7. Injury to Air Resources

Hazardous substance releases at the Arsenal injured Trustee air resources via windblown dispersion of dried contaminated sediments from disposal basins, vapor emissions from surface impoundments, and emissions resulting from response actions – most notably the 1988 Basin F IRA discussed in Chapters 3 and 4. This chapter contains a qualitative discussion of injury to air resources during the Basin F IRA. A quantitative assessment of injury may be explored as part of the assessment, depending on the availability and reliability of data.

Summary of conclusions

Releases of hazardous substances during the Basin F IRA resulted in a measurable adverse short-term change in the chemical and physical quality or viability of air resources. Technical reports, transcripts of meetings, correspondence, and odor logs confirm that hazardous substances were released into the air from Basin F and migrated off-post. Offensive odors were prevalent to the north and northwest of the Arsenal boundary. Emissions not only created noxious odors but are also believed to have caused significant adverse health effects. Because of these adverse effects, local residents reported that they modified their behavior to avoid exposure to the ambient air. Thus, releases from Basin F during the IRA resulted in the loss of human services provided by the State's air resources.

7.1 Injury Determination

Chapter 4 confirms that air resources were exposed to hazardous substances during the Basin F IRA in 1988. However, inadequate sampling and laboratory techniques at the time complicate the determination and quantification of injury to air resources. Regardless of air monitoring results, parties involved in the Basin F IRA recognized that chemicals at concentrations below selected risk-based levels, and sometimes below detection limits, were sufficient to cause the highly noxious odors that were associated with health problems (Basin F Transcripts, October 26, 1988).

7.1.1 Injury definition

According to the DOI regulations, an injury to the air resource has resulted from the release of a hazardous substance if one or more of the following changes in the physical or chemical quality of the resource is measured:

- Concentrations of emissions in excess of standards for hazardous air pollutants established by section 112 of the Clean Air Act, 42 USC § 7412, or by other federal or state air standards established for the protection of public welfare or natural resources [43 CFR § 11.62(d)(1)]

- Concentrations and duration of emissions sufficient to have caused injury as defined in paragraphs (b), (c), (e), or (f) of this section to surface water, groundwater, geologic, or biological resources when exposed to the emissions [43 CFR § 11.62(d)(2)].

Neither EPA nor the State of Colorado has established standards for relevant hazardous air pollutants.

7.1.2 Baseline conditions

The area affected by Basin F emissions is an industrial area, with several other sources of odors and, potentially, airborne hazardous substance emissions. Industries near the Arsenal include Ralston Purina, refineries, and gasoline stations, in addition to urban air releases associated with automobile traffic. Although the air quality near the Arsenal was not pristine in the 1980s, the odors and health effects experienced from the beginning to the end of the Basin F IRA were more extreme and numerous than those reported before or after the response, and most of the odor complaints cited a distinct and familiar odor that was attributable to Basin F (R.L. Stollar & Associates, 1990). Thus, the adverse effects on air resources during the Basin F response exceeded baseline conditions.

7.1.3 Qualitative evidence of injury

The Basin F IRA began on March 22, 1988. Within days, contractors were raising concerns about Basin F emissions, and discussing plans to ascertain the source of the odors (Ebasco Services, 1988). Excavation activities and pumping of Basin F commenced on the last day of April. Prior to commencement, no testing was conducted to characterize the potential emissions, identify target compounds, or design appropriate monitoring and response protocols.

After removal of all free-standing liquid in the northern end of Basin F during the last week of July 1988, the Army and its contractors discovered a false bottom: 26 to 54 inches of stratified, crystallized salts and sludges. Beneath this hard layer were at least 3 million gallons, and possibly as much as 4.5 million gallons, of additional liquid wastes. The capacity of the tanks was inadequate to hold all the liquid waste in Basin F (Campbell, 1988).

In addition to the excess liquids, crystallized salts and material beneath the liner added over 150,000 cubic yards to the estimated 405,000 cubic yards of contaminated sludge expected to be

excavated (Woodward-Clyde, 1990). These saturated soils and sludges had to be dried prior to placement in the Basin F waste pile. To enhance the drying, a piece of equipment called the "Brown Bear" began operations on August 23. The Brown Bear mixed the wet materials with dry soils, exposing more surface area to air in order to dry the materials. This mixing and air-drying of soils and sludges increased the noxious odors released to air. Consequently, the Army discontinued use of the Brown Bear in September (Basin F Transcripts, September 28, 1988).

The first of 200 logged complaints about foul odors came from off-post neighbors during the summer of 1988 (Ebasco Services et al., 1991). In the fall of 1988, with Basin F sludges exposed and the start of Denver's meteorological inversion season, complaints about noxious odors and adverse health effects from the fumes increased. Multiple complaints per night were recorded. In response, the Army asked Ebasco to commence off-post odor tracking on October 5, 1988. Complaints were registered nearly every day in December 1988 (Ebasco Services et al., 1991).

