3. General Field Study Design

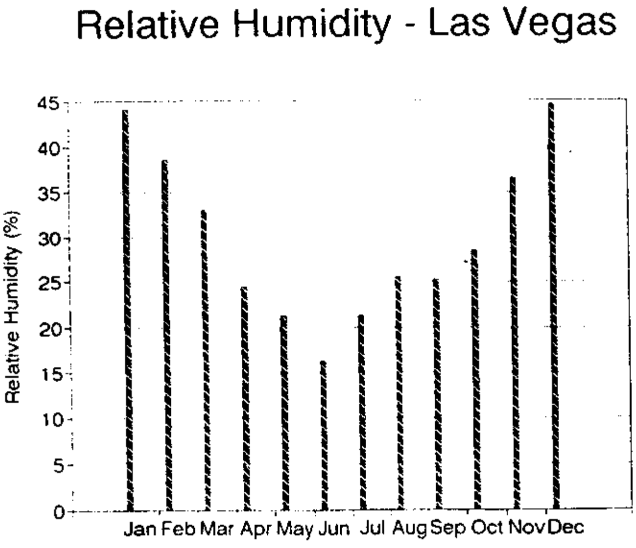
The duration of the field study will be one year. It was considered important in evaluating the overall impact of a source to consider a complete annual cycle. By monitoring for an entire year, all the seasons may be studied. For practical reasons, the year was divided into "intensive" and "non-intensive" periods. During the intensive periods tracer will be emitted from the MPP stack and tracer and particulate data will be collected continuously at over 30 sites. During the non-intensive periods tracer will not be released, the number of particulate monitoring sites will be scaled back considerably and sampling will be done only two days per week. Meteorological and optical monitoring will be done continuously.

Selection of the Intensive Periods

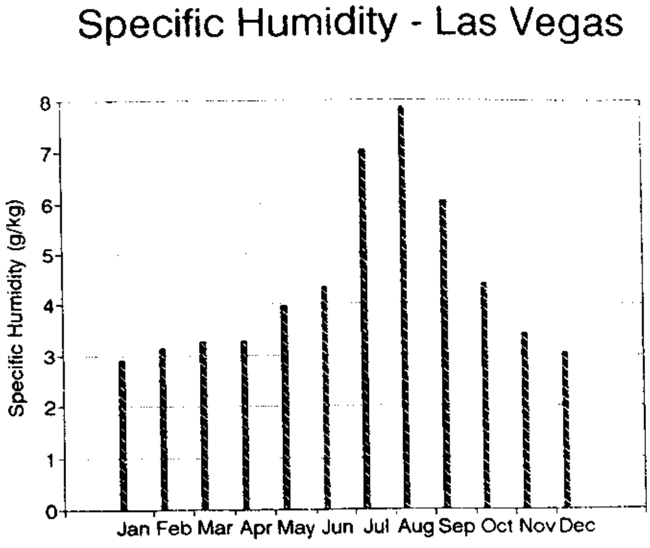
In selecting the intensive study periods, it was desired to select periods in which the MPP may be most likely to contribute to haze in GCNP. It is expected that secondary sulfates formed from oxidation of MPP SO_2 emissions is the largest portion of the MPP contribution to haze in GCNP. Primary particulate emissions from MPP contribute to haze nearer to the power plant, but at the distance of the GCNP, secondary sulfates are expected to dominate. Dry phase oxidation of SO_2 is much slower than aqueous phase oxidation. Thus, cloudy periods can cause much more rapid conversion of SO_2 to sulfate. Aqueous phase oxidation is on the order of 50-100% per hour if oxidants are present in sufficient quantity (Lee, 1986).

Cloudy periods with wind directions transporting the MPP plume toward GCNP are the periods when impacts to visibility at GCNP due to MPP would be most likely to occur. As discussed in Section 2, these conditions may occur during the summer monsoon and certain winter periods. Calculations of the potential impact of MPP to haze at GCNP under highly simplified conditions were done for dry southwesterly and monsoonal summer conditions, and pre-frontal winter conditions. These calculations indicated a potential for perceptible visibility impairment at GCNP from MPP emissions for all three cases (see Appendix 4).

