LA-UR-22-21423

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Intended for:	Report Environmental Regulatory Document
Issued:	2022-03-16 (rev.2)

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Issued:	2022-02-25 (rev.1)

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11 February 2022

2021 Results for Avian Monitoring of Inorganic and Organic Element Concentrations in Passerine Eggs and Nestlings Collected from Technical Area 16 Burn Grounds, Technical Area 36 Minie, and Technical Area 39 Point 6 at Los Alamos National Laboratory

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Prepared for: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Field Office

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CONTENTS

ACRONYMS AND TERMS

ALS	Australian Laboratory Services
EPA	Environmental Protection Agency
LANL	Los Alamos National Laboratory
LOAEL	lowest observable adverse effect levels
mg/kg	milligrams per kilogram
PCBs	polychlorinated biphenyls
RSRLs	regional statistical reference levels
TA	Technical Area
TCDD	tetrachlorodibenzodioxin-2,3,7,8
TEF	toxic equivalent factors
TEQ	toxic equivalents
RCRA	Resource Conservation and Recovery Act
WHO	World Health Organization

1.0 SUMMARY

In 2021, non-viable avian eggs and one nestling were opportunistically collected at Los Alamos National Laboratory (LANL) near open detonation sites located at Technical Area (TA) 16 burn grounds and TA-36 Minie. Similar to previous years, nestboxes were monitored at TA-39 Point 6, however, no avian samples were available for opportunistic collection. Samples were evaluated for inorganic elements (mostly metals), dioxins, and furans. One ash-throated flycatcher (*Myiarchus cinerascens*) egg sample was collected from TA-16 burn grounds. One ash-throated flycatcher and one mountain bluebird (*Sialia currucoides)* egg sample and one deceased western bluebird (*Sialia mexicana*) nestling sample were collected from TA-36 Minie. Concentrations of inorganic elements observed in this study were compared with the regional statistical reference level (RSRL) which is the upper-level bounds of background concentrations (mean + three standard deviations = 99% confidence interval). Several inorganic elements were not detected in avian eggs. Most inorganic elements detected were below the RSRL and all were the lowest observable adverse effect level (LOAEL), when available. The nestling collected from TA-36 did not contain detectable concentrations of dioxin or furan congeners. These data suggest that inorganic and organic element concentrations in eggs and nestlings are not of ecological concern. More data are needed to make a robust assessment and to evaluate trends over time.

2.0 INTRODUCTION

In support of the Resource Conservation and Recovery Act (RCRA) permit process, Los Alamos National Laboratory (LANL) began annual avian monitoring in 2013 around TA-16 burn grounds and at two firing sites, TA-36 Minie and TA-39 Point 6. Biomonitoring is an important tool for assessing environmental contamination by analyzing chemicals or their metabolites from biological tissues (Becker 2003). Avian eggs and nestlings are useful as bioindicators because different species occupy many trophic levels. Additionally, the collection of non-viable eggs and/or nestlings that die of natural causes is non-invasive and is non-destructive to populations. Inorganic elements and organic chemicals can pose risks of adverse effects to birds if exposed at high enough concentrations (Jones and de Voogt 1999). Levels of some constituents in biological tissues can also indicate whether adverse effects could be expected (Gochfeld and Burger 1998). Examining population parameters along with tissue concentrations provides a more comprehensive and robust assessment of potential impacts caused by environmental pollution.

Several congeners of polychlorinated biphenyls (PCBs), dioxins, and furans elicit similar toxic effects (i.e., immunotoxicity, carcinogenicity, and endocrine disruption) as those caused by tetrachlorodibenzodioxin-2,3,7,8 (TCDD), the most potent in this class of chemicals (Van den Berg et al. 2006). These congeners, like TCDD, have a high binding affinity to the aryl hydrocarbon receptor (Van den Berg et al. 2006). The World Health Organization (WHO) developed toxic equivalency factors (TEFs) for TCDD-like compounds that can be used to determine the relative potency, or toxic equivalents (TEQs), of dioxin-like compounds for different classes of animals (i.e., fish, birds, and mammals), as well as to facilitate risk assessment for TCDD-like exposure (Van den Berg et al. 1998).

Sources of inorganic elements include both anthropogenic and natural sources; birds can be exposed through a number of routes, including diet, ingestion of soil, drinking water, and inhalation. Inorganic elements (mostly metals), dioxins, and furans are of interest at open-detonation firing sites (TA-36 and TA-39) and at the burn grounds at TA-16 (Fresquez 2011).

3.0 OBJECTIVES

The objective of this ongoing study is to document chemical concentrations in eggs and nestlings collected near TA-16 burn grounds, TA-36 Minie, and TA-39 Point 6 and to compare concentrations of inorganic elements, PCBs, dioxins, and furans observed in this study with the upper-level bounds of background concentrations.

