REASONABLE FURTHER PROGRESS
REPORT FOR THE
MONO BASIN PM-10
STATE IMPLEMENTATION PLAN

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This document provides a progress report on air quality trends in the Mono Basin federal PM-10 nonattainment area since the adoption of the Mono Basin PM-10 State Implementation Plan in May 1995. It was preceded by a similar RFP Report prepared in September 2001.

Introduction

The Mono Basin PM-10 planning area experiences episodes of high PM-10 concentrations due to dust storms from the exposed lakebed of Mono Lake. PM-10 stands for particulate matter less than 10 microns in average diameter. PM-10-sized particles are thus extremely small, less than one tenth the diameter of a human hair. Because of their small size they can penetrate deeply into the lungs, causing health problems for people, and can aggravate asthma, bronchitis, heart disease and other lung diseases.

The exposure of the lakebed to wind erosion has resulted primarily from the diversion of Mono Lake's tributary streams by the City of Los Angeles from 1941 through 1989. During this period, the City's water diversions caused the Mono Lake surface level to drop approximately 45 feet, exposing more than nine square miles of highly erodible material to wind action. Lakebed sediments and efflorescent salts provide sources of PM-10-sized particles that can become airborne under windy conditions. During spring and late fall, conditions are most conducive to the production of large dust storms. Prior to 1995, PM-10 monitors located downwind from dust source areas at Mono Lake measured peak PM-10 concentrations of around 1,000 $\mu g/m^3$, which was more than six time the National Ambient Air Quality Standard (federal standard) of 150 $\mu g/m^3$ for a 24-hour average.

These high air pollution levels at Mono Lake prompted the U.S. Environmental Protection Agency to designate the portion of the Mono Lake hydrologic basin within California a federal PM-10 nonattainment area in 1993. It is formally referred to as the Mono Basin PM-10 Nonattainment Area. A Mono Basin PM-10 State Implementation Plan (SIP) was adopted by the Great Basin Unified Air Pollution District (District) and the State of California in response to this federal nonattainment designation in accordance with the requirements of the 1990 Clean Air Act (Patton and Ono, 1995). The SIP provides an analysis of the air quality problem and identifies the control measures necessary to reduce air pollution to a level that will attain the federal air quality standards. The Mono Basin SIP relies on a decision of the California State Water Resources Control Board (SWRCB), known as Decision 1631, to provide an enforceable mechanism to reduce particulate air pollution by raising the lake level to 6,391 feet above mean sea level, which will submerge most sources of windblown dust around Mono Lake's shoreline.

Clean air was only one of several public trust values considered in SWRCB Decision 1631, which was approved on 28 September 1994. Decision 1631 amended the City's water rights licenses in the Mono Basin to require specific actions to provide the recovery of resources degraded by 48 years of diversion of Mono Lake's tributary streams. The decision established minimum stream flows and higher flushing flows in tributaries to protect fisheries. It also required an increase in the surface level of Mono Lake to 6,391 feet to protect aquatic and terrestrial ecosystems, enhance scenic resources, and meet clean air standards by submerging sources of windblown PM-10 (SWRCB, 1994).

Air Quality and Lake Level

The air quality modeling analysis in the SIP predicted that the 6,391-foot lake level would likely be sufficient to bring the area into attainment with the federal PM-10 standard, since the lake would then submerge much of the exposed lakebed that was causing dust storms. The time it would take to reach this final lake level would depend on yearly runoff in the Mono Basin.

The SIP estimated (Figure 1) that it would take 26 years for Mono Lake to rise to 6,391 feet under normal runoff conditions. Hydrologic modeling shows that if there is a series of extremely wet years, the lake could reach the target level in as little as nine years. Conversely, a prolonged series of drought years could extend the period to reach attainment to 38 years (Figure 2).

After the adoption of the SIP in 1995, Mono Lake benefited from higher than normal runoff between 1995 and 1999, which brought the lake level up about nine feet to 6,384.8 feet above sea level. However, as shown in Figure 1, an ensuing series of dry years has undone this early progress, and the lake level now stands below that predicted for ten years of normal runoff.

