Appendix A.6

HDSC Spatial Precipitation Frequency Review
Comments and Responses
Semiarid Southwest

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Introduction

The Hydrometeorological Design Studies Center (HDSC) conducted a peer review of the spatially interpolated precipitation frequency estimates for the Semiarid Southwest United States from October 25, to December 6, 2002. This document presents a consolidation of all the spatial review comments with HDSC's response. For the most part, the wording of the comments was unchanged to make sure the meaning was not misconstrued and so individual reviewers can identify their comments. HDSC requested comments from roughly 84 people or agencies, we received comments from only 12. After parsing all of the comments, we found 34 unique comments and they are included in this document.

Similar issues/comments were grouped together and are accompanied by a single response. The comments and their respective responses have been divided into seven categories:

1. **Cartographic comments**
2. **General comments**
3. **Are estimates and patterns reasonable when compared to your local or regional knowledge?**
4. **Are stations located correctly on the map?**
5. **Are extremes (high and low) reasonable and located properly?**

1 Cartographic comments

1.1 There seems to be less isopluvials than NOAA 2.

Response: Although it was not explicitly stated, the review maps were designed to provide maximum "reviewability" and do not necessarily portray how the final maps will look. The final published maps (as PDFs) will include more contours at the lower levels and fewer at the higher levels. We will try to provide as many contours as possible.

1.2 I was also unable to identify the county lines for either state on both the black and white and colored maps.

On the PDF version of the Maps the County lines are barely visible on most plots of the map at any scale. The Highways are very faint at a sheet of 11 X 17.

Response: Thank you…we will increase the line size of the county lines and perhaps the highways.

1.3 The units being used (tenths of inch) need to be very obviously displayed so people don't go and use 52 inches for 0.52 inches.

Response: Our hope was that if we use the same standard used in NOAA Atlas 2 (tenths of inches) that we would actually avoid confusion. An added advantage (in using tenths of inches) is the omission of the decimal point, which allows for more room. Regardless, we will try to make the units obvious.

1.4 On several contiguous sheets although the isolines look identical the little labels (38, 36, and so on) are in different locations. An example is California NW of the intersection of 35 N and 115 W on the mountains trending NE up towards Nevada, where there are labels 52 and 44 for those lines, but they are not on the corresponding part of the Nevada map. (Am I making any sense?) Another example is on the Arizona map, west of the 37 N and 114 W intersection, where the isoline labels for 34 and 32 are placed differently on the isolines than they are on the Utah map. I realize that as long as the labels are on the right isolines they are OK, but I don't know how much you want the overlapping map parts to match each other.

Response: The labels are placed according to a complex algorithm in ESRI's ArcMap (part of the ArcGIS suite). We are not overly concerned with identically overlapping map labels. As you pointed out, as long as the labels are on the right lines, then things are okay.

1.5 Utah, 100-year, 24-hour analysis: I see on all the maps provided that the observing site is noted by a red dot with the station name shown. However, looking in the vicinity of Logan, Utah, I see several stations indicated by a red dot but no station name supplied. Does this have some significance to how individual station data was handled or analyzed? I ask this because I noted that just south of this location that the current Precipitation Frequency (PF) analysis provides depths much higher than NOAA Atlas 2. It seems that on all the other maps provided me to review, wherever you had a red dot, a station name was indicated.

Response: The labeling anomalies you raise are associated with the mapping software and will be corrected. They do not reflect a station's importance, weighting or treatment

1.6 The station name for "Tijeras Ranger Station" appears to obscure the name for "Albuquerque WSFO Airpo". Can this title be relocated?

Response: The final, published maps will only contain about the same number of city/town labels as NOAA Atlas 2, so over-lapping labels will become a non-issue. Labels were provided on the review maps for review purposes only.

1.7 Mean Annual - 60-Minute NM : At approx 35.6 deg N and 106.8 deg W there is a small "7" with a very small associated precip. contour. Some larger isolated zones are located between 36 and 37 N at 105 to 106 W.

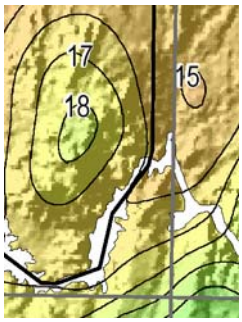
Response: The very smallest contour areas will disappear in the final maps. The contour must meet a certain threshold to be maintained. Hopefully this will tidy up the map, but without loosing an appropriate level of detail.

2 General comments

2.1 Most of my previous concerns are still the same, but would the NWS be installing new/updated gages at more locations (now/soon), so that there will be ample data for the next cycle update?

Response: NOAA's National Weather Service performs precipitation frequency studies at the request of and with funding provided by others. While we agree with the need to improve the resolution of the observing network, we have no mandate to make observations for this purpose.

2.2 Also, the isopluvials were hard to read on the state map due to color and scale, so I enlarged the area I was interested in but it was extremely difficult to print out at the larger scale (it took about an hour to download) and then I still didn't get the area I wanted...maybe it's just my computer.



