Developing the Water-Budget and Calculating the Recharge for the Mesilla Bolson Aquifer

Submitted by:

Pooneh Pahlevani

Advisor:

Dr. Zohrab Samani

Submitted to:

Water Resources Research Institute (WRRI)

Spring 2017

Table of Contents:

Table of figures:

Appendix Table of figures:

Appendix List of Table:

Problem Statement:

Mesilla Boson is a major groundwater basin in Southern New Mexico. The Mesilla Bolson is an extensive intermountain groundwater aquifer which extends from Leasburg in Southern New Mexico to Northern Mexico. It is bordered in the east by organ and Franklin Mountains and in the west by Robledo and East Potrillo Mountains. Mesilla Bolson is the main source of water for municipal, agricultural, and industrial water use and is critical for economic, social, and environmental sustainability of Southern New Mexico. This is the only source of fresh water which sustains the agricultural and industrial activities in dry years. There is an urgent need to develop a real time water budget model to assess the water budget and recharge and thus the sustainability of this aquifer. So far, the only activities by local water agencies have been limited to monitoring the aquifer storage change within the Rio Grande Flood Plain, but the storage change within the flood plain does not represent the recharge or discharge since it does not account for the lateral and vertical transfer of underground water. The pumping rates for water wells (with the exception of domestic wells) are also monitored and reported to NM Office of State Engineer. This information has regulatory values, but is of little use for storage change.

Goals and Objectives: The goals of this project are to develop the water budget and recharge to the Mesilla Bolson as it changes depending on the availability of the surface water. It is proposed to assess the water budget for three years comprising of a full allotment year (wet year), a dry year and a medium year. This will provide the range of recharge within the aquifer under various operating conditions and will provide a tool for future assessments.

Methodology:
To water budget models used in this study accounts for all the inflows and outflows from the basin as described by the following water budget equation.

$$\sum Q_{in} - \sum Q_{out} + \Delta s = 0 \qquad (1)$$

Where $\sum Q_{in}$ Represent all the inflows to the basin and;

$\sum Q_{out}$ Represent all the out flow

And

Δs is the change in the storage.

The inflows in the model include:

1- Stream flow
2- Storm runoff from surrounding watersheds
3- Precipitation

The outflow includes:

1. Stream outflow
2. ET
3. Exported water

Exported water is the pumped water which is exported outside of the Mesilla Basin and does not have any return flow into the system.

The main source of recharge to the aquifer is diversion and seepage from the Rio Grande River. The seepage occurs through irrigated fields, canals, and river. Rainfall is another measurable source of recharge which offsets the ET and also contributes directly to recharge. The Inflow and Outflow to the basin is monitored by USGS and EBID. The inflow stream data used in this study were obtained from EBID, and the outflows were obtained from USGS gauging stations.

The ET for various years were calculated using Regional ET Estimation Model (REEM), Samani et al 2009. Satellite images used in the process were obtained from Aster, Landsat-5, Landsat-7 and Landsat8. Figure 1 is an example of ET maps used in this model.

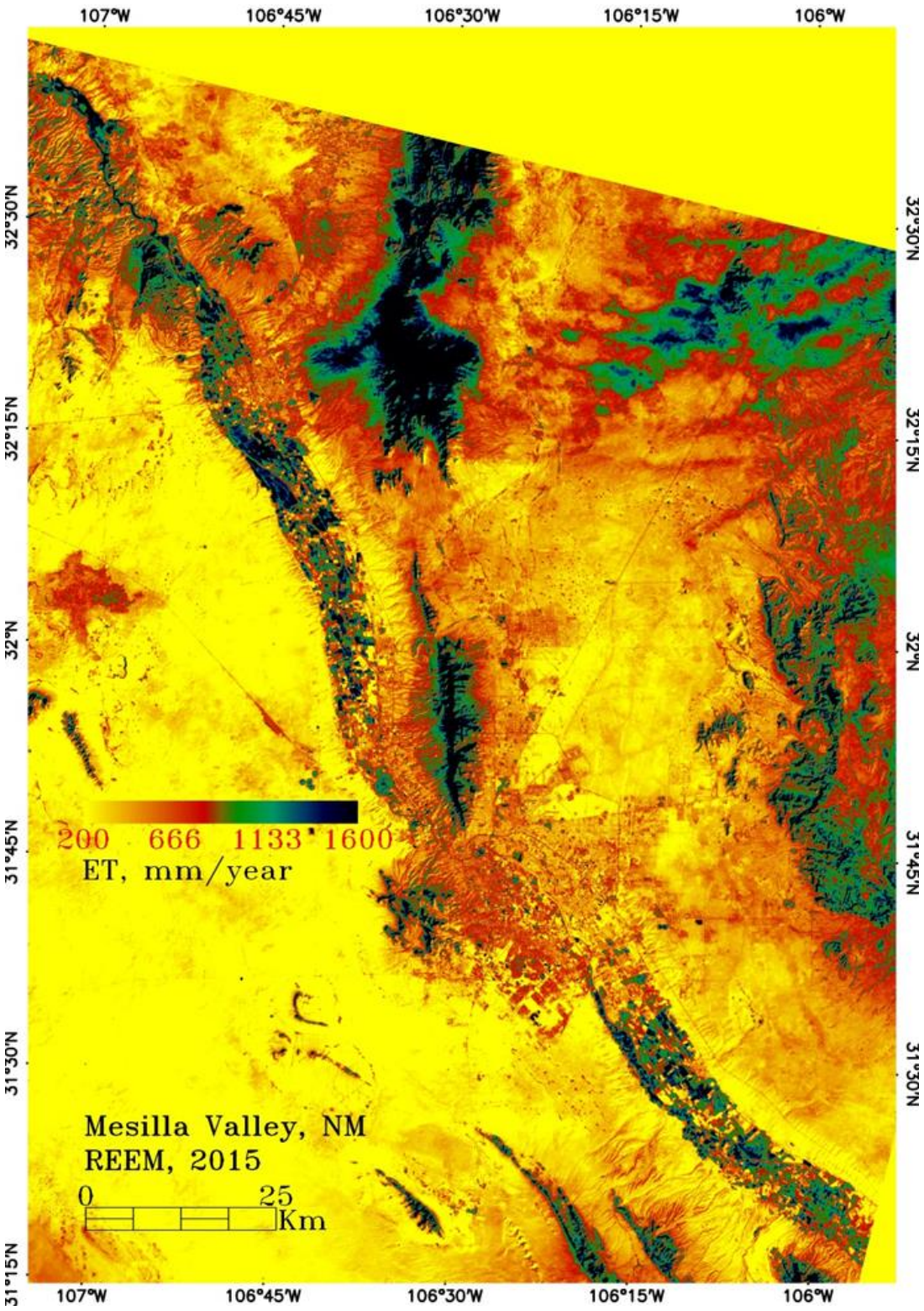


Figure 1. ET map for the year 2015 generated by the REEM Model and Landsat 8 images.

A raster file was created for the irrigated area based on ET maps using ARC-GIS as shown in figure 2.

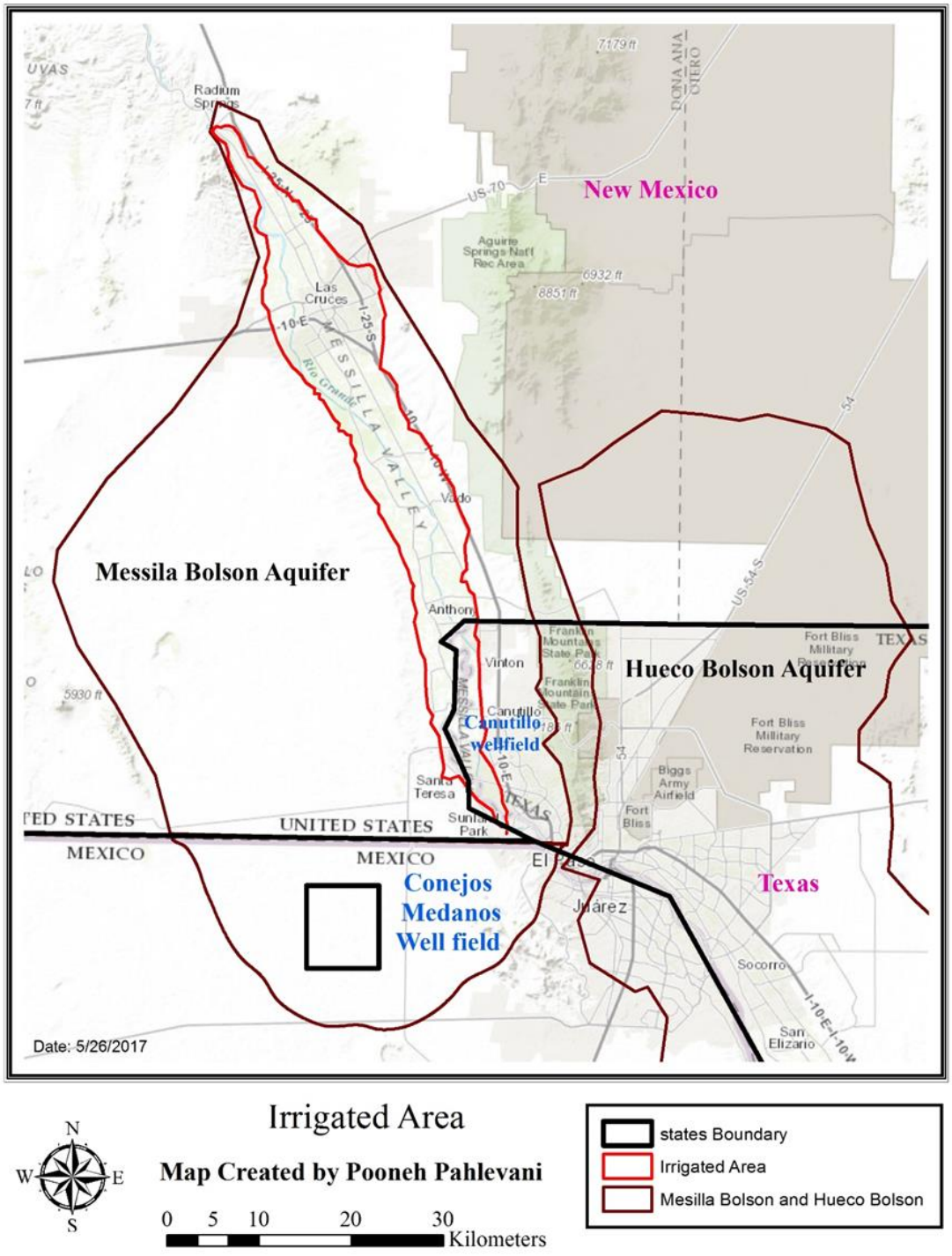


Figure 2. Irrigated area in Mesilla Bolson aquifer.

The irrigated area is the main source of recharge and discharge to and from the basin. The rainfall stored in the soil beyond the irrigated area is mostly evaporated and its contribution to groundwater storage is negligible as is evidenced by remote sensing (Samani et el, 2009) and various Chloride studies (Ojeda 1994).

Results

Using the water budget model, the change in storage for the Mesilla Bolson was calculated annually. The results are shown in figure 3.

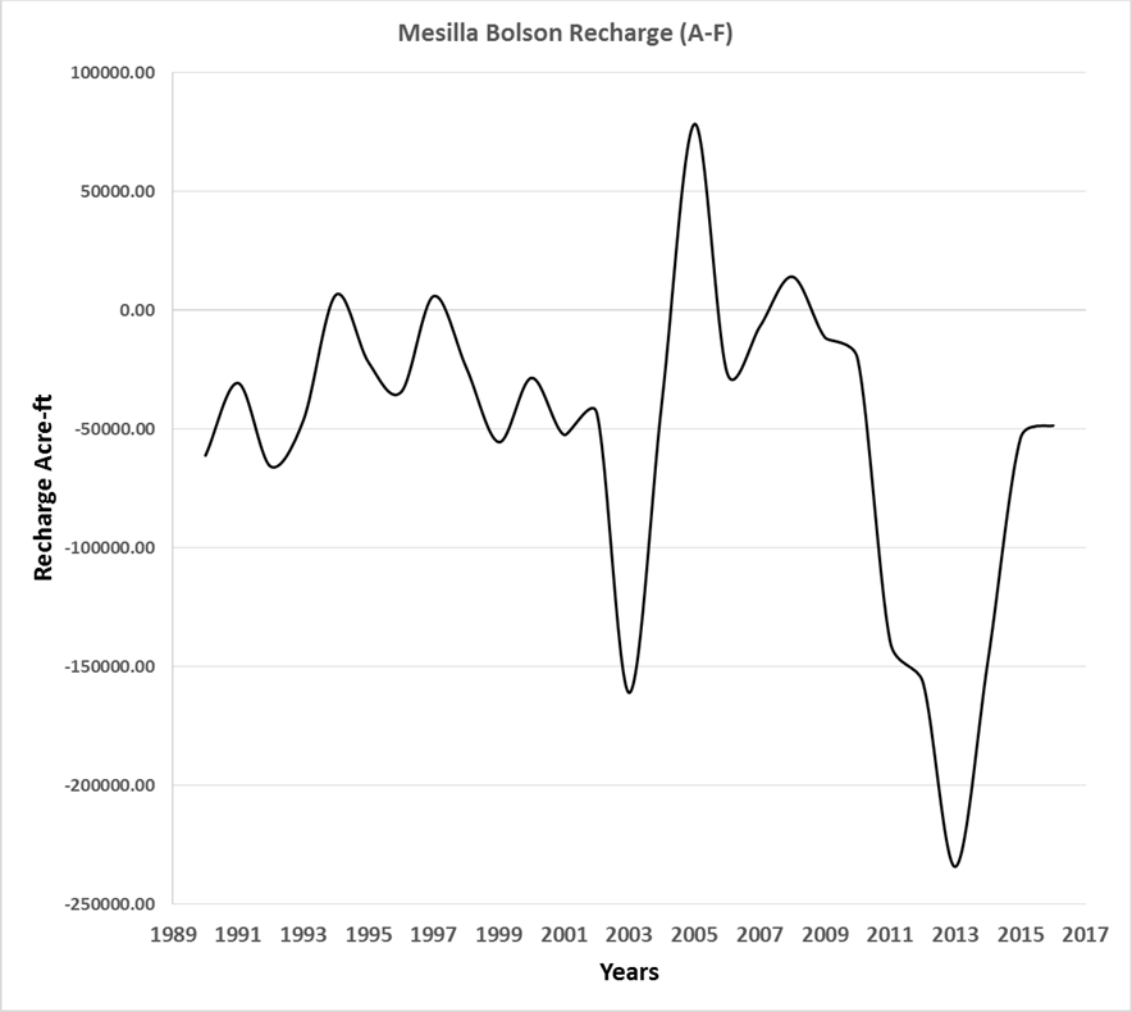


Figure 3. Annual Recharge/Discharge for the Mesilla Bolson Aquifer

The recharge/discharge from the Mesilla Bolson Aquifer is directly related to the EBID annual allotment as the mostly flood irrigated fields of the Mesilla Valley are the main source of recharge. Even though direct seepage from the river also contributes to the recharge. Figure 4 shows the EBID allotment for various years. Comparing figure 2 and figure 3, the importance of EBID allotment in groundwater recharge/discharge is clear.

