrologic and Hydraulic Modeling (with ALERT gages)**
- ☐ **Real-time HEC-1 Modeling for Dam Outflow Prediction for District's 22 dams (with ALERT gages)**
- ☐ **Real-time Rainfall-Runoff Modeling with Live Parameter Calibration for Dam Fill Time and Outflow Prediction**

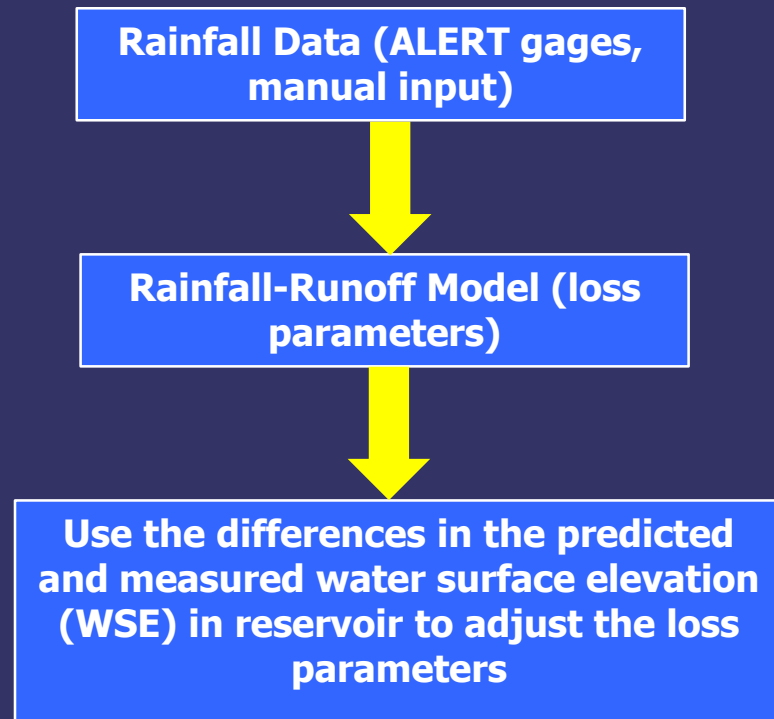


BACKGROUND AND OBJECTIVE

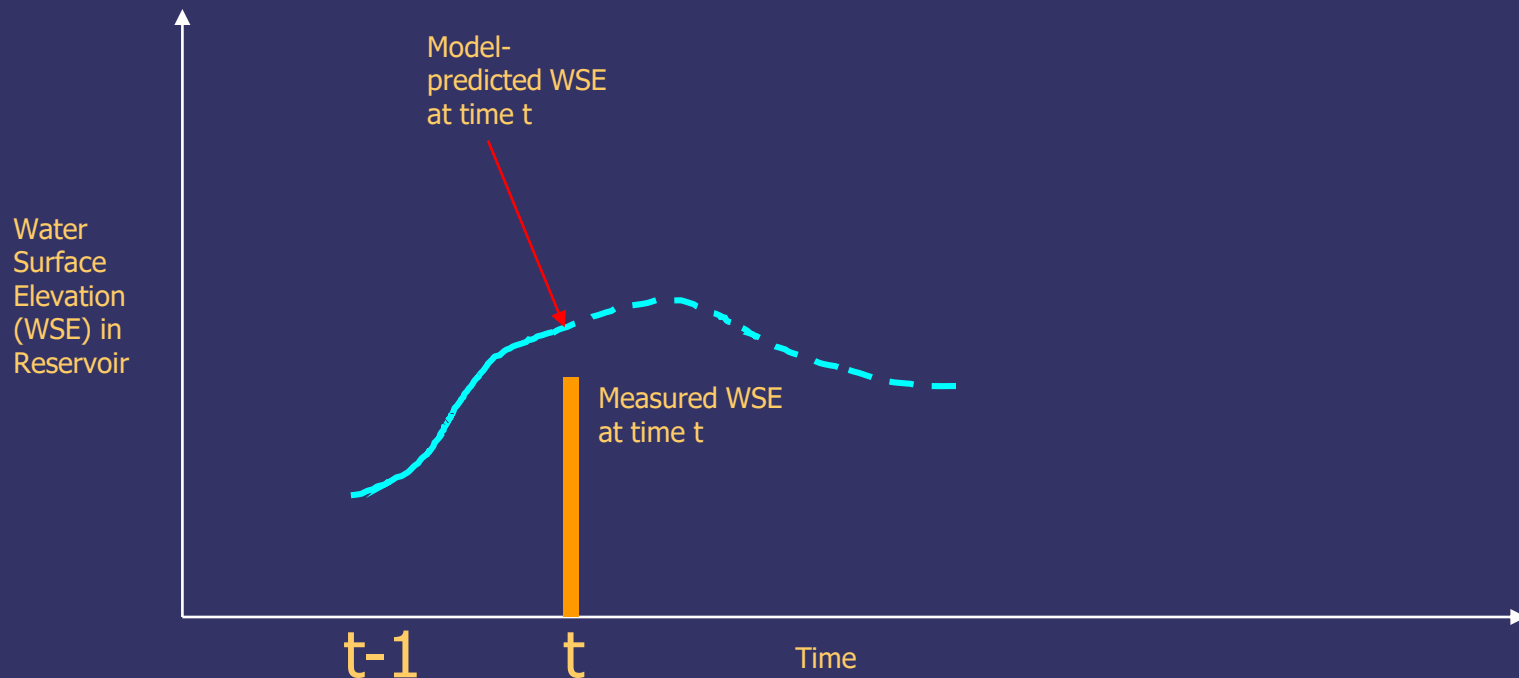
- ❑ **Software Requirements: efficient, accuracy (through feedback for smaller time intervals), no need to use many sub-basins and Green-Ampt loss method**
- ❑ **2016-2017 Strategic Initiative (FCDMC)**
- ❑ **Project Time Line: 7/2016-6/2017**



What is parameter calibration?



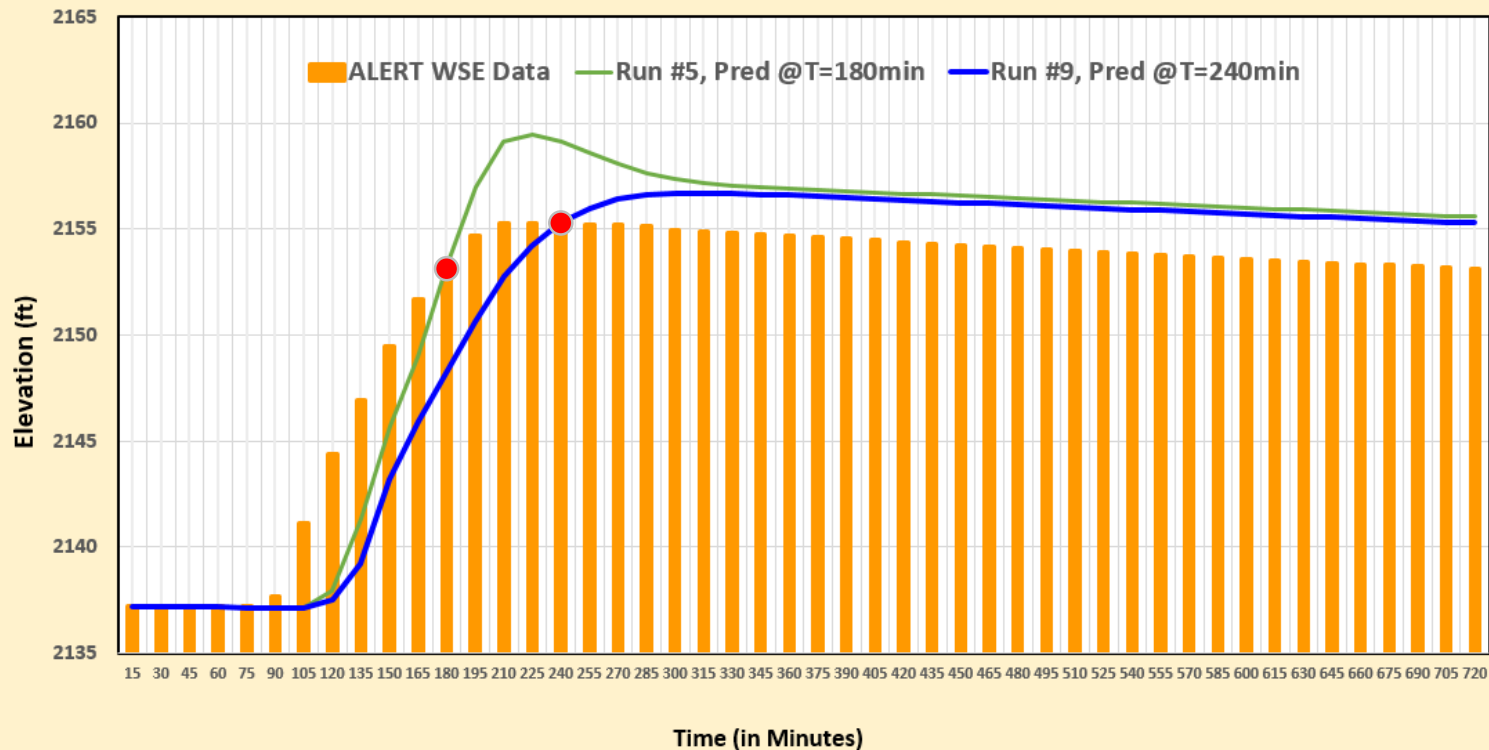
Real-time Parameter Calibration



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

WSE Plot Comparison Observed Data vs Prediction Results

Casandro Dam: Real-Time Predicted WSE



2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018

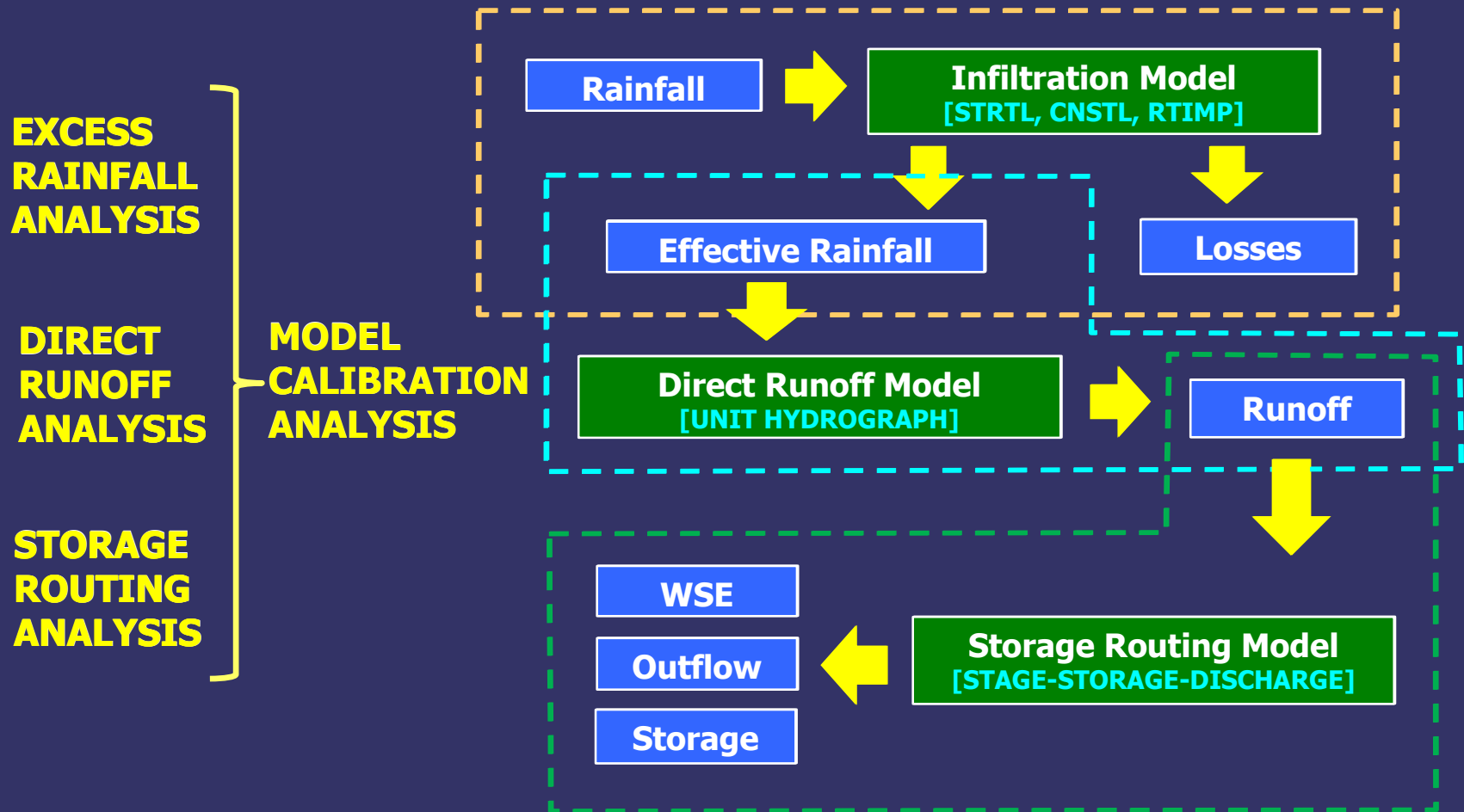


ANALYSIS COMPONENTS

- ☐ EXCESS RAINFALL ANALYSIS**
- ☐ DIRECT RUNOFF ANALYSIS**
- ☐ STORAGE ROUTING ANALYSIS**
- ☐ MODEL CALIBRATION ANALYSIS**



ANALYSIS COMPONENTS



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

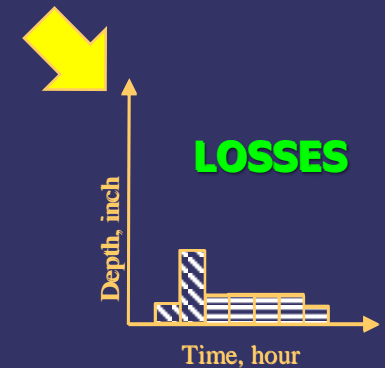
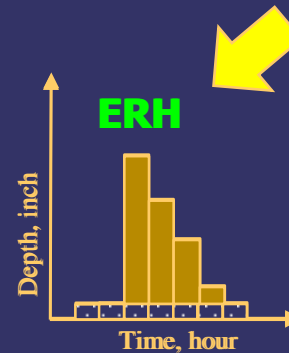
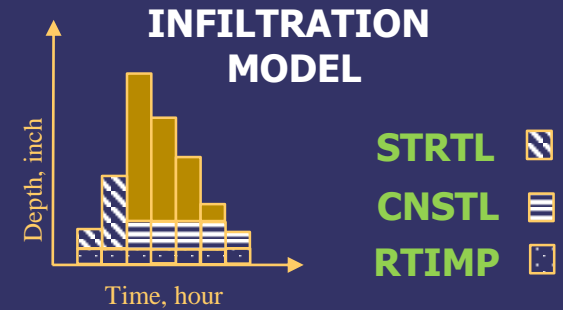
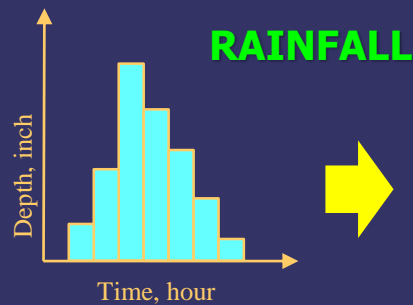
ANALYSIS COMPONENTS

