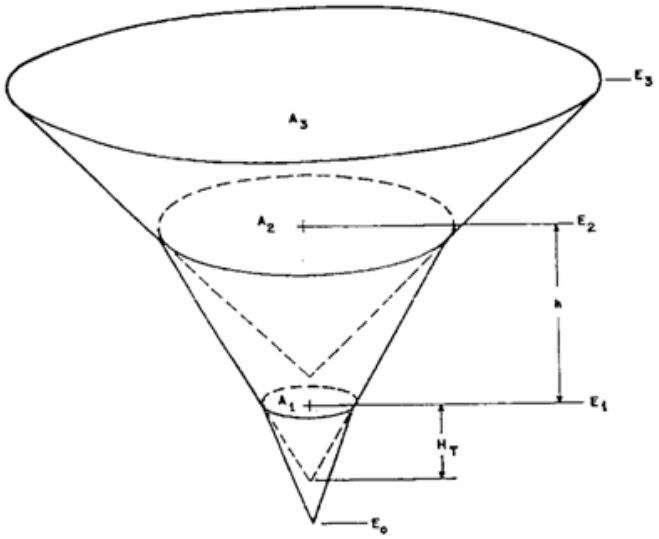
HEC-1 - Manual
"Flood Hydrograph Package"

If pumps or dam breaks are not being simulated, an outflow rating curve is computed for 20 elevations which span the range of elevations given for storage data. Storages are computed for those elevations. The routing is then accomplished by the modified Puls method using the derived storage-outflow relation. For level-pool reservoir routing with pumping or dam-break simulation, outflows are computed for the orifice and weir equations for each time interval.



$$\Delta V_{12} = \frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$$

$$H_T = h/(\sqrt{A_2/A_1} - 1)$$

Where

ΔV_{12} = volume between base areas 1 and 2,

A_i = surface area of base i,

E_i = elevation of base i,

h = vertical distance $(E_2 - E_1)$ between bases A_1 and A_2, and

H_T = height of truncated part of cone.

Figure 3.11 Conic Method for Reservoir Volumes

(3) **Trapezoidal and Ogee Spillways.** Trapezoidal and ogee spillways (Corps of Engineers, 1965) may be simulated as shown in Figure 3.12. The outflow rating curve is computed for 20 stages which span the range of given storage data. If there is a low-level outlet, the stages are evenly spaced between the low-level outlet and the maximum elevation, with the spillway crest located at the tenth elevation. In the absence of a low-level outlet, the second stage is at the spillway crest.

West Branch Calabacillas Arroyo

Project No.: 20130331
Prepared By: Sarah Ganley & Marie VanDerGeest
Edited/Checked By:
Date: 10/18/2015

Developed Conditions Model #2

Adding Quail Ranch Pond - Iteration 3 Final

NEW PAIRED DATA SERIES: MODELING QR POND IN HEC-HMS

Storage values were changed from the original values given in the QR Drainage Plan to a conical method for reservoir volumes. See sheets "Pond Worksheet Calc" and "HEC-1 Figure" for new storage and elevation values and conical method volume equations. Different pond sizes and their results are listed below. (Note: Outlet structure type is conceptual (at this point) and was chosen arbitrarily until adequate results were achieved. Structure type can be changed - possibly try round pipe w/ orifice plate? Also, pond storage does not account for freeboard/spillway - will need to be accounted for in a later phase.

The highlighted results were used in the final DCM#2 QRP model.
Various configurations for the pond will work - all end up with a voume of approx. 215 ac-ft

See sheet "Pond Worksheet Calc" for Storage and Elevation Values

600' x 600' pond bottom, 4:1 side slopes, 19' max ht
(3) 54" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	947	cfs
peak storage	205	ac-ft
peak elev.	5,799.6	ft
peak depth	18.6	ft
drain in 96 hr?	N (0.1 ft elev)	Y /N

540' x 680' pond bottom, 4:1 side slopes, 20' max ht
(3) 54" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	958	cfs
peak storage	204	ac-ft
peak elev.	5,800.0	ft
peak depth	19.0	ft
drain in 96 hr?	N (0.2 ft elev)	Y /N