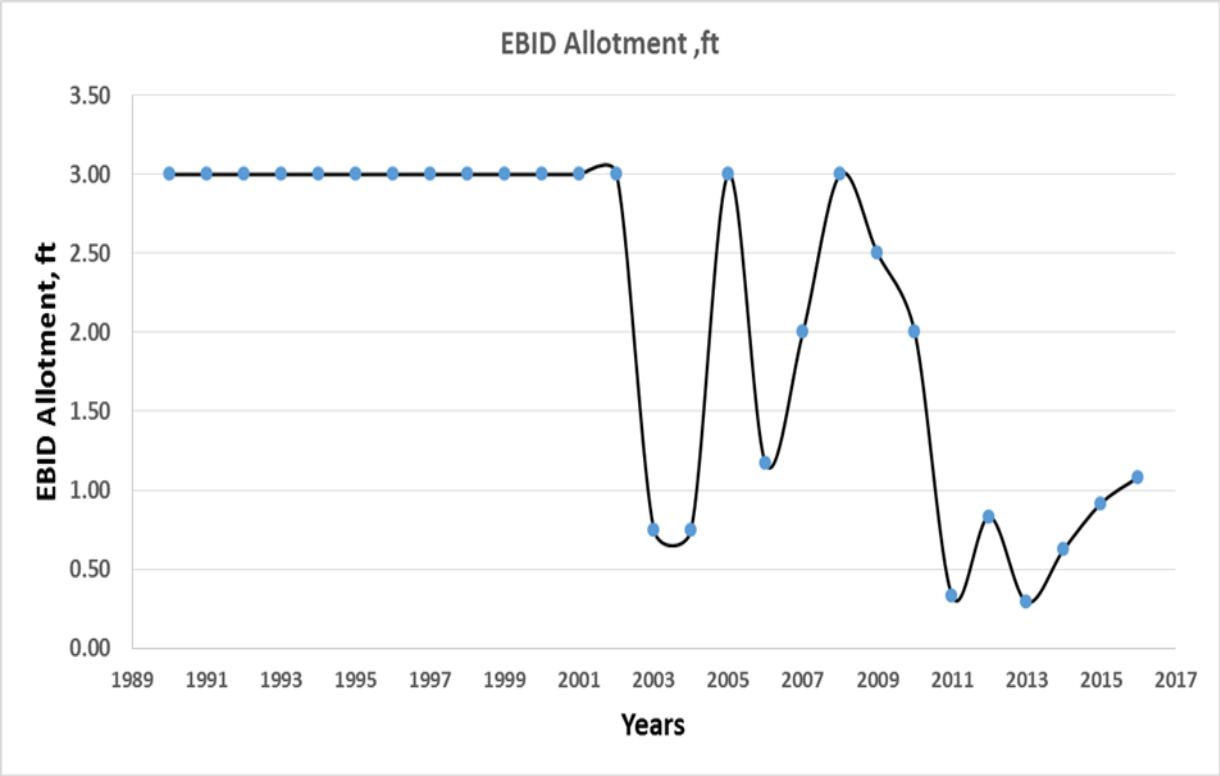


Figure 4. EBID annual Allotment

Conclusions

As the recharge data shows, since the start of a new drought cycle in 2000, the aquifer has been mostly losing water from the storage with the exception of 2005. The aquifer went through a somewhat significant stress during years 2011-2014. This can be attributed to the severe drought, reduction of surface water allocation apparently due to the new water sharing agreement and pumping from Conjeos Medanos which came on line in 2010. However, the change in storage came back to normal or what can be called new normal during 2015 and 2016. Even though the aquifer is not in immediate danger of severe depletion, a more comprehensive and unified approach is needed to develop a long term plan for the sustainability of the aquifer in light of climate change, increasing demand for water and potential loss of surface water allocation.

APPENDIX A

Calculation of Storm Runoff from the Surrounding Watersheds

1. Runoff

1.1. Runoff Order:

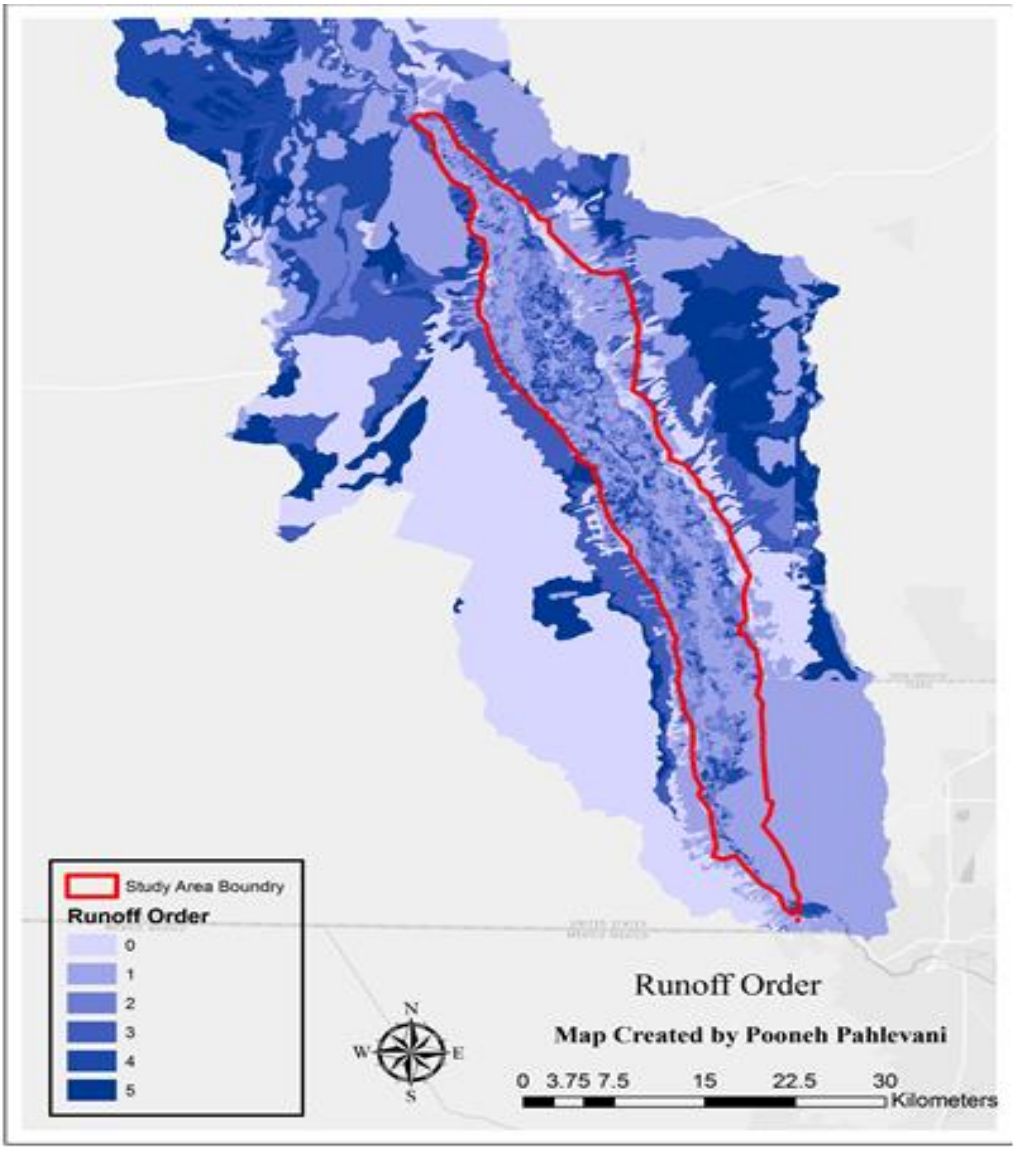


Figure A- 1.Runoff order of study area.

1. **Runoff Amount:**

A total of 13 watersheds were identified that contribute runoff to the Mesilla Bolson watershed. Area of each watershed was delineated as shown in figure A-2. Runoff was calculated using soil type, land use and weighted average curve number.

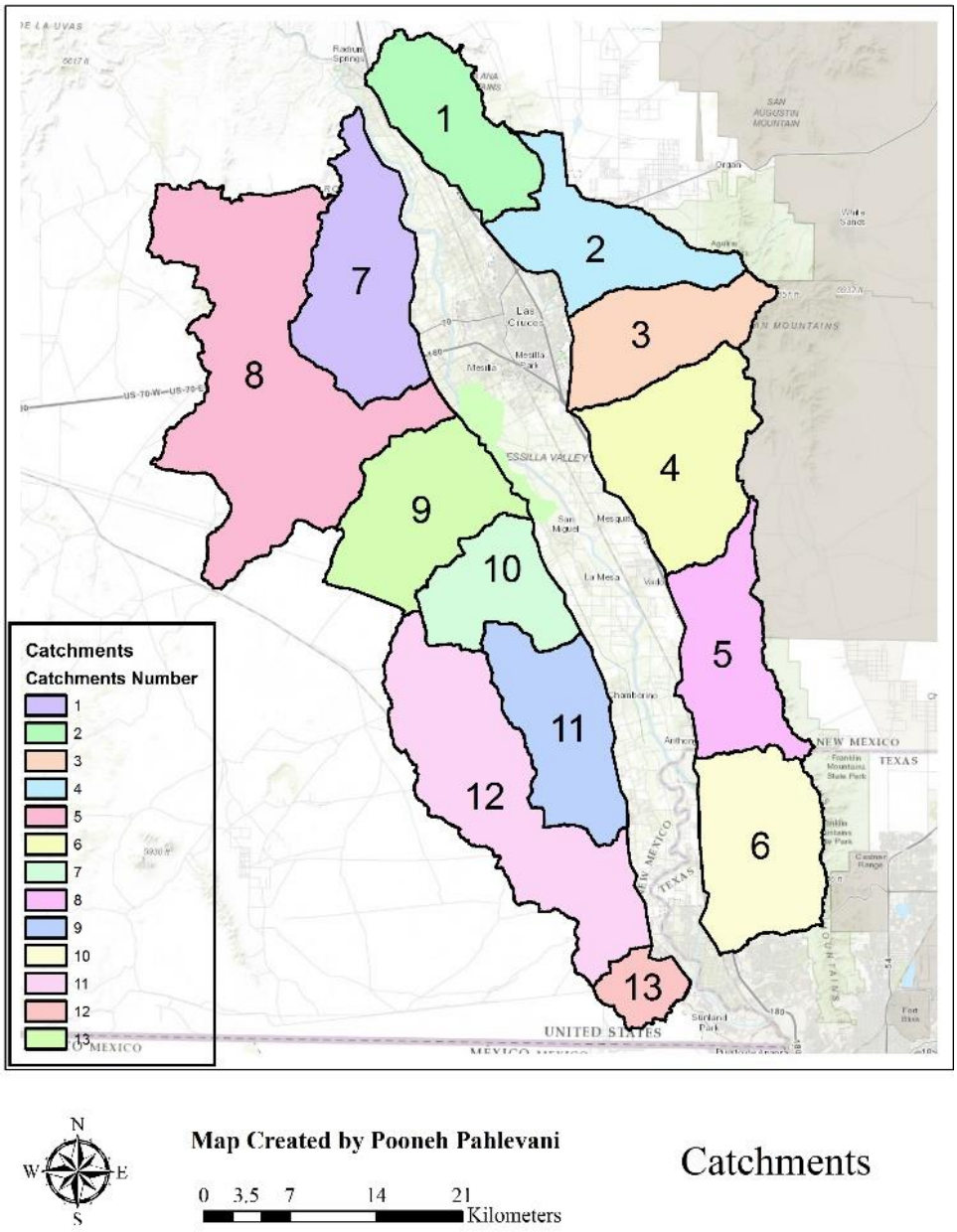


Figure A- 2. Watersheds around irrigated area.

- **Area**

Furthermore, area of each sub basins calculated by calculate geometry in ARC-GIS as follow:

Table 1. Area of each Sub-basin.

	AREA(acre)
Basin 1	27681.801
Basin2	29974.5
Basin 3	27153.70164
Basin 4	41401.33396
Basin 5	30008.58644
Basin 6	35831.79838
Basin 7	39025.0811
Basin 8	89140.0789
Basin 9	35426.29649
Basin 10	22513.58193
Basin 11	30839.02359
Basin 12	59392.48734
Basin 13	8070.327124
	476458.6362

- **Gradient**

Afterwards, in order to obtain the gradients of each sub basin we need to have contour map which was created in ARC-GIS in 50-meter contour interval

The gradients were calculated using equation 2.

$$Gradient = \frac{\text{Upper Elevation} - \text{Lower Elevation}}{\text{Stream Lenght}} \qquad (2)$$

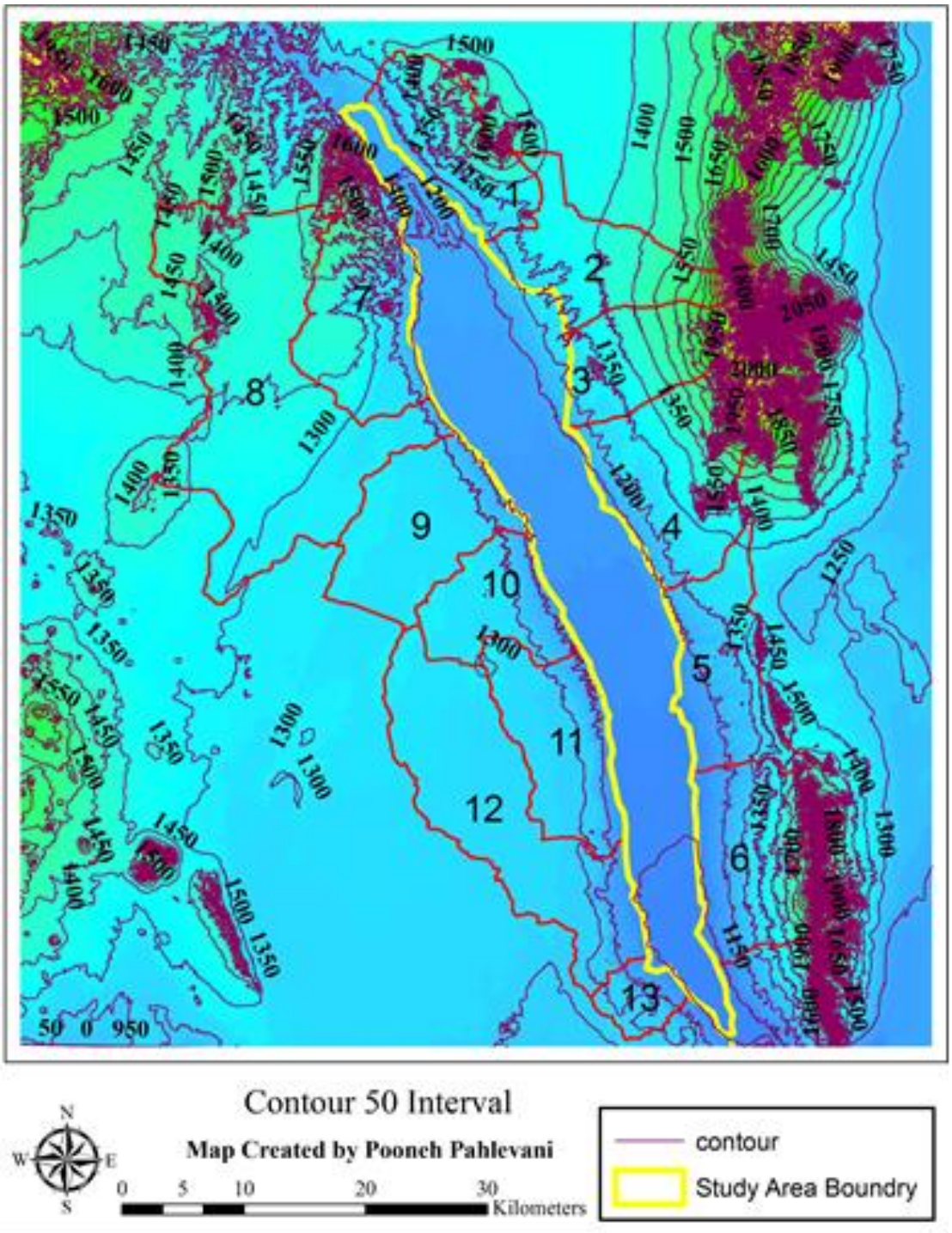


Figure A- 3. Contours with interval of 50.

