COMPARISON OF NOAA ATLAS 14 PRECIPITATION ESTIMATES TO SITE SPECIFIC DATA FOR STORMWATER MANAGEMENT AT QUESTA MINE, NM[1]

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Abstract: Stormwater management design typically starts by obtaining point precipitation frequency estimates from the NOAA Precipitation-Frequency Atlas of the United States for the site in question. NOAA Atlas 14 contains precipitation frequency estimates for the semiarid southwestern United States. A comparison of the NOAA Atlas 14 estimates to actual precipitation data from Red River, NM, which is 8 km east of the Questa mine in northern New Mexico, suggests that the NOAA Atlas 14 precipitation estimates are high for Red River and the nearby Questa Mine. For example, NOAA Atlas 14 indicates that the size of the 100-year, 24-hour event at Red River is 94 mm (3.70 in), however, the size of the actual maximum daily precipitation recorded at the Red River precipitation station, based on over 100 years of data, is considerably smaller at 68 mm (2.68 in). Extreme probability analytical methods were used to estimate precipitation for the Red River data. The results from these methods for a 100-year, 24-hour storm event ranged from 64 mm to 74 mm (2.52 in to 2.91 in), all much smaller than the NOAA Atlas 14 estimate. Comparing the size of a precipitation event in NOAA Atlas 14 to actual data and to that computed by other analytical techniques indicates that the NOAA Atlas 14 precipitation is much larger. Using the elevated precipitation estimates from NOAA Atlas 14 for stormwater runoff system design at the Questa Mine, resulted in stormwater structures designed to storm events much larger than the actual storm events. The 100-year, 24-hour precipitation estimate by NOAA Atlas 14 of 91 mm (3.58 in) for the Questa Mine is equivalent to a much larger event, on the order of a 300- to 2,000-year storm event as estimated by the other methods. A typical earthen channel designed using the estimates from NOAA Atlas 14 would require a 3.1 m (10 ft) bottom width, but the same channel would only require a 1.6 m (5 ft) bottom width using the GEV estimate. A sediment pond with a 28-ha (70 ac) watershed would need a capacity of 8,620 m^3 (6.99 ac-ft) using the estimate from NOAA Atlas 14 compared to a capacity of 5,430 m^3 (4.40 ac-ft) using the GEV estimate. This means that the ditches, ponds and other components of the stormwater system are much larger than is necessary, which increases the costs associated with a reclamation project and may create constraints resulting from oversizing structures.

Additional Key Words: extreme probability, recurrence interval, design precipitation

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Introduction

Stormwater management systems are used to safely convey runoff from precipitation events to sedimentation basins using a network of ditches. Precipitation data are the most fundamental data required for stormwater runoff system design. A storm event, typically the 100-year, 24-hour event, is chosen following regulatory requirements or standard industry practices to design stormwater structures. The NOAA Atlas 14 "precipitation frequency estimates have been endorsed by the Federal Advisory Committee on Water Information's (ACWI) Subcommittee on Hydrology and are de-facto national standards" (Bonnin, 2006). However, data and additional analysis of stormwater events near the Questa Mine in northern New Mexico demonstrate that the precipitation estimates from NOAA Atlas 14 are higher than the precipitation data collected at the site and the gauge in nearby Red River. Precipitation data have been recorded at the Red River gauge since 1906 and therefore provide sufficient data to perform statistical calculations for a storm event with a 1-in-100 year recurrence interval. The maximum 24-hour precipitation value recorded is 68 mm (2.68 in), whereas NOAA Atlas 14 estimates 94 mm (3.70 in) for the 100-year, 24-hour storm event. The 100-year, 24-hour estimate from NOAA Atlas 14 for the mine is 91 mm (3.58 in). The large discrepancy between the historical data and the NOAA Atlas 14 estimates was discussed in closure planning meetings, and the closure planning group began investigating the precipitation estimates so that stormwater structures were designed using the appropriate input data.

The Questa Mine is located in northern New Mexico on the western slope of the Sangre de Cristo Mountains in Taos County, New Mexico. The mine property is located approximately 5.6 km (3.5 mi) east of the Village of Questa and 8 km (5 mi) west of the Town of Red River along the Red River (Fig. 1). The Village of Questa is located in the San Luis Valley, a high alpine valley that is approximately 195 km (120 mi) long and 120 km (75 mi) wide (www.sanluisvalley.us, 2010). The Village of Questa and the San Luis Valley floor are at an elevation of approximately 2,300 m (7,500 ft) above sea level. The Questa Mine and the Town of Red River are in the Sangre de Cristo Mountain Range, which is comprised of rugged terrain with peaks reaching over 4,300 m (14,000 ft) elevation with vertical reliefs of more than 1,600 m (5,200 ft). The Town of Red River is at an elevation of 2,650 m (8,700 ft), and the Questa Mine elevations range from 2,400 m (7,900 ft) to 3,260 m (10,700 ft).