(3) 48" - 786 cfs out
(1) 72' - pond overtops
(2) 66" - 941 cfs out

(2) 5' rise x 4' span CBC - 846 out
(2) 4' rise x 5' span CBC - 862 out

550' x 800' pond bottom, 4:1 side slopes, 19' max ht
(3) 48" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	736	cfs
peak storage	222	ac-ft
peak elev.	5,798.8	ft
peak depth	17.8	ft
drain in 96 hr?	N (0.1 ft elev)	Y /N

540' x 840' pond bottom, 4:1 side slopes, 20' max ht
(3) 48" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	886	cfs
peak storage	211	ac-ft
peak elev.	5,797.7	ft
peak depth	16.7	ft
drain in 96 hr?	N (0.2 ft elev)	Y /N

540' x 680' pond bottom, 4:1 side slopes, 20' max ht
(2) 5' rise x 4' span, flared wingwalls (30-70 deg), n=0.015

100-yr		
Qin	4,288	cfs
Qout	846	cfs
peak storage	214	ac-ft
peak elev.	5,800.7	ft
peak depth	19.7	ft
drain in 96 hr?	Y	Y /N

555' x 680' pond bottom, 4:1 side slopes, 20' max ht
(2) 5' rise x 4' span, flared wingwalls (30-70 deg), n=0.015

100-yr		
Qin	4,288	cfs
Qout	837	cfs
peak storage	215	ac-ft
peak elev.	5,800.4	ft
peak depth	19.4	ft
drain in 96 hr?	Y	Y /N

540' x 680' pond bottom, 4:1 side slopes, 20' max ht
(2) 60" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	803	cfs
peak storage	216	ac-ft
peak elev.	5,800.9	ft
peak depth	19.9	ft
drain in 96 hr?	N (0.2 ft elev)	Y /N

540' x 680' pond bottom, 4:1 side slopes, 20' max ht
(5) 42" RCP (n = 0.013)

100-yr		
Qin	4,288	cfs
Qout	741	cfs
peak storage	223	ac-ft
peak elev.	5,798.5	ft
peak depth	17.5	ft
drain in 96 hr?	N (0.2 ft elev)	Y /N

Project: WBCA DCM#2 Quail Ranch Pond
DETENTION POND VOLUME FOR 100-YEAR STORM
DATE: 5/18/2016

Conic Method for Reservoir Volumes

$$V_{23} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right) + V_{12}$$

BOTTOM WIDTH =	555
BOTTOM LENGTH =	680
SIDE SLOPE (xH:1V)	4

The available area or "open space" is 0.054 sq mi (34.6 ac) (pg. 11, Table 2, Basin ID: O). See also figures 2 and 3.
\\a-abq-fs2\projects\050325\WR\reports\Final\Quail Ranch DMP_Final_8-23-05.doc

Does not account for freeboard or access width			
At max ht	20.0 ft	surface area (acres)	13.8
Top width	715 ft	surface area (sq. mi.)	0.022
Top length	840 ft		

Assuming 3' freeboard (at 4:1) and 25' additional width (spillway & access)			
At max ht	22.5 ft	surface area (acres)	16.4
Top width	785 ft	surface area (sq. mi.)	0.026
Top length	910 ft		
This does not inlcude extra storage for sediment or water quality			

	ELEV. (FT)	AREA (AC)	VOLUME (AC-FT)	
5781	0.0	8.66	0.00	
5781.5	0.5	8.78	4.36	
5782.0	1.0	8.89	8.78	
5782.5	1.5	9.01	13.25	
5783.0	2.0	9.12	17.79	
5783.5	2.5	9.24	22.38	
5784.0	3.0	9.36	27.03	
5784.5	3.5	9.48	31.73	
5785.0	4.0	9.59	36.50	
5785.5	4.5	9.71	41.33	
5786.0	5.0	9.83	46.22	
5786.5	5.5	9.96	51.16	
5787.0	6.0	10.08	56.17	
5787.5	6.5	10.20	61.24	
5788.0	7.0	10.32	66.37	
5788.5	7.5	10.45	71.57	
5789.0	8.0	10.57	76.82	
5789.5	8.5	10.70	82.14	
5790.0	9.0	10.82	87.52	
5790.5	9.5	10.95	92.96	
5791.0	10.0	11.08	98.47	
5791.5	10.5	11.21	104.04	
5792.0	11.0	11.34	109.68	
5792.5	11.5	11.47	115.38	
5793.0	12.0	11.60	121.14	
5793.5	12.5	11.73	126.98	
5794.0	13.0	11.86	132.87	
5794.5	13.5	11.99	138.84	
5795.0	14.0	12.13	144.87	
5795.5	14.5	12.26	150.96	
5796.0	15.0	12.40	157.13	QRP original emergency spillway elevation
5796.5	15.5	12.53	163.36	
5797.0	16.0	12.67	169.66	
5797.5	16.5	12.81	176.03	
5798.0	17.0	12.94	182.47	
5798.5	17.5	13.08	188.97	
5799.0	18.0	13.22	195.55	QRP original top of Embankment
5799.5	18.5	13.36	202.20	
5800.0	19.0	13.50	208.91	
5800.5	19.5	13.65	215.70	100-year WSEL - approx 215 ac-ft required
5801.0	20.0	13.79	222.56	
5801.5	20.5	13.93	229.49	
5802.0	21.0	14.07	236.49	
5802.5	21.5	14.22	243.56	
5803.0	22.0	14.36	250.71	
5803.5	22.5	14.51	257.93	Three feet of freeboard

