

Prepared in cooperation with the Bureau of Indian Affairs

Estimation of Volume and Mass and of Changes in Volume and Mass of Selected Chat Piles in the Picher Mining District, Ottawa County, Oklahoma, 2005–10



Scientific Investigations Report 2013–5011

Front cover:

Left, Eroded chat on the Sooner property.

Right, View of the Sooner chat pile oriented southeast, with small mounds of chat in the foreground.

Bottom banner, Panoramic view of a chat pile (CP039) on the St. Joe property, oriented east.

Back cover:

Top right, View from the north entrance to the Sooner property showing chat piles.

Bottom right, Closeup view of chat on the St. Joe property with a quarter dollar for scale.

Left, Small mound of chat beside Main Street in the former town of Picher, Oklahoma, oriented southeast toward an abandoned baseball field and chat pile (CP037).

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By S. Jerrod Smith

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Scientific Investigations Report 2013–5011

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013

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Contents

Abstract	1
Introduction	1
Purpose	3
Scope	3
Study Area	3
Methods for Estimating Volume and Mass of Selected Chat Piles	3
Digital Elevation Models	3
Chat-Pile Footprints	6
Chat-Pile Average Altitudes	6
Chat-Pile Base Altitudes and Chat-Pile Average Heights	6
Bulk Density of the Chat Piles	6
Assumptions	6
Estimation of 2005 and 2010 Chat-Pile Volumes and Masses	8
Estimation of Changes in Chat Volumes and Masses for 2005 Through 2010	10
Summary	12
References Cited	12

Figures

1. Aerial-photograph-draped, bare-earth light detection and ranging (lidar) survey scenes (2.5 times vertical exaggeration) showing selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, in 2010 (property names are labeled on the scenes). <i>A</i> , View oriented northwest. <i>B</i> , View oriented south. <i>C</i> , View oriented southwest	2
2. Map showing locations and footprints of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma	4
3. Theoretical chat-pile schematics showing data used to compute volumes of selected chat piles in the Picher mining district, Ottawa County, Oklahoma. <i>A</i> , Map. <i>B</i> , Cross section	5
4. Map showing changes in land-surface altitude in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010	7
5. Boxplot showing bulk density of chat piles in the Picher mining district, Ottawa County, Oklahoma, 2005	8
6. Graphs showing estimates of chat-pile volume and mass for selected properties in the Picher mining district, Ottawa County, Oklahoma, 2005 and 2010	9
7. Graph showing estimates of volume and mass changes for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010	11

Tables

1. Characteristics of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, and altitude statistics for selected chat piles, 2005 and 201013
2. Estimates of volume, mass, and change in volume and mass for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 201017

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)
	Area	
acre	4,047	square meter (m ²)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm ²)
acre	0.004047	square kilometer (km ²)
square foot (ft ²)	929.0	square centimeter (cm ²)
square foot (ft ²)	0.09290	square meter (m ²)
square mile (mi ²)	259.0	hectare (ha)
square mile (mi ²)	2.590	square kilometer (km ²)
	Volume	
cubic foot (ft ³)	28.32	cubic decimeter (dm ³)
cubic foot (ft ³)	0.02832	cubic meter (m ³)
cubic yard (yd ³)	0.7646	cubic meter (m ³)
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram (kg)
ton, short (2,000 lb)	0.9072	megagram (Mg)
	Density	
pound per cubic foot (lb/ft ³)	16.02	kilogram per cubic meter (kg/m ³)
pound per cubic foot (lb/ft ³)	0.01602	gram per cubic centimeter (g/cm ³)
ton, short (2,000 lb) per cubic yard (ton/yd ³)	1.187	megagram per cubic meter (Mg/m ³)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Altitude, as used in this report, refers to distance above the vertical datum.

Estimation of Volume and Mass and of Changes in Volume and Mass of Selected Chat Piles in the Picher Mining District, Ottawa County, Oklahoma, 2005–10

By S. Jerrod Smith

Abstract

From the 1890s through the 1970s the Picher mining district in northeastern Ottawa County, Oklahoma, was the site of mining and processing of lead and zinc ore. When mining ceased in about 1979, as much as 165–300 million tons of mine tailings, locally referred to as “chat,” remained in the Picher mining district. Since 1979, some chat piles have been mined for aggregate materials and have decreased in volume and mass. Currently (2013), the land surface in the Picher mining district is covered by thousands of acres of chat, much of which remains on Indian trust land owned by allottees. The Bureau of Indian Affairs manages these allotted lands and oversees the sale and removal of chat from these properties. To help the Bureau of Indian Affairs better manage the sale and removal of chat, the U.S. Geological Survey, in cooperation with the Bureau of Indian Affairs, estimated the 2005 and 2010 volumes and masses of selected chat piles remaining on allotted lands in the Picher mining district. The U.S. Geological Survey also estimated the changes in volume and mass of these chat piles for the period 2005 through 2010.

The 2005 and 2010 chat-pile volume and mass estimates were computed for 34 selected chat piles on 16 properties in the study area. All computations of volume and mass were performed on individual chat piles and on groups of chat piles in the same property. The Sooner property had the greatest estimated volume (4.644 million cubic yards) and mass (5.253 ± 0.473 million tons) of chat in 2010. Five of the selected properties (Sooner, Western, Lawyers, Skelton, and St. Joe) contained estimated chat volumes exceeding 1 million cubic yards and estimated chat masses exceeding 1 million tons in 2010. Four of the selected properties (Lucky Bill Humbah, Ta Mee Heh, Bird Dog, and St. Louis No. 6) contained estimated chat volumes of less than 0.1 million cubic yards and estimated chat masses of less than 0.1 million tons in 2010. The total volume of all selected chat piles was estimated to be 18.073 million cubic yards in 2005 and 16.171 million cubic yards in 2010. The total mass of all selected chat piles was estimated to be 20.445 ± 1.840 million tons in 2005 and 18.294 ± 1.646 million tons in 2010.