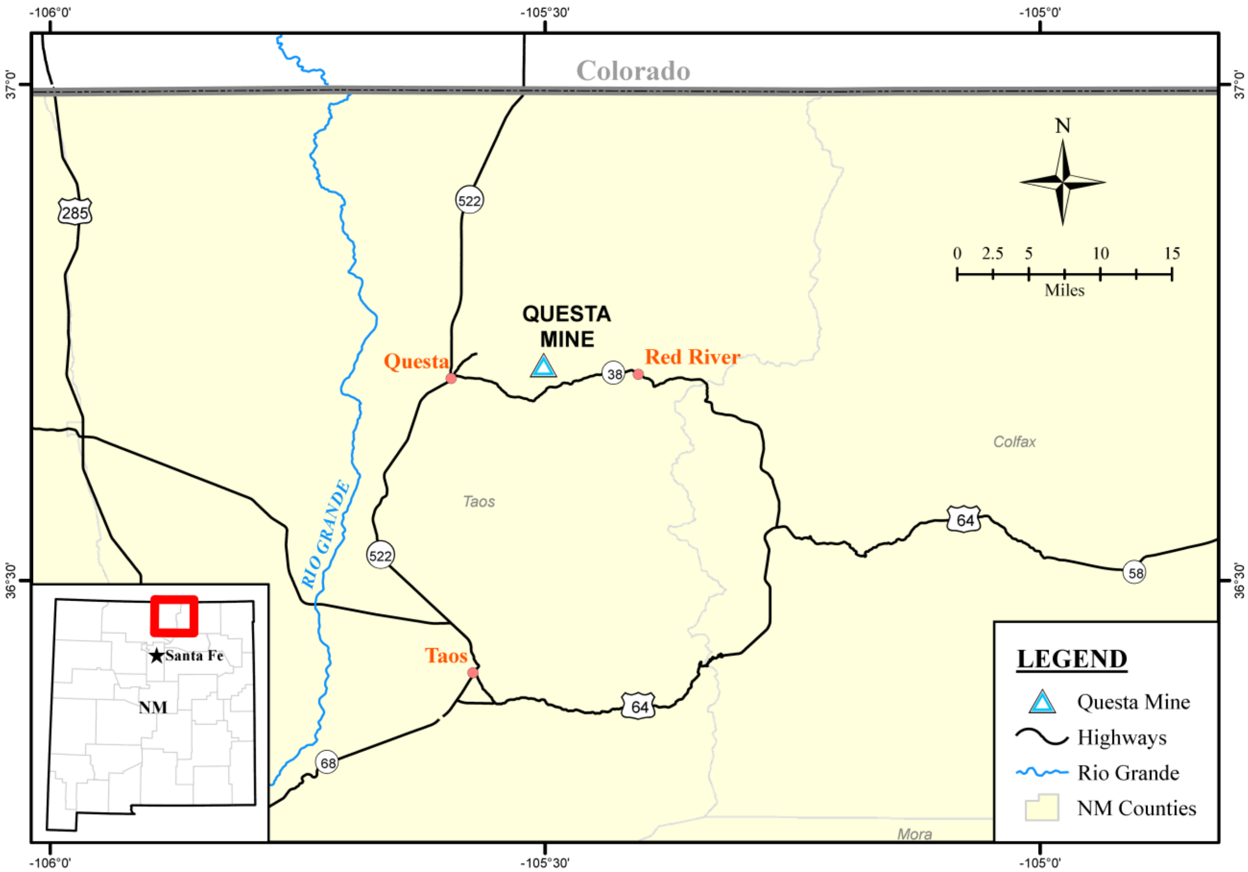

Figure 1. Location Map of the Questa Mine

The climate at Red River is steppe with an average annual precipitation of 524 mm (20.64 in) and mean temperatures ranging from -7°C (19°F) in January to 15°C (59°F) in July (WRCC, 2010). There is abundant sunshine with low humidity. During the summer, frequent afternoon thunderstorms occur, typically with high intensity and short duration. Winter is typically the driest season, and the precipitation that occurs typically falls as snow. The average monthly precipitation measured at Red River is shown in Fig. 2. Precipitation amounts and temperature are highly variable, primarily due to orogenic effects.

Precipitation Data

Precipitation data have been recorded at the Red River gauge since 1906. The NOAA Atlas 14 covers the southwest region of the United States, which was divided into 59 regions. Region 39 utilizes precipitation data from 55 stations located in Colorado and New Mexico, including the Red River station, to estimate precipitation depths for recurrence interval storms in northern New Mexico. The data reported at the Red River station are rainfall, or the rainfall equivalent for snowfall. NOAA Atlas 14 used data from 10 snow monitoring stations for Region 39. The snow monitoring data are too limited in spatial variability and historical duration, compared to the precipitation gauges, to be used for long-term frequency estimates.

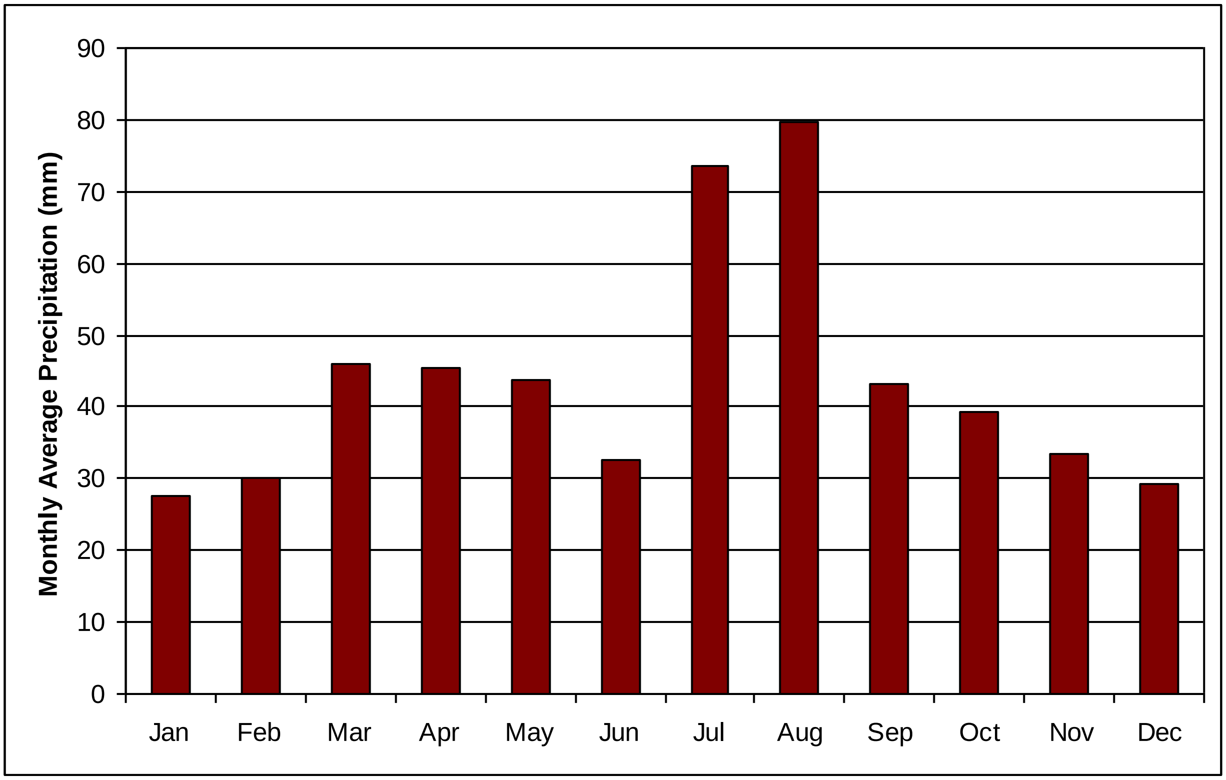

Figure 2. Monthly Average Precipitation at Red River, NM

Red River Precipitation Data

The record of data from the Red River gauge is over 100 years long and extends from 1906 to present. A table of the annual maximum precipitation data recorded at the site is included as Table 1 (Bonnin, 2006). Data are recorded daily; therefore, the Red River data can be used only to estimate storm events with durations equal to, or longer than, 24 hours. The peak annual data are used when estimating extreme values, following extreme value methodologies. The maximum 24-hour precipitation recorded at the Red River gauge was 68 mm (2.68 in). There have been a total of eight years where the maximum 24-hour precipitation was greater than 51 mm (2.0 in) and 20 years where the maximum 24-hour precipitation was less than 25 mm (1.0 in). There are limitations with daily data, particularly the possibility for a storm event to be divided between two days. The short duration, high intensity nature of the storms that occur in northern New Mexico minimizes the effect of this method on the results. The precipitation distributions included in NOAA Atlas 14, developed by NRCS (Type II), and actual data from a storm event recorded at the Questa Mine all show a similar curve, which includes a long period of light rain, followed by a period of heavy rain, and ending with light rain. These three curves are included as Fig. 3.