**EXCESS
RAINFALL
ANALYSIS**

**DIRECT
RUNOFF
ANALYSIS**

**STORAGE
ROUTING
ANALYSIS**

**MODEL
CALIBRATION
ANALYSIS**



EXCESS RAINFALL ANALYSIS

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



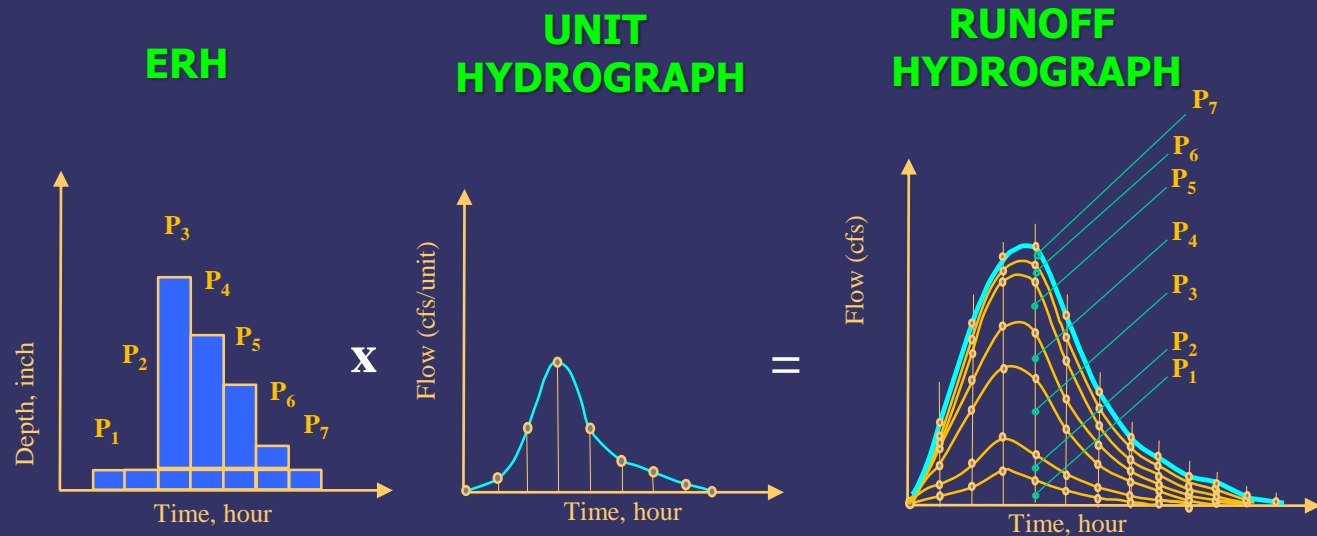
ANALYSIS COMPONENTS

EXCESS
RAINFALL
ANALYSIS

DIRECT
RUNOFF
ANALYSIS

STORAGE
ROUTING
ANALYSIS

MODEL CALIBRATION ANALYSIS



DIRECT RUNOFF ANALYSIS

2018 ASFPM Annual Conference

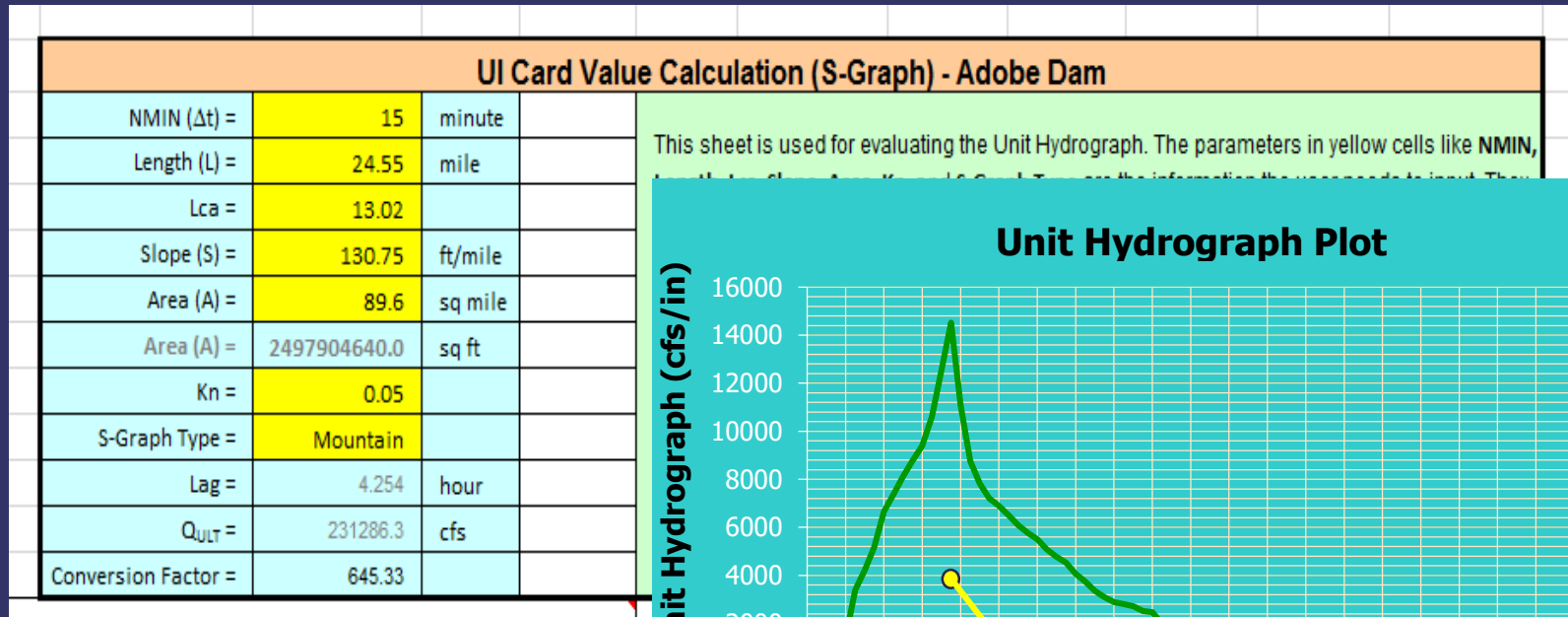
Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

FUNDAMENTALS AND THEORY

❑ DIRECT RUNOFF ANALYSIS – UNIT HYDROGRAPH S-GRAPH



Total Volume = 1 inch

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



FUNDAMENTALS AND THEORY

□ DIRECT RUNOFF ANALYSIS

$$[P] \times [U] = [Q]$$

$$\begin{bmatrix} P_1 & 0 & 0 & \dots & 0 & 0 & \dots & 0 & 0 \\ P_2 & P_1 & 0 & \dots & 0 & 0 & \dots & 0 & 0 \\ P_3 & P_2 & P_1 & \dots & 0 & 0 & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ P_M & P_{M-1} & P_{M-2} & \dots & P_1 & 0 & \dots & 0 & 0 \\ 0 & P_M & P_{M-1} & \dots & P_2 & P_1 & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \ddots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 0 & 0 & \dots & P_M & P_{M-1} \\ 0 & 0 & 0 & \dots & 0 & 0 & \dots & 0 & P_M \end{bmatrix} \cdot \begin{bmatrix} U_1 \\ U_2 \\ U_3 \\ \vdots \\ U_{N-M+1} \end{bmatrix} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ \vdots \\ Q_M \\ Q_{M+1} \\ \vdots \\ \vdots \\ Q_{N-1} \\ Q_N \end{bmatrix}$$

[N x (N-M+1)]

[(N-M+1) x 1]

[N x 1]

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

ANALYSIS COMPONENTS

□ STORAGE ROUTING ANALYSIS

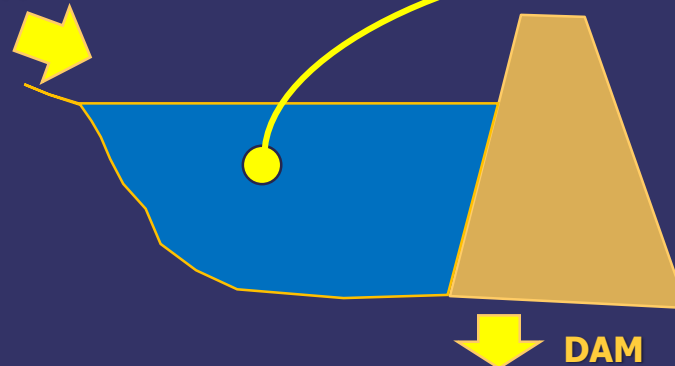
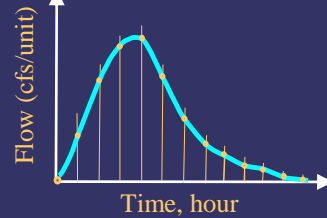
EXCESS
RAINFALL
ANALYSIS

DIRECT
RUNOFF
ANALYSIS

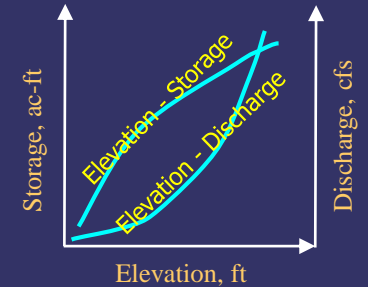
STORAGE
ROUTING
ANALYSIS

MODEL
CALIBRATION
ANALYSIS

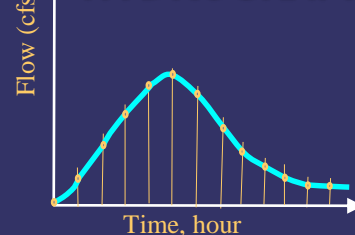
INFLOW
HYDROGRAPH



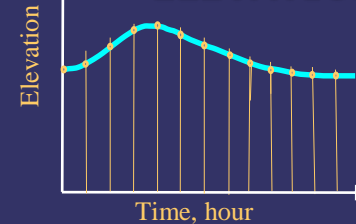
STAGE-STORAGE
DISCHARGE CURVE



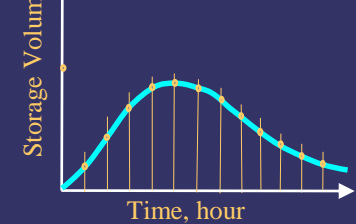
OUTFLOW
HYDROGRAPH



WATER SURFACE
ELEVATION



STORAGE
VOLUME



STORAGE ROUTING ANALYSIS

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



FUNDAMENTALS AND THEORY

□ STORAGE ROUTING ANALYSIS

$$I - Q = \frac{\partial S}{\partial t}$$

$$\frac{S_2 - S_1}{\Delta t} = \frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2}$$

$$Y = \frac{S_2 - S_1}{\Delta t} - \frac{I_1 + I_2}{2} + \frac{O_1 + O_2}{2}$$

KNOWN VARIABLES:

- Inflows (I_1, I_2)
- Outflow (O_1)
- Storage (S_1)

UNKNOWN:

- Outflow (O_2)
- Storage (S_2)

WHERE: Y is the continuity error for the estimated elevation. The estimated elevation is adjusted until Y is less than ± 1 cfs.

FUNDAMENTALS AND THEORY

□ LEVEL-POOL ROUTING ANALYSIS

$$Y = \frac{S_2 - S_1}{\Delta t} - \frac{I_1 + I_2}{2} + \frac{O_1 + O_2}{2} \leq 1.0 \text{ cfs}$$

Known Parameters: S_1, I_1, I_2, O_1 ; where $S_1 = f(E_1)$ and $O_1 = f(E_1)$

Unknown Parameters: S_2, O_2

Iterative Procedure:

- (1) Step 1: Make an estimate of the Water Surface Elevation, E_2 .
- (2) Step 2: From Rating Curve, determine S_2 and O_2 that correspond to E_2 .
- (3) Step 3: Using the values of S_2 and O_2 , evaluate Y .
- (4) Step 4: If the evaluated $Y \geq 1.0$ cfs, repeat Steps 1 to 3.
If the evaluated $Y < 1.0$ cfs, use E_2, S_2 and O_2 as the final values for the period.

Proceed to the next period where $S_1 = S_2$ and $O_1 = O_2$.

2018 ASFPM Annual Conference

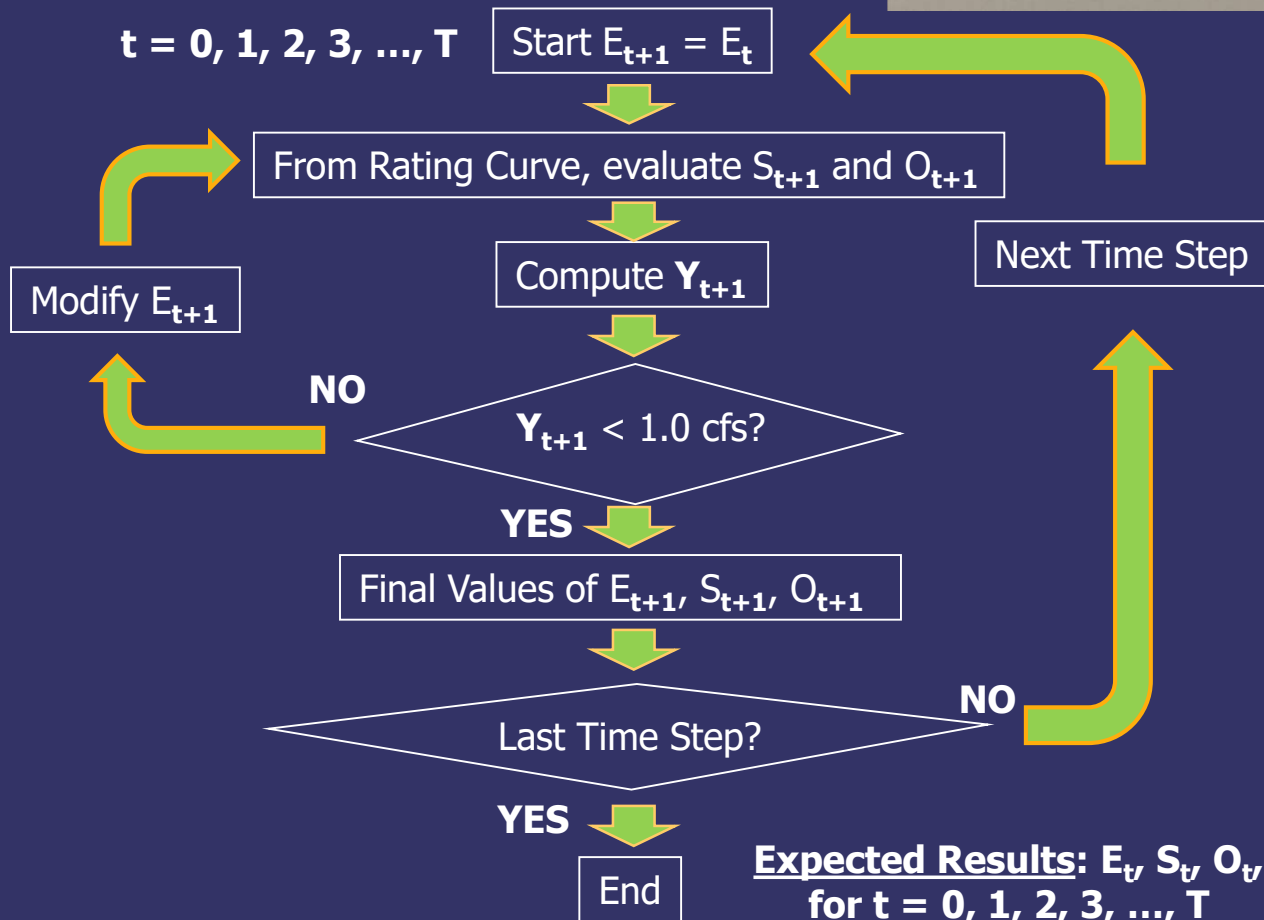
Phoenix, Arizona
June 17-21, 2018



FUNDAMENTALS AND THEORY

□ STORAGE ROUTING ANALYSIS

$$Y = \frac{S_2 - S_1}{\Delta t} - \frac{I_1 + I_2}{2} + \frac{O_1 + O_2}{2} \leq 1.0$$



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

ANALYSIS COMPONENTS

□ MODEL CALIBRATION ANALYSIS

**EXCESS
RAINFALL
ANALYSIS**

**DIRECT
RUNOFF
ANALYSIS**

**STORAGE
ROUTING
ANALYSIS**

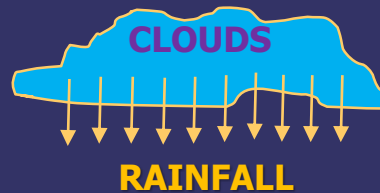


YES

NO

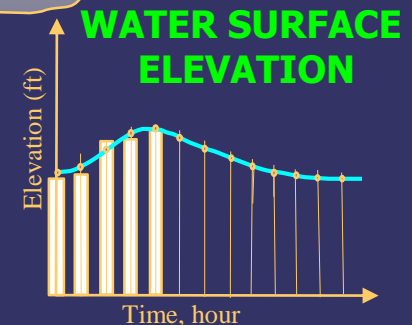
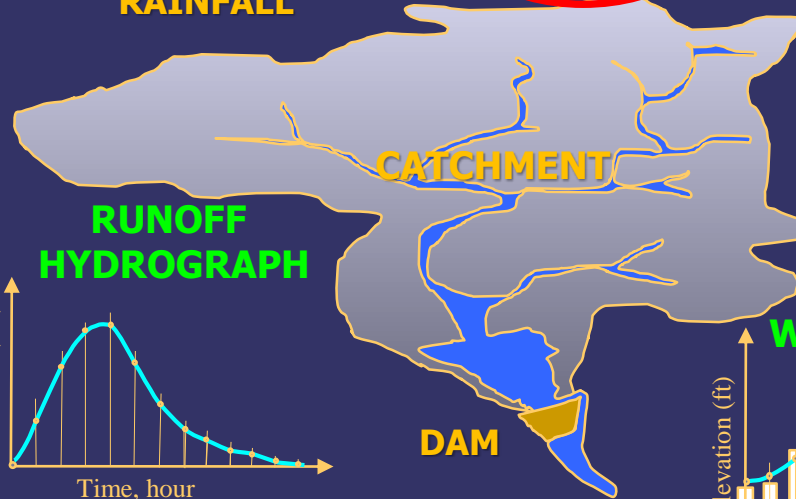
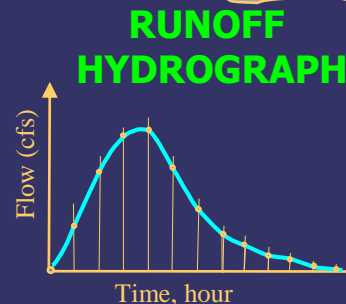
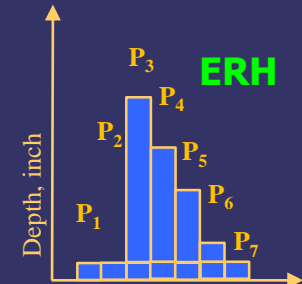
"z"
min?