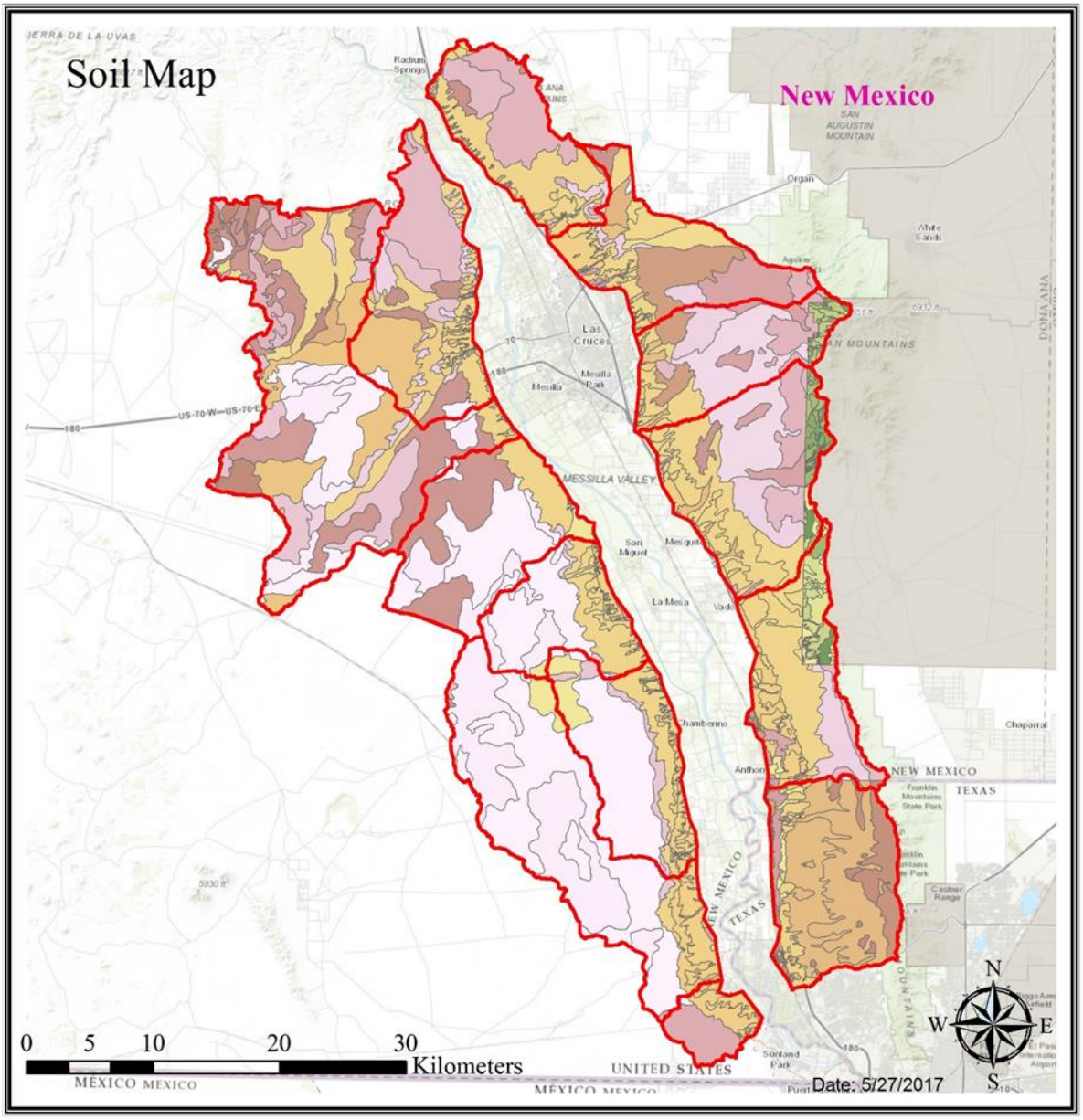
Table 2. Table of Gradient of each basin.

BASINS	Upper Elevation (m)	Lower Elevation (m)	Stream Length (m)	gradients
1	1600	1200	7775	0.051
2	2000	1250	17089	0.044
3	2500	1250	17100	0.073
4	1900	1200	15111	0.046
5	1500	1200	7838	0.038
6	1950	1150	9885	0.081
7	1500	1200	9890	0.030
8	1450	1200	24228	0.010
9	1270	1200	16780	0.004
10	1300	1200	10894	0.009
11	1280	1200	11129	0.007
12	1300	1150	33285	0.005
13	1250	1150	6259	0.016

- **Curve Number**

One parameter that is used for estimate the runoff is CN (curve number). The runoff curve number (also called a curve number or simply CN) is experimental parameter used in hydrology for estimating runoff or infiltration from rainfall. The curve number method was developed by the USDA Natural Resources Conservation Service, which was formerly called the "Soil Conservation Service or SCS". The curve number was developed from an experimental analysis of runoff from small catchments and hill slope plots monitored by the USDA. It is widely used and is an efficient method for determining the approximate amount of direct runoff from a rainfall event in a particular area. The curve number is based on the area's hydrologic soil group, land use, treatment and hydrologic conditions. USDA indicate the runoff curve numbers for characteristic land cover description and hydrologic soil group. By drawing each-sub-basin in USDA map finding the soil type and the percentage of each type of soil and by using the TR55 manual were found each soil type curve number and then calculating weighted curve number for each sub-basin.

In order to find the CN, Soil map were downloaded as follow. Moreover, to find each watershed CN 's, each watershed clipped to the soil map.



Map Created by Pooneh Pahlevani

Legend

Soil Type																								
107	153	173	33	Ad	Ax	Bm	DCD	Gf	LOD	PAA	RT	W												
112	155	182	42	Ae	BJ	Bn	DR	Gs	MN	PN	SH	WH												
12	156	21	51	An	BK	Br	DS	HD	Mg	Pa	ST	WP												
122	161	22	52	Ao	BL	Bs	GP	Ha	Mo	Pb	Sa													
123	162	24	53	Ap	BO	CA	Ga	Hg	NB	RF	TE													
151	163	28	72	Ar	BP	CH	Gc	Hk	NU	RG	TF													
152	171	29	AGB	As	BPC	Cb	Gd	IN	OP	RH	Tg													
	172	30	AL	Aw	Be	DCB	Ge	LM	OR	RL	Vn													

Figure A- 4. Soil map of watersheds.

Then area of each type of soil in each watershed were found using Attribute table in ARC-GIS.

Table 3. Soil table of basin one.

Basin 1	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Adelino sandy clay loam	Ad	Fair	B	72	919	66168
Adelino clay loam	Ae	Poor	B	77	57792	4449984
Anthony-Vinton clay loams	As	Poor	B	77	1223	94171
Armijo clay loam	Aw	Poor	D	88	34046	2996048
Berino-Bucklebar association	BJ	Fair	B	72	854704	61538688
Berino-Dona Ana association	BK	Fair	B	72	24	1728
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	3778399	207811945
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	5395040	296727200
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	39604301	2178236555
Canutio and Arizo gravelly sandy loams	Cb	Fair	B	72	1255640	90406080
Cave-Harrisburg association	CH	Poor	D	88	26181	2303928
Dona Ana-Reagan association	DR	Poor	B	77	112905	8693685
Glendale silty clay loam	Ge	Poor	C	85	24122	2050370
Gravel pit	GP	Poor	D	88	104181	9167928
Harkey loam	Hg	Poor	B	77	6776	521752
Nickel-Upton association	NU	Fair	B	72	4473400	322084800
Onite-Pajarito association	OP	Fair	B	72	114133	8217576
Pajarito fine sandy loam	Pa	Fair	B	72	361488	26027136
Riverwash-Arizo complex	RF	Poor	D	88	1098760	96690880
Rock outcrop-Argids association	RG	Poor	C	85	37869499	3218907415
Rock outcrop-Lozier association	RL	Poor	D	88	12800900	1126479200
Tencee-Upton association	TE	Fair	D	86	4058410	349023260
	Weighted CN=			72	112032843	8012496497

Table 4. Soil table of basin two.

Basin 2	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Berino-Bucklebar association	BJ	Fair	B	72	12106200	871646400
Berino-Dona Ana association	BK	Fair	B	72	4086890	294256080
Berino-Pintura complex	BL	Fair	B	72	7575019	545401368
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	12084400	664642000
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	2149090	118199950
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	11579400	636867000
Cave-Harrisburg association	CH	Poor	D	88	1703349	149894712
Dona Ana-Reagan association	DR	Poor	B	77	5284900	406937300
Dumps	DS	Poor	D	88	202436	17814368
Haplargids, dissected	HD	Fair	B	72	26208099	1886983128
Nickel-Upton association	NU	Fair	B	72	3175220	228615840
Onite-Pajarito association	OP	Fair	B	72	59873	4310856
Pajarito fine sandy loam	Pa	Fair	B	72	1111649	80038728
Pinaleno-Nolam association	PN	Fair	B	72	21133199	1521590328
Riverwash-Arizo complex	RF	Poor	D	88	817219	71915272
Rock outcrop-Argids association	RG	Poor	C	85	3755029	319177465
Rock outcrop-Argids, cool, association	RH	Poor	D	88	936302	82394576
Tencee-Upton association	TE	Fair	D	86	7395959	636052474
	Weighted CN=			70	121364233	8536737845

Table 5. Soil table of basin three.

Basin 3	Soil Type		Hydraulic Group	CN	area(m^2)	CN*area(m^2)
Brewster very gravelly loam, 35 to 65 percent slopes	112	Poor	D	88	117724	10359712
Rotagilla very gravelly loam, 35 to 65 percent slopes	122	Poor	D	88	323630	28479440
Rock outcrop-Rotagilla complex, 65 to 90 percent slopes	123	Poor	D	88	368187	32400456
Enash very gravelly loam, 3 to 8 percent slopes	155	Fair	B	72	127214	9159408
Tuftuff extremely gravelly loam, 15 to 35 percent slopes	161	Poor	B	77	343881	26478837
Silktassel very gravelly loam, 35 to 65 percent slopes	162	Poor	D	88	487854	42931152
Rock outcrop-Silktassel complex, 65 to 95 percent slopes	163	Poor	D	88	153920	13544960
Thaad extremely gravelly loam, 15 to 35 percent slopes	171	Poor	D	88	459477	40433976
Arbol extremely gravelly loam, 35 to 65 percent slopes	172	Poor	B	77	1585459	122080343
Rock outcrop-Arbol complex, 65 to 90 percent slopes	173	Poor	D	88	2288949	201427512
Aguja-Rock outcrop complex, 35 to 65 percent slopes	182	Poor	C	85	2500449	212538165
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	2067939	113736645
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	3378629	185824595
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	13616000	748880000
Canutio and Arizo gravelly sandy loams	Cb	Fair	B	72	3188930	229602960
Haplargids, dissected	HD	Fair	B	72	10570899	761104728
Pinaleno-Nolam association	PN	Fair	B	72	7166659	515999448
Riverwash-Arizo complex	RF	Poor	D	88	179126	15763088
Rock outcrop-Argids association	RG	Poor	C	85	11765899	1000101415
Rock outcrop-Argids, cool, association	RH	Poor	D	88	557345	49046360
Rock outcrop-Lozier association	RL	Poor	D	88	1617849	142370712
Tencee-Upton association	TE	Fair	D	86	10822199	930709114
Terino-Casito association	TF	Fair	D	86	36254699	3117904114
	Weighted CN=			78	109942917	8550877140

Table 6. Soil table of basin four.

Basin 4	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Chipotle extremely gravelly sandy clay loam, 0 to 3 percent slopes	107	Fair	A	55	573310	31532050
Infantry-Sonic complex, 3 to 10 percent slopes	12	Fair	D	86	1508559	129736074
Crotalus extremely gravelly loam, 15 to 35 percent slopes	151	Poor	B	77	76939	5924303
Reduff very gravelly loam, 35 to 65 percent slopes	152	Poor	D	88	2952260	259798880
Rock outcrop-Reduff complex, 65 to 90 percent slopes	153	Poor	D	88	1547379	136169352
Missile very gravelly fine sandy loam, 3 to 15 percent slopes	156	Poor	D	88	3022579	265986952
Tuftuff extremely gravelly loam, 15 to 35 percent slopes	161	Poor	B	77	574002	44198154
Silktassel very gravelly loam, 35 to 65 percent slopes	162	Poor	D	88	1994070	175478160
Rock outcrop-Silktassel complex, 65 to 95 percent slopes	163	Poor	D	88	2055560	180889280
Crossen-Tinney complex, 1 to 3 percent slopes	28	Fair	D	86	402552	34619472
Bankston extremely channery loam, 15 to 35 percent slopes	33	Poor	C	85	611652	51990420
Bissett-Rock outcrop complex, 15 to 35 percent slopes	52	Poor	D	88	155113	13649944
Bissett-Rock outcrop complex, 35 to 65 percent slopes	53	Poor	D	88	1486879	130845352
Berino-Dona Ana association	BK	Fair	B	72	8288310	596758320
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	3921309	215671995
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	472741	26000755
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	15802900	869159500
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	36641998	2015309890
Canutio and Arizo gravelly sandy loams	Cb	Fair	B	72	3767810	271282320
Onite-Pajarito association	OP	Fair	B	72	3378010	243216720
Pinaleno-Nolam association	PN	Fair	B	72	7752460	558177120
Riverwash-Arizo complex	RF	Poor	D	88	851388	74922144
Rock outcrop-Argids association	RG	Poor	C	85	13787300	1171920500
Rock outcrop-Argids, cool, association	RH	Poor	D	88	787482	69298416
Rock outcrop-Lozier association	RL	Poor	D	88	8382949	737699512
Tencee-Upton association	TE	Fair	D	86	14887599	1280333514
Terino-Casito association	TF	Fair	D	86	31947200	2747459200
		Weighted CN=		74	167630310	12338028299

Table 7. Soil table of basin five.

Basin 5	Soil Type		Hydraulic Group	CN	area(m^2)	CN*area(m^2)
Infantry-Sonic complex, 3 to 10 percent slopes	12	Fair	D	86	1957990	168387140
Missile very gravelly fine sandy loam, 3 to 15 percent slopes	156	Poor	D	88	1812749	159521912
Hueco loamy fine sand, 1 to 3 percent slopes	21	Fair	C	81	3157779	255780099
Copia-Nations complex, 1 to 3 percent slopes	22	Fair	A	55	1370309	75366995
Piquin very gravelly sandy loam, 5 to 15 percent slopes	24	Fair	A	55	1034710	56909050
Crossen-Tinney complex, 1 to 3 percent slopes	28	Fair	D	86	2860739	246023554
Tinney loam, 1 to 3 percent slopes	29	Poor	B	77	4022779	309753983
Crossen gravelly fine sandy loam, 2 to 5 percent slopes	30	Fair	D	86	981800	84434800
Bankston extremely channery loam, 15 to 35 percent slopes	33	Poor	C	85	238919	20308115
Copia-Patriot complex, 2 to 5 percent slopes	42	Fair	A	55	883899	48614445
Bissett-Rock outcrop complex, 5 to 15 percent slopes	51	Poor	D	88	40629	3575352
Bissett-Rock outcrop complex, 15 to 35 percent slopes	52	Poor	D	88	306744	26993472
Bissett-Rock outcrop complex, 35 to 65 percent slopes	53	Poor	D	88	1304440	114790720
Yippin loamy sand, 2 to 5 percent slopes	72	Fair	B	72	1430500	102996000
Adelino sandy clay loam	Ad	Fair	B	72	887431	63895032
Adelino clay loam	Ae	Poor	B	77	1230990	94786230
Agustin association, undulating	AGB	Fair	A	55	127179	6994845
Anapra silty clay loam	An	Fair	C	81	7128	577368
Anthony-Vinton fine sandy loams	Ap	Fair	B	72	100183	7213176
Armijo clay loam	Aw	Poor	D	88	14870	1308560
Armijo clay	Ax	Poor	D	88	23184	2040192
Berino-Dona Ana association	BK	Fair	B	72	3682490	265139280
Berino-Pintura complex	BL	Fair	B	72	1290879	92943288
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	10728699	590078445
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	8417650	462970750
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	34400699	1892038445
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	6936289	381495895
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	827324	45502820
Brazito very fine sandy loam, thick surface	Bs	Fair	A	55	61710	3394050
Canutio and Arizo gravelly sandy loams	Cb	Fair	B	72	541374	38978928
Delnorte-Canutio association, undulating	DCB	Fair	D	86	31732	2728952
Delnorte-Canutio association hilly	DCD	Fair	D	86	494067	42489762
Glendale silty clay loam	Ge	Poor	C	85	285921	24303285
Glendale clay loam	Gf	Poor	B	77	815581	62799737
Glendale clay loam, alkali	Gg	Poor	B	77	3080	237160
Gravel pit	GP	Poor	D	88	61	5368
Glendale silty clay	Gs	Poor	C	85	22044	1873740
Harkey loam	Ha	Poor	B	77	404056	31112312
Harkey silty clay loam	Hk	Poor	C	85	92764	7884940
Rock outcrop-Lozier association	LM	Poor	D	88	855655	75297640
Pajarito fine sandy loam	Pa	Fair	B	72	3327140	239554080
Pajarito association, level	PAA	Fair	A	55	359117	19751435
Riverwash-Arizo complex	RF	Poor	D	88	424445	37351160
Rock outcrop-Lozier association	RL	Poor	D	88	6737370	592888560
Tencee-Upton association	TE	Fair	D	86	16910200	1454277200
Vinton fine sandy loam	Tg	Fair	A	55	19701	1083555
Vinton fine sandy loam	Vn	Fair	A	55	37092	2040060
		Weighted CN=		68	121502091	8218491887

Table 8. Soil table of basin six.