All of the selected chat piles decreased in volume and mass for the period 2005 through 2010. Chat piles CP022 (Ottawa property) and CP013 (Sooner property) had some within-property chat-pile redistribution, with both chat piles having net decreases in volume and mass for the period 2005 through 2010. The Sooner property and the St. Joe property had the greatest volume (and mass) changes, with 1.266 million cubic yards and 0.217 million cubic yards (1.432 ± 0.129 million tons and 0.246 ± 0.022 million tons) of chat being removed, respectively. The chat removed from the Sooner and St. Joe properties accounts for about 78 percent of the chat removed from all selected chat piles and properties. The total volume and mass removed from all selected chat piles for the period 2005 through 2010 were estimated to be 1.902 million cubic yards and 2.151 ± 0.194 million tons, respectively.

Introduction

From the 1890s through the 1970s the Picher mining district (PMD) in northeastern Ottawa County, Oklahoma, was the site of mining and processing of lead and zinc ore (State of Oklahoma, 2000). Subsurface mines, some as deep as 400 feet (ft), supplied unprocessed ore to mills on the land surface. When mining ceased in about 1979, as much as 165–300 million tons of mine tailings, locally referred to as “chat,” remained in the PMD (State of Oklahoma, 2000). The U.S. Army Corps of Engineers estimated that 75 million tons of mine tailings remained in the PMD in 2000 (State of Oklahoma, 2000). If an average bulk density of 83.8 pounds per cubic foot (lb/ft^3 ; AATA International, Inc., 2005) or 1.1313 ton per cubic yard (ton/yd^3) is assumed, 75 million tons corresponds to a volume of about 66.7 million cubic yards (yd^3) of chat.

A 2005 report classified the areas of remaining chat into three categories: chat piles, chat bases, and chat fines (AATA International, Inc., 2005). Chat piles are mounded areas of mine tailings that may be higher than 180 ft above the surrounding terrain (fig. 1). Chat piles contain mostly

2 Estimation of Volume and Mass and of Changes in Volume and Mass of Selected Chat Piles in the Picher Mining District

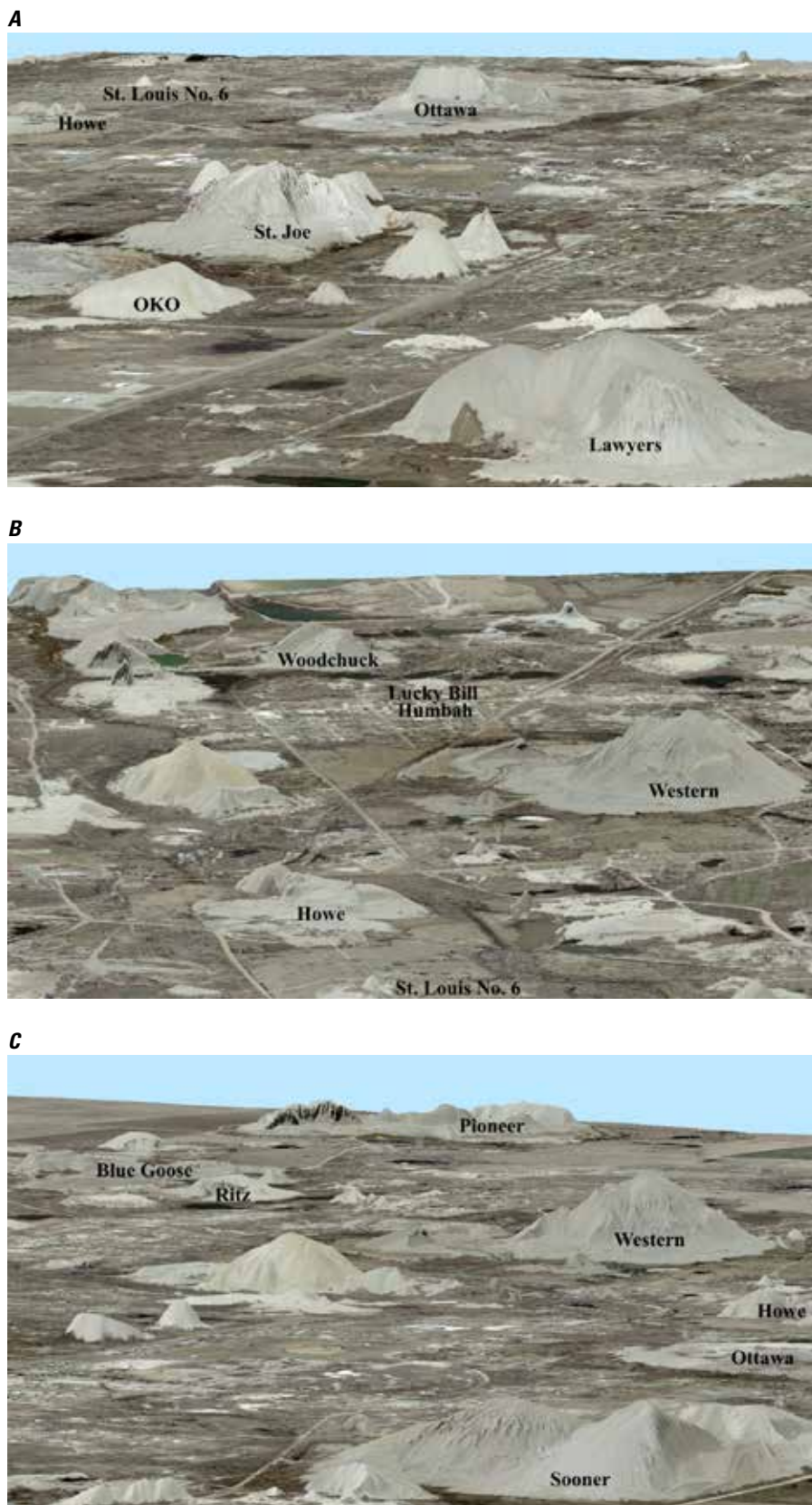


Figure 1. Aerial-photograph-draped, bare-earth light detection and ranging (lidar) survey scenes (2.5 times vertical exaggeration) showing selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, in 2010 (property names are labeled on the scenes). *A*, View oriented northwest. *B*, View oriented south. *C*, View oriented southwest.