Response: HDSC will try making some adjustments to the labels so they are clearer. You may also want to try using the Adobe Acrobat Reader "Graphic Select Tool," which allows you to select a portion of the map, copy it, and paste it into another document (word processor, web page, etc.). This is a nice way of showing the detail of an area that you've zoomed into. (See example on previous page)

Keep in mind, the final maps will be at the same scale (1:2,000,000) and projection (Lambert Conformal Conic) as those in NOAA Atlas 2, which means the paper size will be about that of the review maps (17"x22").

2.3 I note that Albuquerque, NM is not included on the list of Dense Area Rain Gauge Networks for the Depth-Area-Duration (DAD-Spatial Relations) study. Several years ago, I had the impression that the Albuquerque data was one of the primary sources for the DAD study.

The precipitation data collected by the USGS for the Albuquerque area is not yet on any of the maps. I understand that at least some of this data has sufficient time for inclusion in the 60 minute and 24-hour maps.

Response: By agreement with the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), we did not include these in the review maps, however in the final maps/grids, six additional stations/gauges in/around Albuquerque will be included. However, initial results indicate the pattern and magnitude of the precipitation frequency will not change appreciably.

2.4 I have not seen any recent information on n-minute factors since the Thirteenth Progress Report. Recent discussions with Mr. Tye Parzybok have indicated that the maps and precipitation-frequency tables on the web site will incorporate the n-minute factors (with maps available at 5-minutes, 10-minutes, etc). If there are primary maps and tabular values, with n-minute and other time or frequency (ie: 2-hour or 5 year data) data some mathematical function of the primary maps (ie: 5-minute at 33 percent of one hour), then information to identify the primary maps and the mathematical relations would be very useful. Ultimately, the new precipitation map data will be used in numerical models that predict runoff, plant growth, groundwater infiltration and similar physical conditions. Some models will use point precipitation and others will need to review extensive areas. If the mathematical relations are published in an accessible document, then this information can be utilized in future model procedures. The USGS PERFRE program is an example of a program that uses selected precipitation data to obtain a wide range of precipitation frequency values. There are many hydrologic models that use selected precipitation values (ie: 1-hour, 6-hour, 24-hour) to derive design distributions. If there are no unique relationships that can be applied, that is also useful information.

Response: The final report will provide the ratios we used to convert the 60-minute maps to the 5-, 10-, 15- and 30-minute grids/maps. Furthermore, maps/grids of these durations will be available. The Precipitation Frequency Data Server (PFDS) will have the ability to provide either point or areal estimates, depending on your needs. And just to reiterate, the final deliverables for this study will include complete (point and area) precipitation frequency estimates, at all locations, for all study durations at all study frequencies, regardless of station type.

2.5 Is it possible to produce a PDF copy of the maps that clearly prints in black and white? In many cases, the maps will be reproduced in reports and legal documents. The use of color in OK for some applications, but in many cases provides no particularly useful information. The black line format of the old maps may be better that color PDF maps in many applications. Additionally, they will download faster. PDF and TIF are good common use formats because many users will not have access to Arc-Info.

Response: Printing in black and white is easy, but making it clear is another issue. Although our tests have shown that black and white versions of the review maps are hard to read, they are still readable. We recognize the dilemma you raise and we will do what we can to address this. If cartographic maps weren't so labor/time intensive to create, the solution would be to create simple, black and white maps (without topography and interval shading) as well as color maps.

2.6 Will the documentation that comes out with these maps include methods to obtain values for other durations and frequencies that are not actually mapped?

We have need of rainfall data for specific frequencies: 1, 5, 10, 25, 50 100 year, and so forth. How do we get those figures from the new maps?

Response: All point values at the following durations and frequencies will be available through the online Precipitation Frequency Data Server (PFDS); see table below. For those with GIS capabilities, shapefiles of all the maps (5-min through 60-day, 2-year through 1000-yr) will be available through the PFDS. Additionally, GIS ArcInfo ASCII grid files will be available for all frequencies and durations. Cartographic maps will eventually be available for all states in the Semiarid Study area, all frequencies/durations, however at the time of initial delivery only a sub-set of cartographic maps will be available. The "index flood" grids will not be a final deliverable.

Initial (base) grids	Mean ("index Flood")
60-min	*
120-min	*
3-hr	*
6-hr	*
12-hr	*
24-hr	*
48-hr	*