West Branch Calabacillas Arroyo

Project No.: 20130331
Prepared By: Sarah Ganley & Marie VanDerGeest
Edited/Checked By:
Date: 1/13/2016

Developed Conditions Model #3

Paradise West Pond Alternative Options

PAIRED DATA SERIES: MODELING PW POND IN HEC-HMS

Iteration Process:
1) Try to get HEC-HMS model to run (using WBCA_96HR 100 YR Storm), use largest outlets possible (72" pipes, CBCs, etc.)
2) Increase PW pond until downstream constraints are met

Conclusion:
PWP must be Jurisdictional - around 120 ac-ft, non-bulked. A 500'x600'x15' pond reduces flow enough to be

See sheet "Pond Worksheet Calc" for Storage and Elevation Values

CONCEPTUAL ONLY - NEEDS TO BE FINALIZED - WAITING ON DECISION BY AMAFCA

Pond Size: 500'x600' bot dim, 4:1 side slopes, 15' max ht WHEN WE FINALIZE - CAN MAKE DEEPER AND SMALLER
Elevation-Storage Function: (J) PWP_Pond_Worksheet
Outflow Structure: (5) 60" RCPs
n=0.015 WHEN WE FINALIZE - USE N=0.013 FOR RCP AND N=0.015 FOR CBC
Concrete Pipe Culvert, square edge w/ headwall
entrance, exit coeff = 0.5, 1

100-yr		
Qin	4,046	cfs
Qout	1,620	cfs
peak storage	118.70	ac-ft
peak elev.	5,795.1	ft
peak depth	14.1	ft
drain in 96 hr?	N (0.1 ft)	Y /N

Notes:
1. Downstream points are under Design Q at crossings (AP8 & 9)
2. Design Q below 3000 cfs at grade control structures (AP10) when bulked
3. When we finalize the pond can be designed to be deeper and smaller with sloped bottoms to ensure full drainage

PREVIOUS ITERATION - NOT APPLICABLE

Pond Size: 400'x600' bot dim, 4:1 side slopes, 15' max ht
Elevation-Storage Function: (J) PWP_Pond_Worksheet
Outflow Structure: (6) 60" RCPs
n=0.015 WHEN WE FINALIZE - USE N=0.013 FOR RCP AND N=0.015 FOR CBC
Concrete Pipe Culvert, square edge w/ headwall
entrance, exit coeff = 0.5, 1

100-yr		
Qin	4,046	cfs
Qout	1,952	cfs
peak storage	98.20	ac-ft
peak elev.	5,795.2	ft
peak depth	14.2	ft
drain in 96 hr?	N (0.1 ft)	Y /N

Notes:
Downstream points are under Design Q at crossings (AP8 & 9)
Design Q below 3000 cfs at grade control structures (AP10) when unbulked

West Branch Calabacillas Arroyo

Project No.: 20130331
Prepared By: Sarah Ganley & Marie VanDerGeest
'Checked By:
Date: 11/18/2015
Review Comments Addressed 11/18/15

Developed Conditions Model #3

Adding Paradise West Pond (PWP)

Currently have Paradise West Master Plan layout and Bernalillo County Parcel data - which does not have lots/parcels well defined.