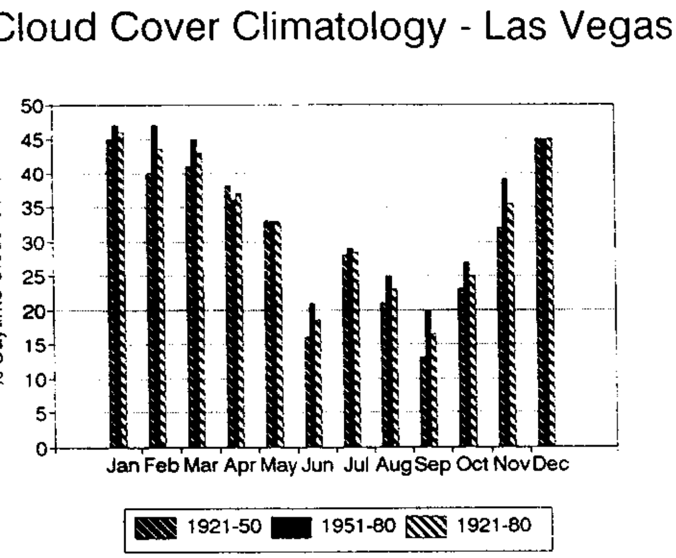
Moisture parameters calculated from long term National Weather Service data from Las Vegas are shown in Figure 4. Specific humidity, which gives the amount of water vapor in the air, is highest in August, with July having slightly less moisture. Average monthly dew point temperature for the years 1982-1990 (Figure 5) at Dri Mountain also showed a peak in August, with slightly lower values in July. Relative humidity peaks in December and January. Also note that August has higher relative humidity than July. December and January are the cloudiest months, with February and March only slightly less cloudy. A secondary peak in cloudiness occurs in July, with somewhat less cloudiness in



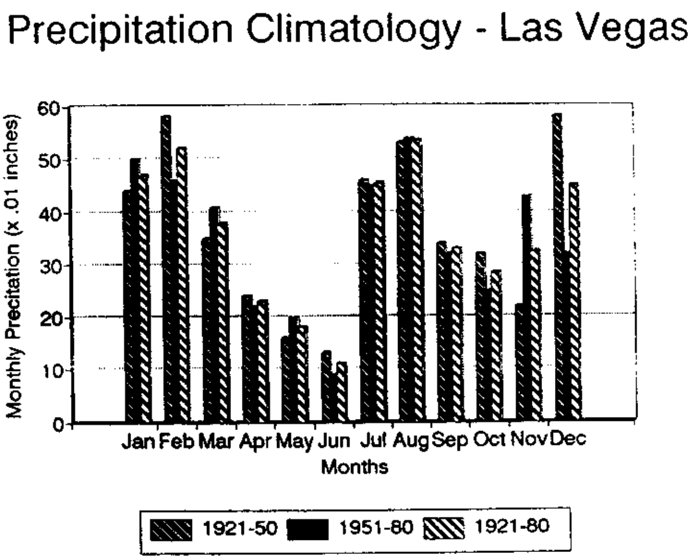
(a)



(b)



(c)



(d)

Figure 4. Las Vegas moisture climatology

(a) Average specific humidity by month: 1951-1980.

(b) Average relative humidity by month: 1951-1980.

(c) Average percent daytime cloud cover by month.

(d) Average precipitation by month.