4-day	*
7-day	*
10-day	*
20-day	*
30-day	*
45-day	*
60-day	*

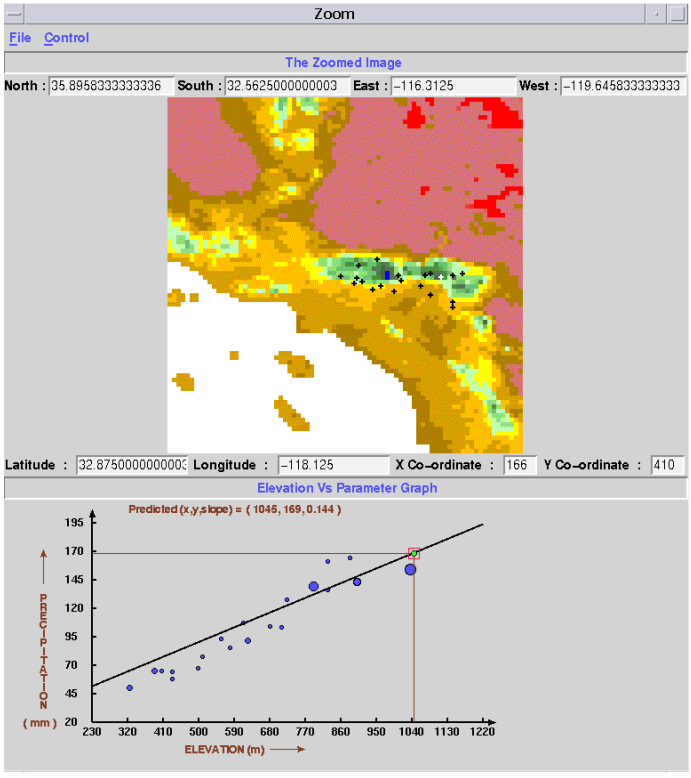
Precipitation frequency grids	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	1000-yr
5-min	*	*	*	*	*	*	*	*	*
10-min	*	*	*	*	*	*	*	*	*
15-min	*	*	*	*	*	*	*	*	*
30-min	*	*	*	*	*	*	*	*	*
60-min	*	*	*	*	*	*	*	*	*
120-min	*	*	*	*	*	*	*	*	*
3-hr	*	*	*	*	*	*	*	*	*
6-hr	*	*	*	*	*	*	*	*	*
12-hr	*	*	*	*	*	*	*	*	*
24-hr	*	*	*	*	*	*	*	*	*
48-hr	*	*	*	*	*	*	*	*	*
4-day	*	*	*	*	*	*	*	*	*
7-day	*	*	*	*	*	*	*	*	*
10-day	*	*	*	*	*	*	*	*	*
20-day	*	*	*	*	*	*	*	*	*
30-day	*	*	*	*	*	*	*	*	*
45-day	*	*	*	*	*	*	*	*	*
60-day	*	*	*	*	*	*	*	*	*

2.7 We rarely use the 2.3 year frequency. Is this present for geomorphologic studies?

Response: No. The 2.3-year frequency map, also known as the "index flood" map represents the mean of the annual maximums and is the mean of the probability distribution at each location. It was sent out for review because the PRISM process of determining the spatial interpolation is applied at this frequency. That grid is then used to derive the spatial grids for all other frequencies and as a result needs to be critically evaluated. This map will not be part of the final deliverable.

2.8 In general, this current spatial analysis is by far a more consistent methodology applied to distribute precipitation frequency estimates throughout the mountainous western States. As I expressed at meetings held at the office of the National Weather Service some time ago, use of mean annual precipitation to distribute precipitation frequency estimates would likely result in precipitation frequency values increasing in magnitude in the higher elevation orographic regions, compared to what is currently provided in NOAA Atlas 2, and in most cases (not all) this comment has been validated by the review I just completed. This fact is especially noted when comparing 100- year, 24-hour precipitation frequency values with tentatively revised versus NOAA Atlas 2 results. The reason I gave as to why this would happen is that in the derivation of a mean annual analysis much precipitation at high elevations can be an accumulation of very light rain/snowfall that over time becomes unrepresentative of storm events defining precipitation occurrences lasting only hours to a few days/weeks. As far as the concerns that I have and what are the true causes or how they might be addressed

Response: You've pointed out perhaps the biggest concern people have expressed about using mean annual precipitation as a "predictor" layer for precipitation frequency maps. However HDSC is now satisfied with the approach. We are only relating mean annual precipitation (MAP) to mean annual maximums, which are both statistically stable and have a strong local correlation. By locally, we mean in a particular area, because if you related MAP to mean annual maximum precipitation over the entire Southwest, the relationship would be poor, justifying your concern. However, at a local level, the relationship is quite strong. The graphic at the left shows the relationship of MAP (y) to the 2-year 24-hour precipitation (x). In fact, we found the square-root of MAP relates even better to the 2-year (and/or 2.3-year "index flood") precipitation frequency estimates, so the relationship is even stronger than shown in graphic to the left. As you can see, there is only limited scatter around the linear regression line. We are utilizing SNOTEL data at the higher elevations where it is available and have found that the relationships between mean annual precipitation and



mean annual maximum precipitation remain sound at those elevations as well. The availability of the SNOTEL data also puts a "cap" on the need to extrapolate in many cases. PRISM allows us to examine the specific regressions at each pixel and by doing so we have become quite confident in the relationship throughout a broad spectrum of elevations and climates.

2.9 I found the colored maps somewhat easier to use than when I printed he maps out in black and white. However, I was unable to download some of the maps in color. Evidently the files must be too large for my system - particularly the 100-yr 24-hr maps.

Response: Downloading problems could be the result of several factors. As part of the final download web page we will provide a "troubleshooting" section for resolving this kind of issue.