gravel- to sand-sized material that has economic value, primarily as aggregate for road construction. Since 1979, some chat piles have been mined for aggregate materials and have decreased in volume and mass. AATA International, Inc. (2005), estimated that 31.2 million yd³ of chat remained in chat piles in 2004. As chat piles are removed for sale, chat bases are exposed. Chat bases are lower lying, level areas that were formerly covered by chat piles. Chat bases contain chat of unknown thickness and are of similar altitude to the surrounding terrain. AATA International, Inc. (2005), estimated that 6.71 million yd³ of chat remained in chat bases in 2004. The third category of chat, chat fines, contains mostly fine-sand-, silt-, and clay-sized particles. Chat fines are located adjacent to chat piles and are the remains of remilled chat piles; they were considered to contain too little coarse material to have economic value at the time of this report (2013). AATA International, Inc. (2005), estimated that 9.16 million yd³ of chat fines remained in 2004.

Currently (2013), the land surface in the PMD is covered by thousands of acres of chat, much of which remains on Indian trust land owned by allottees. The Bureau of Indian Affairs (BIA) manages these allotted lands and oversees the sale and removal of chat from these properties. To help the BIA better manage the sale and removal of chat, the U.S. Geological Survey (USGS), in cooperation with the BIA, estimated the 2005 and 2010 volumes and masses of selected chat piles remaining on allotted lands in the Picher mining district. The USGS also estimated the changes in volume and mass of these chat piles for the period 2005 through 2010.

Purpose

The purposes of this report are to present estimates of volume and mass computed for selected chat piles in 2005 and 2010 and to present estimates of changes in volume and mass for selected chat piles for the period 2005 through 2010. The report also documents data sources, assumptions, and methods that were used to estimate the volumes and masses of selected chat piles so that the computations can be repeated as new data become available. The chat-pile volume and mass estimates in this report may be used by the BIA and other stakeholders to estimate the economic value of remaining chat resources and assess offers and bids to purchase remaining chat resources.

Scope

This report contains volume and mass estimates of 34 selected chat piles on 16 BIA-managed properties in the PMD. Volume and mass estimates are reported for these selected chat piles only; no attempt was made to estimate the volume or mass of chat remaining in other chat piles, chat bases, or chat fines. Because of time and funding constraints, chat-pile volumes were estimated in a geographic information system by using aerially surveyed altitude data rather than by using ground-surveyed altitude data.

Study Area

The study area includes about 12 square miles (mi²) of the PMD in northern Ottawa County, Oklahoma, near the former town of Picher (fig. 2). Where it is not covered by chat, the study area is relatively flat, and there is typically little change in altitude over short distances. At least 50 chat piles of various sizes have been identified in the study area (AATA International, Inc., 2005). Thirty-four of these chat piles were selected for analysis of volume and mass (fig. 2, table 1 at end of report). Each of these chat piles has a unique identification number and is associated with a property that may contain one or more distinct chat piles (AATA International, Inc., 2005); however, some property names used in this report were updated to names that are commonly used by the BIA (table 1). All computations of volume and mass were performed on individual chat piles and on groups of chat piles in the same property.

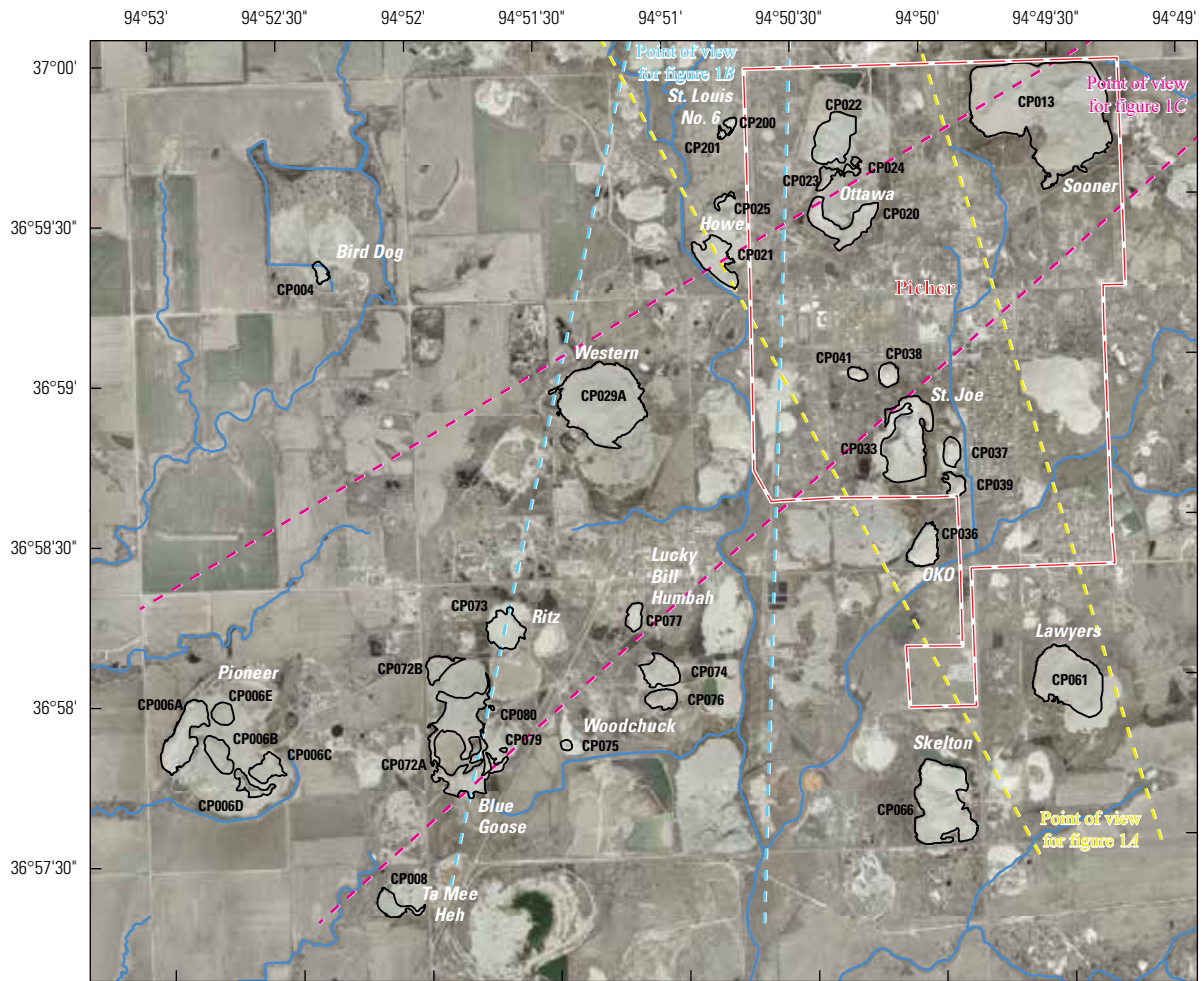
Methods for Estimating Volume and Mass of Selected Chat Piles