Basin 6	Soil Type		Hydraulic Group	CN	area(m^2)	CN*area(m^2)
Agustin association, undulating	AGB	Fair	A	55	3256669	179116795
Anapra silty clay loam	An	Fair	C	81	105058	8509698
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	12217800	671979000
Brazito loamy fine sand	Br	Fair	A	55	36	1980
Delnorte-Canutio association, undulating	DCB	Fair	D	86	41530399	3571614314
Delnorte-Canutio association hilly	DCD	Fair	D	86	49242801	4234880886
Gila fine sandy loam	Ga	Poor	B	77	78680	6058360
Gila loam	Gc	Poor	B	77	250786	19310522
Glendale loam	Gd	Poor	C	85	25631	2178635
Glendale silty clay loam	Ge	Poor	C	85	667199	56711915
Glendale silty clay	Gs	Poor	C	85	201508	17128180
Harkey loam	Ha	Poor	B	77	562830	43337910
Harkey silty clay loam	Hk	Poor	C	85	696300	59185500
Igneous rockland-Brewster association	IN	Poor	D	88	6882780	605684640
Rock outcrop-Lozier association	LM	Poor	D	88	17979900	1582231200
Lozier association, hilly	LOD	Poor	D	88	2519370	221704560
Made land, gila soil material	Mg	Poor	B	77	1706850	131427450
Pajarito association, level	PAA	Fair	A	55	5785280	318190400
Rock outcrop-Lozier association	RL	Poor	D	88	358992	31591296
Saneli silty clay loam	Sa	Fair	D	86	247783	21309338
Tencee-Upton association	TE	Fair	D	86	299605	25766030
Vinton fine sandy loam	Tg	Fair	A	55	31300	1721500
Vinton fine sandy loam	Vn	Fair	A	55	47264	2599520
Water	W	Poor	D	88	384936	33874368
	Weighted CN=			82	145079757	11846113997

Table 9. Soil table of basin seven.

Basin 7	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Adelino sandy clay loam	Ad	Fair	B	72	20635	1485720
Adelino clay loam	Ae	Poor	B	77	108350	8342950
Anthony-Vinton fine sandy loams	Ap	Fair	B	72	9232	664704
Anthony-Vinton clay loams	As	Poor	B	77	11072	852544
Belen loam	Be	Poor	D	88	2568	225984
Berino-Bucklebar association	BJ	Fair	B	72	670125	48249000
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	6243869	343412795
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	8095620	445259100
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	2440589	134232395
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	27318000	1502490000
Cacique-Cruces association	CA	Poor	D	88	27157600	2389868800
Canutio and Arizo gravelly sandy loams	Cb	Fair	B	72	1224720	88179840
Glendale silty clay loam	Ge	Poor	C	85	8666	736610
Glendale clay loam	Gf	Poor	B	77	4118	317086
Harkey loam	Hg	Poor	B	77	8718	671286
Nickel-Badland complex	NB	Fair	B	72	7520040	541442880
Onite-Pajarito association	OP	Fair	B	72	6974810	502186320
Pajarito fine sandy loam	Pa	Fair	B	72	238599	17179128
Riverwash-Arizo complex	RF	Poor	D	88	564947	49715336
Rock outcrop-Argids association	RG	Poor	C	85	1391520	118279200
Rock outcrop-Lozier association	RL	Poor	D	88	38749401	3409947288
Rock outcrop-Torriorthents association	RT	Poor	D	88	11021499	969891912
Simona-Harrisburg association	SH	Poor	D	88	888477	78185976
Tencee-Upton association	TE	Fair	D	86	12629500	1086137000
Wink-Pintura complex	WP	Fair	B	72	4706399	338860728
	Weighted CN=			76	158009074	12076814582

Table 10. Soil table of basin eight.

Basin 8	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Berino-Bucklebar association	BJ	Fair	B	72	3549170	255540240
Berino-Dona Ana association	BK	Fair	B	72	33865398	2438308656
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	959922	52795710
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	8812259	484674245
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	5376120	295686600
Cacique-Cruces association	CA	Poor	D	88	47526199	4182305512
Dona Ana-Reagan association	DR	Poor	B	77	4697909	361738993
Glendale clay loam	Gf	Poor	B	77	908	69916
Masonfort-Nickel association	MN	Fair	D	86	15207799	1307870714
Mimbres silty clay loam	Mo	Poor	B	77	4226299	325425023
Nickel-Upton association	NU	Fair	B	72	15877699	1143194328
Onite-Pajarito association	OP	Fair	B	72	43196399	3110140728
Onite-Pintura complex	OR	Fair	B	72	14915699	1073930328
Pinaleno-Nolam association	PN	Fair	B	72	5692359	409849848
Riverwash-Arizo complex	RF	Poor	D	88	77785	6845080
Rock outcrop-Argids association	RG	Poor	C	85	15472800	1315188000
Rock outcrop-Lozier association	RL	Poor	D	88	9203900	809943200
Rock outcrop-Torriorthents association	RT	Poor	D	88	5483900	482583200
Simona-Harrisburg association	SH	Poor	D	88	38701900	3405767200
Stellar association	ST	Poor	C	85	1712030	145522550
Tencee-Upton association	TE	Fair	D	86	6738180	579483480
Wink-Harrisburg association	WH	Fair	B	72	33826999	2435543928
Wink-Pintura complex	WP	Fair	B	72	45798599	3297499128
	Weighted CN=			77	360920232	27919906607

Table 11. Soil table of basin nine.

Basin 9	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Akela-Rock outcrop complex	AL	Fair	D	86	3391340	291655240
Anthony-Vinton loams	Ar	Fair	B	72	5257	378504
Anthony-Vinton clay loams	As	Poor	B	77	4012	308924
Armijo clay loam	Aw	Poor	D	88	1463	128744
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	278430	15313650
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	19564800	1076064000
Brazito loamy fine sand	Br	Fair	A	55	1135	62425
Glendale clay loam	Gf	Poor	B	77	19326	1488102
Harkey loam	Hg	Poor	B	77	7188	553476
Harkey silty clay loam	Hk	Poor	C	85	4993	424405
Onite-Pajarito association	OP	Fair	B	72	46617900	3356488800
Riverwash-Arizo complex	RF	Poor	D	88	196840	17321920
Tencee-Upton association	TE	Fair	D	86	568534	48893924
Wink-Harrisburg association	WH	Fair	B	72	21233299	1528797528
Wink-Pintura complex	WP	Fair	B	72	51543399	3711124728
	Weighted CN=			70	143437916	10049004370

Table 12. Soil table of basin ten.

Basin 10	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Adelino sandy clay loam	Ad	Fair	B	72	2467	177624
Akela-Rock outcrop complex	AL	Fair	D	86	2418780	208015080
Anthony-Vinton loams	Ar	Fair	B	72	66283	4772376
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	4716320	259397600
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	5652910	310910050
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	22376499	1230707445
Pajarito fine sandy loam	Pa	Fair	B	72	691978	49822416
Riverwash-Arizo complex	RF	Poor	D	88	347144	30548672
Rock outcrop-Torriorthents association	RT	Poor	D	88	15454	1359952
Simona-Harrisburg association	SH	Poor	D	88	929112	81761856
Tencee-Upton association	TE	Fair	D	86	1321640	113661040
Wink-Harrisburg association	WH	Fair	B	72	14280699	1028210328
Wink-Pintura complex	WP	Fair	B	72	38336200	2760206400
	Weighted CN=			67	91155486	6079550839

Table 13. Soil table of basin eleven.

Basin 11	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Akela-Rock outcrop complex	AL	Fair	D	86	10448100	898536600
Anapra clay loam	Ao	Fair	B	72	14019	1009368
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	8820059	485103245
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	3155529	173554095
Bluepoint loamy sand, 1 to 15 percent slopes	BO	Fair	A	55	1179029	64846595
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	22003200	1210176000
Glendale silty clay loam	Ge	Poor	C	85	405	34425
Glendale clay loam	Gf	Poor	B	77	12907	993839
Harkey loam	Hg	Poor	B	77	21510	1656270
Harkey silty clay loam	Hk	Poor	C	85	3699	314415
Pajarito fine sandy loam	Pa	Fair	B	72	89107	6415704
Riverwash-Arizo complex	RF	Poor	D	88	651224	57307712
Rock outcrop-Torriorthents association	RT	Poor	D	88	1072659	94393992
Simona-Harrisburg association	SH	Poor	D	88	10226900	899967200
Wink-Harrisburg association	WH	Fair	B	72	775707	55850904
Wink-Pintura complex	WP	Fair	B	72	66390403	4780109016
	Weighted CN=			70	124864457	8730269380

Table 14. Soil table of basin twelve.

Basin 12	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Adelino sandy clay loam	Ad	Fair	B	72	491190	35365680
Akela-Rock outcrop complex	AL	Fair	D	86	6653989	572243054
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	14718700	809528500
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	8320070	457603850
Bluepoint-Caliza-Yturbide complex	BP	Fair	A	55	3814929	209821095
Onite-Pajarito association	OP	Fair	B	72	338378	24363216
Pajarito fine sandy loam	Pa	Fair	B	72	438908	31601376
Pajarito-Pintura complex	Pb	Fair	B	72	647827	46643544
Riverwash-Arizo complex	RF	Poor	D	88	405189	35656632
Rock outcrop-Torriorthents association	RT	Poor	D	88	107230	9436240
Simona-Harrisburg association	SH	Poor	D	88	1988680	175003840
Wink-Harrisburg association	WH	Fair	B	72	95923797	6906513384
Wink-Pintura complex	WP	Fair	B	72	106625999	7677071928
	Weighted CN=			71	240474886	16990852339

Table 15. Soil table of basin thirteen.

Basin 13	Soil Type		Hydraulic Group	CN	Area(m^2)	CN*area(m^2)
Bluepoint loamy sand, 1 to 5 percent slopes	Bm	Fair	A	55	5148839	283186145
Bluepoint loamy sand, 5 to 15 percent slopes	Bn	Fair	A	55	8697819	478380045
Pajarito-Pintura complex	Pb	Fair	B	72	18291200	1316966400
Wink-Pintura complex	WP	Fair	B	72	538177	38748744
	Weighted CN=			65	32676035	2117281334

Sub-basins information's and maps:

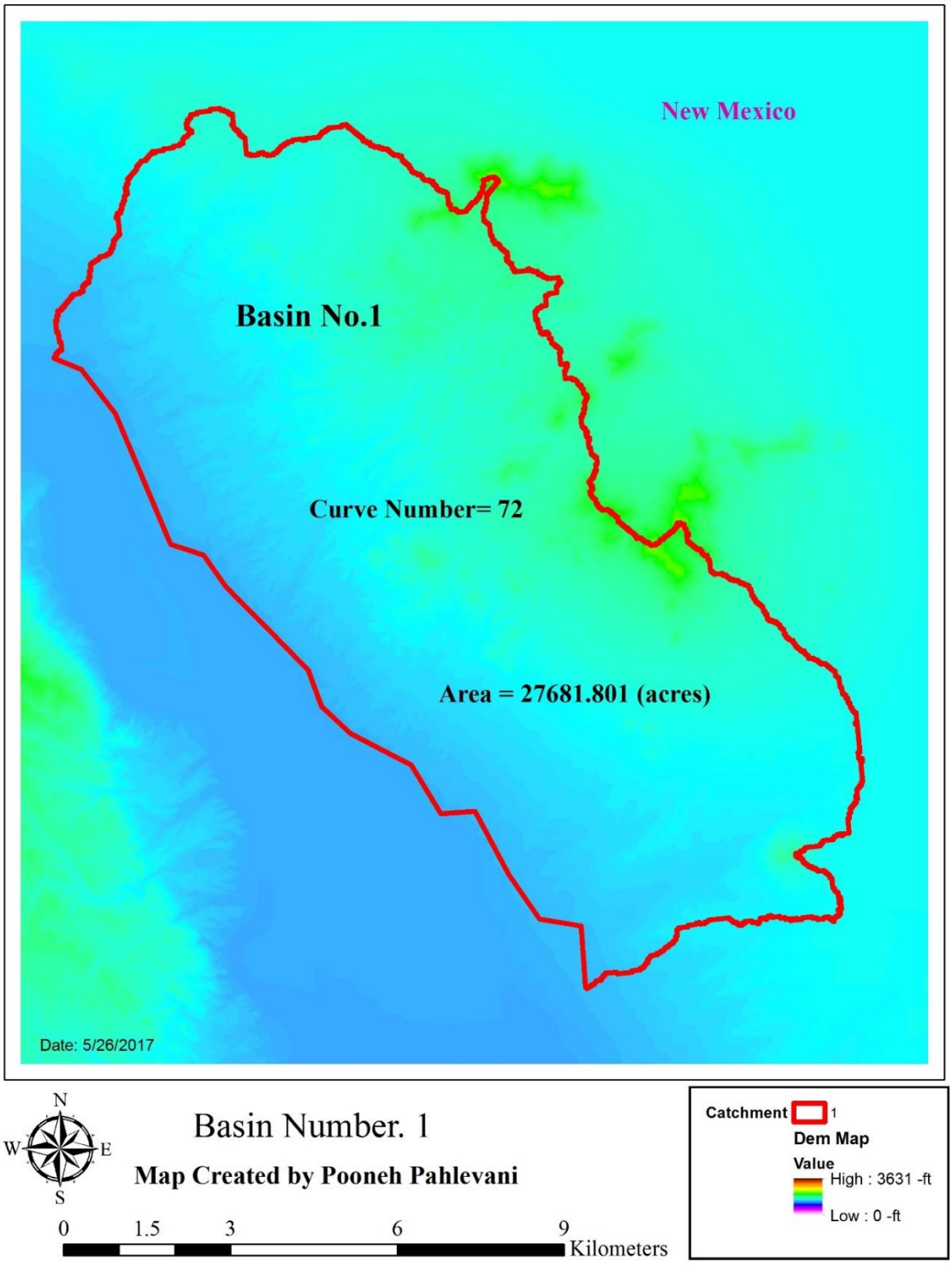


Figure A- 5. Catchment one.

Table 16. Basin one information.