End



- STRTL
- CNSTL
- RTIMP

Control
Variables



$$\text{Minimize } z = [WSE_{\text{OBSERVED}} - WSE_{\text{MODEL}}]^2$$

MODEL CALIBRATION ANALYSIS

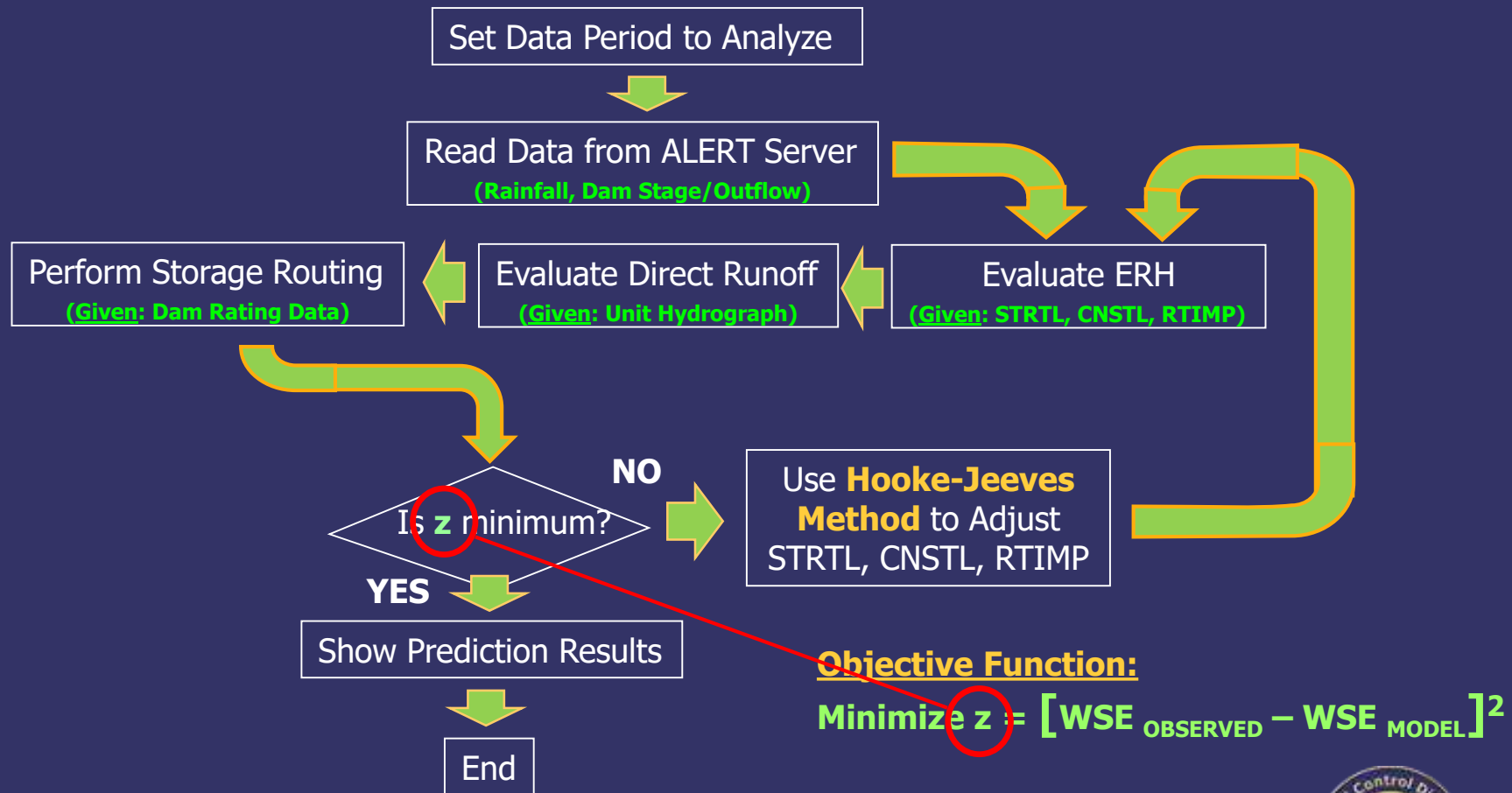
2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



FUNDAMENTALS AND THEORY

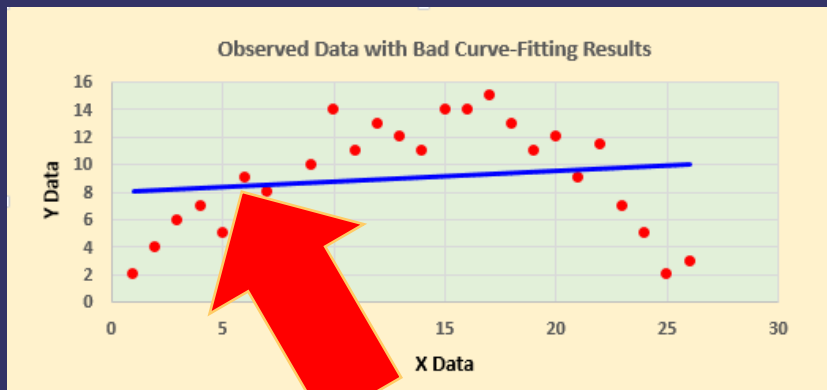
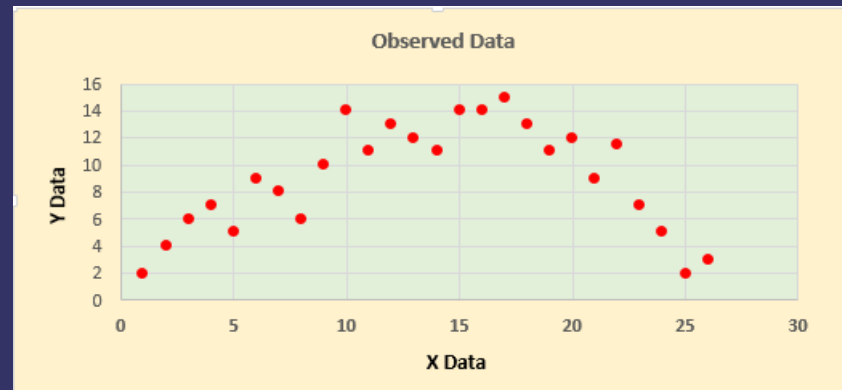
□ CALIBRATION BY OPTIMIZATION ANALYSIS



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

FUNDAMENTALS AND THEORY

□ MODEL CALIBRATION ANALYSIS



**Analysis Results with “Poor”
Model Parameters**



**Analysis Results with “Good”
Model Parameters**

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



FUNDAMENTALS AND THEORY

□ MODEL CALIBRATION – OPTIMIZATION ANALYSIS

Objective Function:

$$\text{Minimize } z = f(\mathbf{u}, \mathbf{x}) \quad (1)$$

Control Variables
State Variables

$$\text{Minimize } z = [\text{WSE}_{\text{OBSERVED}} - \text{WSE}_{\text{MODEL}}]^2$$

subject to:

$$\mathbf{p}(\mathbf{u}, \mathbf{x}) = 0 \quad \text{Governing Equations (2)}$$

$$\mathbf{p}_{\min} \leq \mathbf{p}(\mathbf{u}, \mathbf{x}) \leq \mathbf{p}_{\max} \quad \text{System Constraints (3)}$$

$$\mathbf{u}, \mathbf{x} \geq 0 \quad \text{Non-Negativity Constraints (4)}$$

Control Variables:
Rainfall Loss Parameters

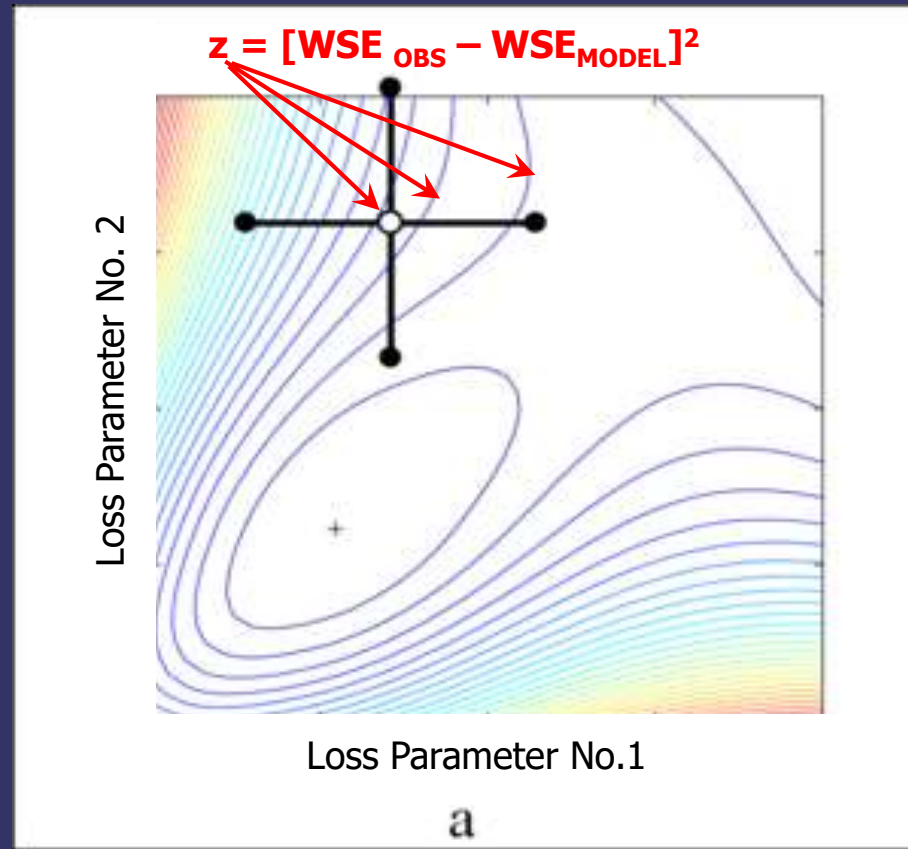
- STRTL
- CNSTL
- RTIMP

FUNDAMENTALS AND THEORY

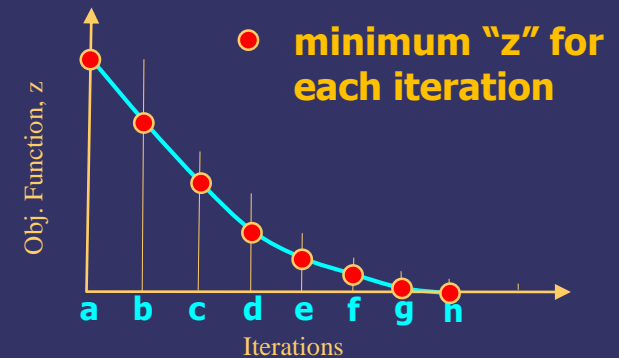
□ MODEL CA

LIBRATION – OPTIMIZATION ANALYSIS

Hooker and Jeeves Method (Direct Search Method):



- The contour lines are represented by evaluated z values.
- The algorithm starts its search from a wide area. Once the best " z " value is found, the algorithm uses that position as a base to search the neighborhood for a better solution employing a narrower search area.



Iterative Search

QUICK PROGRAM OVERVIEW

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward

Ending Date / Time and Time Period:

Current Date / Time: 10/09/2017 11:51:00 Time Step: 15 minutes

Time Period (hrs): 3 ☐ Historical Storm Events Select Historical Storm Event

☐ Beginning and ending Date / Time

Beginning and Ending Time:

Beginning Date/Time: 10/09/2017 08:51:00 Time Step: 15 minutes

Ending Date/Time: 10/09/2017 11:51:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☒ Manual Analysis ☐ Auto-Pilot Analysis

Frequency Update: Manual Auto-Pilot Analysis Length: Select Analysis Length

☐ Use Manual Test Data ☐ Use Auto-Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL-TIME DATA			BASIC DAM DATA		STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS	
				Rainfall	Outflow	Storage	WSE	Spillw.Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time	Rate	Check/Uncheck Dams
																		<input type="checkbox"/> Adobe Dam
																		<input type="checkbox"/> Apache Junction Dam
																		<input type="checkbox"/> Buckeye #1 Dam
																		<input type="checkbox"/> Buckeye #2 Dam
																		<input type="checkbox"/> Buckeye #3 Dam
																		<input type="checkbox"/> Casandro Dam
																		<input type="checkbox"/> Cave Buttes Dam
																		<input type="checkbox"/> Dryden Draw Dam
																		<input type="checkbox"/> Guadalupe Dam
																		<input type="checkbox"/> Harquahala Dam
																		<input type="checkbox"/> McMicken Dam
																		<input type="checkbox"/> New River Dam
																		<input type="checkbox"/> Powerline Dam
																		<input type="checkbox"/> Rittenhouse Dam
																		<input type="checkbox"/> Saddleback Dam
																		<input type="checkbox"/> Signal Butte Dam
																		<input type="checkbox"/> Spookhill Dam
																		<input type="checkbox"/> Sunnyvale Dam
																		<input type="checkbox"/> Sunset Dam
																		<input type="checkbox"/> Vineyard Dam
																		<input type="checkbox"/> White Tanks #3 Dam
																		<input type="checkbox"/> White Tanks #4 Dam

Start Monitor Manual Rain Data Entry Start Manual Prediction without Calibration Start Manual Prediction with Calibration Start Auto-Pilot Prediction Exit

Program Status

Running the Software – Initially Displays the Current Date / Time

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward

Ending Date / Time and Time Period:

Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes

Time Period (hrs): 11 **Historical Storm Events**

Fall Data #1: Sept. 7, 2014

Beginning and Ending Date / Time

Beginning Date/Time: 09/07/2014 22:00:00 Time Step: 15 minutes

Ending Date/Time: 09/08/2014 09:00:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☐ Manual Analysis ☐ Auto-Pilot Analysis

Frequency Update: Manual Auto-Pilot Analysis Length: Select Analysis Length

☐ Use Manual Test Data ☐ Use Auto Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