Figure 3 provides a comparison of lake level to annual runoff (April 1 – March 31) from four creeks that are monitored in the Mono Basin by the City of Los Angeles: Rush, Lee Vining, Parker and Walker Creeks (LADWP, 2004 and MLC, 2004). These runoff data do not include other creeks in the basin, but they do include a high percentage of annual inflow to the basin and have long been considered to be representative of total annual basin inflow. Although the long-term mean runoff of the four creeks is 118,600 ac-ft/yr, based on runoff data from 1946-1995, LADWP has exported 16,000 ac-ft/yr in accordance with its amended license since 1997. Thus, the exported volume is subtracted from the annual average runoff to determine the long-term mean creek runoff to Mono Lake shown in Figure 3.

These figures show that, although the level of Mono Lake has risen since the 1994 SWRCB Decision went into effect, it has not risen as rapidly as was predicted for ten years of normal runoff into the lake. The recent drought cycle has reversed much of the lake-level gains made during the wet years of the late 1990s. It has also become apparent that near-normal runoff years have still resulted in significant declines in lake level. Normal runoff should be able to sustain a higher lake level (6,391 feet), with its resulting larger surface area. According to hydrologist Peter Vorster of the Bay Institute (personal communication, 2004) , “the model is not predicting the Mono Lake level rises and falls as well as could be hoped.” A re-evaluation of the hydrologic model will likely be needed to determine if adjustments need to be made to either the modeling process or the input data. This could, in turn, result in a reassessment of future Mono Basin water exports if the target lake level (6,391 feet above sea level) is not attained by September 28, 2014 (SWRCB, 1994). The SWRCB Decision also states that water exports are not to exceed 4,500 acre-feet/yr if the lake level falls below 6,380 feet, and that exports are to be curtailed altogether if the level drops under 6,377.

Reasonable Further Progress

An air quality modeling analysis was performed as part of the SIP to estimate PM-10 concentrations at the historic Mono Lake shoreline as the lake level rose to submerge source areas for wind-blown dust. The air quality model predicted that the 6,391-foot lake level, required by Decision 1631, would bring the Mono Basin into attainment with the federal air quality standards for PM-10. Figure 4 shows the results of modeled PM-10 impacts for Receptor 45, which is the receptor site with the highest modeled PM-10 concentrations. Predicted concentrations at Receptor 45 are shown for each year, based on the lake level trend for normal runoff, as shown in Figure 1. The Receptor 45 trend line shown in Figure 4 is the “reasonable further progress” trend expected as a result of implementation of the SIP.

In addition to the Receptor 45 normal runoff trend line, Figure 4 also includes modeled air quality trends from 1995 to 2004 at four receptor sites (Simis, Warm Springs, Mono Shore and Receptor 45), based on the actual April 1 lake level for each year. Due to higher than normal runoff from 1995 through 1999, modeled air quality improvement was ahead of schedule, as indicated by the lower than expected modeled concentrations at Receptor 45. The modeled design day PM-10 concentration for Receptor 45 dropped from 838 μg/m^3 in 1995 to 376 μg/m^3 in 1999.

This modeled air quality trend reversed from 2000 to 2004 as the lake level declined, causing estimated PM-10 concentrations to increase. Figure 4 shows that Receptor 45 is not meeting the Reasonable Further Progress trend as of 2004 and measured PM-10 levels have exceeded those predicted by the model for the nearby Mono Shore site. As of April 1, 2004, the lake level was at 6,381.8 feet and is expected to decline from that level during the ensuing year. Modeled and monitored PM-10 concentrations at the Simis site are shown to be in attainment with the federal PM-10 standard since 1996.

Ambient PM-10 Monitor Concentrations

In January 2000, a new ambient PM-10 monitoring site was installed on the north shore of Mono Lake, near Receptor 45, to characterize the area of highest expected PM-10 concentrations in the nonattainment area. Currently, Simis and Lee Vining are the only other active PM-10 monitor sites in Mono Basin. Monitoring at the Warm Springs site, which was used for the 1995 SIP, was discontinued in 1993. These sites are shown in Figure 5, which includes a graphical representation of source areas for wind-blown dust.

The federal Clean Air Act requires attainment of air quality standards in all areas where the public has access, not just at ambient monitoring sites. PM-10 monitor data can be used to demonstrate attainment with federal air quality standards if the monitored site is deemed to be representative of the worst case air quality in the area, after the control strategy has been implemented. The air quality model used for the 1995 SIP determined that Receptor 45 would have the highest PM-10 concentrations when the lake level reached 6,391 feet.