BASIN1	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	27681.80	240.28	14.56
1992	11.03	27681.80	179.71	10.95
1993	9.6	27681.80	72.34	9.57
1994	8.15	27681.80	1608.99	7.45
1995	7.59	27681.80	21.64	7.58
1996	6.21	27681.80	132.50	6.15
1997	10.42	27681.80	108.67	10.37
1998	7.17	27681.80	6.19	7.17
1999	9.18	27681.80	27.71	9.17
2000	9.94	27681.80	1153.55	9.44
2001	5.25	27681.80	0.00	5.25
2002	7.62	27681.80	6.04	7.62
2003	5.51	27681.80	16.85	5.50
2004	13.15	27681.80	822.25	12.79
2005	10.86	27681.80	1715.07	10.12
2006	14.18	27681.80	293.89	14.05
2007	10.29	27681.80	0.61	10.29
2008	9.31	27681.80	2056.64	8.42
2009	8.77	27681.80	0.00	8.77
2010	9.39	27681.80	2347.54	8.37
2011	6.89	27681.80	27.71	6.88
2012	5.52	27681.80	127.57	5.46
2013	6.42	27681.80	7.26	6.42
2014	8.26	27681.80	78.13	8.23
2015	12.6	27681.80	205.96	12.51
2016	8.48	27681.80	106.97	8.43

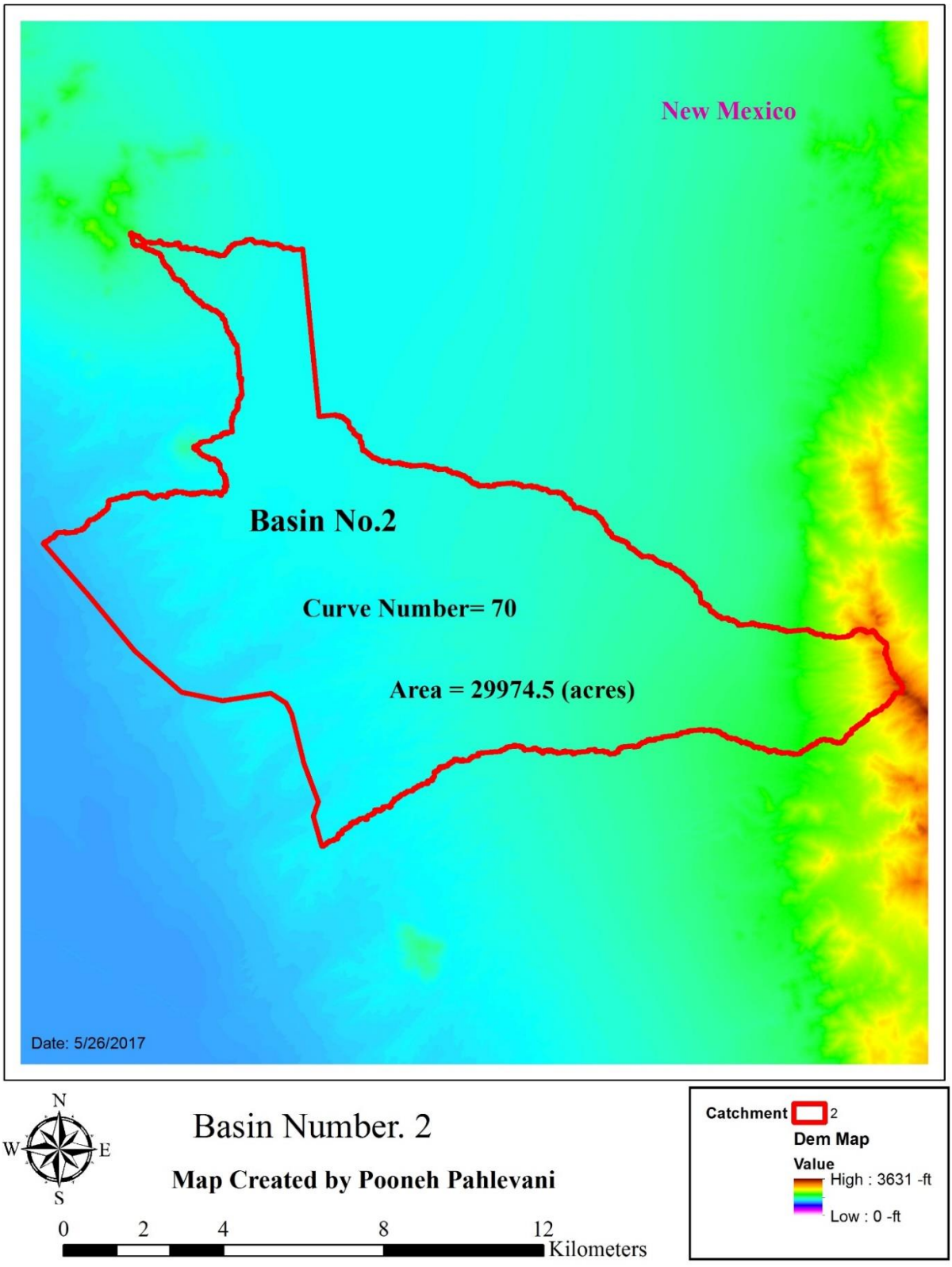


Figure A- 6. Catchment two.

Table 17. Basin two information.

BASIN 2	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	29974.5	160.08	14.60
1992	11.03	29974.5	129.56	10.98
1993	9.6	29974.5	36.00	9.59
1994	8.15	29974.5	1526.96	7.54
1995	7.59	29974.5	4.23	7.59
1996	6.21	29974.5	94.86	6.17
1997	10.42	29974.5	74.54	10.39
1998	7.17	29974.5	0.00	7.17
1999	9.18	29974.5	11.51	9.18
2000	9.94	29974.5	1027.37	9.53
2001	5.25	29974.5	0.00	5.25
2002	7.62	29974.5	0.30	7.62
2003	5.51	29974.5	4.92	5.51
2004	13.15	29974.5	720.50	12.86
2005	10.86	29974.5	1633.68	10.21
2006	14.18	29974.5	178.27	14.11
2007	10.29	29974.5	0.00	10.29
2008	9.31	29974.5	1969.73	8.52
2009	8.77	29974.5	0.00	8.77
2010	9.39	29974.5	2274.98	8.48
2011	6.89	29974.5	11.51	6.89
2012	5.52	29974.5	90.62	5.48
2013	6.42	29974.5	0.62	6.42
2014	8.26	29974.5	46.79	8.24
2015	12.6	29974.5	132.76	12.55
2016	8.48	29974.5	65.71	8.45

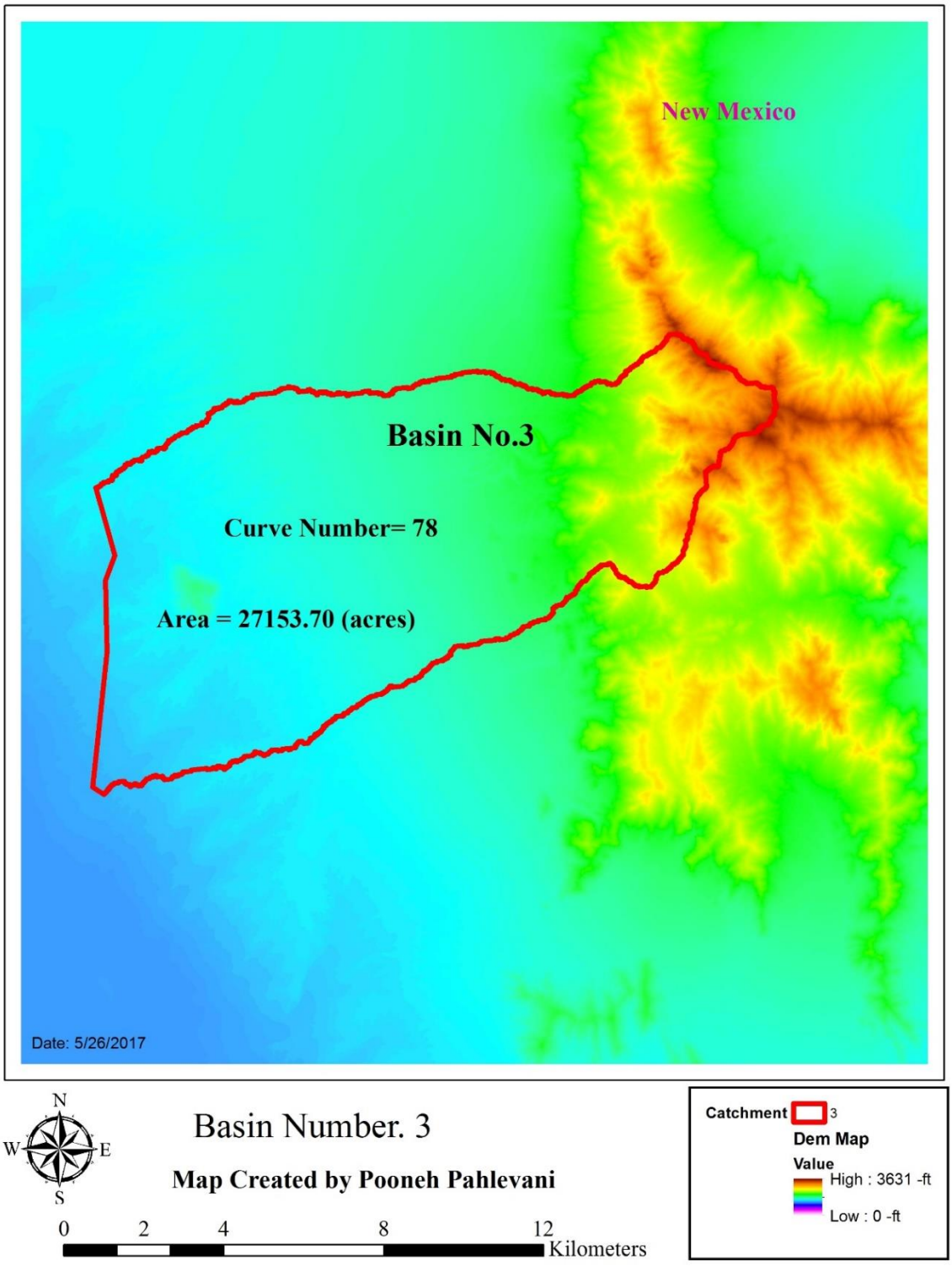


Figure A- 7. Catchment three.

Table 18. Basin three information.

BASIN 3	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	27153.70	782.63	14.31
1992	11.03	27153.70	630.79	10.75
1993	9.6	27153.70	297.28	9.47
1994	8.15	27153.70	2252.82	7.15
1995	7.59	27153.70	218.31	7.49
1996	6.21	27153.70	327.93	6.07
1997	10.42	27153.70	317.91	10.28
1998	7.17	27153.70	119.20	7.12
1999	9.18	27153.70	132.03	9.12
2000	9.94	27153.70	1909.75	9.10
2001	5.25	27153.70	3.40	5.25
2002	7.62	27153.70	72.20	7.59
2003	5.51	27153.70	125.83	5.45
2004	13.15	27153.70	1514.82	12.48
2005	10.86	27153.70	2425.19	9.79
2006	14.18	27153.70	1005.79	13.74
2007	10.29	27153.70	99.46	10.25
2008	9.31	27153.70	2856.07	8.05
2009	8.77	27153.70	33.29	8.76
2010	9.39	27153.70	3118.08	8.01
2011	6.89	27153.70	132.03	6.83
2012	5.52	27153.70	338.76	5.37
2013	6.42	27153.70	76.38	6.39
2014	8.26	27153.70	357.17	8.10
2015	12.6	27153.70	703.47	12.29
2016	8.48	27153.70	354.96	8.32

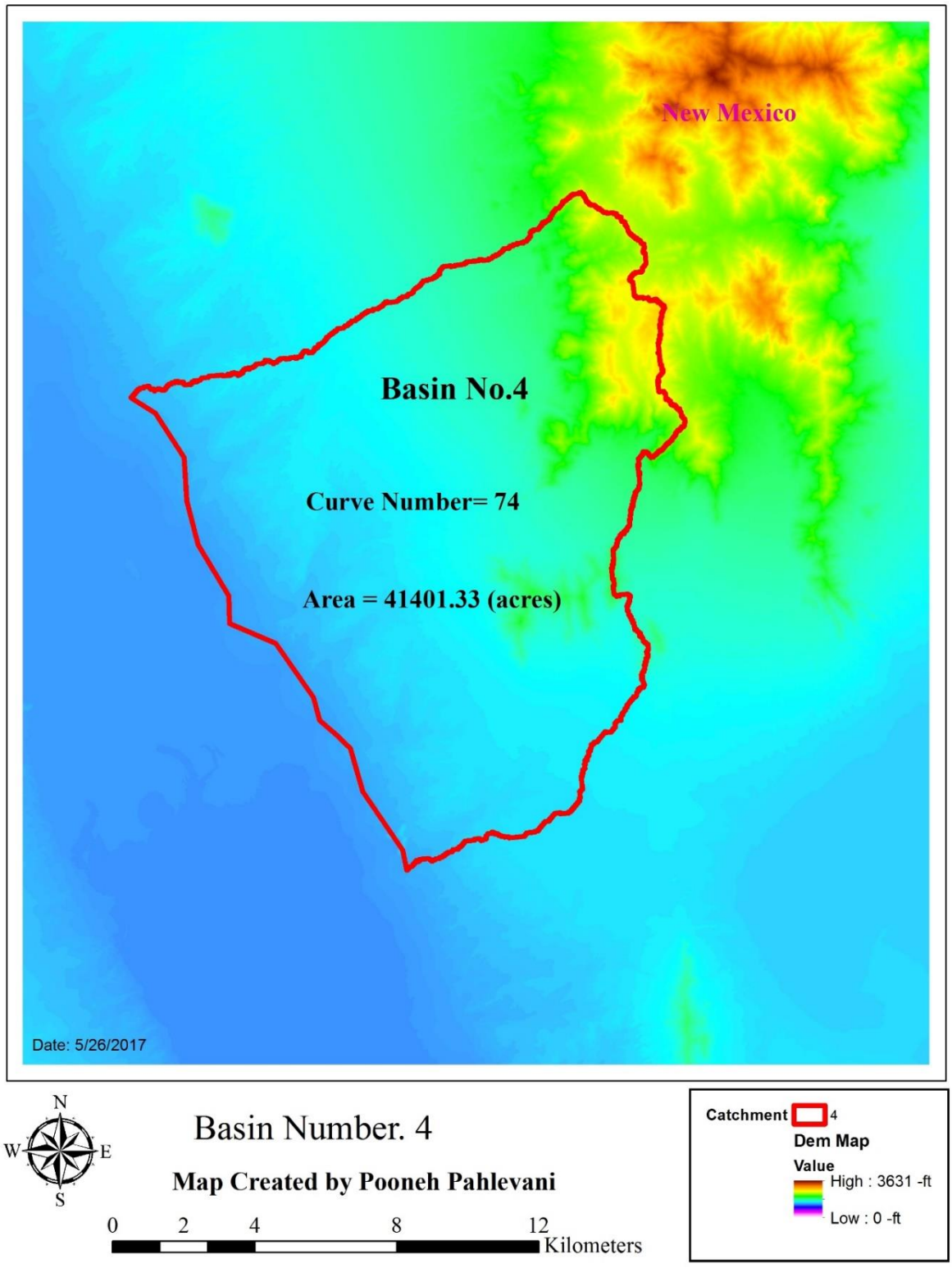


Figure A- 8. Catchment four.

Table 19. Basin four information.