Several datasets were needed to estimate the volume and mass of the selected chat piles. Required datasets were (1) digital elevation models (DEMs) of the land surface in 2005 and 2010, (2) footprints of the selected chat piles, (3) the chat-pile average altitude in each footprint, (4) the base altitude of each chat pile, and (5) the bulk density measurements of the chat piles. The volumes of selected chat piles were computed as the chat-pile average height (the chat-pile average altitude minus the chat-pile base altitude) times the chat-pile footprint area (fig. 3). The masses of selected chat piles were computed as the chat-pile volume times the average chat-pile bulk density.

Digital Elevation Models

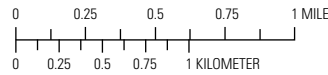
Land-surface altitudes were determined by using 2005 and 2010 bare-earth DEMs developed from aerial-based light detection and ranging (lidar) surveys. The 2005 lidar survey was flown in March 2005 (Aero-Metric, Inc., 2005). The resulting 2005 bare-earth DEM had a horizontal resolution of 10 ft (3.05 meters [m]) and a vertical precision of 0.01 ft (0.003 m). The 2005 lidar survey also included acquisition of high-resolution (0.5 ft) leaf-off aerial orthophotography for the study area (Aero-Metric, Inc., 2005). The 2010 lidar survey was flown on April 11, 2010 (Photo Science, Inc., 2010). The resulting 2010 bare-earth DEM had a horizontal resolution of 3.28 ft (1 m) and a vertical precision of 0.0328 ft (0.01 m). The lidar data were reprojected to Lambert Conformal Conic, Oklahoma State Plane North projection, and the 2005 DEM was resampled by using bilinear interpolation to match the extent and resolution of the 2010 DEM prior to analysis.

4 Estimation of Volume and Mass and of Changes in Volume and Mass of Selected Chat Piles in the Picher Mining District



Base aerial photography from Aero-Metric, Inc., 2005
 Municipal boundary from U.S. Census Bureau, 2000
 Lambert Conformal Conic, Oklahoma State Plane North projection

Chat-pile boundaries modified from AATA International, Inc., 2005
 Mined areas from Brichta, 1960



EXPLANATION	
	Municipal boundary
	Selected chat-pile boundary and identification number (table 1)
	Bureau of Indian Affairs-approved property name (table 1)

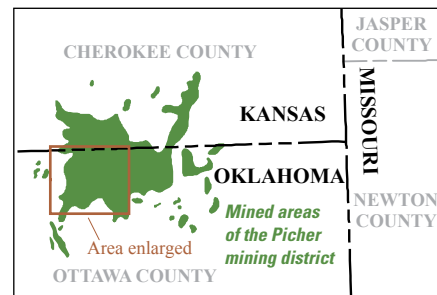
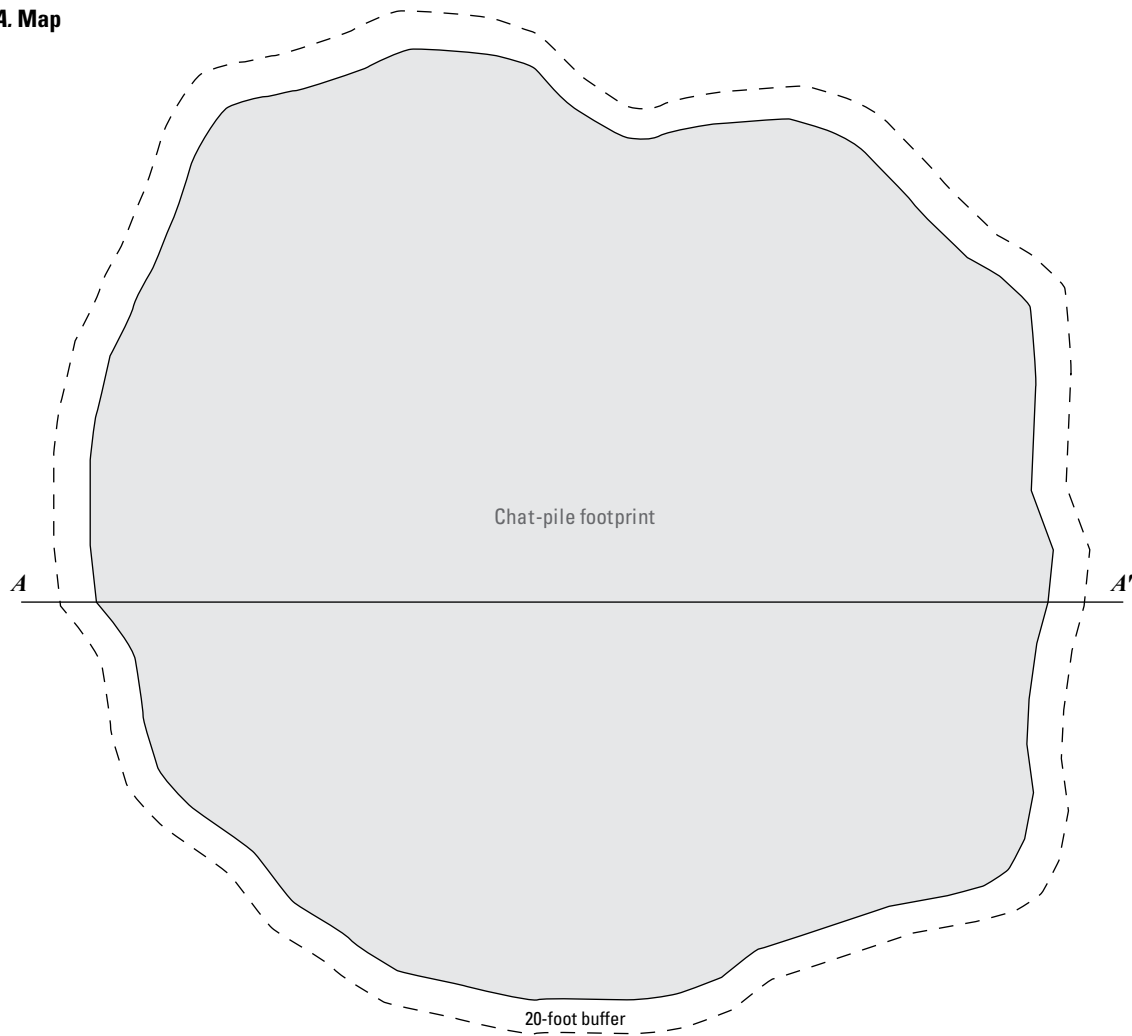