As a result of the odor complaints, the Army abandoned the Phase I IRA plan in December 1988, ordering all remaining waste in the basin to be capped in place (Ebasco Services, 1989). By January 21, 1989, the "final" cover was placed over the Basin F floor, and by the end of February 1989, the waste pile was closed to contaminated material. The last complaint about odors from off-post neighbors was recorded on March 10, 1989 (Ebasco Services, 1989).

The air monitoring during the Basin F IRA was flawed for several reasons. For example, in early August 1988, Ebasco Services discovered that post calibration of real-time air monitoring instruments was not being performed as required, rendering data "questionable" (Lewis, 1988). More significantly, the analytical methodology used for air sampling of aldrin and dieldrin had a recovery of only 28%, meaning as much as 72% of the compound present was not measured or recorded (EPA, 1984; Sullivan Environmental Consulting and E.H. Pechan & Associates, 1991). Alternative methods may have resulted in 90% recoveries (EPA, 1988, 1989). In addition, hexachlorobutadiene (HCBD), an extremely odorous compound, was not monitored at all during the months of maximum emissions. HCBD was not identified as a target compound until January 1989, when air quality tests indicated that HCBD and ammonia were the most prominent contaminants in gases emanating from Basin F soils and sludges (Ebasco Services, 1989; Ranum, 1989). Thus, much of the Army's analytical data cannot be considered reliable for determining contaminant concentrations that were released into the air.

Compounds released to the air were associated with noxious odors, and pesticides in particular were linked to the adverse health effects experienced by exposed individuals. Army documents acknowledge that its cleanup activities caused noxious odors that adversely affected downwind individuals during implementation of the Basin F interim action (Basin F Transcripts, September 28, 1988; Ebasco Services, 1989; Ebasco Services et al., 1991). Reported adverse health effects included:

> …headaches, nausea, vomiting and anorexia, insomnia, burning and tearing eyes, conjunctivitis, wandering eye and visual disturbances, skin rashes, sore throats, runny noses and nose bleeds, respiratory problems including coughing and shortness of breath, muscle and joint pain, tingling and numbness, ringing in the ears, chronic fatigue and perceived weakness, dizziness, taste perversions, chest pain, abdominal pain, diarrhea, tremors, facial twitches, amnesia, disorientation, irritability, incoordination and depression (Burnett, 1990, pp. 20–22).

Many of these symptoms were also experienced by CDPHE employees and Army contractors (Ebasco Services et al., 1991) and were consistent with the known toxicology of Basin F chemicals (Burnett, 1990).

The Army's Odor Response Program logged 200 complaints between August 1988 and March 1989. The program was terminated in May 1989. The EPA, CDPHE, and Tri-County Health Department received additional complaints (Basin F Transcripts, September 6, 1988). In addition to the symptoms described above, nearby residents suspected the noxious emissions from Basin F of causing or exacerbating cancer, lupus, epileptic seizures, sores in the mouth and the unexpected deaths and illnesses of pets (Basin F Transcripts, October 26, 1988; Ebasco Services et al., 1991).

Because of noxious odors, adverse health effects, and fear of serious long-term illness, residents reported that they avoided the outdoors and shut their doors and windows, even during hot summer months, as much as possible. They employed air purifiers provided by the Army for their homes but concerns and discomfort remained (Basin F Transcripts, October 26, 1988).

The qualitative evidence presented above demonstrates that services provided by the State's air resources were lost as a result of Basin F emissions. A more quantitative analysis of air quality data and lost services is anticipated as part of the assessment.

7.2 Injury Quantification

This section contains a preliminary estimate of the spatial and temporal extent of air resources injury as a result of the Basin F response action. A more detailed analysis may be conducted as part of this assessment.

Spatial extent of injury

Odor complaints were clustered around the Arsenal, with most of the more vocal and persistent complaints coming from residents of 96th Avenue just north of the Arsenal and in the Irondale trailer park, located one mile northwest of Basin F. Sullivan Environmental Consulting and

E.H. Pechan & Associates (1991) included a map of the most persistent complainants (Figure 7.1). Other complainants were located as far away as 46th and York Street, and one complainant resided near the south border of the Arsenal.