ALERT Data

REAL-TIME DAM ALERT DATA

No.	Dam	REAL-TIME DATA				BASIC DAM DATA		STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS		
		Date	Time	Rainfall	Outflow	Storage	WSE	Spillw.Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD		Time	Rate
1	Adobe Dam	09/08/2014	09:00:00	2.4730	543.00	334.600	1349.26	1379.58	1404.88	1357.12	1363.87	1370.66	1378.00	1379.58	9.450	-1621...	0.000	<input type="checkbox"/> Adobe Dam
2	Apache Junction Dam	09/08/2014	09:00:00	2.8550	8.00	40.600	1791.55	1801.80	1811.97	1793.17	1795.59	1798.18	1800.78	1801.79	5.630	-1621...	0.000	<input type="checkbox"/> Apache Junction Dam
3	Buckeye No. 1 Dam	09/08/2014	09:00:00	2.1250	69.00	223.895	1056.50	1080.82	1089.60	1068.00	1071.50	1075.60	1076.50	1080.80	8.700	-1621...	0.000	<input type="checkbox"/> Buckeye #1 Dam
4	Buckeye No. 2 Dam	09/08/2014	09:00:00	2.9200	131.00	261.405	1102.99	1113.12	1118.18	1103.08	1106.17	1109.27	1112.70	1113.17	7.310	-1621...	0.000	<input type="checkbox"/> Buckeye #2 Dam
5	Buckeye No. 3 Dam	09/08/2014	09:00:00	2.8900	81.00	237.065	1151.58	1165.03	1171.51	1155.51	1157.97	1160.82	1164.10	1165.07	4.640	-1621...	0.000	<input type="checkbox"/> Buckeye #3 Dam
6	Casandro Dam	09/08/2014	09:00:00	0.9212	0.00	0.373	2136.85	2157.00	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	0.190	-1621...	0.000	<input type="checkbox"/> Casandro Dam
7	Cave Buttes Dam	09/08/2014	09:00:00	1.6080	138.00	13.458	1570.24	1659.10	1681.00	1615.85	1631.11	1643.72	1654.60	1659.10	8.260	-1621...	0.000	<input type="checkbox"/> Cave Buttes Dam
8	Dreamy Draw Dam	09/08/2014	09:00:00	2.8900	0.00	0.000	1371.70	1406.96	1418.46	1389.24	1393.81	1399.66	1405.23	1406.96	0.120	-1621...	0.000	<input type="checkbox"/> Dreamy Draw Dam
9	Guadalupe Dam	09/08/2014	09:00:00	3.7600	0.00	24.227	1265.92	1275.83	1283.28	1258.68	1264.09	1269.29	1274.90	1276.02	14.560	-1621...	0.000	<input type="checkbox"/> Guadalupe Dam
10	Harquahala Dam	09/08/2014	09:00:00	0.6477	0.00	0.340	1376.56	1410.60	1421.50	1396.39	1402.29	1406.09	1409.22	1410.59	1.700	-1621...	0.000	<input type="checkbox"/> Harquahala Dam
11	McMicken Dam	09/08/2014	09:00:00	2.3675	0.00	0.010	1337.60	1355.25	1362.00	1340.86	1345.44	1349.53	1354.11	1355.25	1.600	-1621...	0.000	<input type="checkbox"/> McMicken Dam
12	New River Dam	09/08/2014	09:00:00	1.8260	672.00	409.384	1398.43	1456.20	1486.70	1418.30	1431.07	1443.50	1456.08	1458.50	9.180	-1621...	0.000	<input type="checkbox"/> New River Dam
13	Powerline Dam	09/08/2014	09:00:00	2.2700	49.00	306.480	1563.40	1584.90	1589.40	1569.05	1573.66	1578.74	1582.98	1584.92	3.400	-1621...	0.000	<input type="checkbox"/> Powerline Dam
14	Rittenhouse Dam	09/08/2014	09:00:00	1.7750	49.00	4.000	1582.40	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	3.400	-1621...	0.000	<input type="checkbox"/> Rittenhouse Dam
15	Saddleback Dam	09/08/2014	09:00:00	0.6170	0.00	0.010	1175.40	1195.45	1195.45	1185.31	1188.23	1191.14	1194.10	1194.93	0.300	-1621...	0.000	<input type="checkbox"/> Saddleback Dam
16	Signal Butte Dam	09/08/2014	09:00:00	3.3200	0.00	21.526	1698.58	1714.40	1724.50	1697.50	1701.99	1707.19	1713.23	1714.29	13.050	-1621...	0.000	<input type="checkbox"/> Signal Butte Dam
17	Spookhill Dam	09/08/2014	09:00:00	3.5000	54.00	8.334	1575.96	1583.90	1593.40	1575.82	1579.26	1582.12	1583.78	1583.90	7.860	-1621...	0.000	<input type="checkbox"/> Spookhill Dam
18	Sunnycove Dam	09/08/2014	09:00:00	0.7400	0.00	7.195	2141.55	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.20	6.450	-1621...	0.000	<input type="checkbox"/> Sunnycove Dam
19	Sunset Dam	09/08/2014	09:00:00	0.9484	0.00	8.011	2118.94	2133.81	2144.01	2120.27	2123.91	2127.84	2130.98	2132.86	4.930	-1621...	0.000	<input type="checkbox"/> Sunset Dam
20	Vineyard Dam	09/08/2014	09:00:00	1.8425	54.00	674.904	1564.92	1575.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	2.920	-1621...	0.000	<input type="checkbox"/> Vineyard Dam
21	White Tanks No. 3 Dam	09/08/2014	09:00:00	2.7750	0.00	64.000	1180.00	1212.00	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	8.000	-1621...	0.000	<input type="checkbox"/> White Tanks #3 Dam
22	White Tanks No. 4 Dam	09/08/2014	09:00:00	3.0975	32.00	281.080	1012.70	1051.40	1056.00	1030.01	1036.74	1044.64	1049.89	1051.40	10.700	-1621...	0.000	<input type="checkbox"/> White Tanks #4 Dam

Refresh Manual Rain Data Entry Start Manual Prediction without Calibration Start Manual Prediction with Calibration Start Auto-Pilot Prediction Exit

Program Execution Completed.

Running the Software with Historical Storm Event

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward ☐ Beginning and Ending Date / Time

Ending Date / Time and Time Period:

Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes

Time Period (hrs): 11 Historical Storm Events: Fall Data #1: Sept. 7, 2014

Beginning and Ending Time:

Beginning Date/Time: 09/07/2014 22:00:00 Time Step: 15 minutes

Ending Date/Time: 09/08/2014 09:00:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☒ Manual Analysis ☐ Auto-Pilot Analysis

Frequency Update: Manual Auto-Pilot Analysis Length: Select Analysis Length

☐ Use Manual Test Data ☐ Use Auto Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL-TIME DATA			BASIC DAM DATA			STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS	
				Rainfall	Outflow	Storage	WSE	Spillw.Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time	Rate	Check/Uncheck Dams	
1	Adobe Dam	09/08/2014	09:00:00	2.4730	543.00	334.600	1349.26	1379.58	1404.88	1357.12	1363.87	1370.66	1378.00	1379.58	N/A	N/A	N/A	<input checked="" type="checkbox"/>	
2	Apache Junction Dam	09/08/2014	09:00:00	2.8550	0.00	40.600	1791.55	1801.80	1811.97	1793.17	1795.59	1798.18	1800.78	1801.79	N/A	N/A	N/A	<input type="checkbox"/>	
3	Buckeye No. 1 Dam	09/08/2014	09:00:00	2.1250	69.00	223.895	1056.50	1080.82	1099.60	1068.00	1071.50	1075.60	1076.50	1080.80	N/A	N/A	N/A	<input type="checkbox"/>	
4	Buckeye No. 2 Dam	09/08/2014	09:00:00	2.9200	131.00	261.405	1102.99	1113.12	1118.18	1103.08	1106.17	1109.27	1112.70	1113.17	N/A	N/A	N/A	<input checked="" type="checkbox"/>	
5	Buckeye No. 3 Dam	09/08/2014	09:00:00	2.8900	81.00	237.065	1151.58	1165.03	1171.51	1155.51	1157.97	1160.82	1164.10	1165.07	N/A	N/A	N/A	<input type="checkbox"/>	
6	Casandro Dam	09/08/2014	09:00:00	0.9212	0.00	0.373	2136.85	2157.00	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	N/A	N/A	N/A	<input type="checkbox"/>	
7	Cave Buttes Dam	09/08/2014	09:00:00	1.6080	138.00	13.458	1570.24	1659.10	1681.00	1615.85	1631.11	1643.72	1654.60	1659.10	N/A	N/A	N/A	<input type="checkbox"/>	
8	Dreamy Draw Dam	09/08/2014	09:00:00	2.8900	0.00	0.000	1371.70	1406.96	1418.46	1389.24	1393.81	1399.66	1405.23	1406.96	N/A	N/A	N/A	<input type="checkbox"/>	
9	Guadalupe Dam	09/08/2014	09:00:00	3.7600	0.00	24.227	1265.92	1275.83	1283.28	1258.68	1264.09	1269.29	1274.90	1276.02	N/A	N/A	N/A	<input type="checkbox"/>	
10	Harquahala Dam	09/08/2014	09:00:00	0.6477	0.00	0.340	1376.56	1410.60	1421.50	1396.39	1402.29	1406.09	1409.22	1410.59	N/A	N/A	N/A	<input type="checkbox"/>	
11	McMicken Dam	09/08/2014	09:00:00	2.3675	0.00	0.010	1337.60	1355.25	1362.00	1340.86	1345.44	1349.53	1354.11	1355.25	N/A	N/A	N/A	<input type="checkbox"/>	
12	New River Dam	09/08/2014	09:00:00	1.8260	672.00	409.384	1398.43	1456.20	1486.70	1418.30	1431.07	1443.50	1456.08	1458.50	N/A	N/A	N/A	<input type="checkbox"/>	
13	Powerline Dam	09/08/2014	09:00:00	2.2700	49.00	306.480	1563.40	1584.90	1589.40	1569.05	1573.66	1578.74	1582.98	1584.92	N/A	N/A	N/A	<input checked="" type="checkbox"/>	
14	Rittenhouse Dam	09/08/2014	09:00:00	1.7750	49.00	4.000	1582.40	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	N/A	N/A	N/A	<input type="checkbox"/>	
15	Saddleback Dam	09/08/2014	09:00:00	0.6170	0.00	0.010	1175.40	1195.45	1185.31	1180.23	1191.14	1194.10	1194.93	N/A	N/A	N/A	<input type="checkbox"/>		
16	Signal Butte Dam	09/08/2014	09:00:00	3.3200	0.00	21.526	1698.58	1714.40	1724.50	1697.50	1701.99	1707.19	1713.23	1714.29	N/A	N/A	N/A	<input type="checkbox"/>	
17	Spookhill Dam	09/08/2014	09:00:00	3.5000	54.00	8.334	1575.96	1583.90	1593.40	1575.82	1579.26	1582.12	1583.78	1583.90	N/A	N/A	N/A	<input type="checkbox"/>	
18	Sunnycove Dam	09/08/2014	09:00:00	0.7400	0.00	7.195	2141.55	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.20	N/A	N/A	N/A	<input type="checkbox"/>	
19	Sunset Dam	09/08/2014	09:00:00	0.9484	0.00	8.011	2118.94	2133.81	2144.01	2120.27	2123.91	2127.84	2130.98	2132.86	N/A	N/A	N/A	<input type="checkbox"/>	
20	Vineyard Dam	09/08/2014	09:00:00	1.8425	54.00	674.904	1564.92	1575.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	N/A	N/A	N/A	<input type="checkbox"/>	
21	White Tanks No. 3 Dam	09/08/2014	09:00:00	2.7750	0.00	64.000	1180.00	1212.00	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	N/A	N/A	N/A	<input type="checkbox"/>	
22	White Tanks No. 4 Dam	09/08/2014	09:00:00	3.0975	32.00	281.080	1012.70	1051.40	1056.00	1030.01	1036.74	1044.64	1049.89	1051.40	N/A	N/A	N/A	<input type="checkbox"/>	

Refresh

Manual Rain Data Entry

Start Manual Prediction without Calibration

Start Manual Prediction with Calibration

Start Auto-Pilot Prediction

Exit

Running the Software with Historical Storm Event

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Predicted WSE Plot

Manual Prediction form

Manual Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:
Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes
Time Period (hrs): 11

Beginning and Ending Dates/Times
Beginning Date / Time: Time Step:

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		Cu
		Date	Time	Date	Time	
1	Adobe Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1
2	Buckeye No. 2 Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1
3	Powerline Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1

Simulation Analysis Settings

Select the Objective Function:
Select the Objective Function ...

Set the Accuracy Setting for the Calibration Analysis:
Select your Accuracy Setting ...

Set the Model Parameters to Use:
Fall Data # 1

☐ Use Default Testing Data

Cancel OK

Dam Crest	Outflow	PREDICTION RESULTS		THRESHOLD DISCHARGES		
		Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q
1403.40	543.00	1026.35	17:30:00	3467.00	6933.00	10400.00
1118.18	131.00	130.49	09:00:00	4267.00	8533.00	12800.00
1589.40	49.00	67.49	12:45:00	4933.00	9867.00	14800.00

Gage and Dam Data

Manual Prediction Analysis (without Calibration) is complete.

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close

Running the Software with Historical Storm Event
2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward

Ending Date / Time and Time Period:

Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes

Time Period (hrs): 11 ☒ Historical Storm Events Fall Data #1: Sept. 7, 2014

☐ Beginning and Ending Date / Time

Beginning and Ending Time:

Beginning Date/Time: 09/07/2014 22:00:00 Time Step: 15 minutes

Ending Date/Time: 09/08/2014 09:00:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☒ Manual Analysis ☐ Auto-Pilot Analysis

Frequency Update: Manual Auto-Pilot Analysis Length: Select Analysis Length

☐ Use Manual Test Data ☐ Use Auto Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL TIME DATA				BASIC DAM DATA			STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS Check/Uncheck Dams
				Rainfall	Outflow	Storage	WSE	Spillw.Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time	Rate		
1	Adobe Dam	09/08/2014	09:00:00	2.4730	543.00	334.600	1349.26	1379.58	1404.88	1357.12	1363.87	1370.66	1378.00	1379.58	N/A	N/A	N/A	<input type="checkbox"/> Adobe Dam	
2	Apache Junction Dam	09/08/2014	09:00:00	2.8550	0.00	40.600	1791.55	1801.80	1811.97	1793.17	1795.59	1798.18	1800.78	1801.79	N/A	N/A	N/A	<input checked="" type="checkbox"/> Apache Junction Dam	
3	Buckeye No. 1 Dam	09/08/2014	09:00:00	2.1250	69.00	223.895	1056.50	1080.82	1089.60	1068.00	1071.50	1075.60	1078.50	1080.80	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #1 Dam	
4	Buckeye No. 2 Dam	09/08/2014	09:00:00	2.9200	131.00	261.405	1102.99	1113.12	1118.18	1103.08	1106.17	1109.27	1112.70	1113.17	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #2 Dam	
5	Buckeye No. 3 Dam	09/08/2014	09:00:00	2.8900	81.00	237.065	1151.58	1165.03	1171.51	1155.51	1157.97	1160.82	1164.10	1165.07	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #3 Dam	
6	Casandro Dam	09/08/2014	09:00:00	0.9212	0.00	0.373	2136.85	2157.00	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	N/A	N/A	N/A	<input type="checkbox"/> Casandro Dam	
7	Cave Buttes Dam	09/08/2014	09:00:00	1.6080	138.00	13.458	1570.24	1659.10	1681.00	1615.85	1631.11	1643.72	1654.60	1659.10	N/A	N/A	N/A	<input type="checkbox"/> Cave Buttes Dam	
8	Dreamy Draw Dam	09/08/2014	09:00:00	2.8900	0.00	0.000	1371.70	1406.96	1415.46	1389.24	1393.81	1399.66	1405.23	1406.96	N/A	N/A	N/A	<input type="checkbox"/> Dreamy Draw Dam	
9	Guadalupe Dam	09/08/2014	09:00:00	3.7600	0.00	24.227	1265.92	1275.83	1283.28	1258.68	1264.09	1269.29	1274.90	1276.02	N/A	N/A	N/A	<input type="checkbox"/> Guadalupe Dam	
10	Harquahala Dam	09/08/2014	09:00:00	0.6477	0.00	0.340	1376.56	1410.60	1421.50	1398.39	1402.29	1406.09	1409.22	1410.59	N/A	N/A	N/A	<input type="checkbox"/> Harquahala Dam	
11	McMicken Dam	09/08/2014	09:00:00	2.3675	0.00	0.010	1337.60	1355.25	1362.00	1340.86	1345.44	1349.53	1354.11	1355.25	N/A	N/A	N/A	<input type="checkbox"/> McMicken Dam	
12	New River Dam	09/08/2014	09:00:00	1.8260	672.00	409.384	1398.43	1456.20	1486.70	1418.30	1431.07	1443.50	1456.08	1458.50	N/A	N/A	N/A	<input type="checkbox"/> New River Dam	
13	Powerline Dam	09/08/2014	09:00:00	2.2700	49.00	306.480	1563.40	1584.90	1589.40	1569.05	1573.66	1578.74	1582.98	1584.92	N/A	N/A	N/A	<input checked="" type="checkbox"/> Powerline Dam	
14	Rittenhouse Dam	09/08/2014	09:00:00	1.7750	49.00	4.000	1582.40	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	N/A	N/A	N/A	<input type="checkbox"/> Rittenhouse Dam	
15	Saddleback Dam	09/08/2014	09:00:00	0.6170	0.00	0.010	1175.40	1195.45	1195.45	1185.31	1188.23	1191.14	1194.10	1194.93	N/A	N/A	N/A	<input type="checkbox"/> Saddleback Dam	
16	Signal Butte Dam	09/08/2014	09:00:00	3.3200	0.00	21.526	1698.58	1714.40	1724.50	1697.50	1701.99	1707.19	1713.23	1714.29	N/A	N/A	N/A	<input type="checkbox"/> Signal Butte Dam	
17	Spookhill Dam	09/08/2014	09:00:00	3.5000	54.00	8.334	1575.96	1583.90	1593.40	1575.82	1579.26	1582.12	1583.78	1583.90	N/A	N/A	N/A	<input type="checkbox"/> Spookhill Dam	
18	Sunnycove Dam	09/08/2014	09:00:00	0.7400	0.00	7.195	2141.55	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.20	N/A	N/A	N/A	<input type="checkbox"/> Sunnycove Dam	
19	Sunset Dam	09/08/2014	09:00:00	0.9484	0.00	8.011	2118.94	2133.81	2144.01	2120.27	2123.91	2127.84	2130.98	2132.86	N/A	N/A	N/A	<input type="checkbox"/> Sunset Dam	
20	Vineyard Dam	09/08/2014	09:00:00	1.8425	54.00	674.904	1564.92	1575.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	N/A	N/A	N/A	<input checked="" type="checkbox"/> Vineyard Dam	
21	White Tanks No. 3 Dam	09/08/2014	09:00:00	2.7750	0.00	64.000	1180.00	1212.00	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #3 Dam	
22	White Tanks No. 4 Dam	09/08/2014	09:00:00	3.0975	32.00	281.000	1012.70	1051.40	1056.00	1030.01	1036.74	1044.64	1049.89	1051.40	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #4 Dam	

Refresh
Manual Rain Data Entry
Start Manual Prediction without Calibration
Start Manual Prediction with Calibration
Start Auto-Pilot Prediction
Exit

Program Execution Completed.