2.10 Was it impossible to obtain more data from the Hopi, Navajo, and Apache Reservations? I recall that a number of years ago the NWS state office in Phoenix, Arizona, turned over a number of raingages to those reservations to operate. What happened to the gages and gage data I do not know. The only area on the Navajo Reservation that appeared a little low was the Chuska Mountain area northeast of Lukachokai. The 24-hr values look o.k., but the annual maximum and 100-yr 60-min values may be low. However, I realize that recording gage data are apparently not available for that area.

Response: We have contacted the Arizona State Climate office about this. Depending on the availability, quality, format, and relevance of the data, we will make a judgment as its applicability and usability in the study. However, we are fairly comfortable that with the existing data, coupled with our spatial interpolation process, we are producing appropriate spatial results in this area. Regardless, we will examine any additional data we find in the Chuska Mountains.

2.11 Use of District (Riverside County, California) Station Data over NWS Station Data for stations already incorporated into the NA14 Study. The District maintains 5 NWS Stations that have been included in the NA14 precipitation study (Idyllwild Fire Dept, Cabazon, Temecula, Beaumont, Winchester). The District provides the raw tapes from these District maintained stations to NWS. However, the District also performs corrections and quality control of the NWS station data. These corrections include reconstruction of missing events and removal of erroneous data. These corrected data sets are not routinely provided to NWS nor are they available through NCDC. The corrected sets have been transmitted to you by Steve Clark of our staff. The District strongly recommends the incorporation of these revised data sets into the NA14 model - for both 24-hour and 60-minute duration analyses.

example 1: Beaumont Station was malfunctioning from 2/19/98 to 4/8/98. For this reason approximately 9.8" of rainfall that occurred during the "March Miracle" does not appear in the NCDC Station Data. The "March Miracle" rainfall events have been reconstructed by the District and are included in the District's internal Beaumont Station data sets. The other stations have corrections of similar magnitudes for various events between 1981-2002.

example 2: Winchester Station - The NCDC Station Data extends from Dec 1947 - Feb 1971. At that point NWS discontinued this station. The District however has continued record keeping for this location and with an n-minute station and has an additional 26 years of n-minute record that has not been incorporated into the NA14 study. Comparisons of District and NA14 station analysis indicate that the NA14 analysis is 20-30% low for both 100-year

and 2-year frequencies. It should be noted that the Cabazon Station is similar to Winchester - NWS ceased station operation in 1974, the District replaced it with a n-minute station in 1975. Addition of these data sets would also add more data points for the short duration (60-minute) analysis.

It should be noted that the District's data sets for Beaumont, Cabazon, Idyllwild and Temecula do not include the NWS records before January 1981 (or 1975 for Cabazon), when the District accepted maintenance of the stations. This will require that the District and NWS data sets be merged. The Winchester station was taken over in 1975 and it is my understanding that this data set does include the pre-1975 NWS data.

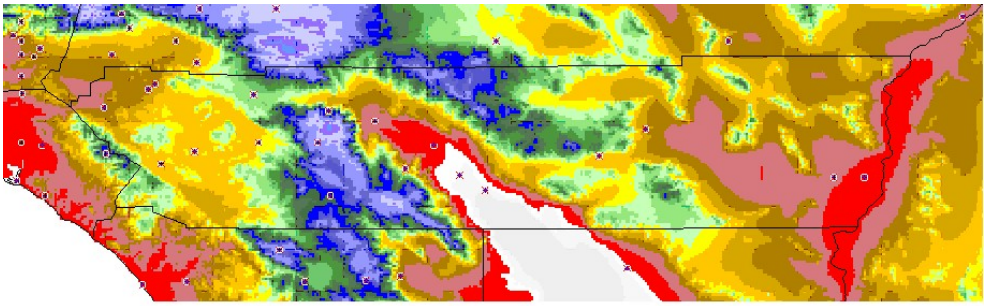
The Anza, Riverside Fire Station #3 and Sun City NWS stations (daily records only in NA14) have a District n-minute station at the same site. Incorporation of the District Station Data would allow for these stations to be used for the 60-minute duration frequency maps. The equivalent District Stations are Anza (Station # 005), Riverside South (Station #179), and Sun City (Station #212), respectively.

Response: We are considering the inclusion of additional data supplied by Riverside County.

2.12 The District (Riverside County, California) has significant concerns with the use of the mean annual precipitation map as a parameter in the solution of regression equations for determining mean precipitation for any given duration. Our concern is that very few (we understand 6 or 7) data points were used in Riverside County to develop the MAP. This may not be nearly enough data points to define a MAP in this hydrometeorologically complex region. Since the mean 24-hour and shorter duration precipitation estimates were developed from the MAP for the NA14 study, we also have concerns regarding their validity. We understand and appreciate that the MAP was peer reviewed, and that your regression analysis of 24-hour, 2 year data to MAP demonstrated a strong correlation, but we remain concerned because of the limited number of station data points used in the regression analysis. Particularly since about a year ago the District provided NOAA with annual series n-minute data files for 38 stations, all with relatively long records. It was reported back to us that with the exception of four "flier" events at four stations, that the data sets were found to be of high quality. The District feels that all of this information should have been used, and question if the inclusion of this information in the regression analysis would not have demonstrated a problem with the methodology.