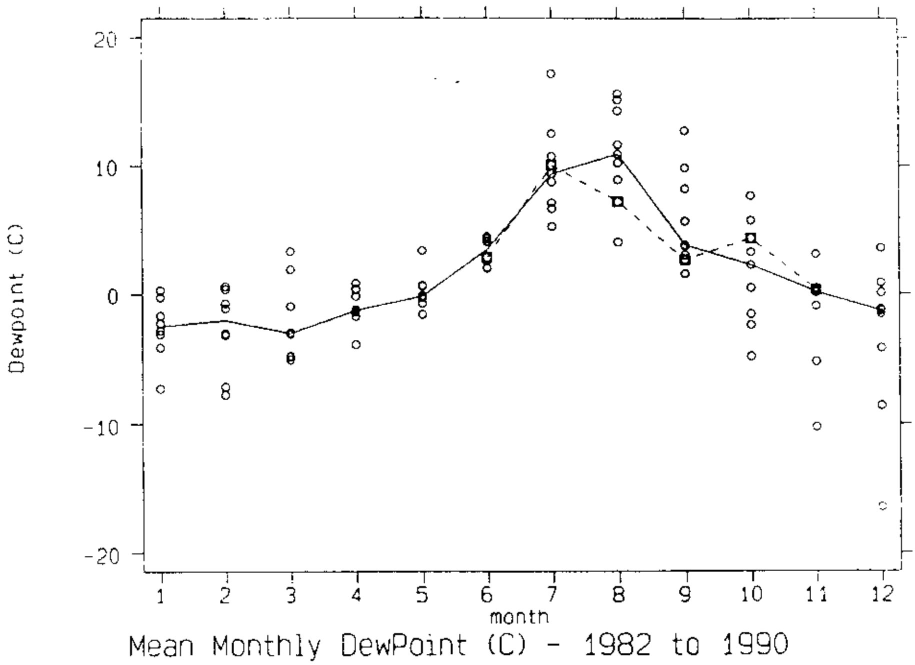


Figure 5. Mean monthly dew point temperature at Dri Mountain: 1982-1990.

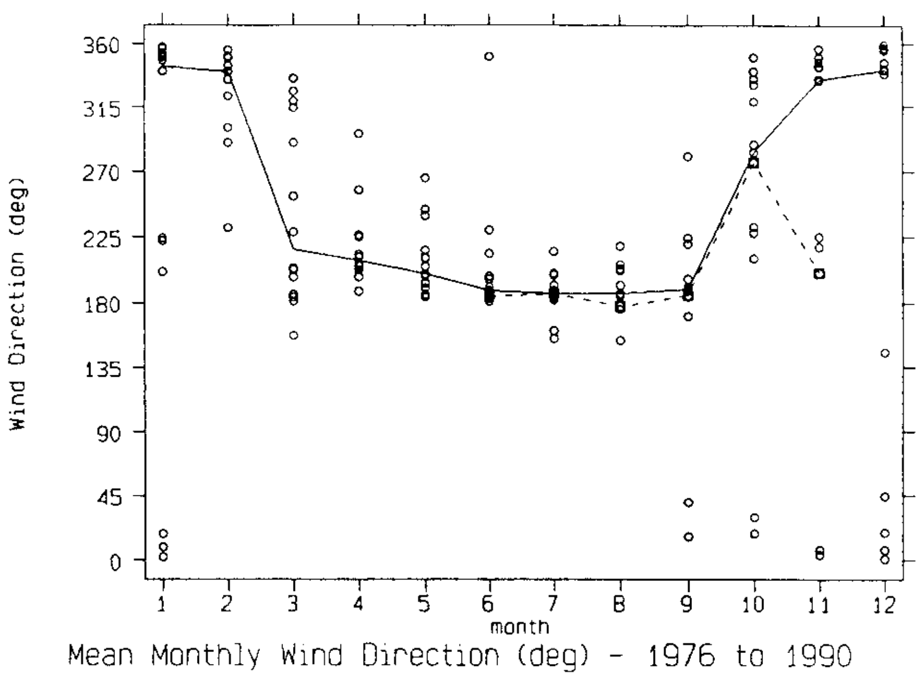


Figure 6. Mean (resultant) wind direction by month at Dri Mountain: 1976-1990.

August. The precipitation data show two distinct peaks; one is July and August, the other December through February. Of interest is the substantial difference in average precipitation in November and December between the 1921-1950 and 1951-1980 data. This suggests that year to year variability is large.

The climatology described above suggests a summer intensive period covering portions of July and August and a winter period that could be any time between December and February. January and December showed the highest values for the moisture related parameters, with January's precipitation data being more consistent than December's. January was chosen for the winter intensive. August has slightly higher relative and specific humidity than July. Thus, the summer intensive will be centered on early August.