Conic Method for Reservoir Volumes

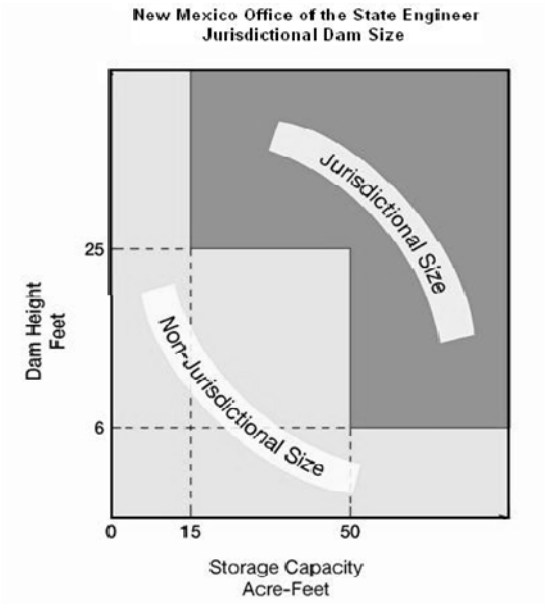
$$V_{23} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right) + V_{12}$$

Jurisdictional

BOTTOM WIDTH =	500	ft
BOTTOM LENGTH =	600	ft
SIDE SLOPE (xH:1V)	4	ft

At height	15.0	ft	WHEN WE FINALIZE - CAN MAKE DEEPER AND SMALLER
Top width	620	ft	
Top length	720	ft	

Does not account for freeboard or access width



ELEV. (FT)	ELEV. (FT)	AREA (AC)	VOLUME (AC-FT)
5781	0.0	6.89	0.00
5781.5	0.5	6.99	3.47
5782.0	1.0	7.09	6.99
5782.5	1.5	7.19	10.56
5783.0	2.0	7.30	14.18
5783.5	2.5	7.40	17.86
5784.0	3.0	7.51	21.58
5784.5	3.5	7.61	25.36
5785.0	4.0	7.72	29.20
5785.5	4.5	7.83	33.08
5786.0	5.0	7.93	37.02
5786.5	5.5	8.04	41.02
5787.0	6.0	8.15	45.06
5787.5	6.5	8.26	49.17
5788.0	7.0	8.37	53.33
5788.5	7.5	8.48	57.54
5789.0	8.0	8.60	61.81
5789.5	8.5	8.71	66.14
5790.0	9.0	8.82	70.52
5790.5	9.5	8.94	74.96
5791.0	10.0	9.05	79.46
5791.5	10.5	9.17	84.02
5792.0	11.0	9.29	88.63
5792.5	11.5	9.40	93.30
5793.0	12.0	9.52	98.04
5793.5	12.5	9.64	102.83
5794.0	13.0	9.76	107.68
5794.5	13.5	9.88	112.59
5795.0	14.0	10.00	117.56
5795.5	14.5	10.13	122.59
5796.0	15.0	10.25	127.69

DCM #4 Pond Summary 5/18/2016

Small basins	Small pond results in zero discharge from modeled pond
Basins without ponds	Areas where existing = developed conditions, ponds were not modeled

Notes:
(1) Analysis Points
(2) Basin Name and corresponding Pond ID as modeled in HMS
(3) Updated drainage area of the basins attributing to the ponds, determined using ArcGIS
(4) Developed conditions peak discharge copied from Developed Conditions Model #1, 100yr 24hr HMS results summary table.
\\a-abq-fs2\projects\20130331\WR\Calculations\Misc Calcs\Developed Conditions\DCM1\Updated_DCM - 1_Results_Summary.xlsx
(5) Existing conditions peak discharge copied from the "Ex_Split" HMS model, 100yr 24hr storm event
\\a-abq-fs2\projects\20130331\WR\Calculations\Misc Calcs\Developed Conditions\DCM4\Ex_Split_Global_Summary.pdf
(6) Peak discharge from proposed pond (should be equal to or below existing conditions peak discharge). Values were copied from the following pond sizing spreadsheets:
\\a-abq-fs2\projects\20130331\WR\Calculations\Misc Calcs\Developed Conditions\DCM4\DCM - 4 Basin Ponds AP1-AP5 - Corrected.xlsx
\\a-abq-fs2\projects\20130331\WR\Calculations\Misc Calcs\Developed Conditions\DCM4\DCM - 4 Basin Ponds AP5-AP10 - Corrected.xlsx