To help verify attainment in the future, the District installed the Mono Shore PM-10 monitor site to represent the worst-case air quality site in the Mono Basin. Since it began operation in January 2000, 28 violations of the federal PM-10 standard (>150 $\mu g/m^3$) have been monitored at the Mono Shore site. The 24-hour average concentrations on fifteen of these violation days exceeded 1,000 $\mu g/m^3$, with the highest concentration over 10,000 $\mu g/m^3$. These concentrations are much higher than predicted by the model, and it may indicate that the source areas have higher emission rates than assumed in the model. The violation days at the Mono Shore site are listed in Table 1. Monitoring is curtailed during winter months when snow cover precludes access to the site (and completely covers source areas for wind-blown dust. Sampling frequency is reduced from daily sampling to every third day in fall when high PM-10 concentrations are rarely experienced.

No violations of the federal PM-10 standard were monitored at the Simis site due to wind-blown dust, which is in keeping with the modeled reduction in PM-10 that should have resulted from the higher lake level (see Figure 4). One violation was measured on August 31, 1996 at Simis with a PM-10 concentration of 158 $\mu g/m^3$, but this was due to a wildfire in nearby Yosemite National Park. The first violation ever recorded at the Lee Vining sampler occurred on February 28, 2002, when very unusual wind patterns carried high concentrations of Mono Lake dust into Lee Vining, resulting in a 24-hour average concentration of 222 $\mu g/m^3$ there. Annual average concentrations at Simis and Lee Vining have not violated federal standards. All 29 violations and one high annual average (153 $\mu g/m^3$ in 2000) at the Mono Shore site can be attributed to wind-blown dust that originated from the exposed lakebed of Mono Lake. The number and magnitude of high values at the Mono Shore site indicate that the PM-10 emission rate for upwind source areas is higher than predicted by the model used for the SIP. Additional monitoring of dust emissions, using techniques developed at Owens Lake for wind-blown dust, may be performed to improve model predictions.

Table 1. Summary of PM-10 Violations at Mono Shore monitor (Jan 2000-Dec 2003).

Date	PM-10 Concentration	Sampling Frequency
April 8, 2000	690 μg/m^3	Daily
May 4, 2000	1,063 μg/m^3	Daily
May 6, 2000	490 μg/m^3	Daily
May 9, 2000	3,059 μg/m^3	Daily
May 10, 2000	1,513 μg/m^3	Daily
June 7, 2000	1,642 μg/m^3	Daily
June 8, 2000	241 μg/m^3	Daily
October 9, 2000	387 μg/m^3	Every 3rd Day
November 29, 2000	10,466 μg/m^3	Every 3rd Day
June 2, 2001	414 μg/m^3	Daily
September 25, 2001	4,482 μg/m^3	Daily
February 28, 2002	195 μg/m^3	Daily
March 10, 2002	396 μg/m^3	Daily
April 14, 2002	3,089 μg/m^3	Daily
April 15, 2002	1,157 μg/m^3	Daily
May 18, 2002	201 μg/m^3	Daily
May 19, 2002	6,505 μg/m^3	Daily
May 20, 2002	1,481 μg/m^3	Daily
November 7, 2002	1,745 μg/m^3	Every 3rd Day
March 13, 2003	487 μg/m^3	Daily
March 14, 2003	1,658 μg/m^3	Daily
March 26, 2003	333 μg/m^3	Daily
April 13, 2003	1,170 μg/m^3	Daily
April 21, 2003	467 μg/m^3	Daily
April 24, 2003	5,283 μg/m^3	Daily
April 25, 2003	5,745 μg/m^3	Daily
April 26, 2003	341 μg/m^3	Daily
April 27, 2003	399 μg/m^3	Daily

Conclusion

Dust storms and federal PM-10 violations continue to occur in the Mono Basin PM-10 nonattainment area. Since it began operation in January 2000, the Mono Shore monitor on the north shore of Mono Lake has recorded 29 violations of the federal PM-10 standard. Fifteen of the violations were over 1,000 μg/m^3, with a peak concentration of 10,466 μg/m^3. The Simis PM-10 data indicate that PM-10 concentrations at this site may now meet the federal standard. The air quality model shows that PM-10 concentrations at all sites should decline as the lake level rises and that the rate of improvement is near, but slightly behind, the reasonable further progress trend predicted for normal runoff. Since lake level changes have not matched those predicted by the hydrologic model for actual runoff input, a re-evaluation of the hydrologic model performance should be done to determine whether the model should be modified for future predictions of lake level.