Figure 2. Locations and footprints of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma.

A. Map



B. Cross section

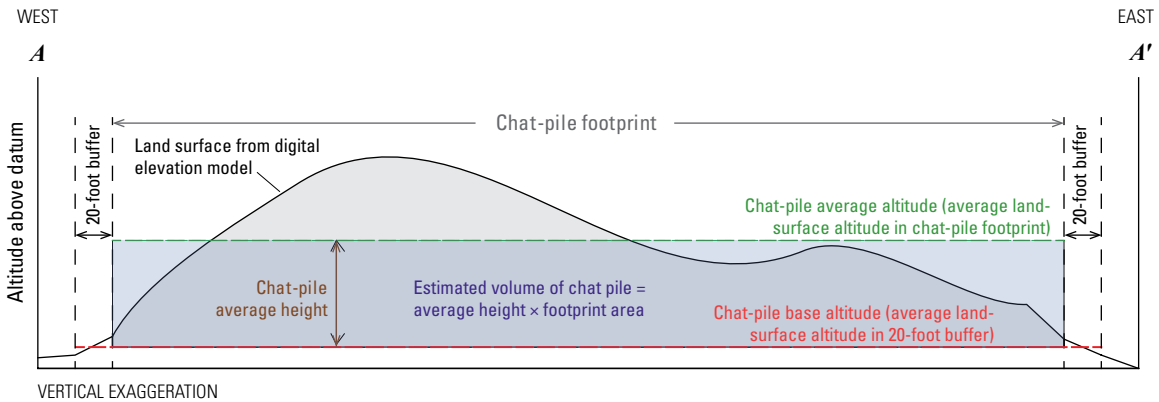


Figure 3. Theoretical chat-pile schematics showing data used to compute volumes of selected chat piles in the Picher mining district, Ottawa County, Oklahoma. *A*, Map. *B*, Cross section.

Chat-Pile Footprints

The chat-pile footprints were originally obtained from AATA International, Inc. (2005). The St. Louis No. 6 chat piles (CP200 and CP201), which had not been delineated by AATA International, Inc. (2005), were delineated in ESRI ArcGIS 10.0 software (Environmental Systems Research Institute, Inc., Redlands, Calif.) at a 1:1,200 scale by using high-resolution (0.5 ft) aerial photographs and digital elevation data (Aero-Metric, Inc., 2005) acquired in March 2005. A preliminary, map-based assessment of land-surface altitude changes was necessary to ensure that the chat-pile footprints covered all areas where chat was removed or redistributed. A map (fig. 4) showing changes in land-surface altitude for the period 2005 through 2010 was created by subtracting the 2005 DEM from the 2010 DEM by using the ArcGIS Raster Calculator tool (ESRI, Inc., 2012a) and rounding to the nearest foot. Yellow and red hues (negative changes in altitude) on the map indicate removal of material (as much as -99 ft), and blue hues (positive changes in altitude) indicate accumulation of material (as much as 59 ft) during the period 2005 through 2010 (fig. 4). For clarity, areas with minimal land-surface altitude changes (between 1 and -1 ft) are not shown on figure 4. The Sooner and Ottawa properties, for which both red and blue areas are indicated (fig. 4), show redistribution of chat as it was removed from one area, sorted or screened, and placed in another area. On the basis of the changes in altitude (fig. 4), the chat-pile footprints for CP022 (Ottawa property) and CP013 (Sooner property) were modified slightly from AATA International, Inc. (2005), to include areas of chat-pile redistribution. All chat-pile footprints and property names were reviewed and approved by the BIA (S. Beets, Realty Specialist, U.S. Bureau of Indian Affairs, written commun., 2012). Areas of selected chat-pile footprints ranged from 0.13 to 97.37 acres (table 1).

Chat-Pile Average Altitudes

The minimum, maximum, and average altitudes in the chat-pile footprint were extracted from the 2005 and 2010 DEMs by using the ArcGIS Zonal Statistics as Table tool (ESRI, Inc., 2012b) (table 1). The average altitude in the chat-pile footprint was used to represent the chat-pile average altitude in computations of chat-pile volume (fig. 3).