Running the Software with Historical Storm Event

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

The screenshot displays the "Manual Prediction Form" window. At the top, there's a title bar and a menu bar. Below the menu bar, the main area is divided into several sections. On the left, under "EVENT DATA SETTINGS", there are input fields for "Ending Date / Time and Time Period:", "Current Date / Time:" (set to 09/08/2014 09:00:00), "Time Stop:" (set to 15 minutes), and "Time Period (hrs):" (set to 11). Below this is the "REAL-TIME PREDICTION" section with a table header showing columns for No., Dam, Starting Date, Time, Ending Date, and Time. A modal dialog box titled "Analysis Settings" is open in the center. It contains three sections: "Select the Objective Function:" with a dropdown set to "RT Obj.Function #1, z = f(|Obs_Stage-Mod_Stage|^2)"; "Set the Accuracy Setting for the Calibration Analysis:" with a dropdown set to "Very High Accuracy (Epsilon = 0.000001)"; and "Set the Model Parameters (STRTL, CNSTL, RTIMP) to use:" with a dropdown set to "Fall Data # 1". There is also a checked checkbox for "Use Default Testing Data" and three buttons at the bottom: "Cancel", "Review", and "OK". In the background, partially visible, is another table under "PREDICTION RESULTS" with columns for DAM, Peak Q, Time@PeakQ, and THRESHOLD DISCHARGES (1/3 Full Q, 2/3 Full Q, Full Q).

Manual Prediction Form

Manual Prediction Analysis for Selected Dams

EVENT DATA SETTINGS
 Ending Date / Time and Time Period:
 Current Date / Time: 09/08/2014 09:00:00 Time Stop: 15 minutes
 Time Period (hrs): 11

REAL-TIME PREDICTION

No.	Dam	STARTING	ENDING
Date	Time	Date	Time

Analysis Settings

Select the Objective Function:

RT Obj.Function #1, $z = f(|\text{Obs_Stage} - \text{Mod_Stage}|^2)$

Set the Accuracy Setting for the Calibration Analysis:

Very High Accuracy (Epsilon = 0.000001)

Set the Model Parameters (STRTL, CNSTL, RTIMP) to use:

Fall Data # 1

☒ Use Default Testing Data

Cancel Review OK

DAM	PREDICTION RESULTS	THRESHOLD DISCHARGES
outflow	Peak Q	Time@PeakQ

Gage and Dam Data
 Manual Prediction Analysis (with Calibration)

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Predicted WSE Plot

Predicted Water Surface Elevation Results

Manual Prediction Form

Manual Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:

Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes

Time Period (hrs): 11

Beginning and Ending Dates/Time:

Beginning Date/Time: 09/07/2014 22:00:00 Time Step: 15 minutes

Ending Date/Time: 09/08/2014 09:00:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS					STORAGE THRESHOLD AND DAM ELEVATION					DAM	DAM CREST	OUTFLOW	PREDICTION RESULTS		THRESHOLD DISCHARGES		
		Date	Time	Date	Time	Curr. WSE	Next WSE	Time@Peak	Peak WSE	Time@DamFill	10%	25%	50%	90%	100%				Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q
1	Apache Junction Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1791.42	1791.521	18:15:00	1791.632	N/A	1793.17	1793.39	1798.18	1800.78	1801.79	1811.97	8.00	31.98	18:15:00	3550.00	7100.00	10450.00	
2	Powerline Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1567.22	1567.754	13:00:00	1569.328	N/A	1569.05	1573.66	1578.74	1582.98	1584.92	1589.40	49.00	73.64	13:00:00	4933.00	9867.00	14800.00	
3	Vineyard Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1567.12	1567.291	12:15:00	1568.070	N/A	1566.83	1569.17	1571.92	1574.01	1575.50	1580.60	54.00	78.97	12:15:00	5933.00	11867.00	17800.00	

Gage and Dam Data

Manual Prediction Analysis (with Calibration) is complete.

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Predicted Outflow Plot

Predicted Dam Outflow Results

Manual Prediction Form

Manual Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:

Current Date / Time: 09/08/2014 09:00:00 Time Step: 15 minutes

Time Period (hrs): 11

Beginning and Ending Dates/Time:

Beginning Date/Time: 09/07/2014 22:00:00 Time Step: 15 minutes

Ending Date/Time: 09/08/2014 09:00:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS					STORAGE THRESHOLD AND DAM ELEVATION					DAM		PREDICTION RESULTS		THRESHOLD DISCHARGES		
		Date	Time	Date	Time	Curr. WSE	Next WSE	Time@Peak	Peak WSE	Time@DamFill	10%	25%	50%	90%	100%	Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q
1	Apache Junction Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1791.42	1791.521	18:15:00	1791.632	N/A	1793.17	1793.39	1798.18	1800.78	1801.79	1811.97	8.00	31.98	18:15:00	3550.00	7100.00	10450.00
2	Powerline Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1567.22	1567.754	13:00:00	1569.328	N/A	1569.05	1573.66	1578.74	1582.98	1584.92	1589.40	49.00	73.64	13:00:00	4933.00	9867.00	14800.00
3	Vineyard Dam	09/07/2014	22:00:00	09/08/2014	09:00:00	1567.12	1567.291	12:15:00	1568.070	N/A	1566.83	1569.17	1571.92	1574.01	1575.50	1580.60	54.00	78.97	12:15:00	5933.00	11867.00	17800.00

Gage and Dam Data

Manual Prediction Analysis (with Calibration) is complete.

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward

Ending Date / Time and Time Period:

Current Date / Time: 07/18/2015 21:00:00 Time Step: 15 minutes

Time Period (hrs): 5 ☒ Historical Storm Events Summer Data #2: July 18, 2015

☐ Beginning and Ending Date / Time

Beginning and Ending Time:

Beginning Date/Time: 07/18/2015 16:00:00 Time Step: 15 minutes

Ending Date/Time: 07/18/2015 21:00:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☐ Manual Analysis ☒ Auto-Pilot Analysis

Frequency Update: Every 15 minutes Auto-Pilot Analysis Length: 1.0 hour

☐ Use Manual Test Data ☐ Use Auto-Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL-TIME DATA				BASIC DAM DATA		STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)		DAM FOR ANALYSIS	
				Rainfall	Outflow	Storage	WSE	Spillw.Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time		Rate
1	Adobe Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1339.81	1379.58	1404.88	1357.12	1363.87	1370.66	1378.00	1379.58	N/A	N/A	N/A	<input type="checkbox"/> Adobe Dam
2	Apache Junction Dam	07/18/2015	21:00:00	0.0600	0.00	0.000	1785.92	1801.80	1811.97	1793.17	1795.59	1798.18	1800.78	1801.79	N/A	N/A	N/A	<input type="checkbox"/> Apache Junction Dam
3	Buckeye No. 1 Dam	07/18/2015	21:00:00	0.0700	0.00	0.100	1055.80	1080.82	1089.60	1068.00	1071.50	1075.60	1078.50	1080.80	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #1 Dam
4	Buckeye No. 2 Dam	07/18/2015	21:00:00	0.0400	0.00	0.010	1095.60	1113.12	1118.18	1103.00	1106.17	1109.27	1112.70	1113.17	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #2 Dam
5	Buckeye No. 3 Dam	07/18/2015	21:00:00	0.0400	0.00	0.100	1146.94	1165.03	1171.51	1155.51	1157.97	1160.82	1164.10	1165.87	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #3 Dam
6	Casandro Dam	07/18/2015	21:00:00	4.1479	27.00	110.757	2155.00	2157.00	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	N/A	N/A	N/A	<input checked="" type="checkbox"/> Casandro Dam
7	Cave Buttes Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1561.98	1659.10	1681.00	1615.85	1631.11	1643.72	1654.60	1659.10	N/A	N/A	N/A	<input type="checkbox"/> Cave Buttes Dam
8	Dreamy Draw Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1371.58	1406.96	1418.46	1389.24	1393.81	1399.66	1405.23	1406.96	N/A	N/A	N/A	<input type="checkbox"/> Dreamy Draw Dam
9	Guadalupe Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1251.36	1275.83	1283.28	1258.68	1264.09	1269.29	1274.90	1276.82	N/A	N/A	N/A	<input type="checkbox"/> Guadalupe Dam
10	Harquahala Dam	07/18/2015	21:00:00	0.0924	0.00	0.000	1374.86	1410.60	1421.50	1398.39	1402.29	1406.09	1409.22	1410.59	N/A	N/A	N/A	<input type="checkbox"/> Harquahala Dam
11	McMicken Dam	07/18/2015	21:00:00	0.4750	0.00	0.000	1336.00	1355.25	1362.00	1340.86	1345.44	1349.53	1354.11	1355.25	N/A	N/A	N/A	<input type="checkbox"/> McMicken Dam
12	New River Dam	07/18/2015	21:00:00	0.0000	0.00	5.143	1392.13	1456.20	1486.70	1418.30	1431.07	1443.50	1456.08	1458.50	N/A	N/A	N/A	<input type="checkbox"/> New River Dam
13	Powerline Dam	07/18/2015	21:00:00	0.0400	0.00	0.000	1560.00	1584.90	1589.40	1569.05	1573.86	1578.74	1582.98	1584.92	N/A	N/A	N/A	<input type="checkbox"/> Powerline Dam
14	Rittenhouse Dam	07/18/2015	21:00:00	0.1200	0.00	0.000	1579.00	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	N/A	N/A	N/A	<input type="checkbox"/> Rittenhouse Dam
15	Saddleback Dam	07/18/2015	21:00:00	0.0404	0.00	0.000	1175.10	1195.45	1195.45	1185.31	1188.23	1191.14	1194.10	1194.93	N/A	N/A	N/A	<input type="checkbox"/> Saddleback Dam
16	Signal Butte Dam	07/18/2015	21:00:00	0.0400	0.00	0.000	1687.28	1714.40	1724.50	1697.50	1701.99	1707.19	1713.23	1714.29	N/A	N/A	N/A	<input type="checkbox"/> Signal Butte Dam
17	Spookhill Dam	07/18/2015	21:00:00	0.0100	0.00	0.000	1568.10	1583.90	1593.40	1575.82	1579.26	1582.12	1583.78	1583.90	N/A	N/A	N/A	<input type="checkbox"/> Spookhill Dam
18	Sunnycove Dam	07/18/2015	21:00:00	4.3100	7.00	148.990	2166.95	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.20	N/A	N/A	N/A	<input checked="" type="checkbox"/> Sunnycove Dam
19	Sunset Dam	07/18/2015	21:00:00	3.8555	6.00	68.036	2130.19	2133.81	2144.01	2126.27	2123.91	2127.84	2130.98	2132.86	N/A	N/A	N/A	<input checked="" type="checkbox"/> Sunset Dam
20	Vineyard Dam	07/18/2015	21:00:00	0.0800	0.00	0.000	1562.00	1575.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	N/A	N/A	N/A	<input type="checkbox"/> Vineyard Dam
21	White Tanks No. 3 Dam	07/18/2015	21:00:00	0.0200	0.00	91.000	1180.90	1212.00	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #3 Dam
22	White Tanks No. 4 Dam	07/18/2015	21:00:00	0.0200	0.00	25.000	1002.00	1051.40	1056.00	1030.01	1036.74	1044.64	1049.89	1051.40	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #4 Dam

Refresh Manual Rain Data Entry Start Manual Prediction without Calibration Start Manual Prediction with Calibration **Start Auto-Pilot Prediction** Exit

Program Execution Completed.

Running the Software with Historical Storm Event

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

[illegible]

Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Predicted WSE Plot

Auto-Pilot Prediction Form

Auto-Pilot Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:

Current Date / Time: 07/18/2015 21:00:00 Time Step: 15 minutes

Time Period (hrs): 5

Beginning and Ending Dates/Time:

Beginning Date/Time: 07/18/2015 16:00:00 Time Step: 15 minutes

Ending Date/Time: 07/18/2015 21:00:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS					STORAGE THRESHOLD AND DAM ELEVATION					DAM	PREDICTION RESULTS	THRESHOLD DISCHARGES				
		Date	Time	Date	Time	Curr. WSE	Next WSE	Time@Peak	Peak WSE	Time@Dam Fill	10%	25%	50%	90%	100%			Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2155.00	2154.983	21:00:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:00:00	2467.00	4933.00	7400.00
2	Sunnycove Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2166.95	2168.132	23:45:00	2171.819	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.01	00:30:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2130.19	2130.054	21:00:00	2130.190	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	73.01	21:00:00	1377.00	2753.00	4130.00
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2155.00	2154.974	21:15:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:15:00	2467.00	4933.00	7400.00
2	Sunnycove Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2166.95	2167.891	24:00:00	2170.937	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.00	00:30:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2130.89	2129.914	21:15:00	2130.090	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	72.41	21:15:00	1377.00	2753.00	4130.00
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2155.00	2154.974	21:30:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:30:00	2467.00	4933.00	7400.00
2	Sunnycove Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2166.95	2167.689	24:00:00	2170.132	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.00	00:15:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2129.89	2129.780	21:30:00	2129.890	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	71.21	21:30:00	1377.00	2753.00	4130.00
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2155.00	2154.973	21:45:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:45:00	2467.00	4933.00	7400.00
2	Sunnycove Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2166.95	2167.533	24:00:00	2169.244	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	76.14	24:00:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2129.79	2129.594	21:45:00	2129.790	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	70.61	21:45:00	1377.00	2753.00	4130.00
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2155.00	2154.965	22:00:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	22:00:00	2467.00	4933.00	7400.00
2	Sunnycove Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2166.75	2167.190	23:45:00	2168.333	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	75.23	23:45:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2129.69	2129.492	22:00:00	2129.690	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	70.01	22:00:00	1377.00	2753.00	4130.00

Gage and Dam Data

Auto-Pilot Prediction Analysis (with Calibration) is complete.

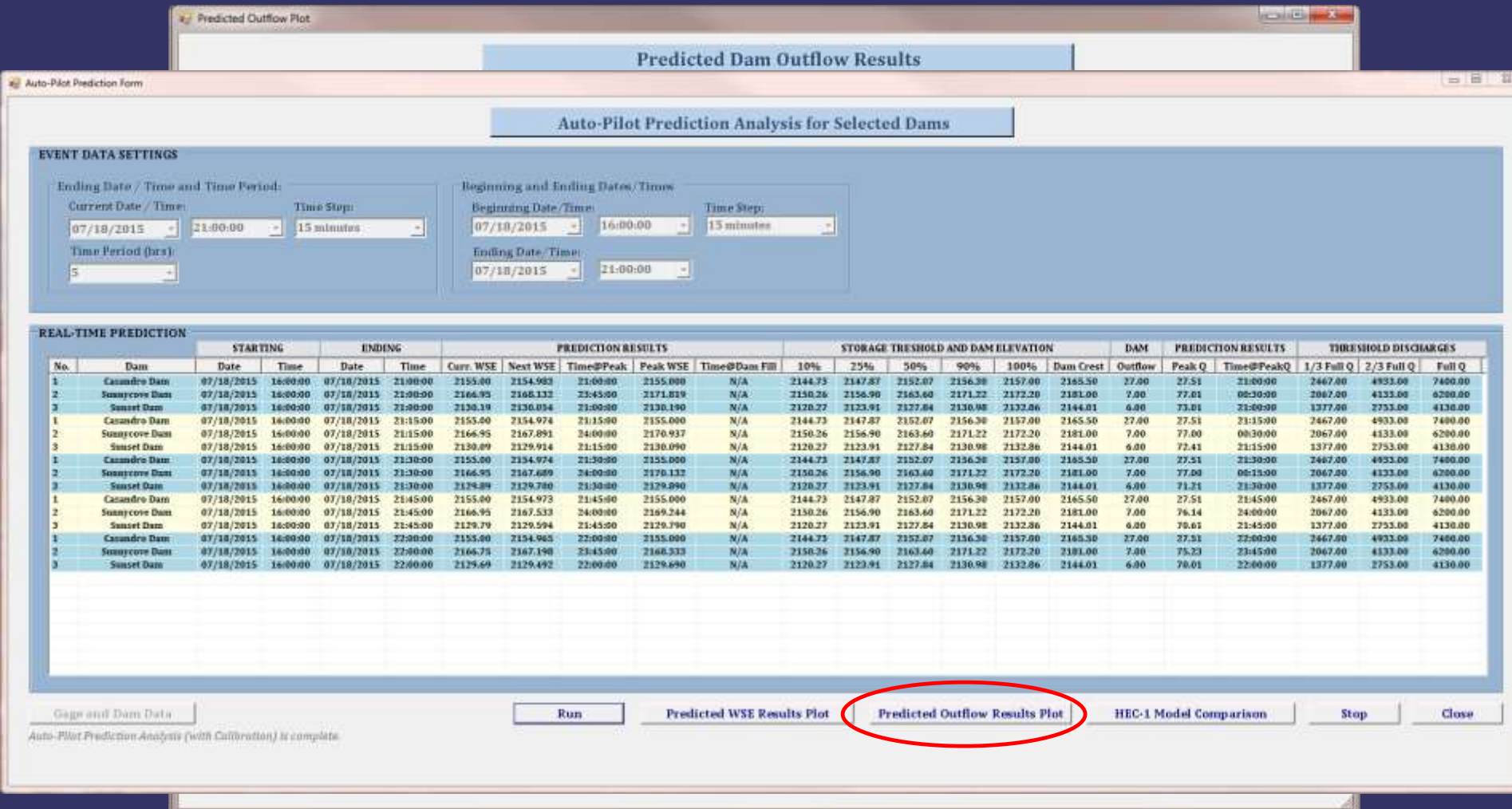
Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close