The District believes that all its high quality n-minute data sets should have been incorporated in the NA14 study. At a minimum, we believe the 24-hour mean to MAP relationship should be validated against all District n-minute data not previously used, and that the regional L-moment statistics adopted for NA14 over Riverside County also be validated against the District's data sets.

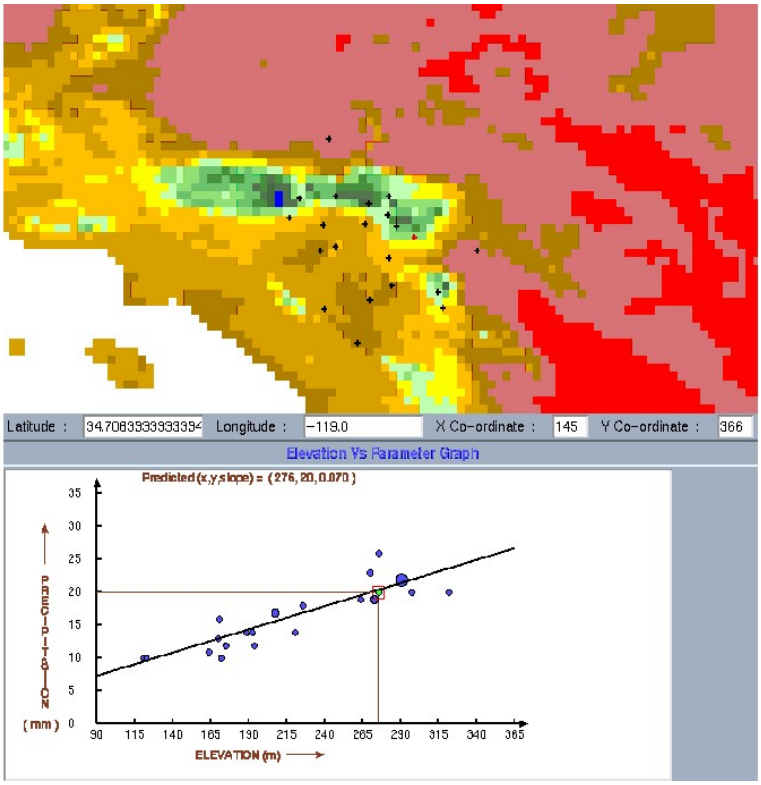
Response: Actually there were 19 stations within Riverside County that were used in the development of the PRISM MAP. See graphic below:



Locations of Riverside County stations used in development of the PRISM 1961-1990 mean annual precipitation (MAP) grids. Background is 1-km elevation grid.

To help address your concerns with using MAP as the predictor for the mean annual maximum (a.k.a. "index flood") values (particularly at the short durations), see the graphic below (next page). This is a screen snap shot from the PRISM graphical user interface (GUI). Notice that we are not actually using MAP, but the square-root of MAP regressed against the "index flood." Although the PRISM GUI has the x-axis labeled as "ELEVATION," this is actually the square root of MAP, while the y-axis is the 1-hour "index flood." The background color map (grid) is MAP at a resolution of 4-km (2.5-min).

PRISM scatterplot of sqrt(MAP) vs. 1-hr index flood values for the San Bernardino Mtns. Background is 4-km MAP. Red plus sign is pixel being estimated, black plus signs are stations. Size of scatterplot symbols denotes station weights. R2 of linear regression is 0.83.



Regardless, we are considering adding additional data supplied by Riverside.

3 Are estimates and patterns reasonable when compared to your local or regional knowledge?

3.1 Utah, 100-year, 24-hour analysis: Just east of 38N and 111W and about at 37.80N and 109.30W there are two centers of precipitation identified. The former center has a central value of 36 whereas the latter has a value of 52. Why would the precipitation values at these two locations be that different in magnitude? I see that at the latter center that there are several stations (one also unnamed) available to help describe the point frequency in that area but at the other location, none to limited data are observed. To me the terrain features look similar and I wonder why one location analysis provided such a larger central value than at the other location.

Response: The center (3.6") atop the Henry Mountains is lower than the center (5.4") atop the Abajo Mountains largely because the mean annual precipitation is lower in the Henry Mountains than the Abajo Mountains (27" vs. 37"). In fact, the mean annual precipitation in the Henry's is lower than in the Lasal Mountains (32") to the northeast. Although the PF maps don't have a gage in the Henry Mountains, the lower mean annual precipitation is justified by a gage in the southern portion of the range. The relationship PRISM develops between the mean annual precipitation and the 2.3-year precipitation for the Henry Mountains uses information from the Abajo and Lasal Mountains as well.

3.2 New Mexico, 100-year, 24-hour analysis: At a location located just south of the center of the State, at Bosque Del Apache, a high precipitation center is indicated that looks suspicious when compared to surrounding topography (especially in relationship to another center located immediately to the northwest). I assume that the data obtained at Bosque Del Apache is the driving force behind the current analysis for this location. Please recheck the station precipitation for this station to verify if the analysis is good. Would think that if this station data is valid than one would have to greatly increase the general level of nonorographic precipitation throughout the majority of the State. I notice that there is no center as such that shows up on the mean annual, 24-hour map for Bosque Del Apache.