Chat-Pile Base Altitudes and Chat-Pile Average Heights

Determination of the base altitudes of the selected chat piles was accomplished in ArcGIS by using the Buffer tool (ESRI, Inc., 2012c) to delineate a 20-ft buffer around each BIA-approved chat-pile footprint (fig. 3). The minimum, maximum, and average altitudes in the 20-ft chat-pile buffer were extracted from the 2005 and 2010 DEMs by using the ArcGIS Zonal Statistics as Table tool (ESRI, Inc., 2012b)

(table 1). The base of each chat pile was assumed to be a horizontal plane with an altitude equal to the 2010 average altitude in the chat-pile buffer (table 1). The 2010 DEM was used to establish the chat-pile base altitude because the 2010 DEM was of finer resolution than the 2005 DEM. For each selected chat pile, the chat-pile base altitude was subtracted from the 2005 and 2010 chat-pile average altitudes to compute chat-pile average height in 2005 and 2010 (fig. 3, table 2 at end of report).

Bulk Density of the Chat Piles

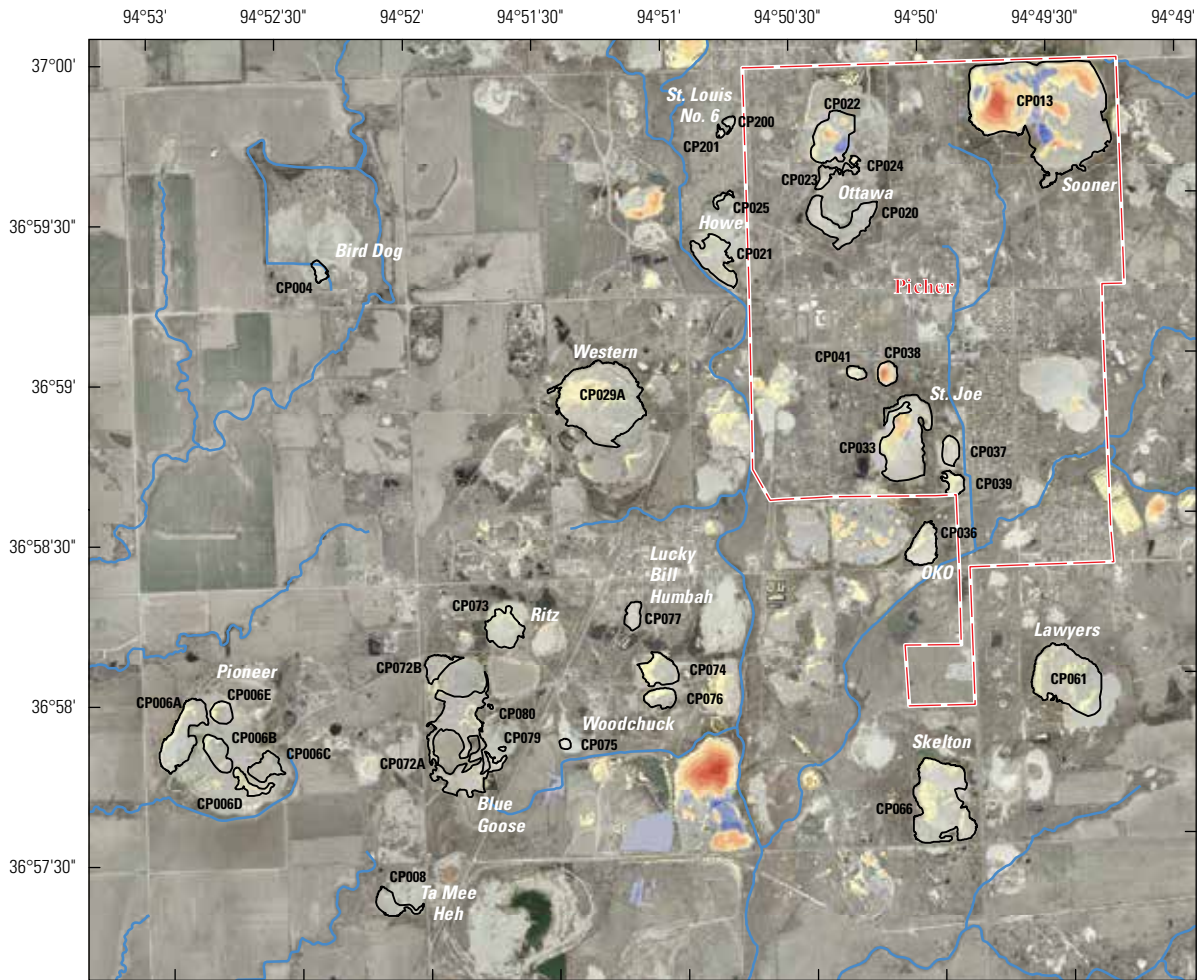
Bulk density (the mass of a substance divided by its bulk volume) is used to describe the density of a substance that is a complex mixture of materials that may contain air or pore space. AATA International, Inc. (2005), collected and analyzed 41 bulk-density samples from 41 different chat piles in the PMD. The AATA International, Inc. (2005), bulk-density measurements ranged from 70.0 lb/ft³ (0.9450 ton/yd³) to 97.6 lb/ft³ (1.3176 ton/yd³) and averaged 83.8 lb/ft³ (1.1313 ton/yd³) (fig. 5). The 10th and 90th percentiles of bulk density measurements were 76.6 lb/ft³ (1.0341 ton/yd³) and 91.6 lb/ft³ (1.2366 ton/yd³), respectively (fig. 5). For this report, an average bulk density of 1.1313 ton/yd³ was used to convert chat-pile volume to chat-pile mass (table 2). The 10th and 90th percentiles of bulk densities reported by AATA International, Inc. (2005), which correspond to about plus or minus 9 percent of the average bulk density, were used to assign error margins to all masses computed in this report.