Even though we are attempting to optimize the study periods for the specific conditions described above, meteorological conditions are highly variable from year to year. Most frequent winter flow at MPP is away from GCNP. However, winter flow is often toward the Joshua Tree Wilderness, another Class I visibility protected area. In summer, we are likely to experience dry flow from the southwest a significant portion of the time in addition to the moist monsoonal flow. Thus, information about other common conditions will also be obtained.

Mean vector (resultant) wind direction each month for the years 1976-1990 at Dri Mountain is shown in Figure 6. Dri Mountain is a pointed hill 150 meters high and adjacent to the Colorado River a few kilometers north of MPP. The instrument level is approximately at the same elevation (MSL) as the top of the MPP stack. However, the plume centerline is generally 400-700 m, averaging 663 m above stack base, which is 250-550 m above Dri Mountain. The winds at Dri Mountain would be expected to be influenced more by channeling due to topographic features than the winds at plume height, particularly during nighttime and morning hours. Winds at plume height typically have a greater westerly component (toward GCNP) than Dri Mountain winds. The winds at Dri Mountain indicate a predominance of northerly winds during November through February and southerly winds during April through September. March and October are transitional periods. Three January periods during 1976-1990 had south to southwest resultant winds, indicating more frequent flow toward GCNP during these years.

The analysis of humidity, clouds, precipitation, and winds suggest optimal of January 4-31, 1992 for the winter intensive and July 15 to August 25, 1992 for the summer intensive.

Siting of Monitoring Instrumentation

The aerosol, tracer and optical monitoring network includes three classes of sites. These are denoted as (1) receptor, (2) other Class I, and (3) background sites. A more detailed description of air quality and meteorological monitoring is described in sections 5 and 6, respectively. The aerosol and tracer monitoring was designed to provide sampling and analysis every day for many sites during the intensive periods, and sampling and analysis two days a week during the rest of the study year. The reduction of monitoring for the non-intensive periods is necessary due to cost considerations.

The preliminary network of sites is shown in Figure 7. The siting will be finalized after a monitoring planning meeting to be held in Las Vegas in early October. A listing of the sites, approximate elevation, instrumentation, and a brief reason for selecting each site is given in the table below. The receptor sites (R1-R4) are either within or in very close proximity to GCNP. The other Class I sites (I1-I6) are in areas that may be impacted by MPP and/or serve as background sites. Most of the receptor and other Class I sites had some degree of existing or planned monitoring prior to Project MOHAVE. These sites will have supplemental monitoring associated with Project MOHAVE and will operate during the entire study year. The background sites (B1-B21) are intended to characterize high elevation and low elevation transport into the study area as well as showing more detailed concentration patterns within the study area. The background sites will operate only during the intensive periods. The instrumentation to be used is described in Sections 4-7 and references cited in those sections.

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SITE IDENTIFICATION TABLE

Id No	Name	Elevation (meters)	Particle & Tracer	Optical	Meteorology
R1	Meadview	900	1	T,N,P	S,U
R2	Long Mesa	1830	4	N	S
R3	Hopi Point	2160	1	T,N,P	S
R4	Indian Gardens	1220	1	T,N,P	S
I1	San Gorgonio	1680	2	T,P	
I2	Joshua Tree	1500	2	P	
I3	Tonto	730	2	T,P	S
I4	Sycamore Canyon	2000	2	P	
I5	Petrified Forest	1680	2	T,P	S
I6	Bryce Canyon	2600	2	P	
B1	Tehachapi Pass	1240	3		
B2	Cajon Pass	1380	3		
B3	Baker	280	3		
B4	Amboy	190	3		
B5	Parker	130	3		

B6	Wickenburg	620	3	
B7	Las Vegas Wash	370	3	
B8	Cottonwood Cove	210	3	S,U
B9	Yucca	580	3	
B10	Dolan Springs	850	3	
B11	Truxton	1370	3	S,U
B12	Seligman	1620	3	
B13	Prescott (airport)	1620	3	
B14	Overton Beach	370	3	
B15	New Harmony	1520	3	
B16	Marble Canyon	1220	3	
B17	Mt Springs Summit	1680	3	
B18	Spirit Mountain	1700	3	
B19	Hualapai Mt Park	1980	3	
B20	Camp Wood	1980	3	
B21	Jacob Lake	2400	3	