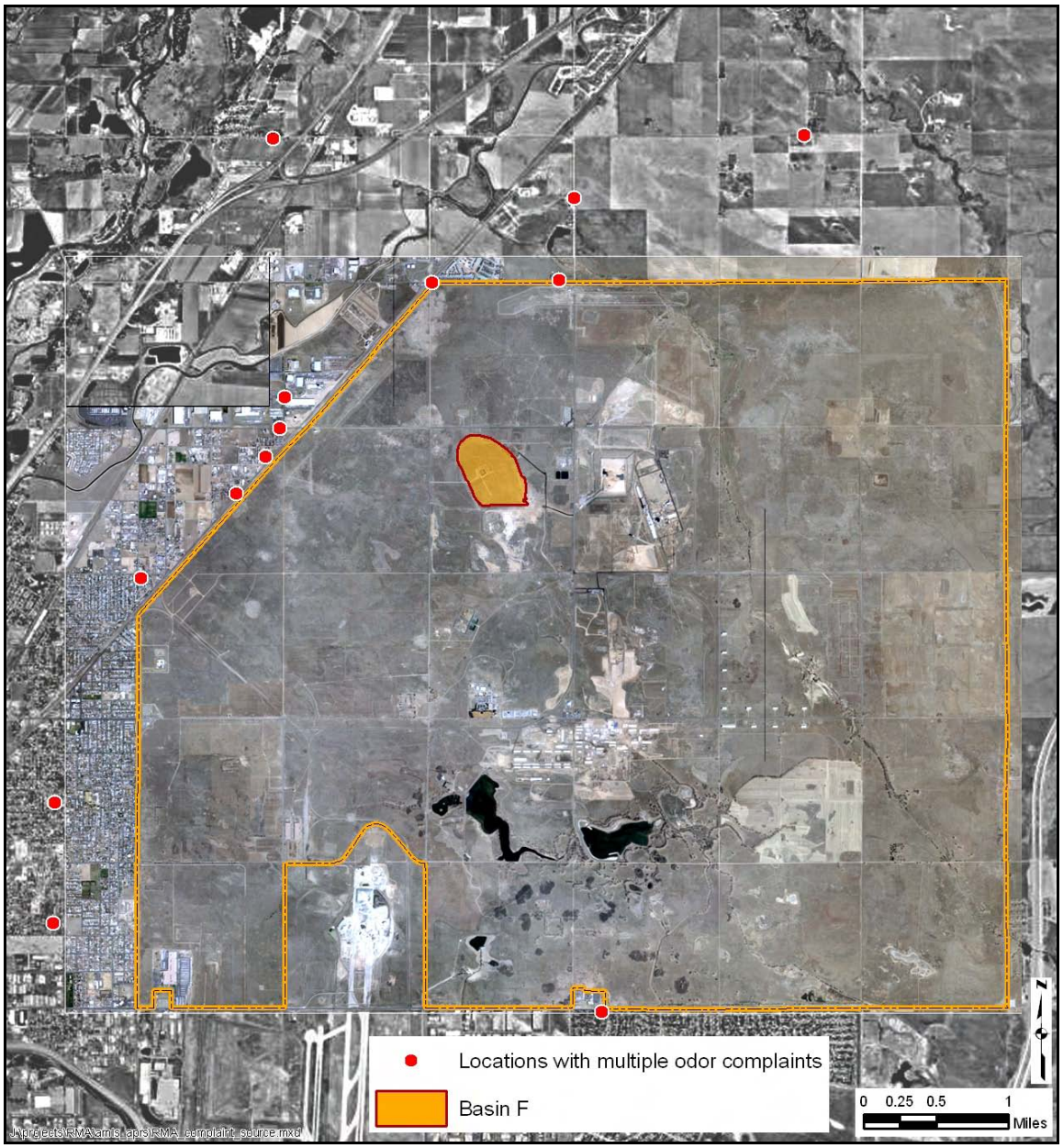

Figure 7.1. Location of complainants noting persistent noxious odors during the Basin F interim response action.

Source: Sullivan Environmental Consulting and E.H. Pechan & Associates, 1991, Figure 7.

Temporal extent of injury

The Basin F response action began on March 22, 1988. By March 28, 1988, contractors were expressing concerns to the Army about the odors (Ebasco Services, 1988). Odor response monitoring for offsite complaints commenced on August 5, 1988 and continued through May 5, 1989. A formal odor response program, which included plume tracking, was initiated in October 1988 and terminated in May 1989 after complaints ceased (Ebasco Services et al., 1991).

7.3 Assessment Activities

As part of the assessment, the Trustees may perform a more quantitative evaluation of injuries to air resources. In particular, the Trustees may:

- Review quantitative data from air quality monitoring during the Basin F IRA to determine if specific injury thresholds were exceeded, or if injury to air resources may have occurred but was not measured due to inadequate technology and human error
- Compile odor complaints to assess the likely spatial and temporal extent of injury during the Basin F IRA
- Review air dispersion models to better quantify hazardous substance releases to air, and the transport of those release through air resources
- Review on-post fugitive dust emissions data to evaluate other potential injury to air resources.

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