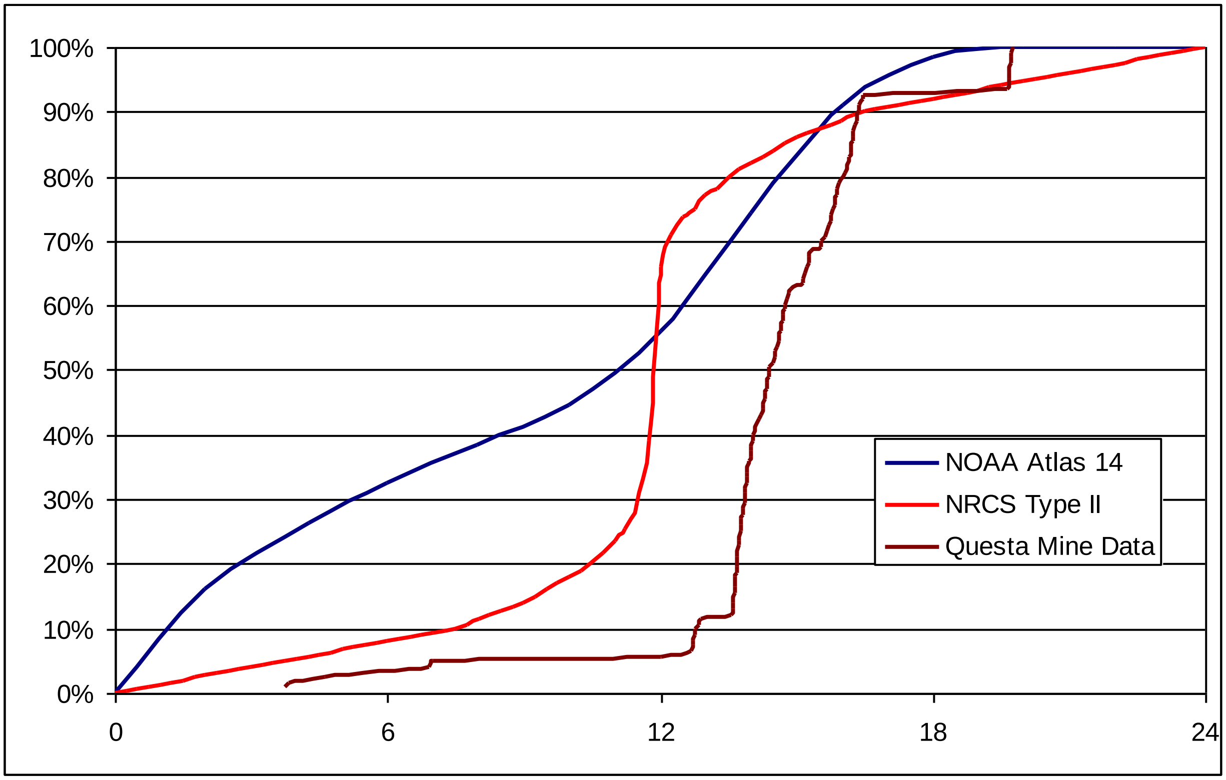

Figure 3. Rainfall Distribution Curves for Northern New Mexico

Table 1. Annual Maximum Precipitation Recorded at Red River, NM

Year	Maximum 24-Hour Precipitation (mm)	Year	Maximum 24-Hour Precipitation (mm)	Year	Maximum 24-Hour Precipitation (mm)	Year	Maximum 24-Hour Precipitation (mm)
1906	53	1932	22	1958	27	1984	35
1907	25	1933	24	1959	25	1985	51
1908	46	1934	36	1960	35	1986	28
1909	21	1935	28	1961	40	1987	31
1910	23	1936	44	1962	19	1988	35
1911	27	1937	23	1963	34	1989	45
1912	28	1938	17	1964	22	1990	31
1913	25	1939	23	1965	29	1991	45
1914	34	1940	20	1966	45	1992	26
1915	25	1941	25	1967	19	1993	27
1916	44	1942	38	1968	26	1994	28
1917	35	1943	41	1969	35	1995	45
1918	42	1944	64	1970	28	1996	18
1919	23	1945	43	1971	32	1997	22
1920	28	1946	51	1972	27	1998	35
1921	38	1947	25	1973	19	1999	58
1922	26	1948	30	1974	66	2000	31
1923	29	1949	43	1975	43	2001	25
1924	25	1950	25	1976	29	2002	54
1925	52	1951	20	1977	36	2003	39
1926	20	1952	30	1978	25	2004	48
1927	44	1953	28	1979	30	2005	23
1928	29	1954	27	1980	45	2006	28
1929	19	1955	68	1981	26		
1930	28	1956	21	1982	31		
1931	22	1957	34	1983	30		

The Red River data were analyzed to estimate the precipitation depths for recurrence interval storm events using the extreme value probability methods listed below:

- Pearson Type III (Pearson)
- Gumbel Distribution (Gumble)
- Lognormal Distribution (Lognormal)
- Generalized Extreme Value (GEV)

These statistical methods are commonly used to estimate infrequent events for a variety of data types, including hydrologic data. The Pearson, Gumble, and Lognormal analyses were performed using spreadsheets. The GEV analysis was performed using the computer program extRemes, which was developed to calculate extreme value statistics for weather and climate purposes (Gillelan, 2008). The results of the statistical analyses are listed in Table 2 and displayed on Fig. 4. For the range of the 100-year historical record, the results from the different methods match closely. As the data are extrapolated beyond the historical data range (i.e. for recurrence intervals beyond 100 years) the variability of the results computed from the different methods increases. The results from the lognormal analysis provide lower-bound estimates, and the results from the GEV analysis provide upper-bound estimates. The 1-in-100-year average recurrence interval results vary from 64 mm (2.52 in) to 74 mm (2.91 in), which is reasonable considering the 100-yr data range with a maximum value of 68 mm (2.68 in).