References

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Vorster, Peter , 2004. Personal communication, August 24, 2004.

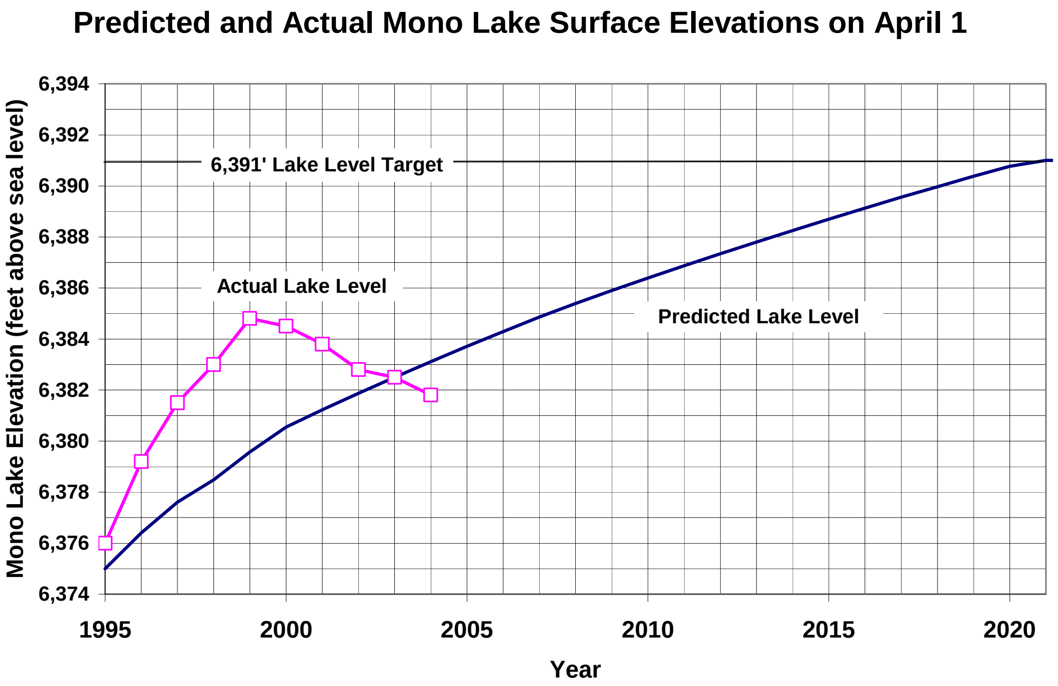

Figure 1. Predicted lake level for normal runoff and actual Mono Lake elevations on April 1.