Looking at the NM draft 100 yr 60 min precip map: The 2.7 "bullseye" over Beaverhead (Gila) should be less of a concentric circle and more terrain oriented (higher elev gets bigger precip...SW slopes get more precip than valleys and E slopes...)

Response: These stations have been the focus of much attention. Bosque Del Apache and Beaverhead RS are being treated as "at-site" stations. In other words their annual maximum precipitation series were markedly different from other stations in the area. We have extensively checked the data and have eliminated that as a source of this discordancy. The result is that neither station could be used for estimating "regional" shape factors for the probability distributions and each has been treated individually. i.e., each of them has their own unique "at-site" probability distribution function. We are reluctant to simply discard these sites and have followed the convention of including them despite their discordant nature, but based on your comments we will experiment with ways to mitigate the "bullseyes."

3.3 Nevada, 100-year, 24-hour analysis: One of the driving forces for Reclamation to do a re-analysis of precipitation frequency for the southwest States were comments from Reclamation Regional staff located in Boulder City, NV. They really felt that the magnitude of various return period precipitation was too low, especially around the Las Vegas area and for short durations. I see on the re-analysis that the 100-year, 24-hour estimate has gone from a level of

about 30 in NOAA Atlas 2 to a 24 for the current analysis. This would be in the opposite sense from what my Regional people have indicated. I haven't run any short duration comparisons but I hope that the new analysis would be at least somewhat higher than what NOAA Atlas 2 provided for various return periods in the Las Vegas region.

Arizona, 100-year, 24-hour analysis: the Reclamation's Regional people also thought that the short duration precipitation in and around Phoenix was too low and analyzed in NOAA Atlas 2. However, the new analysis for 100-year, 24-hour indicates even a lesser value now than what is given in NOAA Atlas 2. There appears to be abundant station data available so I'd only ask that you check and make sure what you are going to provide for short duration precipitation frequency estimates for PHX is reasonable.

I noted that in general, precipitation analyzed in valleys of larger areal extent appear to be usually lower than that provided in the current NOAA Atlas 2 publication. The reasons for this in general are not obvious to me for I thought the addition of many more stations and increased years of record might help verify what was originally provided in NOAA Atlas 2 and the revised precipitation frequency analysis would be even closer than what is currently indicated. As far as the concerns that I have and what are the true causes or how they might be addressed?

Response: Based on the station data, two-thirds of the Semiarid results are within +/- 10% of NA2 (for 100-year 24-hour), which is remarkable considering all of technological changes/advances we have implemented. This gives us confidence that we are in fact homing in on the "real" point probabilities. Regardless of more stations, more data, more observed extreme events, the point precipitation probabilities are staying about the same. However, there are areas where the estimates have changed.

Greater numbers of rain gages generally lead to more observed extreme events and we now have reasonably dense rain gage networks in the area of concern. This can lead to a false impression that point precipitation frequency estimates have increased. We looked for climatic trends in the data for the Semiarid Study area and found no obvious linear trend or shift in mean or variance for the majority (~87%) of stations. We had already carefully examined these data and our results because of the changes you have noted, and are confident in our estimates. Your observation that large (areal extent) valley's tend to be lower than NOAA Atlas 2 is interesting. It was once feared that PRISM's linear regressions would drag the interpolated precipitation frequency estimates too low in climatologically dry, open valleys. From what we have seen thus far this is not happening, but your comment warrants further investigation. Another possible reason for this is the lack of topography for the NOAA Atlas 2 analyzers to use while drawing contour lines. In effect, this would lead to generalizations in valley's where now we have more detail.

3.4 The following comments regarding the draft precipitation maps are based on comparisons of the NA14 isohyets to point depths from regional station analysis of 38 District (Riverside County, California) n-minute stations. Thirty-three of these stations were not incorporated into the NA14 study. The District's station analysis was performed using the regional methods described in the California Department of Water Resources Bulletin 195. We have found reasonable correlation between the results of District's station analysis and station analysis performed using the techniques adopted for NA14 on comparable data sets. The District therefore believes that the comparison provides a reasonable indicator of regional accuracy of the Draft Precipitation Maps. Nearly all 38 n-minute District stations used for this review had lengths of record exceeding 20 years. Unfortunately, we found major variations between the

District's station analysis and the NA14 isohyets where the District's data was not incorporated into NA14. The District also discovered what we believe to be some data quality issues with data sets incorporated into the NA14 study.

The District (Riverside County, California) has identified four major regions of concern from its review of the preliminary NA14 Mean Annual and 100-Year Precipitation maps. The District feels that addition of District n-minute Station data within these areas would provide the additional detail necessary to accurately model the precipitation variation within these regions. For each region of concern, the District would recommend that the subsequently listed stations be added to the study. The District provided NOAA with data for these stations in July 2001. The corresponding District Station Number and years of record are listed in parenthesis.