2018 ASFP Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software



2018 ASFP Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

Utility Viewer for Dam Flow Prediction Program

Auto-Pilot Prediction Form

Auto-Pilot Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:

Current Date / Time: 07/18/2015 21:00:00 Time Step: 15 minutes

Time Period (hrs): 5

Beginning and Ending Dates/Time:

Beginning Date/Time: 07/18/2015 16:00:00 Time Step: 15 minutes

Ending Date/Time: 07/18/2015 21:00:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS					STORAGE THRESHOLD AND DAM ELEVATION					DAM	PREDICTION RESULTS		THRESHOLD DISCHARGES			
		Date	Time	Date	Time	Curr. WSE	Next WSE	Time@Peak	Peak WSE	Time@Dam Fill	10%	25%	50%	90%	100%		Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q
1	Casandra Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2155.00	2154.983	21:00:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:00:00	2467.00	4933.00	7400.00
2	Sunnycore Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2166.95	2168.132	23:45:00	2171.819	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.01	00:30:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2130.19	2130.054	21:00:00	2130.190	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	73.01	21:00:00	1377.00	2753.00	4130.00
1	Casandra Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2155.00	2154.974	21:15:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:15:00	2467.00	4933.00	7400.00
2	Sunnycore Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2166.95	2167.891	24:00:00	2170.937	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.00	00:30:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:15:00	2130.89	2129.914	21:15:00	2130.090	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	72.41	21:15:00	1377.00	2753.00	4130.00
1	Casandra Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2155.00	2154.974	21:30:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:30:00	2467.00	4933.00	7400.00
2	Sunnycore Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2166.95	2167.689	24:00:00	2170.132	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.00	00:30:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:30:00	2129.89	2129.780	21:30:00	2129.890	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	71.21	21:30:00	1377.00	2753.00	4130.00
1	Casandra Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2155.00	2154.973	21:45:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	21:45:00	2467.00	4933.00	7400.00
2	Sunnycore Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2166.95	2167.533	24:00:00	2169.244	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	76.14	24:00:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:45:00	2129.79	2129.594	21:45:00	2129.790	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	70.61	21:45:00	1377.00	2753.00	4130.00
1	Casandra Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2155.00	2154.965	22:00:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	27.00	27.51	22:00:00	2467.00	4933.00	7400.00
2	Sunnycore Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2166.75	2167.190	23:45:00	2168.333	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	75.23	23:45:00	2067.00	4133.00	6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	22:00:00	2129.69	2129.492	22:00:00	2129.690	N/A	2120.27	2123.91	2127.84	2130.98	2132.86	2144.01	6.00	70.01	22:00:00	1377.00	2753.00	4130.00

Gage and Dam Data

Auto-Pilot Prediction Analysis (with Calibration) is complete.

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-1 Model Comparison Stop Close

\\DamFlow\101\Dams\Casandra\Run#005

2018 ASFP Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

- ❖ REAL-TIME PREDICTION ANALYSIS
- ❖ "ON-THE-FLY" MODEL CALIBRATION
- ❖ "HEC-1 LIKE LITE" PROGRAM
- ❖ E-MAIL NOTIFICATION FEATURE
- ❖ "AUTO-PILOT" ANALYSIS
- ❖ "MANUAL" PREDICTION ANALYSIS
- ❖ "ASK QUESTION" FEATURE

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ REAL-TIME PREDICTION ANALYSIS

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward

Ending Date / Time and Time Period:

Current Date / Time: 10/09/2017 08:29:00 Time Step: 15 minutes

Time Period (hrs): 3 ☐ Historical Storm Events ☐ Select Historical Storm Event

Beginning and Ending Date / Time

Beginning and Ending Time:

Beginning Date/Time: 10/09/2017 05:29:00 Time Step: 15 minutes

Ending Date/Time: 10/09/2017 08:29:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☒ Manual Analysis ☐ Auto-Pilot Analysis

Frequency Update: Manual Auto-Pilot Analysis Length: Select Analysis Length

☐ Use Manual Test Data ☐ Use Auto-Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL TIME DATA			BASIC DAM DATA			STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS	
				Rainfall	Outflow	Storage	WSE	Spill/Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time	Rate	Check/Uncheck Dams	
1	Adobe Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1339.81	1379.38	1484.88	1357.12	1363.87	1370.66	1378.00	1379.58	N/A	N/A	N/A	<input type="checkbox"/> Adobe Dam	
2	Apache Junction Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1785.92	1801.80	1811.97	1793.17	1795.59	1798.18	1800.78	1801.79	N/A	N/A	N/A	<input type="checkbox"/> Apache Junction Dam	
3	Buckeye No. 1 Dam	10/09/2017	08:29:00	0.0000	0.00	0.100	1055.80	1060.82	1069.60	1040.00	1071.50	1075.60	1078.50	1080.80	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #1 Dam	
4	Buckeye No. 2 Dam	10/09/2017	08:29:00	0.0000	0.00	0.010	1095.68	1113.12	1118.18	1183.08	1186.17	1189.27	1112.78	1113.17	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #2 Dam	
5	Buckeye No. 3 Dam	10/09/2017	08:29:00	0.0000	0.00	0.100	1146.94	1165.82	1171.31	1155.51	1157.93	1160.82	1164.10	1165.07	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #3 Dam	
6	Casandro Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	2136.66	2157.80	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	N/A	N/A	N/A	<input type="checkbox"/> Casandro Dam	
7	Cave Buttes Dam	10/09/2017	08:29:00	0.0000	0.00	0.458	1563.89	1659.10	1681.00	1615.85	1631.11	1643.72	1654.60	1659.10	N/A	N/A	N/A	<input type="checkbox"/> Cave Buttes Dam	
8	Dreamy Draw Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1271.58	1406.96	1418.44	1389.24	1392.81	1399.66	1405.23	1406.96	N/A	N/A	N/A	<input type="checkbox"/> Dreamy Draw Dam	
9	Guadalupe Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1251.36	1275.83	1283.28	1258.48	1264.09	1269.29	1274.90	1276.02	N/A	N/A	N/A	<input type="checkbox"/> Guadalupe Dam	
10	Harquahala Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1374.86	1410.60	1421.50	1398.39	1402.29	1406.09	1409.22	1410.59	N/A	N/A	N/A	<input type="checkbox"/> Harquahala Dam	
11	McNicken Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1336.00	1355.25	1362.00	1340.86	1345.44	1349.33	1354.11	1355.25	N/A	N/A	N/A	<input type="checkbox"/> McNicken Dam	
12	New River Dam	10/09/2017	08:29:00	0.0000	30.00	8.351	1392.18	1456.20	1486.70	1418.30	1431.07	1443.50	1456.08	1458.50	N/A	N/A	N/A	<input type="checkbox"/> New River Dam	
13	Powerline Dam	10/09/2017	08:29:00	0.0000	6.00	22.995	1560.44	1584.90	1589.40	1569.05	1573.66	1578.74	1582.98	1584.93	N/A	N/A	N/A	<input type="checkbox"/> Powerline Dam	
14	Rittenhouse Dam	10/09/2017	08:29:00	0.0000	6.00	0.000	1579.44	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	N/A	N/A	N/A	<input type="checkbox"/> Rittenhouse Dam	
15	Saddleback Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1175.18	1195.45	1195.45	1185.31	1188.23	1191.14	1194.10	1194.93	N/A	N/A	N/A	<input type="checkbox"/> Saddleback Dam	
16	Signal Butte Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1687.53	1714.40	1724.50	1697.30	1701.99	1707.19	1713.23	1714.29	N/A	N/A	N/A	<input type="checkbox"/> Signal Butte Dam	
17	Spookhill Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1568.10	1583.90	1593.40	1575.82	1579.26	1582.12	1583.70	1583.90	N/A	N/A	N/A	<input type="checkbox"/> Spookhill Dam	
18	Sunnyvale Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	2135.10	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.20	N/A	N/A	N/A	<input type="checkbox"/> Sunnyvale Dam	
19	Sunset Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	2114.01	2153.81	2144.01	2120.27	2123.91	2127.84	2130.98	2132.86	N/A	N/A	N/A	<input type="checkbox"/> Sunset Dam	
20	Vineyard Dam	10/09/2017	08:29:00	0.0000	0.00	0.000	1562.00	1575.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	N/A	N/A	N/A	<input type="checkbox"/> Vineyard Dam	
21	White Tanks No. 3 Dam	10/09/2017	08:29:00	0.0000	0.00	64.000	1180.00	1212.00	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #3 Dam	
22	White Tanks No. 4 Dam	10/09/2017	08:29:00	0.0000	0.00	25.000	1002.00	1051.40	1056.00	1030.81	1036.74	1044.64	1049.89	1051.40	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #4 Dam	

Refresh Manual Rain Data Entry Start Manual Prediction without Calibration Start Manual Prediction with Calibration Start Auto-Pilot Prediction Edit

Program Execution Completed

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ "ON-THE-FLY" MODEL CALIBRATION

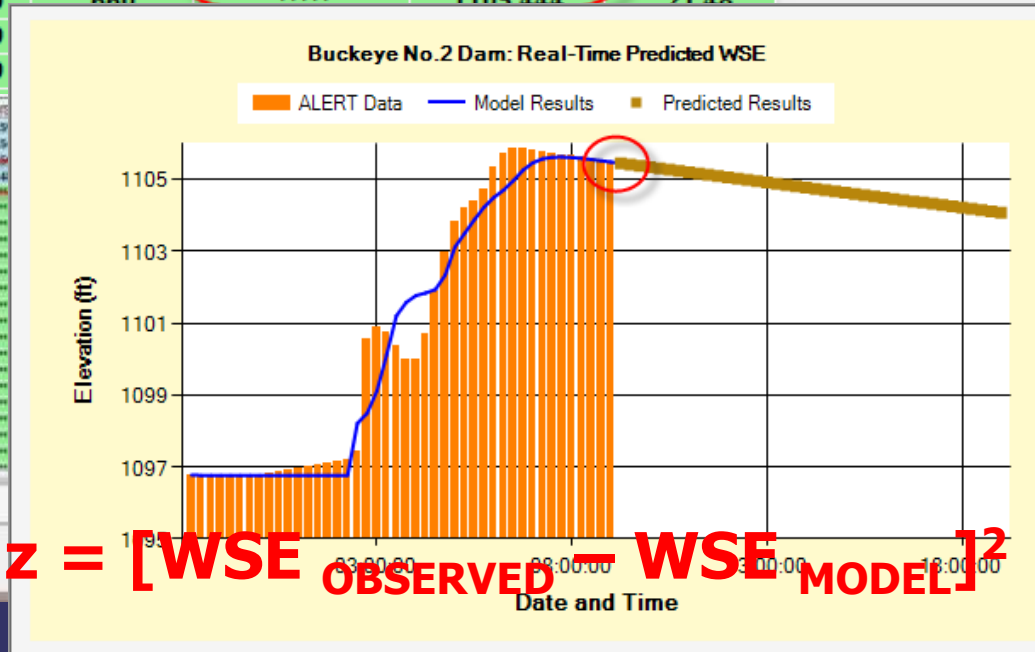
WSE Prediction Results Table

Dam Name: Buckeye No. 2 Dam

No.	Date	Time	Time (min)	ALERT WSE (ft)	Pred WSE (ft)	% Capacity
41	09/08/2014	08:15:00	600	1105.592	1105.581	22.19
42	09/08/2014	08:30:00	615	1105.546	1105.550	21.97
43	09/08/2014	08:45:00	630	1105.500	1105.516	21.75
44	09/08/2014	09:00:00	645	1105.480	1105.480	21.65
45	09/08/2014	09:15:00	660	*****	1105.444	21.48
46	09/08/2014	09:30:00				
47	09/08/2014	09:45:00				

Time Step: 15 minutes
Time: 09:00:00
No. of Ordinates: 45

No.	Date	Time	Time (min)	ALERT WSE
41	09/08/2014	08:15:00	600	1105.5
42	09/08/2014	08:30:00	615	1105.5
43	09/08/2014	08:45:00	630	1105.5
44	09/08/2014	09:00:00	645	1105.4
45	09/08/2014	09:15:00	660	*****
46	09/08/2014	09:30:00	675	*****
47	09/08/2014	09:45:00	690	*****
48	09/08/2014	10:00:00	705	*****
49	09/08/2014	10:15:00	720	*****
50	09/08/2014	10:30:00	735	*****
51	09/08/2014	10:45:00	750	*****
52	09/08/2014	11:00:00	765	*****
53	09/08/2014	11:15:00	780	*****
54	09/08/2014	11:30:00	795	*****
55	09/08/2014	11:45:00	810	*****
56	09/08/2014	12:00:00	825	*****
57	09/08/2014	12:15:00	840	*****
58	09/08/2014	12:30:00	855	*****
59	09/08/2014	12:45:00	870	*****
60	09/08/2014	13:00:00	885	*****
61	09/08/2014	13:15:00	900	*****



$$\text{Minimize } z = [WSE_{OBSERVED} - WSE_{MODEL}]^2$$

2018 ASFPM Annual Conference

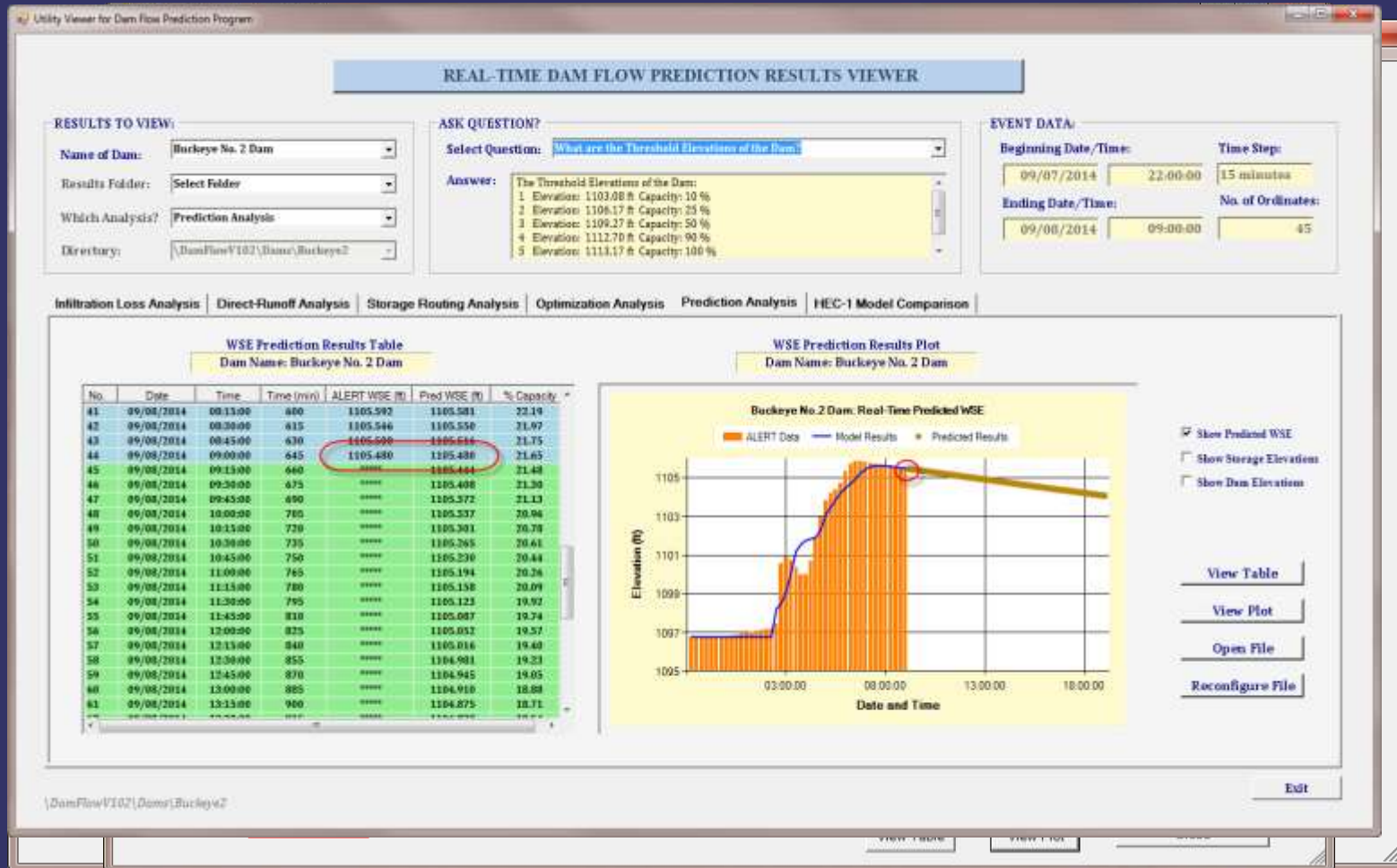
Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “ON-THE-FLY” MODEL CALIBRATION