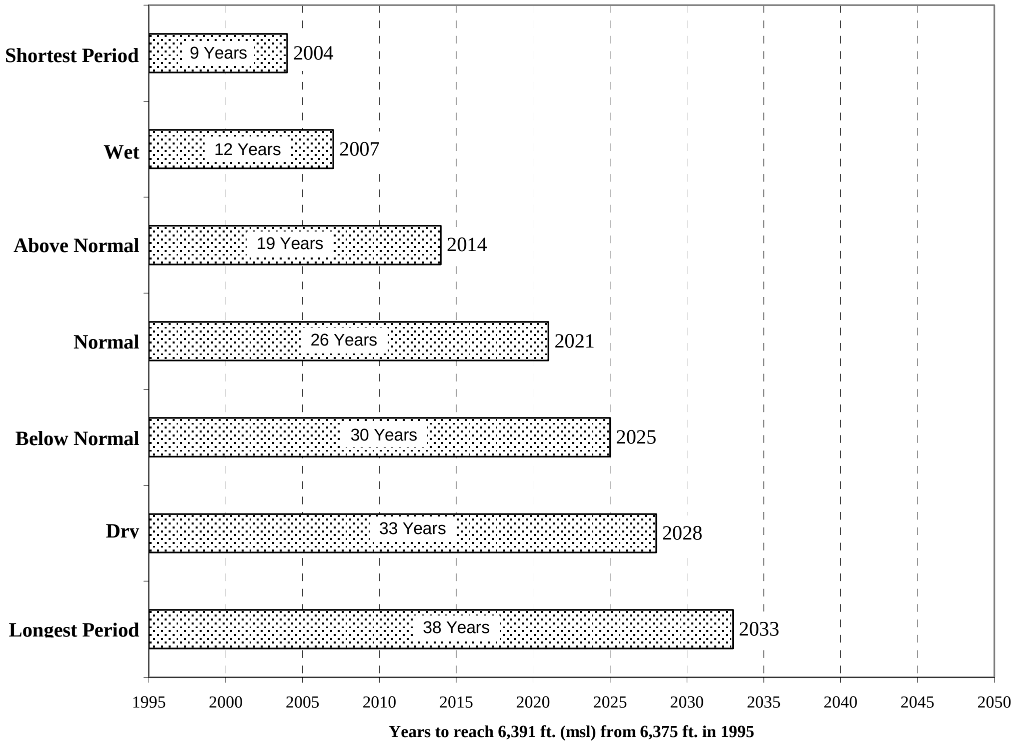

Figure 2. Transition Period Scenarios for Mono Lake Elevation to Reach 6,391 Feet, using D-1631 Operational Rules.

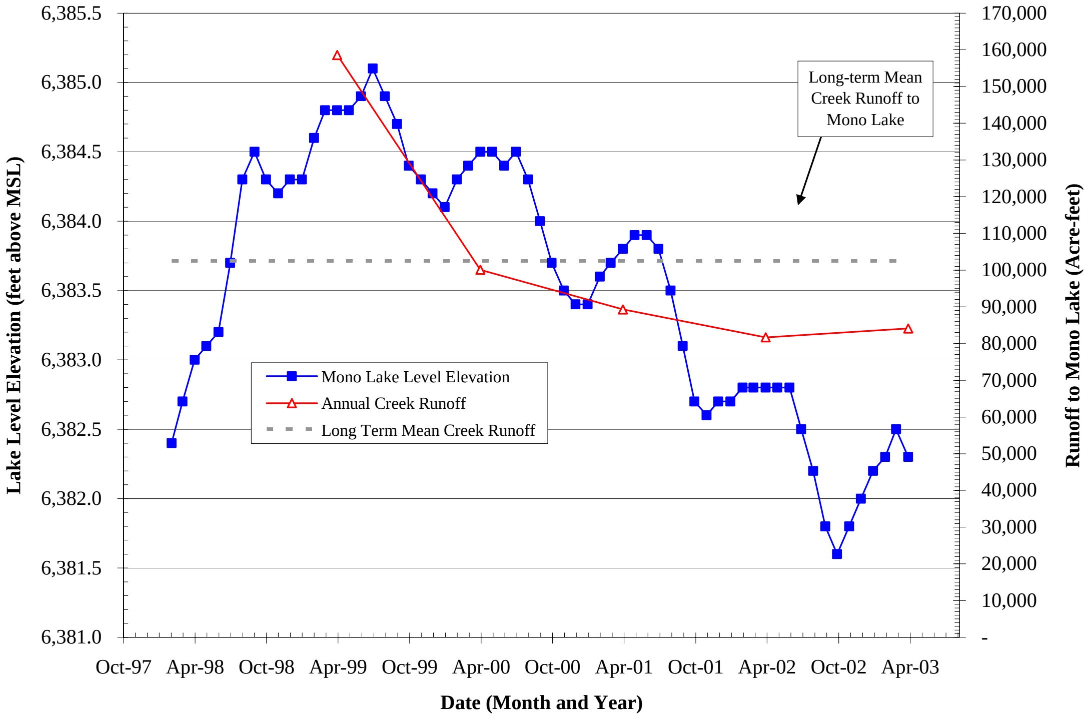

Figure 3. Runoff into Mono Lake and lake level elevations for January 1998 through May 2003 for Rush, Lee Vining, Parker and Walker Creeks (LADWP, 2004 and MLC, 2004).