Explanatory notes:

1 Full IMPROVE samplers. 24-hour samples midnight to midnight, Wednesday and Saturday during the non-intensive periods. Twice daily samples of aerosol and tracer will be taken each day during the intensives. Specific hours for the beginning and end of each daily sampling period will be determined at the monitoring coordination meeting. DRUM samplers with 4 or 6 hour sampling periods (only selected samples will be analyzed).

2 Full IMPROVE samplers. 24-hour samples (aerosol and tracer) each day during the intensives. 24-hour samples midnight to midnight Wednesday and Saturday during non-intensive periods.

3 IMPROVE channel A and filter pack for SO_2. 24-hour samples (aerosol and tracer) each day during the intensives. No sampling during non-intensives.

4 Long Mesa will only have a DRUM sampler for particle monitoring.

T= transmissometer, N= nephelometer, P= photography, S= surface meteorology, U= upper air meteorology

Surface and upper air meteorological data will be collected at additional sites identified in Section 6.

Important considerations in selecting sites include the availability of power and accessibility. The power requirement imposes strict limitations on siting.

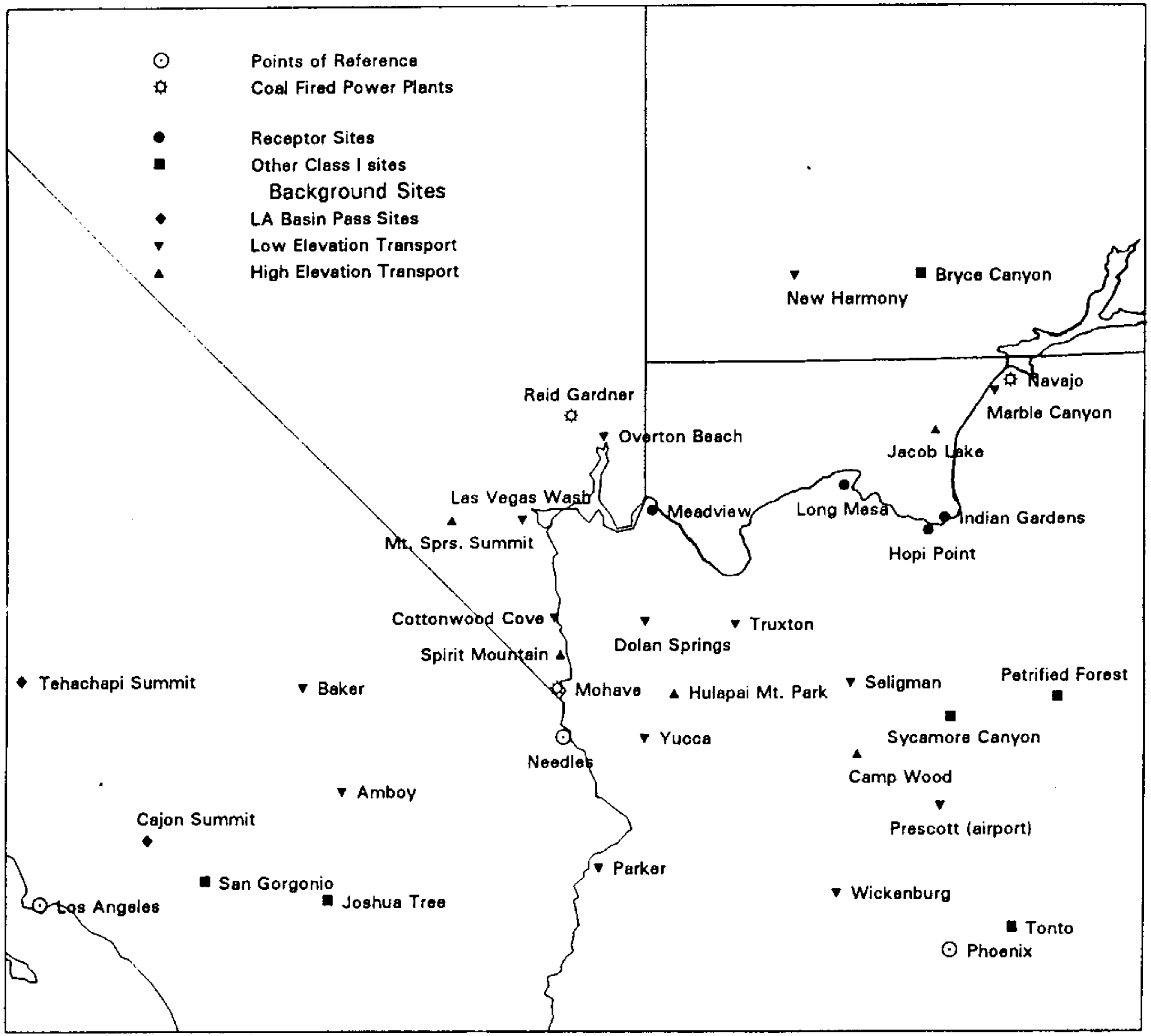

Figure 7. Location of air quality and tracer monitoring sites.

Meadview was chosen because it is within about 5 km of GCNP, has existing monitoring by the Desert Research Institute (DRI), and is at the west end of GCNP, thus closer to MPP than other areas of GCNP. Long Mesa is also at the edge of GCNP and the location of another DRI monitoring site. Hopi Point and Indian Gardens are existing NPS monitoring sites within GCNP. Joshua Tree and Sycamore Canyon are potentially impacted by MPP. The remaining Class I sites will help characterize transport into the area.

The Tehachapi Pass site (B1) is located in a pass between the San Joaquin Valley and Mojave Desert and is intended to monitor the exchange of air between these areas. The San Joaquin Valley is a large source of SO_2. The Cajon Pass site (B2) is located between the Los Angeles Basin and Mojave Desert and is a major exit pathway for Los Angeles Basin air. Sites B3-B6, I2, and I3 are low elevation southern boundary sites. These locations form an arc to characterize the sulfur flow into the main study area from the southwest to southeast.