Assumptions

Several computational assumptions were necessary because of uncertainty associated with the footprints and compositions of the chat piles. All computations presented in this report assumed the following:

1. the chat-pile footprints encompassed the entire chat-pile resource in 2005 and 2010,
2. the bases of the chat piles were planar and horizontal,
3. the average altitude in a 20-ft buffer surrounding each chat pile represented a reasonable estimate of the altitude of the chat-pile base,
4. differences in DEM horizontal resolution and vertical precision were not a source of systematic error in the volume computations, and
5. the average bulk density of each chat pile was 1.1313 ton/yd³.

Any decreases in chat-pile volume and mass were expected to be caused by removal of material by humans. Decreases in chat-pile volume and mass also may occur, however, as a result of natural processes such as settling, erosion by water and wind (an Enhanced Fujita [EF]-4 tornado



Base aerial photography from Aero-Metric, Inc., 2005
 Municipal boundary from U.S. Census Bureau, 2000
 Lambert Conformal Conic, Oklahoma State Plane North projection

Chat-pile boundaries modified from AATA International, Inc., 2005
 Mined areas from Brichta, 1960

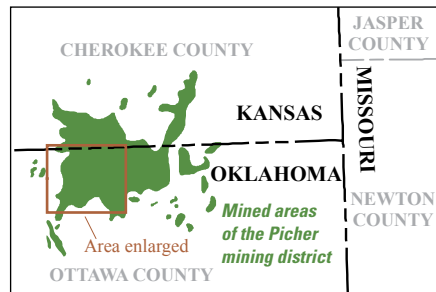
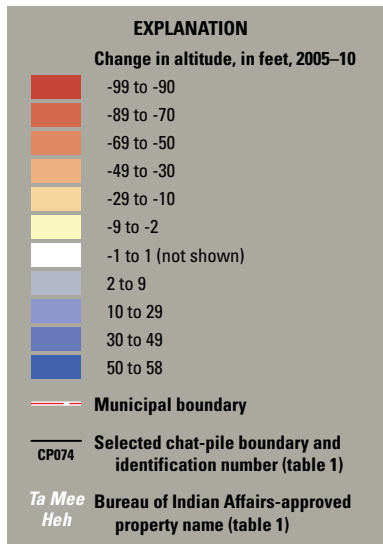
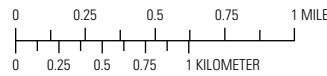


Figure 4. Changes in land-surface altitude in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.

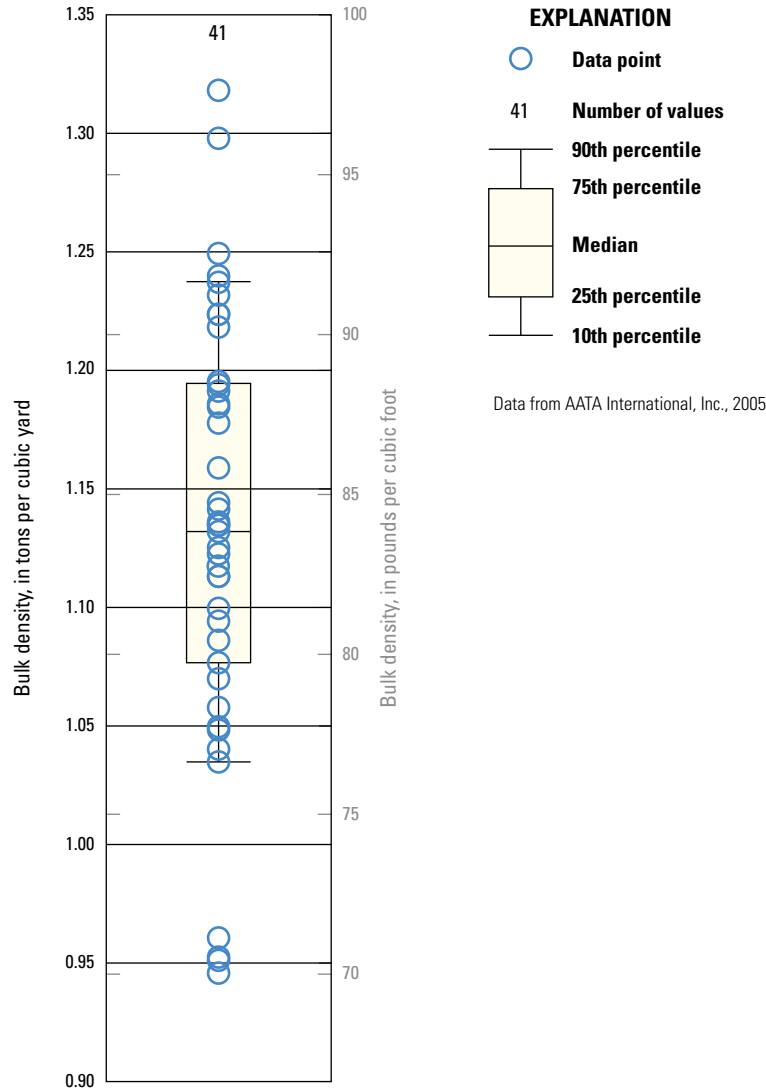


Figure 5. Bulk density of chat piles in the Picher mining district, Ottawa County, Oklahoma, 2005.

destroyed many structures and vegetated areas in the vicinity of the St. Joe chat piles on May 10, 2008 [Aber and Aber, 2009]), or subsurface mine collapse and subsidence. No attempt was made in this report to differentiate between causes of chat-pile volume and mass changes.

Estimation of 2005 and 2010 Chat-Pile Volumes and Masses

The 2005 and 2010 chat-pile volume estimates were computed for the 34 chat piles on the 16 properties by multiplying the average chat-pile height by the chat-pile area and converting to units of cubic yards (table 2). For convenience, volume and mass estimates discussed in this

report have been rounded to the nearest 1,000 yd³ (0.001 million yd³) and the nearest 1,000 tons (0.001 million tons), respectively. The Sooner property chat pile (CP013) had the greatest estimated volume (5.910 million yd³ in 2005 and 4.644 million yd³ in 2010) of chat, whereas the St. Louis No. 6 property (chat piles CP200 and CP201) had the smallest estimated volume (0.011 million yd³ in 2005 and 0.009 million yd³ in 2010) of chat. Five of the selected properties (Sooner, Western, Lawyers, Skelton, and St. Joe) contained estimated chat volumes exceeding 1 million yd³ in 2005 and 2010 (fig. 6, table 2). Four of the selected properties (Lucky Bill Humbah, Ta Mee Heh, Bird Dog, and St. Louis No. 6) contained estimated chat volumes of less than 0.1 million yd³ in 2005 and 2010 (fig. 6, table 2). The total volume of all selected chat piles was estimated to be 18.073 million yd³ in 2005 and 16.171 million yd³ in 2010.