1) The Easterly (leeward) side of the San Jacinto Mountains shows 60-minute storm isohyet values 30% to 40% lower than the District's analysis. The 24-hour storm values are also consistently low. Please add the following Station Data Sets to your model:

-Tachevah Dam (#216, 34)
-Tramway Valley Station (#224, 24)
-Whitewater North (#233, 24)
-Thousand Palms (#222, 43)
-Cathedral City (#034, 34)
-Haystack Mountain (#081, 22)
-Pinyon Flat (#157, 24)
-Snow Creek (#207, 13)
-Wide Canyon Dam (#243, 26)

2) The Northwest corner of the County shows isohyet values 25% to 30% higher than District analysis. Recommended stations to add:

-Norco (#131, 19)
-Lake Mathews (#102, 40)
-Woodcrest (#250, 46)
-Chase and Taylor (#035, 34)
-Mira Loma (#120, 30)

3) The District believes the Anza Valley area is a significantly different region than the Hurkey Creek and Idyllwild areas to the north, which are dominated by significant orographic influences. We believe this is why the Anza record (Station #005, 43 years in length) was found discordant with respect to other stations within the region. The isohyet values for Anza and Aguanga Valley, an adjacent District n-minute station within the same orographic region but not included in the study, appear significantly higher than District station analysis would indicate for the 24hour duration. Agaunga Valley station analysis also indicates that the 60-minute isohyets may be 40% higher than necessary. Recommended stations to add:

-Aguanga Valley (#002, 22)

4) Isohyets in the area surrounding Santa Rosa Plateau appear consistently low, often by as much as 40%. Recommended stations to add:

-El Cariso Station (#062, 23)

-Wildomar La Cresta (#274, 12)
-Santa Rosa Plateau (#199, 12)
-Murrieta Creek at Tenaja (#128, 15)

The District has identified two additional stations that may need to be considered in the study. Isohyet values for the 100-year frequency durations at Banning Bench appeared approximately 20% low. Isohyet values at the 60-minute San Jacinto Valley Station appeared approximately 25% low.

-Banning Bench (#011, 27)
-San Jacinto Valley (#186, 12)

Response: The data sets form Riverside County we have been analyzing were those agreed on with County staff late last year. As a result of further discussions during the last few weeks we are adding additional Riverside County data to the analysis.

3.5 The 3.6 Red Bluff "bullseye" seems a bit artificial.

Response: This is an artifact of the contour interval interacting with the low gradient in the estimates and does not appear in the underlying gridded data. We will try to mitigate the artifact by modifying some of our map derivation steps.

3.6 Regarding the NM 100-year 1-hour map…Higher terrain from north of Chama to east of Tierra Amarilla (N - NE of El Vado Dam) should show some sort of maximum contouring...not unlike what is already depicted N of Abiquiu Dam.

Response: In order to justify higher values in this area, we would need data to support it. The spatial patterns in the current estimates are consistent with those of NOAA Atlas 2 100-yr 6-hr map for the are of concern and yet they were arrived at using quite different methods. We suspect the maps are depicting the area north of Chama less than the area north of Abiquiu Dam because extreme short-duration events are confined to the upper eastern slopes of the mountains due to moisture inflows from the southeast. That being said, if you have data to support your suggestion, we'd be more than happy to take a look at it.

3.7 When I look at the NM 100-year 60-minute map, I see several areas with concentric circles at the precipitation contours. Many of them seem strange because terrain and ground elevations in many areas are not particularly unique. When I look at the Arizona 100-year 60-minute maps, I don't see the same patterns. Areas of special concern are at "Beaverhead RS" and "Florida" in SW New Mexico. Additionally remarkable are the differences between "Red Bluff Dam, TX" at 3.6 inches and "Caprock 4 SE" at 2.8 inches. I wonder of there is not something unusual about the data from one or both of these stations. Overall, the problem seems to be associated with rare events in areas with very sparse gauge spacing.

Response: For a response to the Beaverhead RS comment please see 3.2. As for Red Bluff Dam, TX, Florida, NM and Caprock 4 SE, we agree, however this is largely an artifact of the contour interval used on the maps interacting with low gradients in the values and it does not appear in the underlying grids. We will try to mitigate the bullseyes by modifying some of our map derivation steps, but we certainly don't want to over generalize the results and lose spatial detail in the process.

3.8 The only comment we have relates to the isopluvials around Wickenburg, Arizona where it appears that the Vulture Mine Gage may have overly influenced the pattern. I have attached our recommended correction on the file attached (changes in red). Please contact Steve Waters (602-506-4694) if you need any clarification on this recommended change.

Response: The values in this area are what the data are telling us. If you have additional data to support your suggestion please let us know.

3.9 On the Nevada 100-year 24-hour isohyet map, there is an interesting "loop" in the 2.8" isohyet along I-15 NE of Las Vegas. Also regarding this same map, there appears to be a significant increase in the total rainfall for high elevations (e.g., the Spring Mtns west of Las Vegas) and only a very moderate increase in the rainfall totals for the lower elevations. Inasmuch as there are no gages located at the higher elevations, I'm curious as to how this is justified.

Response: The "loop" is an artifact of contouring the grid. This type of situation will likely be mitigated by a minor change made to the Cascade, Residual Add-back (CRAB) precipitation frequency grid derivation procedure.