Locations B17-B20 form a second arc to the south of GCNP. These sites are located on terrain that rises 900 to 1200 meters above the surrounding area. The sites should be in the middle of the mixed layer during the summer intensive and frequently above the mixing layer during the winter intensive. Measurements from these sites when tracer is absent, coupled with the nearby low-elevation southern sites B7-13, should characterize the sulfur flux from the southwest through southeast exclusive of MPP sulfur into the receptor area. At other times, tracer from MPP may be present at these sites. In conjunction with the low elevation southern sites, these sites will help determine vertical distributions of sulfur and tracer.

Sites B7-B13 are located in possible MPP transport corridors between the southern boundary sites and GCNP. These locations will indicate if the emissions from MPP are transported toward GCNP in a narrow cone or more widely dispersed air mass, in addition to identifying the most common transport corridor from MPP to GCNP.

The MPP plume usually travels to the south along the Colorado River in the winter. It is suspected that the plume may sometimes leave the river area in an eastward direction through a gap in the mountains near site B9. The high elevation sites B18-B20 along with B10-B12 should be able to verify if MPP emissions are being transported from the area of B9 to the east or northeast in a low-level surface layer or more dispersed in a deeper layer.

Locations B7, B8, B10, and B14 are placed in an attempt to isolate emissions of MPP, the Reid Gardner power plant, and Las Vegas as they are mixed over Lake Mead on their way to the western end of GCNP (Meadview). Under stagnation conditions, the high elevation sites B17 and B18 should characterize the cleaner regional air above the mixing layer.

The northern boundary sites B15, B16, B21, and I6 are located to characterize flow into the region from the north. These sites will help identify the effects of the Wasatch Front urban and industrial sources, the NGS, and other coal-fired powerplants to the north and east. Site B15 is very close to Zion

National Park. Flow from MPP is likely to be transported toward this site often during the summer. Locations B15 and B16 serve as low elevation sites. I6 and B21 are high elevation sites.