BASIN 4	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	41401.33	562.73	14.50
1992	11.03	41401.33	439.79	10.90
1993	9.6	41401.33	193.24	9.54
1994	8.15	41401.33	2725.75	7.36
1995	7.59	41401.33	92.15	7.56
1996	6.21	41401.33	281.08	6.13
1997	10.42	41401.33	237.69	10.35
1998	7.17	41401.33	41.07	7.16
1999	9.18	41401.33	80.02	9.16
2000	9.94	41401.33	2069.63	9.34
2001	5.25	41401.33	0.00	5.25
2002	7.62	41401.33	29.38	7.61
2003	5.51	41401.33	56.10	5.49
2004	13.15	41401.33	1518.19	12.71
2005	10.86	41401.33	2902.73	10.02
2006	14.18	41401.33	713.39	13.97
2007	10.29	41401.33	13.14	10.29
2008	9.31	41401.33	3465.30	8.31
2009	8.77	41401.33	3.17	8.77
2010	9.39	41401.33	3901.39	8.26
2011	6.89	41401.33	80.02	6.87
2012	5.52	41401.33	272.09	5.44
2013	6.42	41401.33	32.70	6.41
2014	8.26	41401.33	206.39	8.20
2015	12.6	41401.33	490.31	12.46
2016	8.48	41401.33	256.40	8.41

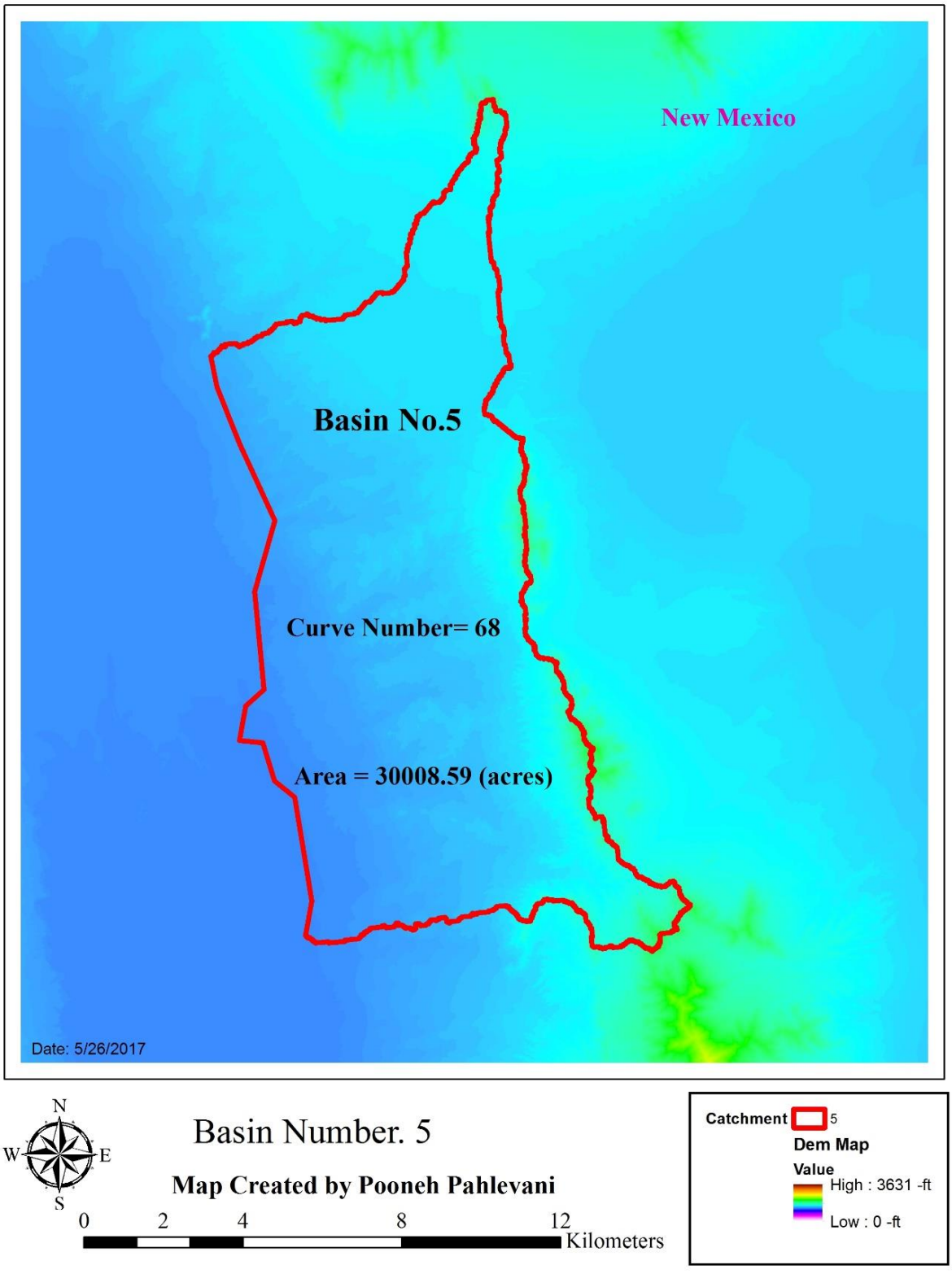


Figure A- 9. Catchment five.

Table 20. Basin five information.

BASIN 5	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	30008.59	1.15	14.66
1992	11.03	30008.59	0.55	11.03
1993	9.6	30008.59	0.14	9.60
1994	8.15	30008.59	15.94	8.14
1995	7.59	30008.59	0.00	7.59
1996	6.21	30008.59	0.68	6.21
1997	10.42	30008.59	0.50	10.42
1998	7.17	30008.59	0.00	7.17
1999	9.18	30008.59	0.02	9.18
2000	9.94	30008.59	9.99	9.94
2001	5.25	30008.59	0.00	5.25
2002	7.62	30008.59	0.00	7.62
2003	5.51	30008.59	0.00	5.51
2004	13.15	30008.59	6.92	13.15
2005	10.86	30008.59	17.13	10.85
2006	14.18	30008.59	1.04	14.18
2007	10.29	30008.59	0.00	10.29
2008	9.31	30008.59	20.85	9.30
2009	8.77	30008.59	0.00	8.77
2010	9.39	30008.59	24.31	9.38
2011	6.89	30008.59	0.02	6.89
2012	5.52	30008.59	0.64	5.52
2013	6.42	30008.59	0.02	6.42
2014	8.26	30008.59	0.32	8.26
2015	12.6	30008.59	0.94	12.60
2016	8.48	30008.59	0.41	8.48

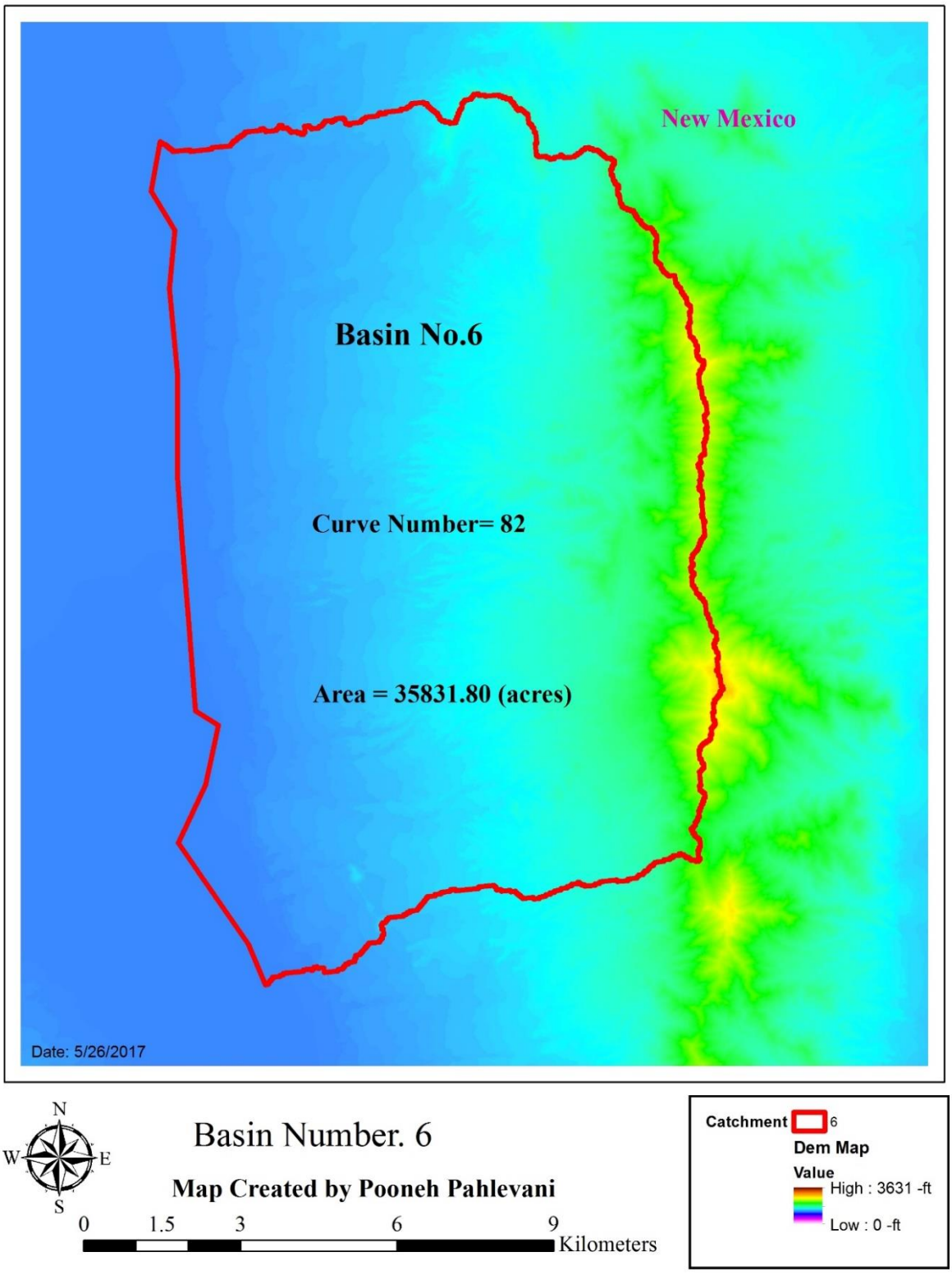


Figure A- 10. Catchment six.

Table 21. Basin six information.

BASIN 6	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	35831.80	1972.60	14.00
1992	11.03	35831.80	1581.96	10.50
1993	9.6	35831.80	758.93	9.35
1994	8.15	35831.80	3689.60	6.91
1995	7.59	35831.80	717.42	7.35
1996	6.21	35831.80	723.28	5.97
1997	10.42	35831.80	850.91	10.14
1998	7.17	35831.80	387.21	7.04
1999	9.18	35831.80	340.94	9.07
2000	9.94	35831.80	3495.93	8.77
2001	5.25	35831.80	58.90	5.23
2002	7.62	35831.80	246.00	7.54
2003	5.51	35831.80	427.34	5.37
2004	13.15	35831.80	3082.63	12.12
2005	10.86	35831.80	4108.53	9.48
2006	14.18	35831.80	2531.04	13.33
2007	10.29	35831.80	483.10	10.13
2008	9.31	35831.80	4712.47	7.73
2009	8.77	35831.80	201.61	8.70
2010	9.39	35831.80	5013.54	7.71
2011	6.89	35831.80	382.36	6.76
2012	5.52	35831.80	818.21	5.25
2013	6.42	35831.80	390.11	6.29
2014	8.26	35831.80	988.14	7.93
2015	12.6	35831.80	1777.22	12.00
2016	8.48	35831.80	846.52	8.20

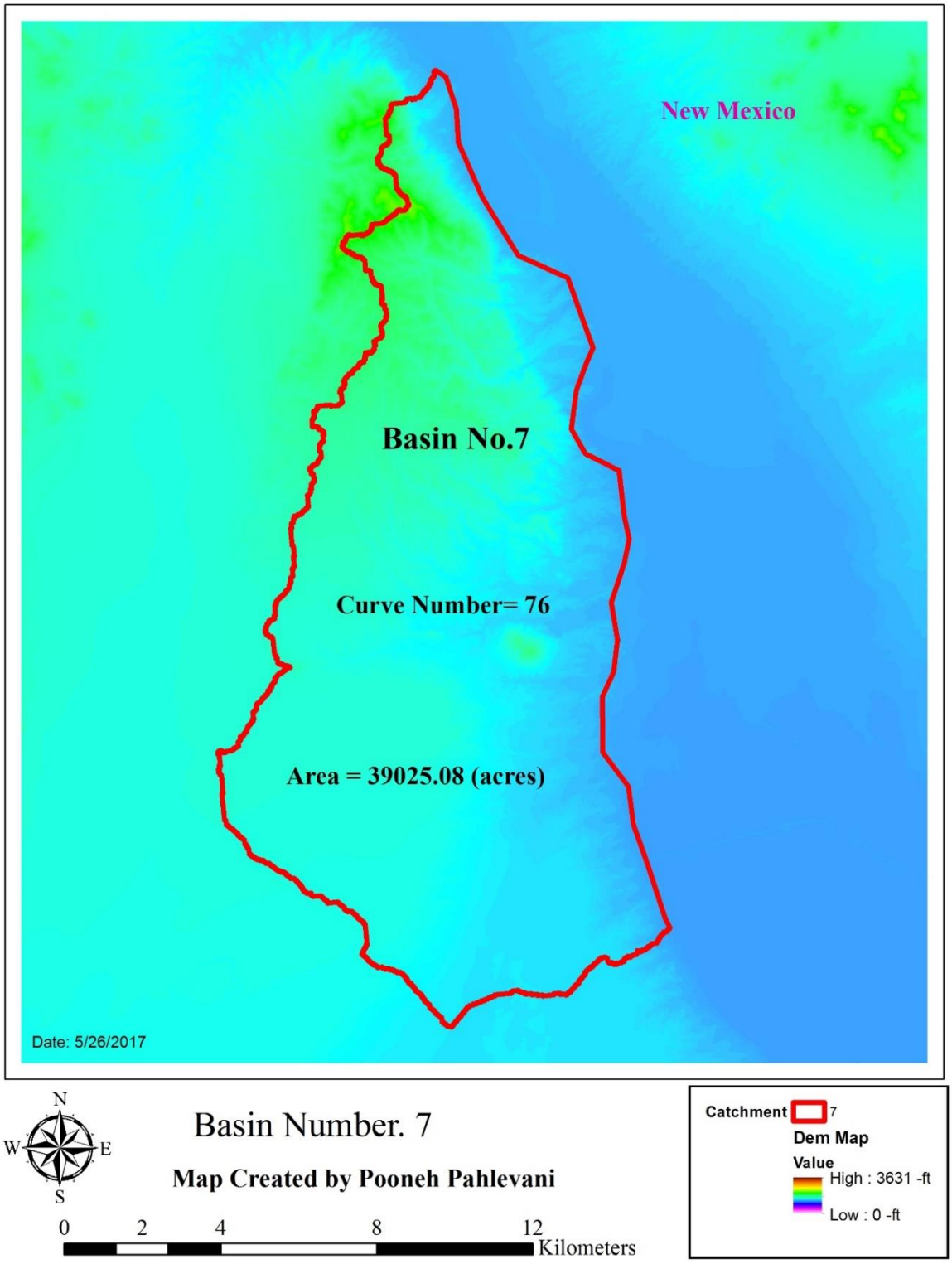


Figure A- 11. Catchment seven.

Table 22. Basin seven information.