4.0 METHODS

4.1. Sample Collection

Eggs and nestlings were collected from nest boxes when they were determined to be non-viable, based on documented timing of known incubation periods for the species. We collected a total of four non-viable eggs and one deceased nestling at LANL near the TA-16 burn grounds (Figure 1) and near open detonation site TA-36 Minie (Figure 2). At TA-16 burn grounds, two non-viable ash-throated flycatcher (*Myiarchus cinerascens*) egg samples were collected and submitted as one composite sample. At TA-36 Minie, one non-viable mountain bluebird egg (*Sialia currucoides)*, one non-viable ash-throated flycatcher egg, and one deceased western bluebird (*Sialia mexicana*) nestling were collected and submitted as individual samples. All samples were collected May through July of 2021. Concentrations of chemicals in eggs and nestlings have been monitored annually at these locations since 2014.

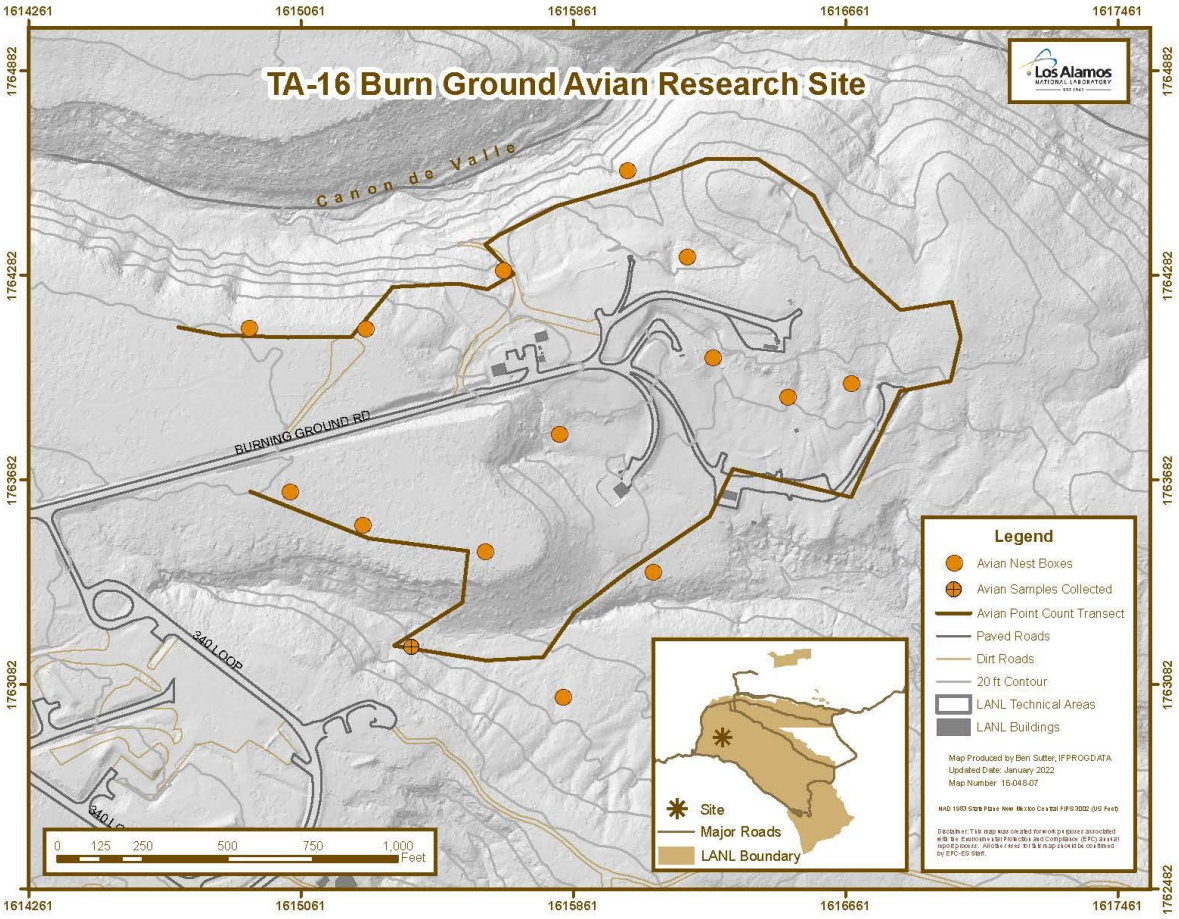

Figure 1. Avian nest box locations around TA-16 burn grounds.