Table 2. Results of Statistical Analyses of Precipitation Data from Red River, NM

	Gumbel Estimate		Pearson Estimate		Lognormal Estimate		GEV Estimate	
ARI*	(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)
2	31	1.22	30	1.18	31	1.22	30	1.18
5	41	1.61	40	1.57	40	1.57	39	1.54
10	47	1.85	47	1.85	46	1.81	46	1.81
20	53	2.09	53	2.09	52	2.05	54	2.13
100	68	2.68	70	2.76	64	2.52	74	2.91
200	74	2.91	78	3.07	69	2.72	84	3.31
500	82	3.23	89	3.50	76	2.99	98	3.86
1000	88	3.46	98	3.86	81	3.19	110	4.33
2000	94	3.70	107	4.21	86	3.39	124	4.88

*ARI – Average Recurrence Interval

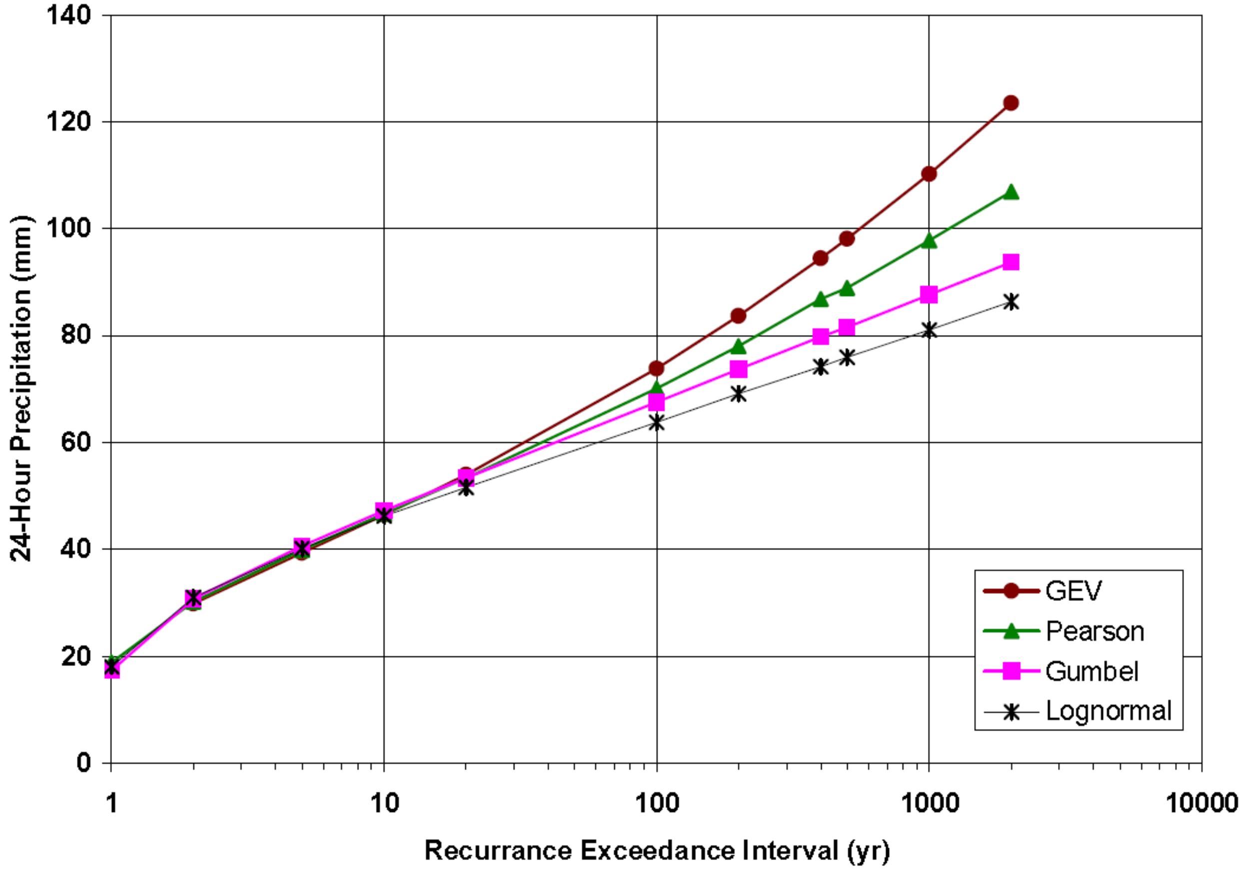

Figure 4. Comparison of Recurrence Interval Storm Calculation Methods

NOAA Atlas 14 Data

NOAA Atlas 14 includes the southwestern portion of the United States. This area was subdivided into 59 regions that were considered to be homogeneous. Region 39 of NOAA Atlas 14 includes north central New Mexico, which encompasses the locations of the Red River gage and the Questa Mine. NOAA used data from 55 precipitation stations in New Mexico and Colorado were used to estimate precipitation values for Region 39. Details for these 55 stations are included in Table 3. The latest data used by NOAA Atlas 14 are from 2000. The locations of the stations and local features are shown on Fig. 5 (Bonnin, 2006).

Table 3. Region 39 Precipitation Station Details

NOAA Station Number	Name	State	Latitude	Longitude	Elevation (m)	Years of Data*	Maximum 24-Hour Precipitation (mm)	(in)
05-0102	AGUILAR 1 SE	CO	37.4011	-104.6547	1951	21	79	3.11
05-0130	ALAMOSA WSO AP	CO	37.4361	-105.8656	2296	69	45	1.77
05-0776	BLANCA	CO	37.4333	-105.5167	2362	66	42	1.65
05-1458	CENTER 4 SSW	CO	37.7067	-106.1439	2339	57	55	2.17
05-1939	CREEDE	CO	37.8531	-106.9253	2698	21	79	3.11
05-2048	CUMBRES	CO	37.0167	-106.45	3056	40	78	3.07
05-2184	DEL NORTE 2 E	CO	37.6739	-106.3242	2399	79	65	2.56
05-3222	GARDNER	CO	37.7667	-105.1833	2123	29	80	3.15
05-3541	GREAT SAND DUNES N M	CO	37.725	-105.5189	2475	50	53	2.09
05-3951	HERMIT 7 ESE	CO	37.7717	-107.1097	2758	81	77	3.03
05-4870	LA VETA PASS	CO	37.4667	-105.1667	2818	43	109	4.29
05-5322	MANASSA	CO	37.1739	-105.9394	2344	93	44	1.73
05-5706	MONTE VISTA 2 W	CO	37.5806	-106.1861	2332	58	32	1.26
05-5990	NORTH LAKE	CO	37.2167	-105.05	2684	66	88	3.46
05-6258	PAGOSA SPRINGS	CO	37.2425	-107.0167	2210	76	93	3.66
05-7315	RYE	CO	37.9	-104.9333	2088	44	155	6.10
05-7428	SAN LUIS 3 SE	CO	37.1783	-105.4064	2443	30	76	2.99
05-8429	TRINIDAD	CO	37.1789	-104.4867	1838	96	107	4.21
05-8436	TRINIDAD LAKE	CO	37.1506	-104.5569	1865	23	75	2.95
05-8742	WAGON WHEEL GAP 3 N	CO	37.8	-106.8333	2593	23	66	2.60
05-8781	WALSENBURG	CO	37.6464	-104.7681	1874	65	94	3.70
05-9181	WOLF CREEK PASS 1 E	CO	37.4744	-106.7906	3243	41	104	4.09
05-9183	WOLF CREEK PASS 4 W	CO	37.4833	-106.8667	2876	29	124	4.88
29-0041	ABIQUIU DAM	NM	36.2333	-106.4333	1945	44	38	1.50
29-0606	ASPEN GROVE RANCH	NM	36.65	-106.1833	2959	40	84	3.31
29-0646	AURORA	NM	36.2667	-105.05	2480	52	97	3.82
29-0795	BATEMAN RANCH	NM	36.5167	-106.3167	2715	60	66	2.60
29-1000	BLACK LAKE	NM	36.3	-105.2833	2547	89	115	4.53
29-1180	BRAZOS LODGE	NM	36.7436	-106.4444	2440	31	102	4.02
29-1389	CANJILON R S	NM	36.4833	-106.45	2386	61	47	1.85
29-1630	CERRO	NM	36.7408	-105.5956	2332	87	56	2.20
29-1653	CHACON	NM	36.1667	-105.3833	2591	72	127	5.00
29-1664	CHAMA	NM	36.9178	-106.5781	2393	97	68	2.68
29-1813	CIMARRON 4 SW	NM	36.4661	-104.9456	1993	97	101	3.98
29-2139	COWLES	NM	35.8167	-105.6667	2471	60	66	2.60
29-2384	DAWSON	NM	36.6667	-104.7833	1952	52	152	5.98
29-2608	DULCE	NM	36.9358	-107	2070	90	102	4.02
29-2700	EAGLE NEST	NM	36.3908	-105.2628	2524	71	91	3.58
29-2820	EL RITO	NM	36.3333	-106.1833	2094	71	73	2.87