2018 ASFPM Annual Conference

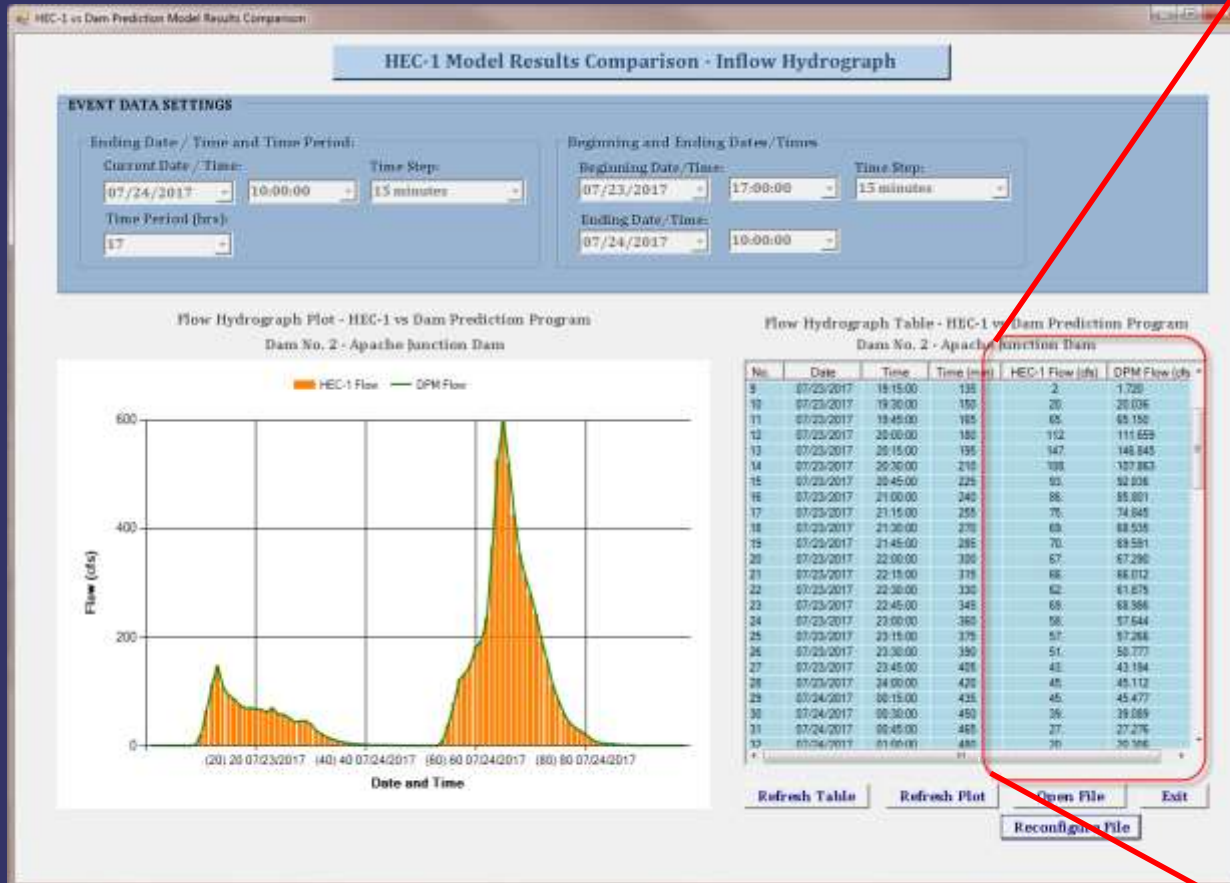
Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “HEC-1 LIKE” PROGRAM



HEC-1 Flow (cfs)	DPM Flow (cfs)
2.	1.720
20.	20.036
65.	65.150
112.	111.659
147.	146.845
108.	107.863
93.	92.836
86.	85.801
75.	74.845
69.	68.535
70.	69.591
67.	67.290
66.	66.012
62.	61.875
69.	68.986
58.	57.644
57.	57.266
51.	50.777
43.	43.194
45.	45.112
45.	45.477
39.	39.089
27.	27.276
20.	20.306

2018 ASFPM Annual Conference

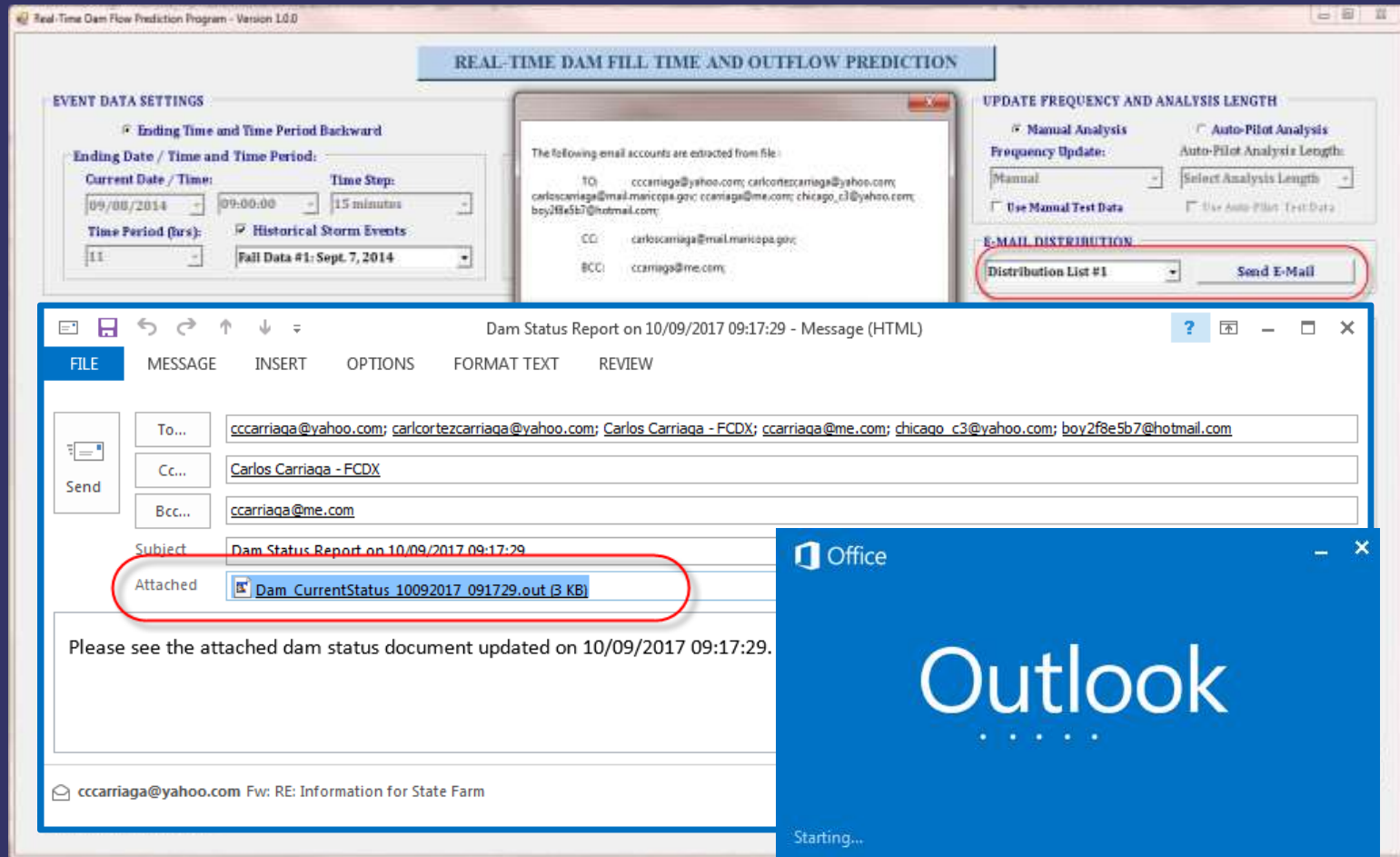
Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ E-MAIL NOTIFICATION FEATURE



2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “AUTO-PILOT” ANALYSIS

Real-Time Dam Flow Prediction Program - Version 1.0.0

REAL-TIME DAM FILL TIME AND OUTFLOW PREDICTION

EVENT DATA SETTINGS

☒ Ending Time and Time Period Backward
☐ Beginning and Ending Date / Time

Ending Date / Time and Time Period:
 Current Date / Time: 07/18/2015 21:00:00 Time Step: 15 minutes
 Time Period (hrs): 5 Historical Storm Events: Summer Data #2: July 18, 2015

Beginning and Ending Time:
 Beginning Date/Time: 07/18/2015 16:00:00 Time Step: 15 minutes
 Ending Date/Time: 07/18/2015 21:00:00

UPDATE FREQUENCY AND ANALYSIS LENGTH

☐ Manual Analysis
☒ Auto-Pilot Analysis

Frequency Update: Every 15 minutes
 Auto-Pilot Analysis Length: 1.0 hour

☐ Use Manual Test Data
☒ Use Auto-Pilot Test Data

E-MAIL DISTRIBUTION

Distribution List #1
 Send E-Mail

REAL-TIME DAM ALERT DATA

No.	Dam	Date	Time	REAL TIME DATA			BASIC DAM DATA			STORAGE THRESHOLD ELEVATION DATA					RISE AND DRAWDOWN (DD)			DAM FOR ANALYSIS	
				Rainfall	Outflow	Storage	WSE	Spills Crest	Dam Crest	10%	25%	50%	90%	100%	Rise/DD	Time	Rate	Check/Uncheck Dams	
1	Adobe Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1339.91	1379.58	1404.88	1357.12	1363.87	1370.66	1378.00	1379.58	N/A	N/A	N/A	<input type="checkbox"/> Adobe Dam	
2	Apache Junction Dam	07/18/2015	21:00:00	0.0600	0.00	0.000	1785.92	1801.80	1811.97	1795.17	1795.59	1798.18	1800.78	1801.79	N/A	N/A	N/A	<input type="checkbox"/> Apache Junction Dam	
3	Buckeye No. 1 Dam	07/18/2015	21:00:00	0.0700	0.00	0.100	1055.80	1060.82	1069.60	1068.00	1071.50	1075.60	1078.50	1080.80	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #1 Dam	
4	Buckeye No. 2 Dam	07/18/2015	21:00:00	0.0400	0.00	0.010	1095.68	1113.12	1110.18	1103.06	1106.17	1109.27	1112.70	1113.17	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #2 Dam	
5	Buckeye No. 3 Dam	07/18/2015	21:00:00	0.0400	0.00	0.100	1146.94	1165.03	1171.51	1155.51	1157.97	1160.82	1164.10	1165.07	N/A	N/A	N/A	<input type="checkbox"/> Buckeye #3 Dam	
6	Casandro Dam	07/18/2015	21:00:00	4.1479	27.08	110.757	2138.00	2157.00	2165.50	2144.73	2147.87	2152.07	2156.30	2157.00	N/A	N/A	N/A	<input checked="" type="checkbox"/> Casandro Dam	
7	Cave Butte Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1561.96	1659.10	1681.00	1615.83	1631.11	1643.73	1654.60	1659.10	N/A	N/A	N/A	<input type="checkbox"/> Cave Butte Dam	
8	Dreamy Draw Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1371.58	1406.96	1418.46	1389.24	1393.81	1399.66	1405.23	1406.96	N/A	N/A	N/A	<input type="checkbox"/> Dreamy Draw Dam	
9	Guadalupe Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1251.36	1275.83	1283.28	1258.68	1264.09	1269.29	1274.90	1276.02	N/A	N/A	N/A	<input type="checkbox"/> Guadalupe Dam	
10	Harquahala Dam	07/18/2015	21:00:00	0.0924	0.00	0.000	1374.66	1410.40	1421.50	1398.39	1402.29	1406.89	1409.22	1410.59	N/A	N/A	N/A	<input type="checkbox"/> Harquahala Dam	
11	McMicken Dam	07/18/2015	21:00:00	0.4750	0.00	0.000	1336.00	1355.25	1362.00	1340.86	1345.44	1349.53	1354.11	1355.25	N/A	N/A	N/A	<input type="checkbox"/> McMicken Dam	
12	New River Dam	07/18/2015	21:00:00	0.0000	0.00	5.143	1392.13	1456.20	1486.70	1418.30	1431.07	1443.50	1456.88	1458.50	N/A	N/A	N/A	<input type="checkbox"/> New River Dam	
13	Powerline Dam	07/18/2015	21:00:00	0.0400	0.00	0.000	1560.00	1584.90	1589.40	1569.05	1573.66	1578.74	1582.98	1584.92	N/A	N/A	N/A	<input type="checkbox"/> Powerline Dam	
14	Rittenhouse Dam	07/18/2015	21:00:00	0.1700	0.00	0.000	1579.00	1598.40	1603.40	1588.94	1591.74	1594.63	1596.55	1598.40	N/A	N/A	N/A	<input type="checkbox"/> Rittenhouse Dam	
15	Saddleback Dam	07/18/2015	21:00:00	0.0404	0.00	0.000	1175.10	1195.45	1195.45	1185.31	1188.23	1191.14	1194.10	1194.93	N/A	N/A	N/A	<input type="checkbox"/> Saddleback Dam	
16	Signal Butte Dam	07/18/2015	21:00:00	0.0400	0.00	0.000	1687.28	1714.40	1724.50	1697.50	1701.99	1707.19	1713.22	1714.29	N/A	N/A	N/A	<input type="checkbox"/> Signal Butte Dam	
17	Spookhill Dam	07/18/2015	21:00:00	0.0100	0.00	0.000	1568.10	1583.90	1593.40	1575.82	1579.28	1582.12	1583.78	1583.90	N/A	N/A	N/A	<input type="checkbox"/> Spookhill Dam	
18	Sunnycove Dam	07/18/2015	21:00:00	4.3100	7.00	148.988	2166.95	2172.10	2181.00	2150.26	2156.90	2163.60	2171.22	2172.10	N/A	N/A	N/A	<input checked="" type="checkbox"/> Sunnycove Dam	
19	Sunset Dam	07/18/2015	21:00:00	3.8555	0.00	68.036	2130.19	2133.81	2144.01	2120.27	2123.91	2127.84	2130.98	2132.86	N/A	N/A	N/A	<input checked="" type="checkbox"/> Sunset Dam	
20	Vineyard Dam	07/18/2015	21:00:00	0.0000	0.00	0.000	1562.00	1573.70	1580.60	1566.83	1569.17	1571.92	1574.01	1575.50	N/A	N/A	N/A	<input type="checkbox"/> Vineyard Dam	
21	White Tanks No. 3 Dam	07/18/2015	21:00:00	0.0200	0.00	91.000	1180.90	1212.60	1218.00	1194.42	1199.60	1204.76	1210.01	1212.00	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #3 Dam	
22	White Tanks No. 4 Dam	07/18/2015	21:00:00	0.0200	0.00	25.000	1002.00	1051.40	1056.00	1030.01	1036.74	1044.64	1049.09	1051.40	N/A	N/A	N/A	<input type="checkbox"/> White Tanks #4 Dam	

Program Execution Completed

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “AUTO-PILOT” ANALYSIS

Auto-Pilot Prediction Form

Auto-Pilot Prediction Analysis for Selected Dams

EVENT DATA SETTINGS

Ending Date / Time and Time Period:

Current Date / Time: 07/18/2015 21:00:00 Time Step: 15 minutes

Time Period (hrs): 5

Beginning and Ending Dates/Times:

Beginning Date/Time: 07/18/2015 16:00:00 Time Step: 15 minutes

Ending Date/Time: 07/18/2015 21:00:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS					STORAGE TRESHOLD AND DAM ELEVATION					DAM	PREDICTION RESULTS		THRESHOLD DISCHARGES					
		Date	Time	Date	Time	Curr. WSE	Next WSE	Time@Peak	Peak WSE	Time@Dam Fill	10%	25%	50%	90%	100%		Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q	
1	Casandro Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2155.00	2154.903	21:00:00	2155.000	N/A	2144.73	2147.87	2152.07	2156.30	2157.60	2165.30	27.00	27.51	21:00:00	2467.00		4933.00		7400.00
2	Sunupcore Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2166.95	2168.132	23:45:00	2171.819	N/A	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	7.00	77.01	00:30:00	2067.00		4133.00		6200.00
3	Sunset Dam	07/18/2015	16:00:00	07/18/2015	21:00:00	2130.19	2130.854	21:00:00	2130.190	N/A	2120.27	2123.91	2127.84	2130.90	2132.86	2144.01	6.00	73.01	21:00:00	1377.00		2753.00		4130.00

Gage and Dam Data

Run Predicted WSE Results Plot Predicted Outflow Results Plot HEC-J Model Comparison Stop Close

Auto-Pilot Prediction Analysis (with Calibration) for Sunset Dam is in progress ...