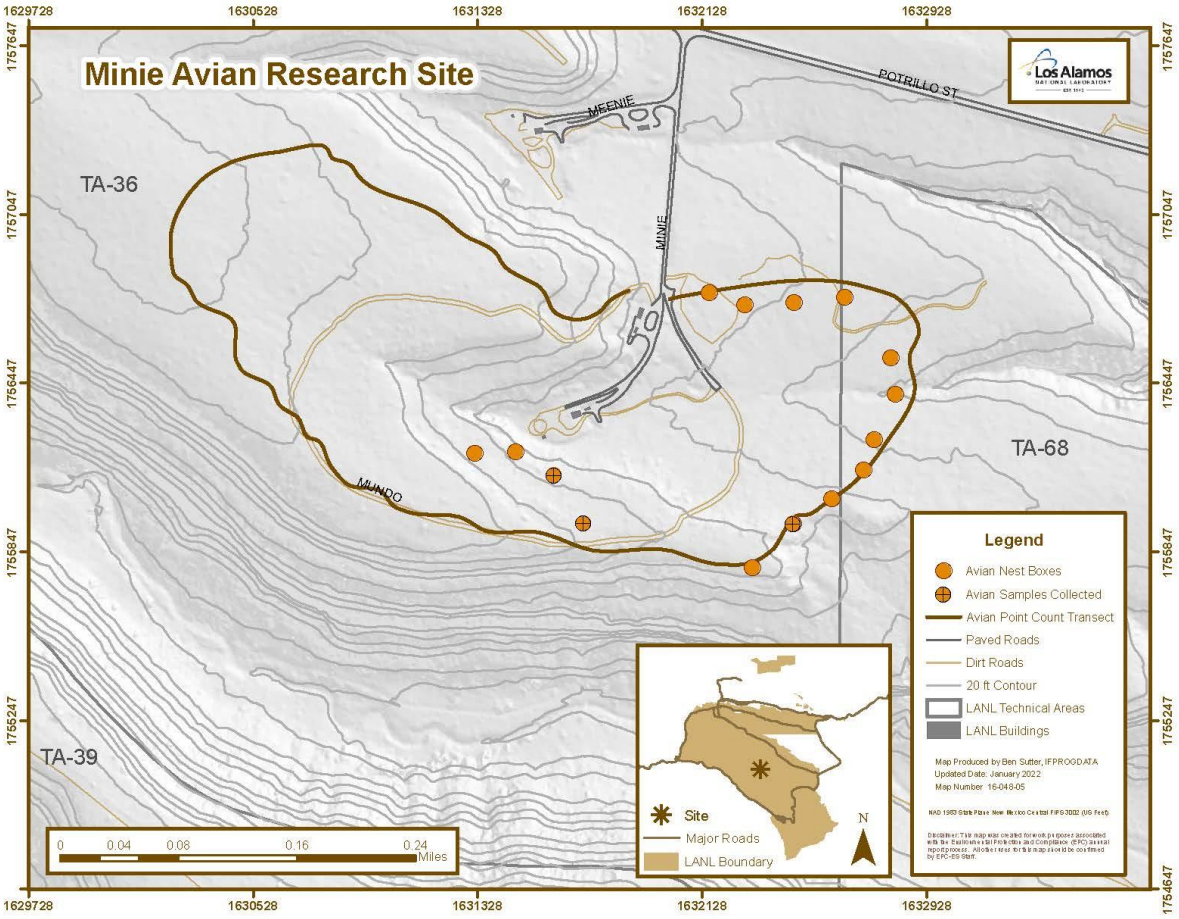

Figure 2. Avian nest box locations around TA-36 Minie.

4.2. Chemical Analyses

Due to limited sample mass, non-viable eggs were analyzed for total analyte list (mostly inorganic metals) only and were analyzed at ALS (Australian Laboratory Services, formerly Paragon Analytics, Inc.) in Fort Collins, Colorado. Antimony, arsenic, cadmium, lead, selenium, silver, and thallium concentrations were measured in egg samples by inductively coupled plasma mass spectrometry (Environmental Protection Agency [EPA] SW-846 Method 6020), and aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc were measured by inductively coupled plasma atomic emission spectrometry (EPA SW-846 Method 6010B). Mercury was measured by cold-vapor atomic absorption procedure (EPA SW-846 Method 7471A). All inorganic element results were reported on an mg/kg (milligram per kilogram) wet weight basis.

The non-viable nestling sample collected near TA-36 Minie was analyzed for dioxin and furan congeners by EPA SW-846 Method 8290 at Cape Fear Analytical LLC, Wilmington, North Carolina. All organic chemical results are reported on a wet weight basis.

4.3. Statistical Methods

The 2021 results were compared with the regional statistical reference levels (RSRL), which represents natural and fallout levels of chemicals, and are the upper-level bounds of background concentrations (mean + three standard deviations = 99% confidence interval). Regional statistical reference levels were calculated from non-viable eggs of western bluebirds and ash-throated flycatchers collected from Bandelier National Monument from 2021 (n = 10 samples). Non-viable egg results are also compared with the lowest observable adverse effect levels (LOAEL) from peer reviewed literature, when available.