Table 3. Region 39 Precipitation Station Details, continued

NOAA Station Number	Name	State	Latitude	Longitude	Elevation (m)	Years of Data*	Maximum 24-Hour Precipitation (mm)	(in)
29-2837	EL VADO DAM	NM	36.6	-106.7333	2054	67	62	2.44
29-2860	ELIZABETHTOWN	NM	36.6167	-105.2833	2583	41	64	2.52
29-3031	ESPANOLA	NM	35.9833	-106.0667	1704	37	51	2.01
29-3488	GASCON	NM	35.8917	-105.4481	2514	47	88	3.46
29-3505	GAVILAN	NM	36.4333	-106.9667	2263	41	53	2.09
29-3511	GHOST RANCH	NM	36.3297	-106.4747	1969	58	56	2.20
29-4960	LINDRITH 3 NNW	NM	36.3333	-107.05	2352	29	57	2.24
29-5691	MIAMI	NM	36.35	-104.7667	1922	49	130	5.12
29-6275	OCATE 2 NW	NM	36.2	-105.0667	2333	40	85	3.35
29-6321	OJO CALIENTE	NM	36.3	-106.05	1919	35	61	2.40
29-6705	PENASCO RANGER STN	NM	36.1667	-105.6833	2416	45	57	2.24
29-7323	RED RIVER	NM	36.7058	-105.4036	2644	93	68	2.68
29-8668	TAOS	NM	36.3906	-105.5864	2123	100	74	2.91
29-8845	TIERRA AMARILLA 4 NNW	NM	36.75	-106.5667	2263	68	89	3.50
29-9085	TRES PIEDRAS	NM	36.6667	-105.9833	2481	93	74	2.91
29-9113	TRUCHAS	NM	36.0333	-105.8167	2449	53	63	2.48

* Years of data is through year 2000.

The annual maximum precipitation data for each of the Region 39 gauges are listed in NOAA Atlas 14 (Bonnin, 2006). Region 39 covers approximately 44,000 km^2 (17,000 mi^2)and includes the San Juan Mountain Range, Sangre de Cristo Mountain Range, Jemez Mountain Range, Eastern Plains, and the San Luis Valley. The lengths of the historical data range from as short as 21 years (Aguilar and Creede, CO) to 100 years (Taos, NM). The historical maximum recorded precipitation values range from 32 mm (1.26 in) at Monte Vista, CO to 155 mm (6.10 in) at Rye, CO. Elevations range from 1,704 m (5,590 ft) at Espanola, NM to 3,243 m (10,640 ft) at Wolf Creek Pass 1 E, CO.