BASIN 7	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	39025.08	788.93	14.42
1992	11.03	39025.08	630.51	10.84
1993	9.6	39025.08	289.60	9.51
1994	8.15	39025.08	2892.04	7.26
1995	7.59	39025.08	179.19	7.53
1996	6.21	39025.08	359.23	6.10
1997	10.42	39025.08	317.87	10.32
1998	7.17	39025.08	92.07	7.14
1999	9.18	39025.08	125.18	9.14
2000	9.94	39025.08	2320.19	9.23
2001	5.25	39025.08	0.00	5.25
2002	7.62	39025.08	58.92	7.60
2003	5.51	39025.08	101.03	5.48
2004	13.15	39025.08	1766.91	12.61
2005	10.86	39025.08	3087.06	9.91
2006	14.18	39025.08	1013.26	13.87
2007	10.29	39025.08	55.16	10.27
2008	9.31	39025.08	3667.39	8.18
2009	8.77	39025.08	16.32	8.76
2010	9.39	39025.08	4066.58	8.14
2011	6.89	39025.08	125.18	6.85
2012	5.52	39025.08	351.53	5.41
2013	6.42	39025.08	63.57	6.40
2014	8.26	39025.08	327.21	8.16
2015	12.6	39025.08	699.28	12.38
2016	8.48	39025.08	360.48	8.37

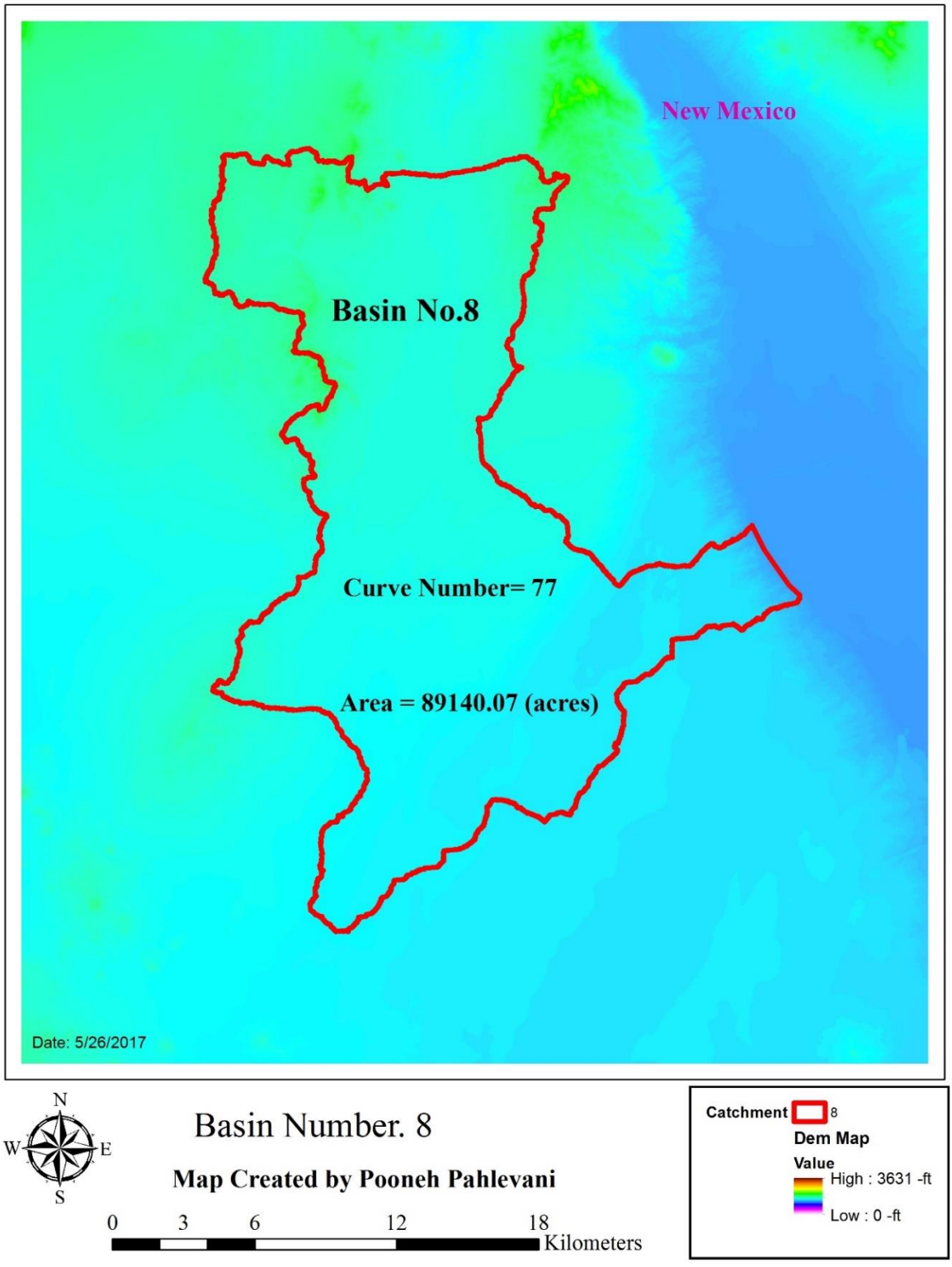


Figure A- 12. Catchment eight.

Table 23. Basin eight information.

BASIN 8	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	89140.08	2159.35	14.37
1992	11.03	89140.08	1737.36	10.80
1993	9.6	89140.08	809.59	9.49
1994	8.15	89140.08	6994.00	7.21
1995	7.59	89140.08	548.23	7.52
1996	6.21	89140.08	943.19	6.08
1997	10.42	89140.08	871.17	10.30
1998	7.17	89140.08	293.00	7.13
1999	9.18	89140.08	355.21	9.13
2000	9.94	89140.08	5766.02	9.16
2001	5.25	89140.08	0.00	5.25
2002	7.62	89140.08	181.44	7.60
2003	5.51	89140.08	311.37	5.47
2004	13.15	89140.08	4482.05	12.55
2005	10.86	89140.08	7494.58	9.85
2006	14.18	89140.08	2780.58	13.81
2007	10.29	89140.08	212.44	10.26
2008	9.31	89140.08	8865.66	8.12
2009	8.77	89140.08	66.80	8.76
2010	9.39	89140.08	9751.93	8.08
2011	6.89	89140.08	355.21	6.84
2012	5.52	89140.08	947.57	5.39
2013	6.42	89140.08	193.91	6.39
2014	8.26	89140.08	943.85	8.13
2015	12.6	89140.08	1928.82	12.34
2016	8.48	89140.08	985.03	8.35

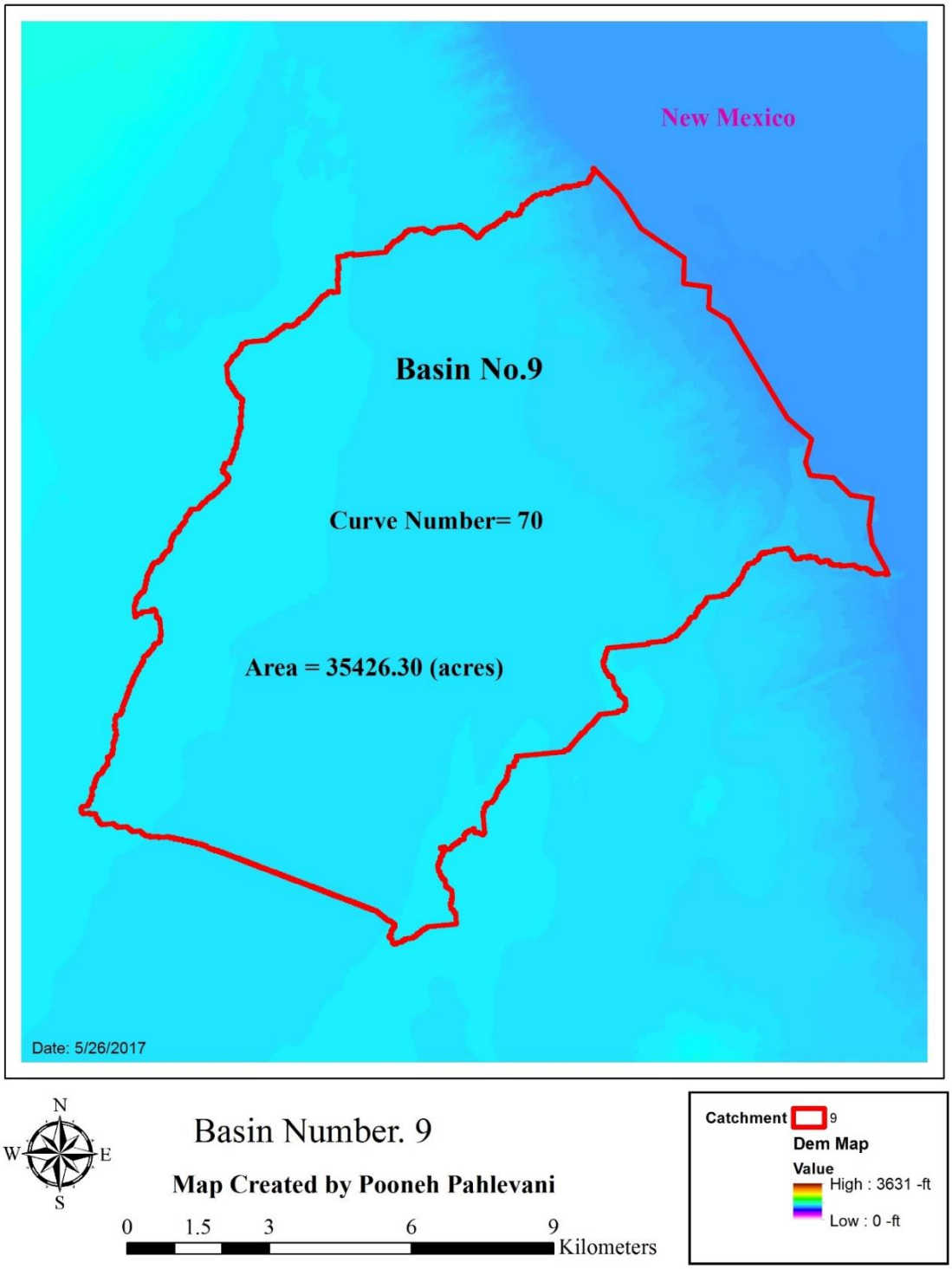


Figure A- 13. Catchment nine.

Table 24. Basin nine information.

BASIN 9	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	35426.30	189.19	14.60
1992	11.03	35426.30	125.07	10.99
1993	9.6	35426.30	42.54	9.59
1994	8.15	35426.30	1804.68	7.54
1995	7.59	35426.30	4.64	7.59
1996	6.21	35426.30	112.11	6.17
1997	10.42	35426.30	88.10	10.39
1998	7.17	35426.30	0.00	7.17
1999	9.18	35426.30	13.60	9.18
2000	9.94	35426.30	1214.23	9.53
2001	5.25	35426.30	0.00	5.25
2002	7.62	35426.30	0.00	7.62
2003	5.51	35426.30	5.81	5.51
2004	13.15	35426.30	853.10	12.86
2005	10.86	35426.30	1930.81	10.21
2006	14.18	35426.30	209.96	14.11
2007	10.29	35426.30	0.00	10.29
2008	9.31	35426.30	2327.99	8.52
2009	8.77	35426.30	0.00	8.77
2010	9.39	35426.30	2688.75	8.48
2011	6.89	35426.30	13.60	6.89
2012	5.52	35426.30	107.10	5.48
2013	6.42	35426.30	0.00	6.42
2014	8.26	35426.30	55.30	8.24
2015	12.6	35426.30	156.87	12.55
2016	8.48	35426.30	77.66	8.45

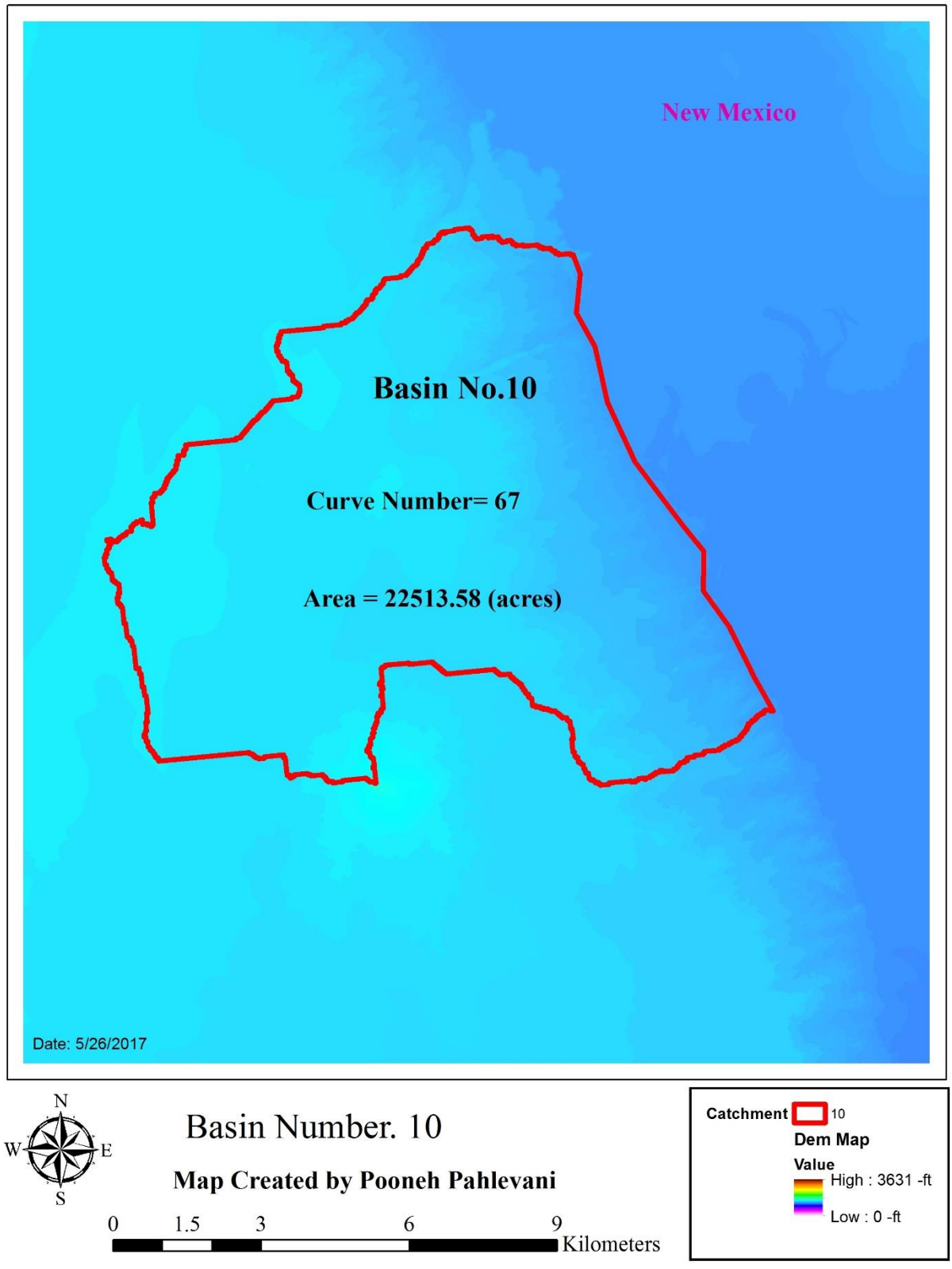


Figure A- 14. Catchment ten.

Table 25. Basin ten information.