Detectable concentrations of dioxin and furans congeners are compared with RSRLs and LOAELs, when available. The nestling RSRL was calculated from non-viable nestlings of western bluebirds and ash-throated flycatchers at background locations from Bandelier National Monument in 2018 through 2020 (n = 8 samples).

5.0 RESULTS AND DISCUSSION

Similar with previous years, many of the inorganic elements assessed in this study were not detected in passerine egg samples. Several elements are not (or very little is) maternally transferred into eggs or do not accumulate in eggs and include cadmium (Leach et al. 1979; Stoewsand et al. 1986), lead (Pattee 1984), vanadium (White and Dieter 1978), and silver (Schwarzbach et al. 2006; Seiler and Skorupa 2001), which may explain why these elements were mostly not detected. Similarly, no dioxins and furans were detected in the nestling sample collected from TA-36 Minie.

5.1. TA-16 Burn Grounds

The composite ash-throated flycatcher egg sample collected from nest boxes at TA-16 burn grounds did not contain detectable concentrations of aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, silver, thallium or vanadium. Mercury was detected at a concentration of 0.031 mg/kg and slightly exceeded the RSRL of 0.011 (Table 1), but was far below the LOAEL of 1.9 mg/kg (Shore et al. 2011). The remaining detectable elements were below the RSRLs (Table 1). Selenium concentrations were also below the LOAEL of 2.6 mg/kg (Ohlendorf and Heinz, 2011,); no other LOAELs were available.

5.2. TA-36 Minie

The one mountain bluebird and one ash-throated flycatcher egg sample collected from TA-36 Minie, did not have detectable levels of several elements, including aluminum, arsenic, beryllium, cadmium, chromium, cobalt, lead, nickel, silver, thallium, or vanadium. The mountain bluebird egg sample contained antimony concentrations of 0.024, which slightly exceeded the RSRL of 0.019 mg/kg (Table 2). The ash-throated flycatcher egg sample contained mercury concentrations of 0.019 mg/kg which slightly exceeded the RSRL of 0.011 (Table 2), but was far below the LOAEL of 1.9 mg/kg (Shore et al. 2011). The remaining detectable elements were below the RSRLs (Table 2). Selenium concentrations were also below the LOAEL of 2.6 mg/kg (Ohlendorf and Heinz, 2011,); no other LOAELs were available. No dioxin and furan congeners were detected in the western bluebird nestling sample collected from TA-36 Minie.

6.0 CONCLUSIONS

The overall results indicate that the levels of constituents detected in the eggs and nestlings are not likely to cause adverse effects in breeding bird populations. Several constituents were not detected in the non-viable egg and nestling samples collected near TA-16 burn grounds and TA-36 Minie. The majority of constituents that were detected were below RSRLs and all were below the LOAELs, when available. These results suggest that the detectable concentrations observed here are not of ecological concern. More data from non-viable eggs and nestlings are needed to make a robust assessment and to examine trends over time. Evaluating avian nestling samples for high explosives are also of interest for future work as those data become available.

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Table 1. Detectable inorganic element concentrations (mg/kg wet weight) detected in a composite egg samples collected near TA-16 burn grounds compared with RSRL. The RSRL is the upper limit background concentrations (mean + three standard deviations) for passerine eggs based on data in 2021 (n = 10).

Element	Ash-throated Flycatcher (n = 2) SFB-21-233901	RSRL
Barium	0.47	3.9
Calcium	550	6,588
Copper	0.53	1.71
Iron	23	70
Magnesium	62	130
Mercury	0.031	0.011
Potassium	1,900	3,227
Selenium	0.85	1.0
Sodium	2,400	3,506
Zinc	11	23.1

Table 2. Inorganic element concentrations (mg/kg wet weight) detected in a single egg sample collected near the TA-36 Minie compared with RSRL. The RSRL is the upper limit background concentrations (mean + three standard deviations) for passerine eggs based on data in 2021 (n = 10).

Element	Mountain bluebird (n = 1) SFB-21-233902	Ash-throated flycatcher (n = 1) SFB-21-233903	RSRL
Antimony	0.024	ND	0.019
Barium	1.9	ND	3.9
Calcium	690	640	6,588
Copper	0.45	0.54	1.71
Iron	17	23	70
Magnesium	81	72	130
Manganese	ND	0.36	1.04
Mercury	0.003	0.019	0.011
Potassium	2,000	1,400	3,227
Selenium	0.42	0.64	1.0
Sodium	2,300	1,900	3,506
Zinc	7.4	9.5	23.1

ND = Not detected