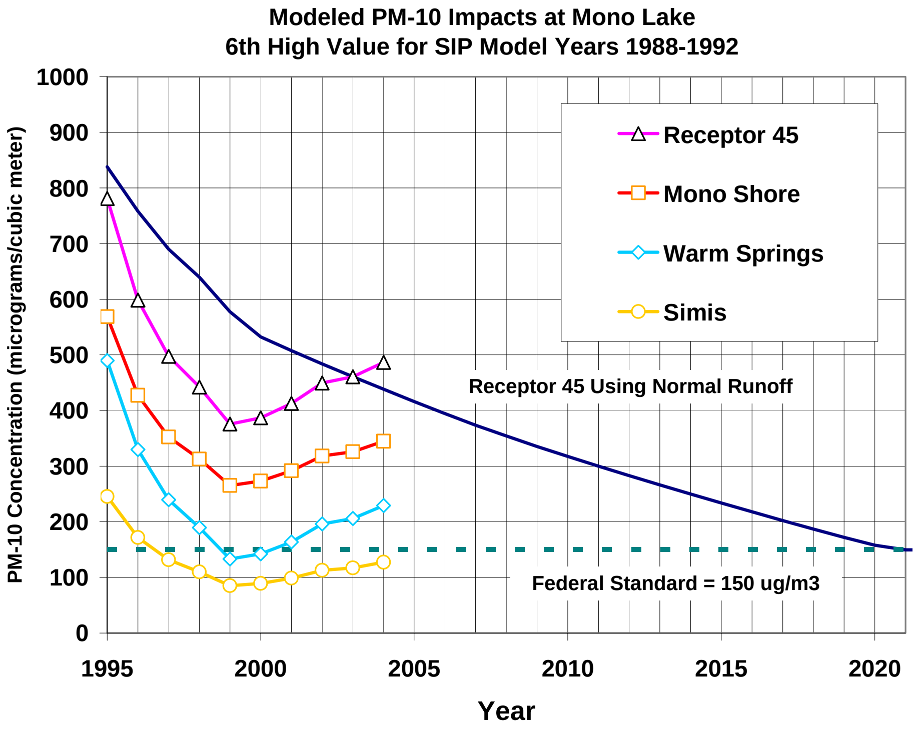

Figure 4. Modeled PM-10 impacts at Mono Lake sites compared to the reasonable further progress trend at Receptor 45 for normal runoff.

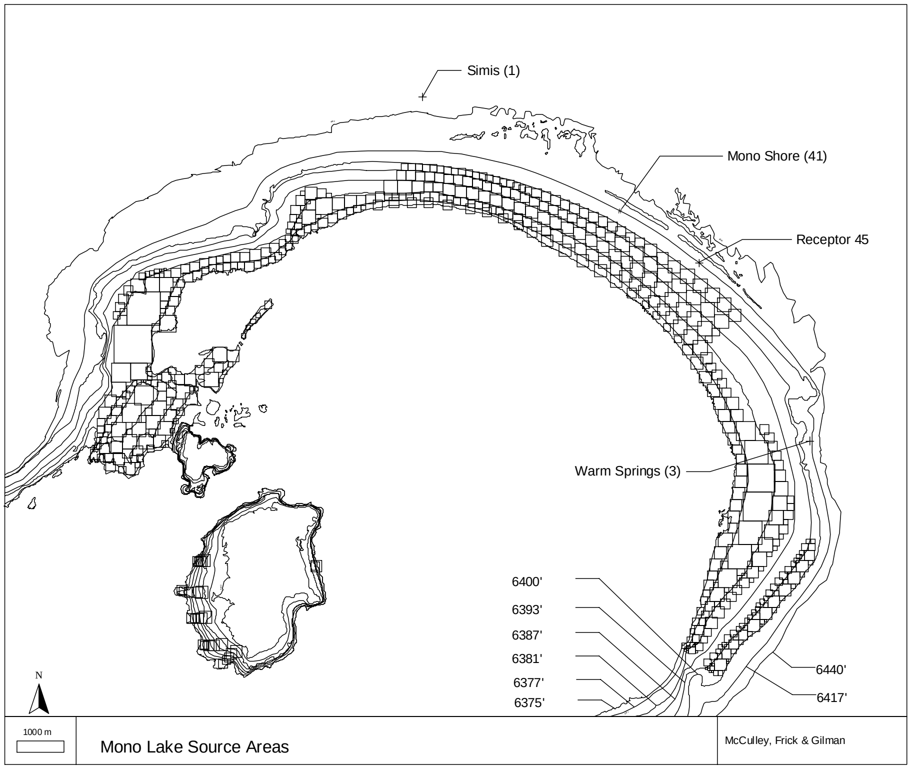

Figure 5. Mono Lake dust source areas and locations of Receptor 45 and monitoring sites at Simis, Mono Shore and Warm Springs.