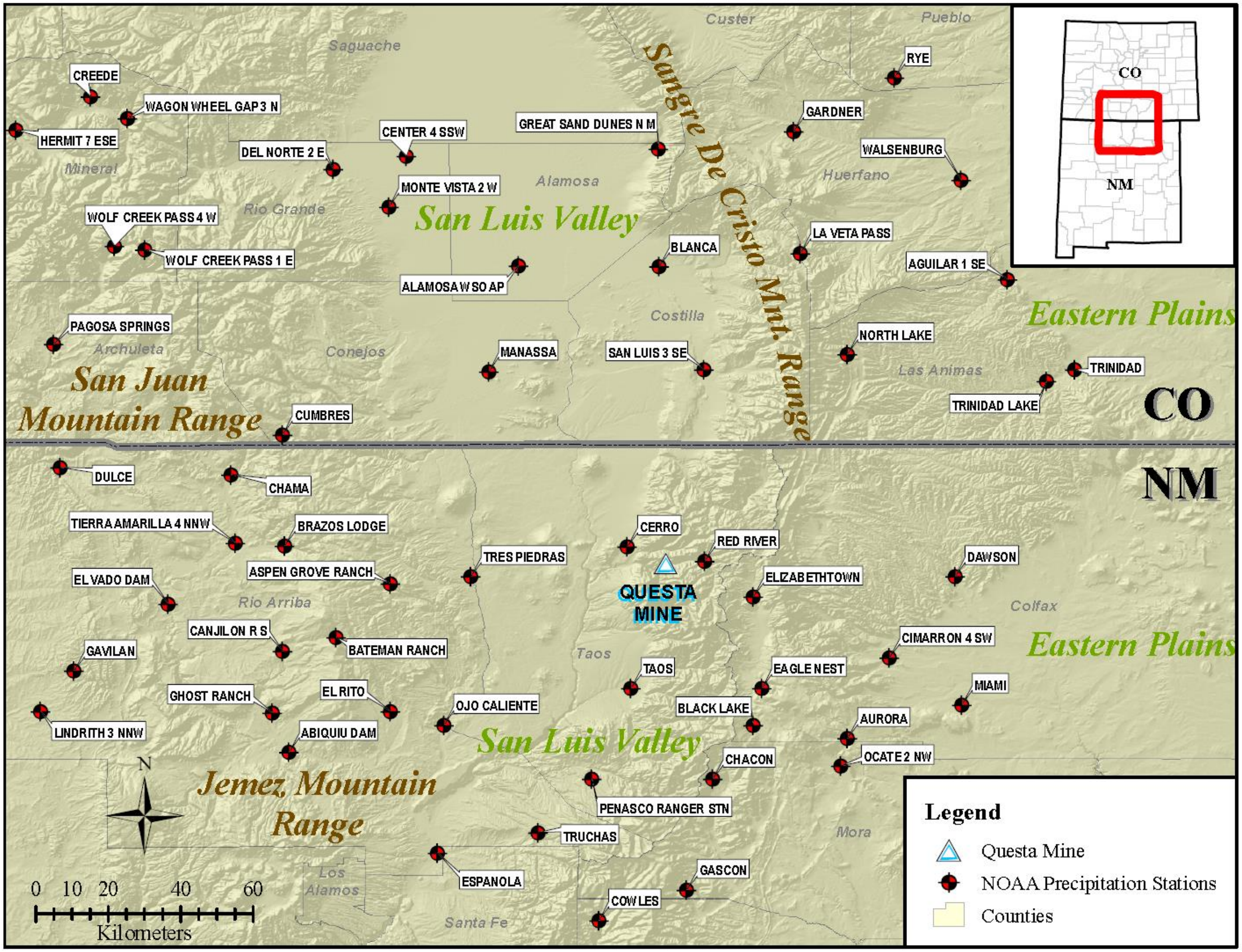

Figure 5. NOAA Atlas 14 Region 39 Precipitation Station Locations

Data from each of the 55 precipitation stations in Region 39 are spatially interpolated to estimate precipitation data for recurrence interval storms for any location within New Mexico that is within the extents of Region 39. The precipitation estimates generated by NOAA Atlas 14 for the location of the Red River station are included in Table 4 (Bonnin, 2006). The 100-year, 24-hour estimate is 94 mm (3.70 in), which is 26 mm (1.02 in) greater than the historical record of approximately 100 years at Red River. The 24-hour estimates from NOAA Atlas 14 and the estimates calculated from just the Red River data are shown on Fig. 6. Figure 6 shows that the curve generated by the NOAA estimates is offset, approximately 25% higher, from the curves generated from the Red River data, with a curve shape that is most similar to that from the GEV method.

Table 4. NOAA Atlas 14 Precipitation Estimates (mm) for Red River, NM

ARI	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day
1	14	18	21	23	27	31	33	40	47	57
2	19	23	27	29	34	40	41	50	59	70
5	25	31	36	38	43	50	51	61	72	86
10	30	38	44	45	51	59	59	71	84	99
25	38	47	54	56	63	71	72	85	100	116
50	44	54	63	65	73	82	83	95	112	130
100	50	62	73	74	84	93	94	106	125	144
200	57	71	83	85	95	105	106	118	138	157
500	67	83	98	100	112	123	124	134	156	176
1000	75	93	110	113	125	137	138	147	170	191

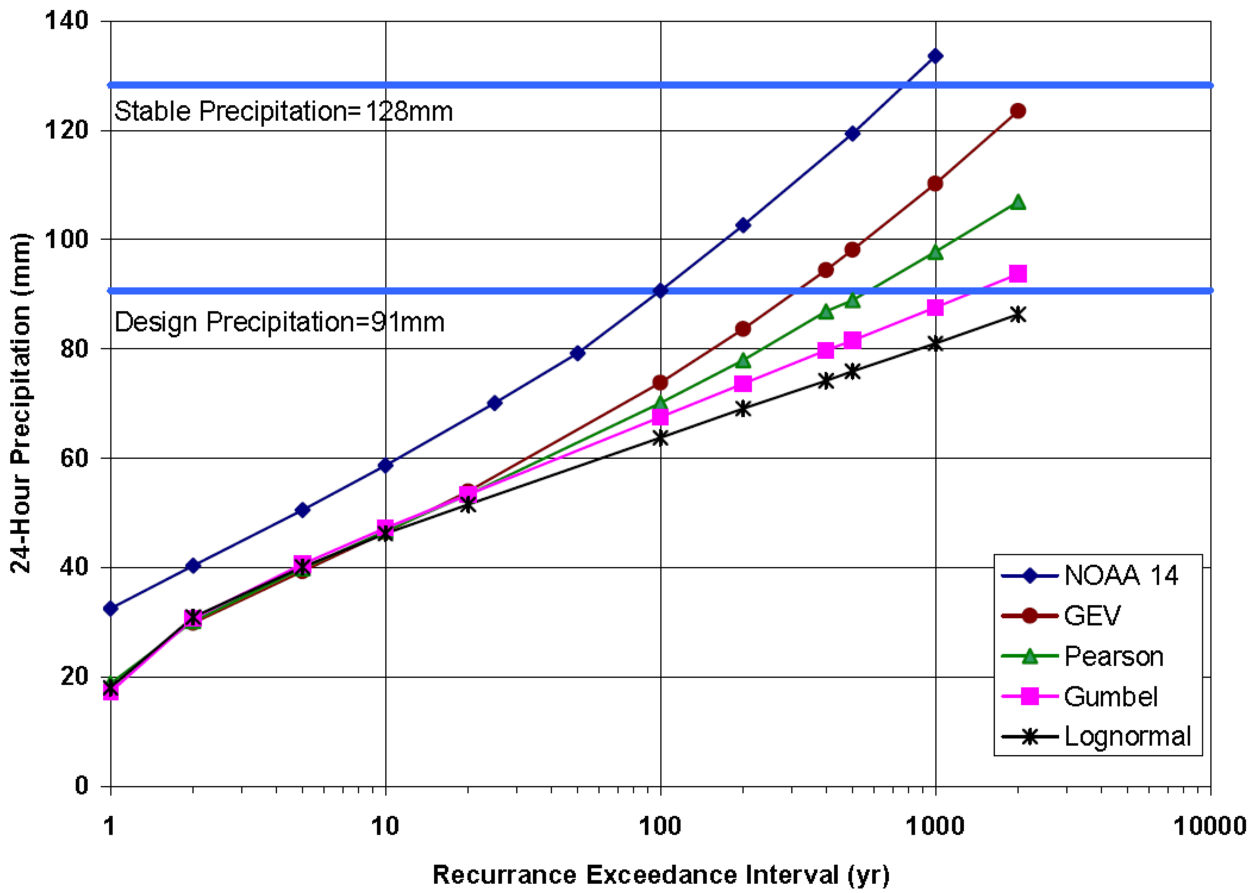

Figure 6. Comparison of Recurrence Interval Storm Calculation Methods to NOAA Atlas 14

Precipitation data measured at the Questa Mine tracks those recorded at Red River, but the mine receives approximately 25% less precipitation on an annual basis. The smaller amount of precipitation is most likely due to the mine being located at a slightly lower elevation in the Red River Valley. The precipitation estimates from NOAA Atlas 14 for the Questa Mine are listed in Table 5 (Bonnin, 2006). The 100-year, 24-hour estimate is 91 mm (3.58 in), which is 17 mm (0.67 in) greater than the historical record of approximately 100 years at Red River.

This discrepancy between the Red River and NOAA curves is likely the result of the 55 Region 39 sites not all being representative of the conditions at Red River and the Questa Mine. The precipitation gauges in the San Juan Mountain Range, Jemez Mountain Range, Eastern plains, and the San Luis Valley are in locations that are sufficiently different from the Red River/Questa Mine location that they should not be used to calculate precipitation estimates at those locations. The elevations among the Region 39 sites vary significantly, and elevation is one of the primary factors governing climate in New Mexico (WRCC, 2010). Equally as important, the surrounding terrain, and its impact on precipitation, varies significantly among most of the gauge locations and Red River. The gauges in the San Luis Valley and Eastern Plains are in relatively flat locations, and the gauges in the San Juan Mountain Range and the Jemez Mountain Range are on the leeward side of the continental divide. Several of the Sangre de Cristo Mountain Range gauge locations are also on the leeward side of the mountain range further affecting the similarities between their locations and Red River.