The "significant" increase in rainfall for the high elevations is due to extrapolation along the strong linear relationship of "index flood" and the square-root of mean annual precipitation (MAP). In other words, with increasing MAP comes higher precipitation frequency estimates in this area. Lower elevations have fewer undulations in the MAP field, thus fewer significant rises/falls in the precipitation frequency estimates. Furthermore, the estimates in the Spring Mountains (which were carefully evaluated) are being influenced by Red Rock Canyon State Park (26-6691) that reported a remarkably high, but validated annual maximum rainfall of 5.38" in March 1986.

3.10 Regarding the Nevada 100-year 1-hour isohyet map, it would appear that the rainfall depth for Las Vegas is something slightly less than 1.6". This is to be compared with the 1.44" depth from NOAA Atlas II, and the 2.06" which the Regional Flood Control District uses. While we agree with the direction of the change, we disagree with the magnitude of the change. As we have briefly discussed in the past, we believe that the rainfall data which the District has collected throughout Clark County over the past 15 years justifies higher design rainfall values; however we recognize that the length of record for our gages is not sufficient to have that data included in your study. Once again, I encourage you to include a statement (or two) in your final report which recognizes and encourages the use of design rainfall values based on local knowledge and data not included in your study.

Response: We have paid particular attention to the estimates in the Las Vegas area and are confident in our current results. (See response for 3.3 for more information)

4 Are stations located correctly on the map?

4.1 The Idyllwild Fire Department Station identified on the Draft Precipitation Maps appears to be incorrectly located. Our understanding of the current location is Latitude 33° 44'50"; Longitude 116° 42'52"; elevation 5,397'. It is our understanding that this station is located on the southeast corner of Highway 243 and Pine Crest Road, across the street from the Fire Station since approximately June 18, 1952. The District began maintenance of this station for NWS on December 1979.

Response: Thank you for the correct longitude and latitude coordinates for this station. We will make this adjustment.

4.2 The station labeled "Carlsbad Caverns" is not located correctly on the Mean Annual - 24-Hour-NM and 100-Year - 24-Hour – NM map. Carlsbad caverns is located SE of the City of Carlsbad, NM

Response: Thank you so much for noticing this. According to NCDC records this station moved from 32.18, -104.45 (lat,lon) to 32.53472,-103.93666 in June 1996; this is a distance of about 38 miles. We used the newest location on our maps, but the prior location was the location since the station was established and is obviously inline with where it should be, as you note. We will adopt the old location for this station and assume a station move of 38 miles (in the West) indicates a metadata error and not a real station move. However we will also investigate to determine if this is merely a metadata error or if in fact we are looking at a time series from different locations.

4.3 Chamita located just NW of Chama is a SNOTEL location, but not a town. However, there is a community named Chamita in NM...located just NW of Espanola. Either drop the Chamita from the draft map, or re-label as Chamita SNOTEL.

Otto FAA Airport is not an airport, but may be a FAA NAVAID.

Raton WB Airport should be Raton Municipal Airport

Dawson is an abandoned mining town. (USGS river gaging site with raingage is 1N.)

Response: The final maps will not contain the station names for the stations, but rather a representative set of towns/cities for reference. Regardless, we identify SNOTEL stations by their ID number and not their name in our calculations. As for Raton WB and Dawson, we want to be consistent with the stations names NCDC uses, even if they aren't technically right. In our published time series, we will provide both ID and name so that you can accurately identify the location we used.

4.4 Panchuela was a SNOTEL site, but precip recording equipment has been removed. Either remove it, or re-label as Panchuela Snow Course site (NRCS)

Response: We used the SNOTEL data from this site before it was converted to a Snow Course, so the review map label for this site is indicating what we want. For reasons described in 4.3, this label will not appear on the final maps.

4.5 I continue to have some concern about the relative location of "Roswell WSO Airport" and "Roswell FAA Arpt". Perhaps Charlie Liles can provide some information about the location.

Response: We have contacted Charlie Liles and will research the station location carefully.

5 Are extremes (high and low) reasonable and located properly?

5.1 New Mexico, 100-year, 24-hour analysis: There is a terrain feature located at about 33.6N and 105.4W that I would have thought might have a small 46 center drawn over it. This feature is

located just north of Hondo 1SE and Fort Stanton.

Response: According to the mean annual precipitation and NOAA Atlas 2, this terrain feature (Capitan Mtns) should have more of a maximum, but for some reason it doesn't on our map. The maximum grid value in these mountains is a 4.53" (or 45), which is a smidgen higher than the contours portrayed. Prompted by this comment, a change to the CRAB mapping procedure was made such that it maintains more spatial detail throughout the evolution of the maps. This change resulted in a small maximum on the terrain feature you mention.

5.2 100-Year - 60-Minute – NM: At approx 35.6 deg N and 106.7 deg W precipitation contour at 1.8 inches has a very strange shape.

Response: This jagged contour is the result of a contour traversing the grid in an area with a very gentle precipitation gradient. We've seen other contours like this and we will resolve this by increasing the size (5x5 to a 7x7 grid cell) of the weighted filter used to smooth the grids.