BASIN 10	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	22513.58	55.00	14.63
1992	11.03	22513.58	19.64	11.02
1993	9.6	22513.58	4.11	9.60
1994	8.15	22513.58	925.62	7.66
1995	7.59	22513.58	0.00	7.59
1996	6.21	22513.58	31.26	6.19
1997	10.42	22513.58	21.77	10.41
1998	7.17	22513.58	0.00	7.17
1999	9.18	22513.58	0.00	9.18
2000	9.94	22513.58	558.04	9.64
2001	5.25	22513.58	0.00	5.25
2002	7.62	22513.58	0.00	7.62
2003	5.51	22513.58	0.00	5.51
2004	13.15	22513.58	384.75	12.94
2005	10.86	22513.58	996.73	10.33
2006	14.18	22513.58	41.49	14.16
2007	10.29	22513.58	0.00	10.29
2008	9.31	22513.58	1220.82	8.66
2009	8.77	22513.58	0.00	8.77
2010	9.39	22513.58	1429.12	8.63
2011	6.89	22513.58	0.00	6.89
2012	5.52	22513.58	29.23	5.50
2013	6.42	22513.58	0.00	6.42
2014	8.26	22513.58	10.03	8.25
2015	12.6	22513.58	38.88	12.58
2016	8.48	22513.58	0.00	8.48

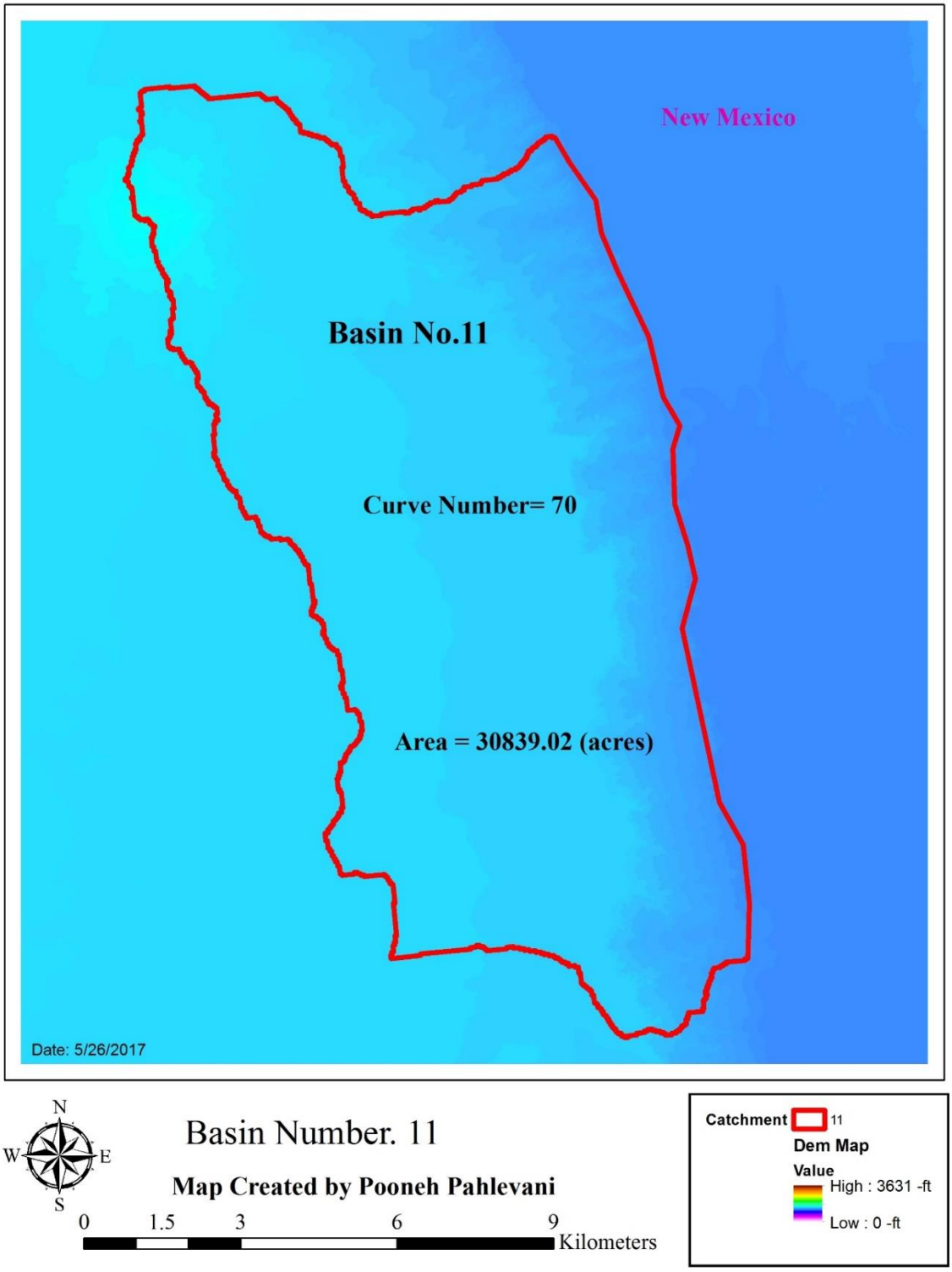


Figure A- 15. Catchment eleven.

Table 26. Basin eleven information.

BASIN 11	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	30839.02	164.70	14.60
1992	11.03	30839.02	108.88	10.99
1993	9.6	30839.02	37.03	9.59
1994	8.15	30839.02	1571.00	7.54
1995	7.59	30839.02	4.04	7.59
1996	6.21	30839.02	97.59	6.17
1997	10.42	30839.02	76.69	10.39
1998	7.17	30839.02	0.00	7.17
1999	9.18	30839.02	11.84	9.18
2000	9.94	30839.02	1057.00	9.53
2001	5.25	30839.02	0.00	5.25
2002	7.62	30839.02	0.00	7.62
2003	5.51	30839.02	5.06	5.51
2004	13.15	30839.02	741.28	12.86
2005	10.86	30839.02	1680.79	10.21
2006	14.18	30839.02	182.77	14.11
2007	10.29	30839.02	0.00	10.29
2008	9.31	30839.02	2026.54	8.52
2009	8.77	30839.02	0.00	8.77
2010	9.39	30839.02	2340.59	8.48
2011	6.89	30839.02	11.84	6.89
2012	5.52	30839.02	93.23	5.48
2013	6.42	30839.02	0.00	6.42
2014	8.26	30839.02	48.14	8.24
2015	12.6	30839.02	136.55	12.55
2016	8.48	30839.02	67.60	8.45

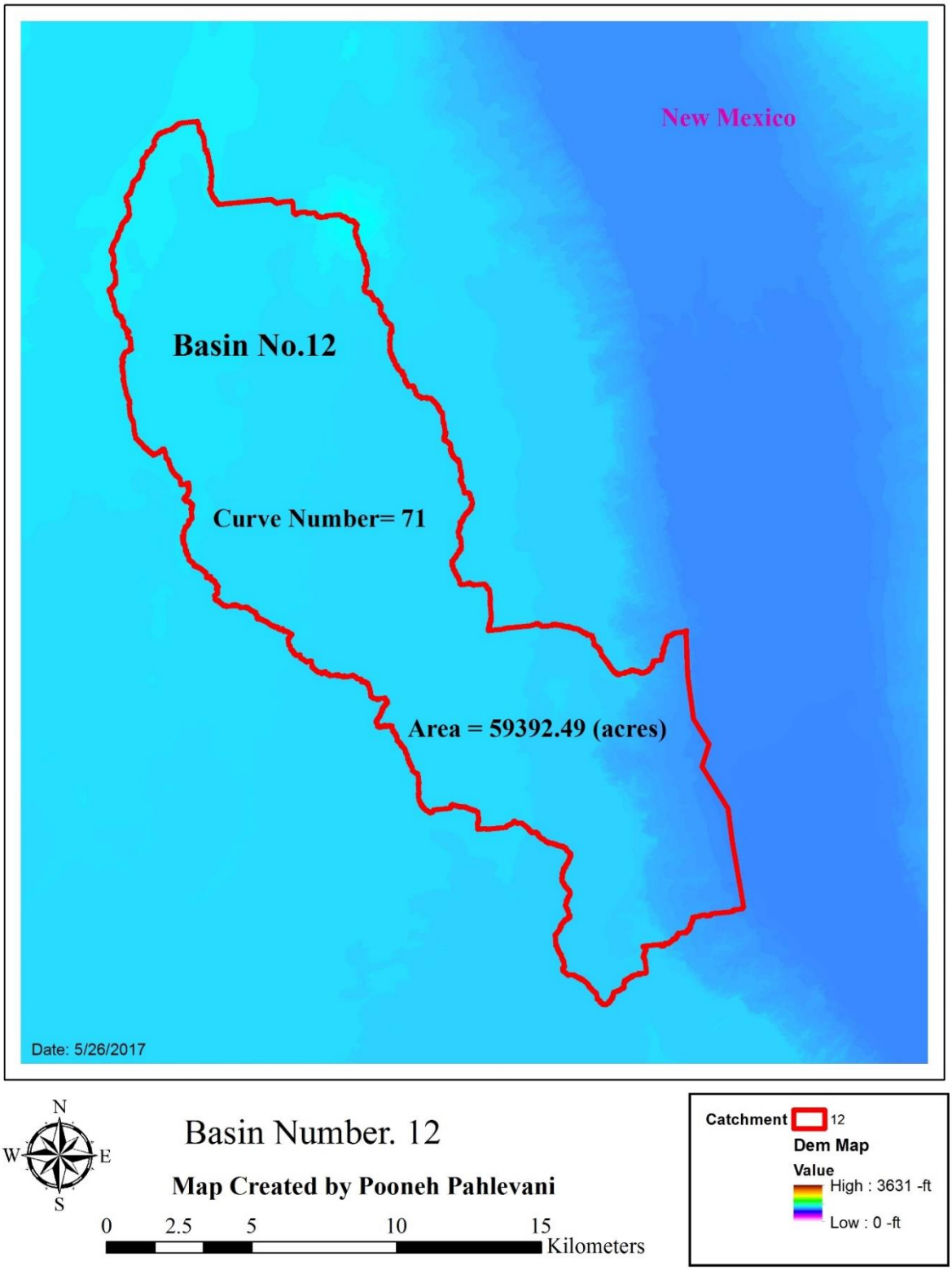


Figure A- 16. Catchment twelve.

Table 27. Basin twelve information.

BASIN 12	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	59392.49	401.60	14.58
1992	11.03	59392.49	289.94	10.97
1993	9.6	59392.49	108.68	9.58
1994	8.15	59392.49	3235.01	7.50
1995	7.59	59392.49	22.58	7.59
1996	6.21	59392.49	233.41	6.16
1997	10.42	59392.49	187.79	10.38
1998	7.17	59392.49	0.00	7.17
1999	9.18	59392.49	38.88	9.17
2000	9.94	59392.49	2248.72	9.49
2001	5.25	59392.49	0.00	5.25
2002	7.62	59392.49	4.75	7.62
2003	5.51	59392.49	20.79	5.51
2004	13.15	59392.49	1588.10	12.83
2005	10.86	59392.49	3454.45	10.16
2006	14.18	59392.49	478.02	14.08
2007	10.29	59392.49	0.00	10.29
2008	9.31	59392.49	4151.81	8.47
2009	8.77	59392.49	0.00	8.77
2010	9.39	59392.49	4768.42	8.43
2011	6.89	59392.49	38.88	6.88
2012	5.52	59392.49	223.93	5.47
2013	6.42	59392.49	6.36	6.42
2014	8.26	59392.49	124.31	8.23
2015	12.6	59392.49	341.96	12.53
2016	8.48	59392.49	175.15	8.44

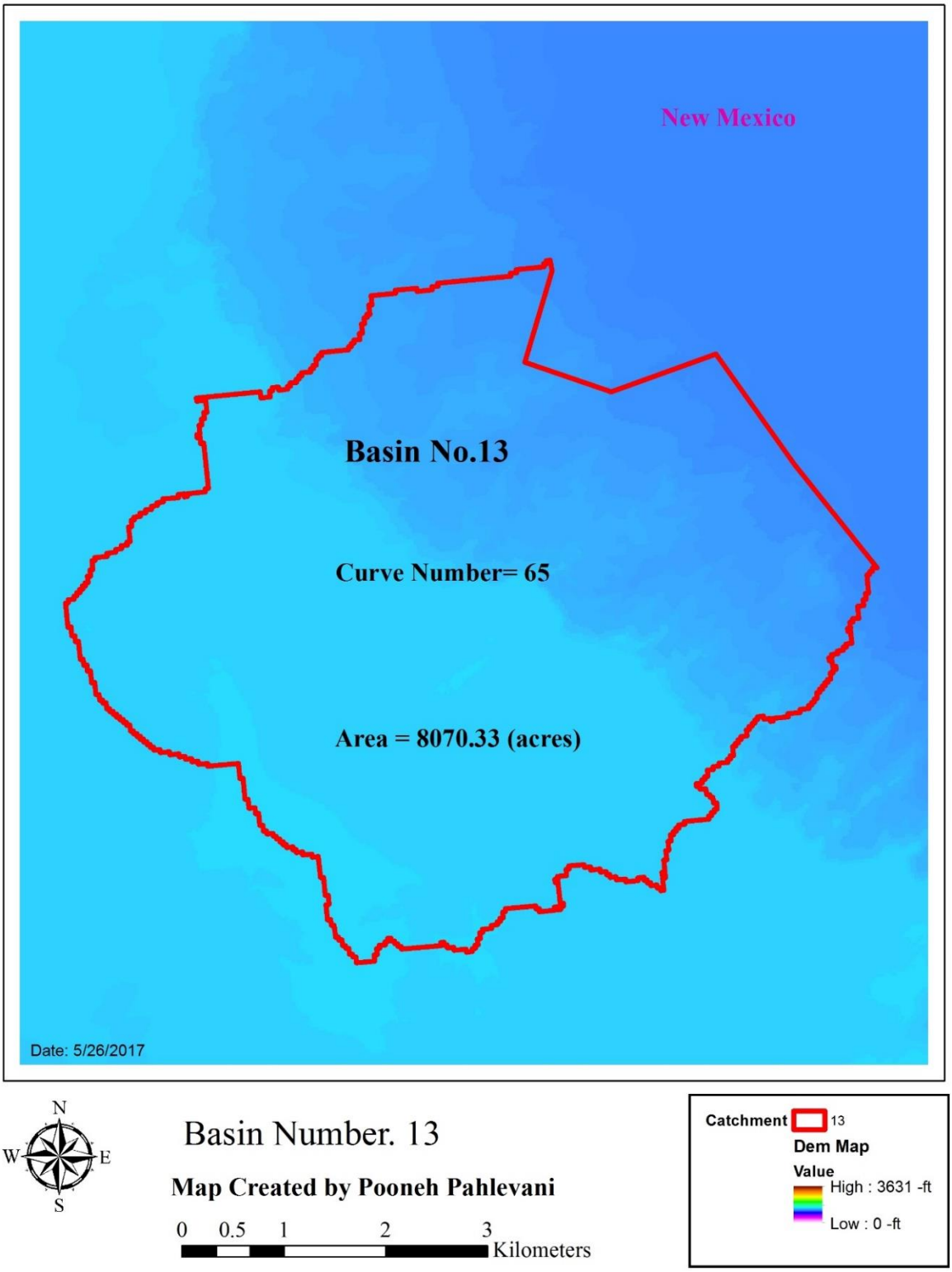


Figure A- 17. Catchment thirteen.

Table 28. Basin thirteen information.

BASIN 13	RAINFALL(in)	AREA(acre)	RUNOFF(A-F)	ET, Inch
1991	14.66	8070.33	12.92	14.64
1992	11.03	8070.33	1.56	11.03
1993	9.6	8070.33	0.00	9.60
1994	8.15	8070.33	283.80	7.73
1995	7.59	8070.33	0.00	7.59
1996	6.21	8070.33	4.96	6.20
1997	10.42	8070.33	2.85	10.42
1998	7.17	8070.33	0.00	7.17
1999	9.18	8070.33	0.00	9.18
2000	9.94	8070.33	157.15	9.71
2001	5.25	8070.33	0.00	5.25
2002	7.62	8070.33	0.00	7.62
2003	5.51	8070.33	0.00	5.51
2004	13.15	8070.33	107.89	12.99
2005	10.86	8070.33	307.15	10.40
2006	14.18	8070.33	4.05	14.17
2007	10.29	8070.33	0.00	10.29
2008	9.31	8070.33	381.14	8.74
2009	8.77	8070.33	0.00	8.77
2010	9.39	8070.33	450.38	8.72
2011	6.89	8070.33	0.00	6.89
2012	5.52	8070.33	4.49	5.51
2013	6.42	8070.33	0.00	6.42
2014	8.26	8070.33	0.66	8.26
2015	12.6	8070.33	5.97	12.59
2016	8.48	8070.33	1.85	8.48

References:

- Samani, Z., A.S. Bawazir, M. Bleiweiss, R. Skaggs, J. Longworth, V.D. Tran, and A. Piñon.2009. Using Remote Sensing to Evaluate the Spatial Variability of Evapotranspiration and Crop Coefficient in the Lower Rio Grande Valley, New Mexico. Irrigation Science 28:93-100.

- Ojda C.G. 1994. Aquifer Recharge Estimation at the Mesilla Bolson and Guaymas Aquifer Systems. Instituto Mexicano de Technologia del Agua.

\

Acknowledgment:

The support for this study was provided by the Dr.zohrab Samani. Support was also provided by the Water Resources Research Institute (WRRI) and also New Mexico State University, civil engineering department.