Table 5. NOAA Atlas 14 Precipitation Estimates (mm) for the Questa Mine

ARI	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day
1	14	17	20	21	25	30	33	39	46	56
2	18	22	25	27	32	38	40	49	58	70
5	24	29	34	35	40	48	51	60	72	86
10	29	36	41	42	48	57	59	70	84	99
25	36	44	51	52	59	69	70	84	100	117
50	41	51	59	60	68	79	79	94	113	131
100	48	59	68	70	78	90	91	106	126	146
200	54	67	78	80	89	102	103	118	140	160
500	64	79	92	94	105	118	119	134	159	180
1000	72	89	104	106	118	132	134	147	173	196

Stormwater Management Design

Stormwater runoff system structures are designed to convey runoff waters in a controlled manner. Stormwater management design at the Questa Mine includes collecting runoff from rock piles in earthen ditches, which convey flow to sedimentation basins. The steep slopes and mountainous terrain at the site limit potential locations for channels and basins. Structures also need to be sized with the minimum footprint possible to maximize the number of potential sites and to minimize construction costs. The 100-year, 24-hour storm event is typically used to design channels and non-discharging sedimentation basins.

Channel Design

Channels are constructed at the Questa Mine to convey stormwater in a controlled manner to detention ponds. Channels at the Questa Mine are typically designed using the computer program SEDCAD 4.0 (Schwab, 2005), which follows the SCS curve number method (USDA, 1986). The curve number method involves separating contributing watershed into subwatersheds that have similar soil, vegetation, and hydrologic conditions. The curve number, ranging from 40 to 100, assigned to each subwatershed is used to calculate runoff volumes and peak flows. A curve number of 72 was used to estimate runoff from mine rock piles, as they are a sandy gravel material with high infiltration rates. Native, vegetated slopes had a curve number of 60. This curve number was assumed to be representative of fully reclaimed conditions. For the channels at the Questa Mine, the Type II hyetograph was used to represent the high intensity, short duration storms that occur in the area. The typical watershed for a channel was 1.6 ha (4.0 ac). Channels at the mine were designed to be trapezoidal in shape with a 3.1 m (10 ft) bottom width and 3H:1V side slopes, 0.6 m (2 ft) depth, and a 4% channel slope. The limiting velocity for erodible channels was 1.07 m/s (3.50 ft/s).

Using the channel geometry described above with a curve number of 72 and the precipitation estimates from NOAA Atlas 14, the peak velocity in the channel would be 1.01 m/s (3.31 ft/s). Once the contributing watershed is fully vegetated and the curve number decreases to 60, the velocity would be 0.77 m/s (2.53 ft/s). This conservancy incorporated into design assumptions results in velocities that are well below the limiting velocity of 1.07 m/s (3.50 ft/s). The 24-hour precipitation amount that yields a peak velocity of 1.07 m/s (3.50 ft/s) was determined to be 128 mm (5.04 in) for reclaimed conditions (CN=60). As shown on Figure 6, this amount of precipitation is approximately a 1-in-700-year event using the estimates from NOAA Atlas 14, and it is greater than a 1-in-2000 year event using the estimates calculated from solely the Red River data.

Using the same channel geometry with a curve number of 72 and the precipitation estimates from the Red River data, the peak velocity in the channel would be 0.86 m/s (2.82 ft/s). The channel bottom width could be reduced to 1.6 m (5 ft) while maintaining the stable velocity of 1.06 m/s (3.48 ft/sec). This decreased bottom width can significantly reduce construction volumes considering the total length of the channels on one rock pile is 2,000 m (6,560 ft). Reducing the channel width from 3.1 m (10 ft) to 1.6 m (5 ft) results in 7.8 m^2 (84 ft^2) per meter of channel that does not have to be moved. The typical channel configuration, combined with the smaller channel required for the smaller design precipitation value, is shown on Fig. 7. The smaller channel design results in 46% less earth that has to be moved. Considering the 2,000 m (6,560 ft) of channel, this can potentially result in a significant cost savings.