(1)	(2)	(3)	(4)	(5)	(6)	(7)
AP	Pond ID	Drainage Area	Developed Conditions Peak Discharge (Q_{100})	Existing Conditions Peak Discharge (Q_{100})	Proposed Peak Discharge	Proposed Pond Volume
		(mi^2)	(cfs)	(cfs)	(cfs)	(ac-ft)
	QR9	0.6311	724	140.5	133.8	28
	QR7	0.4703	424	115.2	107.7	16
	QR8	0.3193	258	68.9	62.7	11
	QR4	0.4686	439	100.3	88.7	20
	QR6	0.2806	328	85.8	79.1	12
	QR1	0.2690	319	67.6	62.1	11
	QR3	0.1955	228	47.8	47.1	8
	QR2	0.0637	89	24.9	23.4	4
	QR15	0.1295	142	49.3	47.3	5
AP1	QR3_15					
	QR20N	0.1204	131	32.5	28.6	7
	QR20S	0.1999	240	58.7	59.2	13
AP2	QR3_20					
	QR23N	0.1912	158	30.3	31.3	8
	QR23S	0.2733	228	111.7	109.3	8
	QR24	0.4061	417	67.7	59.5	19
	QR21	0.3261	310	80.6	79.1	12
	QR26	0.2344	317	67.9	69.2	13
	QR25	0.2336	251	32.8	31.9	10
	QR27	0.1403	186	93.2	93.4	5
AP3-QRP	QR3_24					
	PW4N	0.3404	345	11.0	10.7	18
	PW4S	0.0817	62	4.3	4.4	3
AP4	QR3_25_PW4					
	PW3	0.3455	454	155.4	159.8	12
	PW2	0.1005	156	52.9	48.5	4
	PW7	0.4753	704	185.3	162.6	23
	PW6	0.4550	581	221.2	213.9	18
	PW1	0.1036	181	52.6	48.8	5
	PW10	0.4080	608	101.2	92.8	22
	PW12	0.3457	493	146.7	151.1	15
	PW5	0.1806	286	25.0	27.1	11
	PW5.1	0.0165	29	0.6	0.4	1

AP	Pond ID	Drainage Area	Developed Conditions Peak Discharge (Q_{100})	Existing Conditions Peak Discharge (Q_{100})	Proposed Peak Discharge	Proposed Pond Volume
	PW8N	0.0393	37	1.6	1.7	2
	PW8S1	0.0621	84	13.3	13.8	3
	PW8S2	0.0317	39	1.1	1.2	2
	PW10.2	0.0144	19	0.6	0	1
	PW10.1	0.0058	12	0.2	0	1
AP5	PW1_12					
AP6	PW_VRW3					
	VRW3N	0.1954	202	47.2	49.1	8
	VRW3S	0.1549	184	125.1	120.4	4
	PW15N	0.3388	369	13.4	11.6	21
	PW15S	0.0623	64	12.6	13.5	3
	PW14.1	0.2124	275	46.9	40.7	11
	PW13	0.0551	68	13.6	13.3	3
	PW14.2	0.0244	34	2.8	3	2
	PW14	0.1191	146	23.2	22.3	6
	PW15.1	0.0233	43	1.1	1.5	2
AP7	PW14_VRW3					
	VR5	0.2576	263	168.8	151.9	7
	TVI1	0.0959	106	92.3	88.2	2
	TVI1.1	0.0636	119	9.7	9.3	4
AP8	VR_TVI_PW					
	SEV1N	0.1028	116	116.1		None Ex - Dev
	SEV1S	0.0669	62	48.3	49.1	1
AP9	VR_TVI_PW_SEV					
	VRW1	0.3317	415	176.6	159.3	12
	PW11	0.1269	226	214.9	198.3	2
	VRW2	0.2003	245	241.4		None Ex - Dev
	VR2	0.2503	300	299.8		None Ex - Dev
	VR4	0.2532	277	275.6		None Ex - Dev
	VR1	0.0857	135	138.7		None Ex - Dev
	VR3	0.3276	371	351.9		None Ex - Dev
	VR6	0.1927	207	208.3		None Ex - Dev
	Las Ventanas Dam	1.7684	72	70.7		
	VR7	0.1948	197	180.9		None Ex - Dev
	Little Window Dam	0.1948	30	29.3		
	SEV2N	0.0205	2	1.8		None Ex - Dev
	SEV2S	0.0347	19	18.5		None Ex - Dev
AP10	SWINBURNE_INFLOW					