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “MANUAL” PREDICTION ANALYSIS

Prediction Analysis with Manual Rainfall Input

Manual Prediction Analysis for Selected Dams

RAINFALL DATA INPUT

☒ Rainfall Data in Time Series

Import Rainfall Data in Time Series

Select Dam to Monitor: All Dams

Import Data

File Name

Time Step / Interval: 15 minutes

Enter Data

Plot Data: Edit Data

☐ Rainfall Data with Design Pattern

Rainfall Data with Design Pattern

Select Dam to Monitor: Select Dam

Depth of Rainfall (Inches): Enter Rainfall Depth

Design Rainfall Pattern: Select Rainfall Pattern

Time Step / Interval: 15 minutes

☐ Rainfall Data with Historical Pattern

Rainfall Data with Historical Pattern

Select Dam to Monitor: Select Dam

Depth of Rainfall (Inches): Enter Rainfall Depth

Historical Rainfall Pattern: Select Rainfall Pattern

Time Step / Interval: 15 minutes

Storm Event Start Date \ Time:

☒ Use Default Date and Time

☐ Set the Date and Time

Start Date and Time: 01/01/2000 00:00:00

End Date and Time: 01/01/2000 00:00:00

REAL-TIME PREDICTION

Rainfall Data Entry Form

Enter Time (min): 30

Enter R. Depth (inch): 1.2

Add

Save Data

Close Form

No.	Dam
1	
2	
3	
4	
5	
6	

No.	Time (min)	R. Depth (inch)
1	0	0
2	15	1.2
3	30	1.3
4	45	1.5
5	60	1.3
6	75	0.5

STORAGE THRESHOLD AND DAMELEVATION						DAM	PREDICTION RESULTS		THRESHOLD DISCHARGES				
WSE	Time@Dam Fill	10%	25%	50%	90%	100%	Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q

Run

WSE Results Plot

Outflow Results Plot

HEC-1 Model Comparison

Stop

Close

Program Status

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “MANUAL” PREDICTION ANALYSIS

Prediction Analysis with Manual Rainfall Input

Manual Prediction Analysis for Selected Dams

RAINFALL DATA INPUT

☒ Rainfall Data in Time Series

Import Rainfall Data in Time Series

Select Dam to Monitor: All Dams

Import Data: RainTS_02.txt

Time Step / Interval: 15 minutes

Enter Data Plot Data Edit File

The Rainfall Data from C:\DamFlow\102\Dam\RainTS_02.txt:
Number of Ordinates = 7
Total Rainfall Depth (inch) = 5.80
(1) 0.0
(2) 15.12
(3) 30.13
(4) 45.15
(5) 60.13
(6) 75.05
(7) 90.0

☐ Rainfall Data with Historical Pattern

Rainfall Data with Historical Pattern

Select Dam to Monitor: Select Dam

Depth of Rainfall (inches): Enter Rainfall Depth

Historical Rainfall Pattern: Select Rainfall Pattern

Time Step / Interval: 15 minutes

Storm Event Start Date \ Time

☒ Use Default Date and Time

☐ Set the Date and Time

Start Date and Time: 01/01/2000 00:00:00

End Date and Time: 01/01/2000 01:30:00

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS										STORAGE THRESHOLD AND DAMELEVATION					PREDICTION RESULTS					THRESHOLD DISCHARGES		
		Date	Time	Date	Time	Cur. WSE	Nest WSE	Time@Peak	Peak WSE	Time@DamFill	10%	25%	50%	90%	100%	Dam Crest	Outflow	Peak Q	Time@PeakQ	1/3 Full Q	2/3 Full Q	Full Q						
1	Adobe Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	11:30:00	1367.083	N/A	1357.12	1363.87	1370.66	1378.00	1379.58	1403.40	N/A	1490.33	11:30:00	3467.00	4933.00	10440.00						
2	Apache Junction Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	03:15:00	1803.499	02:00:00	1793.17	1793.59	1798.18	1800.78	1801.79	1811.97	N/A	1121.20	03:15:00	3550.00	7100.00	10650.00						
3	Buckeye No. 1 Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	02:45:00	1063.478	02:15:00	1068.00	1071.50	1073.60	1075.50	1080.00	1089.60	N/A	6297.47	03:45:00	19668.00	39333.00	59000.00						
4	Buckeye No. 2 Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	02:45:00	1107.978	N/A	1103.08	1106.17	1109.27	1113.70	1113.17	1118.18	N/A	138.83	02:45:00	4267.00	8533.00	12000.00						
5	Buckeye No. 3 Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	04:45:00	1163.543	N/A	1155.51	1157.97	1160.82	1164.10	1165.07	1171.51	N/A	94.22	04:45:00	11333.00	22667.00	34000.00						
6	Caanduro Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	03:30:00	2154.038	N/A	2144.73	2147.87	2152.07	2156.30	2157.00	2165.50	N/A	26.87	03:30:00	2467.00	4933.00	7400.00						
7	Carr Buttes Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	11:45:00	1638.365	N/A	1615.85	1631.11	1643.72	1654.40	1656.10	1681.00	N/A	415.42	11:45:00	49900.00	98000.00	147000.00						
8	Dreamy Draw Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	02:15:00	1398.747	N/A	1389.24	1393.81	1399.66	1405.23	1406.94	1418.44	N/A	196.72	02:15:00	4500.00	9000.00	13500.00						
9	Guadalupe Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	01:00:00	1276.357	01:30:00	1258.68	1264.89	1269.29	1274.90	1276.02	1283.20	N/A	9.01	06:00:00	2467.00	4933.00	10400.00						
10	Harcqahala Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	05:00:00	1414.580	02:30:00	1398.39	1402.29	1406.09	1409.22	1410.59	1421.50	N/A	3881.87	05:00:00	5267.00	10533.00	15800.00						
11	McMichen Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	04:45:00	1357.366	03:15:00	1340.86	1345.44	1349.53	1354.11	1355.23	1362.00	N/A	34905.71	04:45:00	37667.00	75333.00	113000.00						
12	New River Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	11:45:00	1443.855	N/A	1418.30	1431.07	1443.50	1456.00	1458.50	1486.70	N/A	2501.64	11:45:00	15083.00	30167.00	43230.00						
13	Powderline Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	07:45:00	1500.178	N/A	1549.05	1573.46	1578.74	1582.98	1584.92	1599.40	N/A	133.13	07:45:00	4933.00	9867.00	14800.00						
14	Rittenhouse Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	05:30:00	1601.264	03:00:00	1588.94	1591.74	1594.63	1596.35	1598.40	1603.40	N/A	4818.16	05:30:00	4933.00	9867.00	14800.00						
15	Saddleback Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	17:45:00	1194.914	N/A	1185.31	1188.23	1191.14	1194.10	1194.93	1194.93	N/A	1335.95	17:45:00	443.00	887.00	1330.00						
16	Signal Butte Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	01:45:00	1721.803	00:45:00	1697.50	1701.99	1707.19	1713.23	1714.29	1724.50	N/A	6990.23	01:45:00	4333.00	8667.00	13000.00						
17	Spookhill Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	04:15:00	1584.260	03:15:00	1575.82	1579.26	1582.12	1583.76	1583.90	1593.40	N/A	2013.39	04:15:00	7967.00	15933.00	23900.00						
18	Sunaycove Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	04:00:00	2173.135	03:45:00	2150.26	2156.90	2163.60	2171.22	2172.70	2181.00	N/A	394.19	04:00:00	2067.00	4133.00	6200.00						
19	Sunset Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	03:00:00	2133.623	N/A	2120.27	2123.91	2127.84	2130.90	2132.86	2144.01	N/A	135.56	03:00:00	1377.00	2753.00	4130.00						
20	Vineyard Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	03:30:00	1579.563	02:00:00	1566.83	1569.37	1571.92	1574.01	1575.50	1580.60	N/A	12665.12	03:30:00	5933.00	11867.00	17800.00						
21	White Tanks No. 3 Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	05:00:00	1212.349	04:15:00	1194.42	1199.60	1204.76	1210.01	1212.00	1218.00	N/A	2270.89	05:00:00	15667.00	31333.00	47000.00						
22	White Tanks No. 4 Dam	01/01/2000	00:00:00	01/01/2000	01:30:00	N/A	N/A	02:15:00	1054.818	02:15:00	1030.01	1036.74	1044.64	1049.89	1051.40	1056.00	N/A	9137.99	03:15:00	637.00	1273.00	1910.00						

Run WSE Results Plot Outflow Results Plot HEC-1 Model Comparison Stop Close

Manual Prediction Analysis with Rainfall Data in Time Series is complete.

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



❖ “MANUAL” PREDICTION ANALYSIS



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “MANUAL” PREDICTION ANALYSIS

Prediction Analysis with Manual Rainfall Input

Manual Prediction Analysis for Selected Dams

RAINFALL DATA INPUT

☐ Rainfall Data in Time Series

Import Rainfall Data in Time Series

Select Dam to Monitor:

Import Data:

Time Step / Interval:

☒ Rainfall Data with Design Pattern

Rainfall Data with Design Pattern

Select Dam to Monitor:

Depth of Rainfall (inches):

Design Rainfall Pattern:

Time Step / Interval:

The Rainfall Data (P) to be used for 2-hour Pattern:
Number of Ordinates = 9
Total Rainfall (inch) = 5.4
(1) 0.0000
(2) 15.01134
(3) 30.01512
(4) 45.05130
(5) 60.14796
(6) 75.23400
(7) 90.05292
(8) 105.01512
(9) 120.01134

OK

Storm Event Start Date \ Time

☒ Use Default Date and Time

☐ Set the Date and Time

Start Date and Time:

End Date and Time:

REAL-TIME PREDICTION

No.	Dam	STARTING		ENDING		PREDICTION RESULTS										THRESHOLD DISCHARGES						
		Date	Time	Date	Time	Corr. WSE	Next WSE	Time@Peak	Peak WSE	Time@DamFill	10%	20%	30%	40%	50%	60%	70%	80%	90%	Full Q		
1	Adahle Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	12:15:00	1374.017	N/A	1357.12	1363.87	1370.86	1378.00	1379.58	1403.40	N/A	1757.57	12:15:00	3467.00	6932.00	10400.00
2	Apache Junction Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:45:00	1004.723	02:30:00	1793.17	1795.59	1799.10	1800.78	1801.79	1811.97	N/A	1821.97	03:45:00	3550.00	7100.00	10650.00
3	Buckeye No. 1 Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	04:15:00	1084.697	02:45:00	1068.00	1071.50	1075.60	1078.50	1080.20	1089.60	N/A	11069.12	04:15:00	19668.00	39333.00	59000.00
4	Buckeye No. 2 Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:30:00	1111.677	N/A	1103.08	1106.17	1109.27	1112.70	1113.17	1118.18	N/A	151.77	03:30:00	4267.00	8533.00	12000.00
5	Buckeye No. 3 Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	04:00:00	1103.922	03:00:00	1155.51	1157.97	1160.82	1164.10	1165.07	1171.51	N/A	1276.18	04:00:00	11333.00	22667.00	34000.00
6	Casandro Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:00:00	2157.661	03:00:00	2144.73	2147.87	2152.87	2156.30	2157.00	2165.50	N/A	396.43	03:00:00	2467.00	4933.00	7400.00
7	Cave Buttes Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	12:15:00	1642.992	N/A	1615.85	1631.11	1643.72	1654.60	1659.10	1681.00	N/A	430.63	12:15:00	49000.00	98000.00	147000.00
8	Dreamy Draw Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:00:00	1403.502	N/A	1399.24	1393.01	1399.66	1405.23	1406.96	1418.46	N/A	215.41	03:00:00	4500.00	9000.00	13500.00
9	Goodaluge Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	06:30:00	1277.931	02:00:00	1258.68	1264.09	1269.29	1274.90	1276.82	1283.28	N/A	55.10	05:45:00	5467.00	6933.00	10400.00
10	Harquahala Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	05:30:00	1415.802	03:00:00	1390.39	1402.29	1406.99	1409.27	1410.39	1421.50	N/A	5696.48	05:30:00	5267.00	10533.00	15000.00
11	McMicken Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	05:15:00	1356.836	03:45:00	1340.86	1345.44	1349.53	1354.11	1355.25	1362.00	N/A	54026.19	05:15:00	37667.00	75333.00	113000.00
12	New River Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	12:15:00	1446.752	N/A	1418.30	1431.07	1443.50	1456.08	1458.50	1486.70	N/A	2572.14	12:15:00	15083.00	30167.00	45250.00
13	Powerline Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	08:00:00	1585.261	05:15:00	1569.05	1573.66	1578.74	1582.98	1584.92	1599.40	N/A	562.91	08:00:00	4933.00	9867.00	14800.00
14	Rittenhouse Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	05:30:00	1604.030	03:15:00	1508.94	1591.74	1594.63	1596.55	1598.40	1603.40	N/A	9580.85	05:30:00	4933.00	9867.00	14800.00
15	Saddleback Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	17:45:00	1194.996	N/A	1185.31	1188.23	1191.14	1194.10	1194.93	1194.93	N/A	1335.47	17:45:00	443.00	887.00	1330.00
16	Signal Butte Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	02:15:00	1722.447	01:30:00	1697.50	1701.99	1707.19	1713.23	1714.29	1724.50	N/A	913.27	02:15:00	4333.00	8667.00	13000.00
17	Spookhill Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	04:45:00	1585.267	03:15:00	1575.82	1579.26	1582.12	1585.70	1585.90	1593.40	N/A	3024.11	04:45:00	7967.00	15933.00	23900.00
18	Sunmycove Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	04:15:00	2174.432	03:45:00	2150.26	2156.90	2163.60	2171.22	2172.20	2181.00	N/A	1872.25	04:15:00	2067.00	4133.00	6200.00
19	Sunset Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:15:00	2135.432	02:45:00	2120.27	2123.91	2127.84	2130.90	2132.86	2144.61	N/A	505.65	03:15:00	1377.00	2753.00	4150.00
20	Vineyard Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	05:30:00	1580.315	02:30:00	1566.83	1569.17	1571.92	1574.01	1575.50	1580.60	N/A	17083.83	05:30:00	5933.00	11867.00	17800.00
21	White Tanks No. 3 Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	04:30:00	1213.275	03:30:00	1194.42	1199.60	1204.76	1210.01	1212.00	1218.00	N/A	8083.99	04:30:00	15667.00	31333.00	47000.00
22	White Tanks No. 4 Dam	01/01/2000	00:00:00	01/01/2000	02:00:00	N/A	N/A	03:45:00	1055.733	02:45:00	1050.01	1056.74	1064.84	1069.89	1073.40	1078.00	N/A	14790.71	03:45:00	637.00	1273.00	1910.00

Manual Prediction Analysis for Rainfall Data with Design Pattern is complete.

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



Topic: Real-Time Dam Fill Time and Outflow Prediction Software

PROGRAM FEATURES AND CAPABILITIES

❖ “ASK QUESTION” FEATURE

Utility Viewer for Dam Flow Prediction Program

REAL-TIME DAM FLOW PREDICTION RESULTS VIEWER

RESULTS TO VIEW:

Name of Dam:

Results Folder:

Which Analysis?

Directory:

ASK QUESTION?

Select Question:

Answer:

The WSE Predictions in the next 1 hour:

1	Date and Time: 07/18/2015 22:15:00	WSE = 2154.965 ft	CAP = 77.38 %
2	Date and Time: 07/18/2015 22:30:00	WSE = 2154.923 ft	CAP = 76.98 %
3	Date and Time: 07/18/2015 22:45:00	WSE = 2154.876 ft	CAP = 76.53 %
4	Date and Time: 07/18/2015 23:00:00	WSE = 2154.826 ft	CAP = 76.06 %

EVENT DATA:

Beginning Date/Time: 16:00:00

Time Step:

Ending Date/Time: 22:00:00

No. of Ordinates:

Information Loss Analysis | Direct-Runoff Analysis | Storage Routing Analysis | Optimization Analysis | Prediction Analysis

ASK QUESTION?

Select Question:

Answer:

The WSE Predictions in the next 1 hour:

- 1 Date and Time: 07/18/2015 22:15:00 WSE = 2154.965 ft CAP = 77.38 %
- 2 Date and Time: 07/18/2015 22:30:00 WSE = 2154.923 ft CAP = 76.98 %
- 3 Date and Time: 07/18/2015 22:45:00 WSE = 2154.876 ft CAP = 76.53 %
- 4 Date and Time: 07/18/2015 23:00:00 WSE = 2154.826 ft CAP = 76.06 %

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018



FACTS AND FIGURES

- ❑ Number of Forms: 21**
- ❑ Lines of Code: 63,845 lines**
- ❑ Computer Language: C#**
- ❑ IDE: MS Visual Studio 2012**
- ❑ Number of Functions: 255**
- ❑ Graphics: Chart Control**



PROGRAM FUTURE IMPROVEMENTS

- ❖ **IMPLEMENT MULTI-THREADING**
 - PARALLEL EXECUTION OF JOBS TO RUN CONCURRENTLY
- ❖ **E-MAIL NOTIFICATION FEATURE**
 - NOTIFICATION LIST OF KEY PEOPLE AND RESPONDERS
- ❖ **VIEWER UTILITY PROGRAM**
 - TO INCLUDE MORE FUNCTIONALITIES
- ❖ **REAL-TIME ACTIVATION TOOL**
 - **TOOL TO RUN 24/7 TO ACTIVATE THE SOFTWARE WHEN RAINFALL ACTIVITY IS DETERMINED.**
- ❖ **"ASK QUESTION" FEATURE**
 - QUESTIONS OFTEN ASKED DURING FLOOD EMERGENCIES





Real-Time Dam Fill Time and Outflow Prediction Software DAMFLOWV100

Thank You!! Questions?

Carlos Carriaga, PhD, PE, CFM
carloscarriaga@mail.maricopa.gov

Bing Zhao, PhD, PE
biz@mail.maricopa.gov

2018 ASFPM Annual Conference

Phoenix, Arizona
June 17-21, 2018