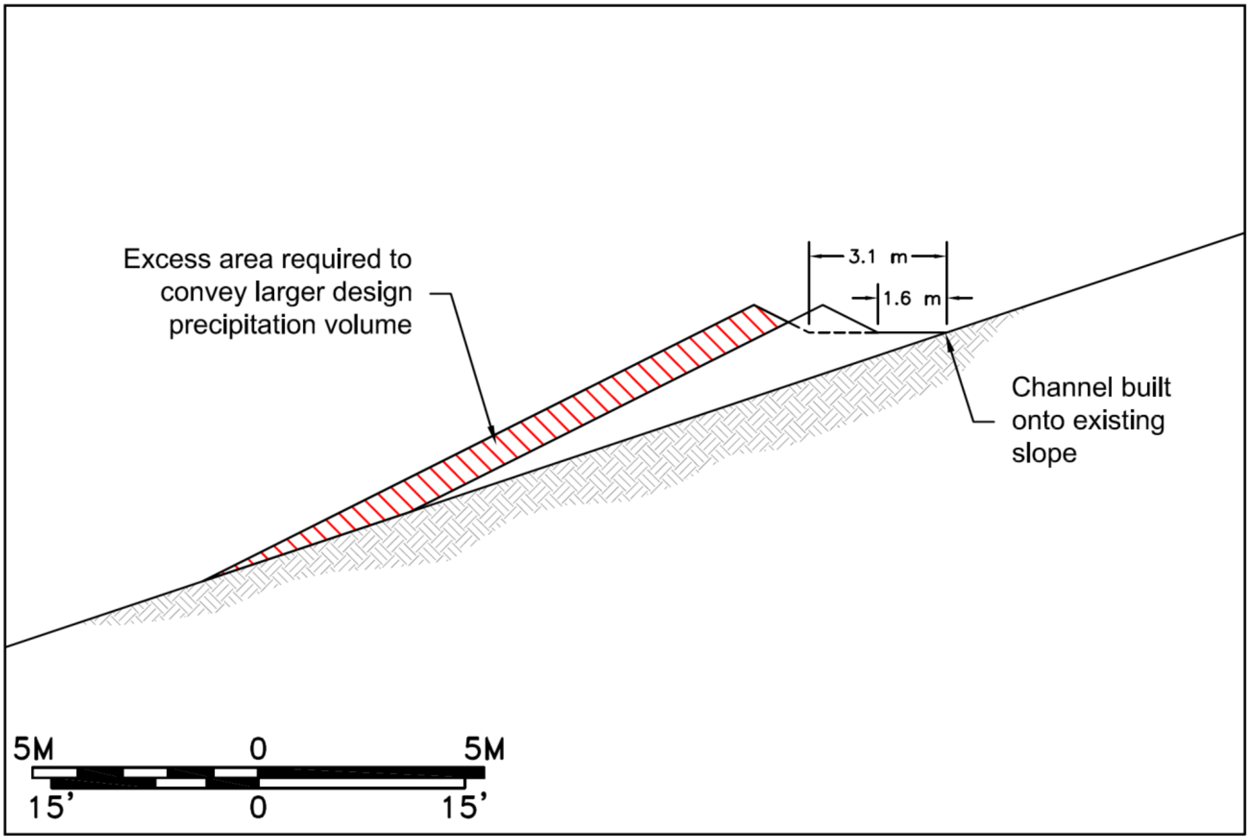

Figure 7. Typical Channel Design Showing Excess Area

<u>Sedimentation Basin Design</u>

Sedimentation basins at the Questa Mine are also designed using the SCS curve number method. The same curve numbers (72 for rock piles and 60 for native slopes) are used for sedimentation basin design as channel design. The mountainous terrain limits the number of potential locations for sedimentation basins, and the watershed for an existing sedimentation basin is approximately 28 ha (70 ac). Sedimentation basins are typically designed to be non-discharging structures and are therefore designed to contain all the runoff from the 100-year, 24-hour storm event. The NOAA Atlas 14 precipitation estimate of 91 mm (3.58 in) was used to design the structure, and the sedimentation basin has a containment capacity of 8,620 m^3 (6.99 ac-ft). Using the precipitation estimate of 74 mm (2.91 in) calculated from the Red River data, the sedimentation basin only needs a containment capacity of 5,430 m^3 (4.40 ac-ft). This equates to a reduction in the excavation volume of 3190 m^3 (4170 yd^3) or 37%. The basin was lined with HDPE, and reducing the volume would reduce the aerial extent of the basin, further reducing the cost to construct the basin. The lined area could be reduced from 5260 m^2 (56,600 ft^2) to 3240 m^2 (34,800 ft^2). The reduced area of 2020 m^2 (21,800 ft^2) is a 39% savings. Figure 8 shows an existing sedimentation basin that highlights the excess area required due to the larger design precipitation. The smaller rainfall volume not only reduces construction cost of one sedimentation basin by 38%, but it increases the number of potential locations for the sedimentation basins by reducing the required footprint.

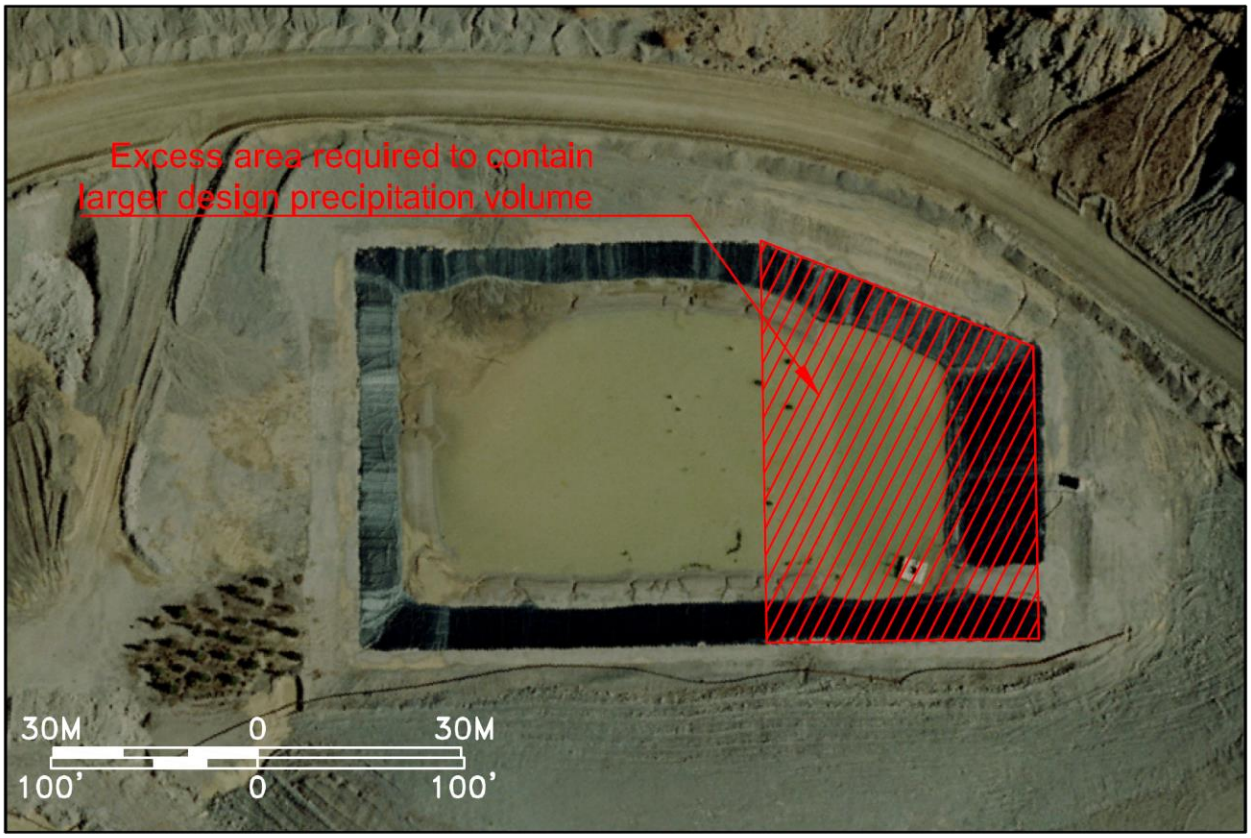

Figure 8. Existing Sedimentation Basin Showing Excess Area

Conclusions

A comparison of the historic precipitation data from the gauge at Red River, NM to the estimates calculated from NOAA Atlas 14 demonstrated that the 100-year, 24-hour precipitation of 94 mm (3.70 in) estimated by NOAA Atlas 14 was significantly greater than the maximum 24-hour precipitation value of 68 mm (2.68 in). Analysis of the Red River precipitation data using accepted extreme value statistical methods resulted in an estimate of 74 mm (2.91 in) for the 100-year, 24-hour storm. Site specific data are always different than regionalized data, especially in northern New Mexico, where there are relatively small amounts of precipitation and diverse topography and relief. The best available input data should always be used for modeling purposes, and site specific data are preferred over regionalized data, provided the site specific data are accurate. Using the higher precipitation estimates from NOAA Atlas 14 results in stormwater structures that have been designed for much larger storm events. This results in more expensive structures and limits the placement options. A channel system costs an extra 46%, and a sediment detention pond costs an extra 38% when the NOAA Atlas 14 data are used and not the site specific data. The lower precipitation numbers still allows for a conservative design of stormwater structures as the structures are estimated to be stable during runoff from storm events larger than the 1000-year, 24-hour event under long-term conditions, when they are required to convey up to and including the 100-year, 24-hour event.

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