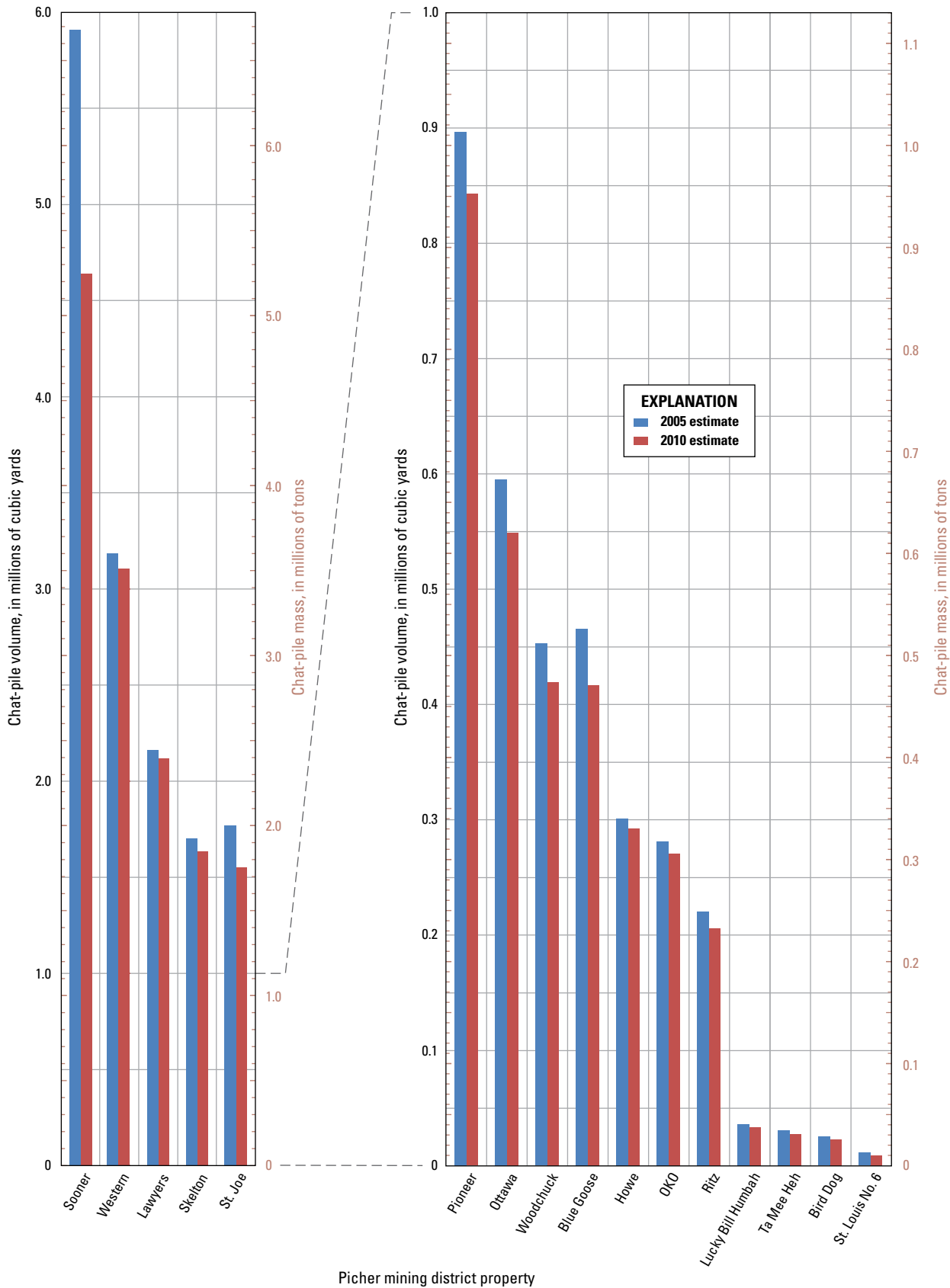


Figure 6. Estimates of chat-pile volume and mass for selected properties in the Picher mining district, Ottawa County, Oklahoma, 2005 and 2010.

The 2005 and 2010 chat-pile mass estimates were computed for the 34 chat piles on the 16 properties by multiplying the chat-pile volume by an average bulk density of 1.1313 ton/yd³ (fig. 6, table 2). The Sooner property chat pile (CP013) had the greatest estimated mass (6.686 ± 0.602 million tons in 2005 and 5.253 ± 0.473 million tons in 2010) of chat, whereas the St. Louis No. 6 property (chat piles CP200 and CP201) had the smallest estimated mass (0.013 ± 0.001 million tons in 2005 and 0.010 ± 0.0009 million tons in 2010) of chat. Six of the selected properties (Sooner, Western, Lawyers, Skelton, St. Joe, and Pioneer) contained estimated chat masses exceeding 1 million tons in 2005, and five of the selected properties (Sooner, Western, Lawyers, Skelton, and St. Joe) contained estimated chat masses exceeding 1 million tons in 2010 (fig. 6, table 2). Four of the selected properties (Lucky Bill Humbah, Ta Mee Heh, Bird Dog, and St. Louis No. 6) contained estimated chat masses of less than 0.1 million tons in 2005 and 2010 (fig. 6, table 2). The total mass of all selected chat piles was estimated to be 20.445 ± 1.840 million tons in 2005 and 18.294 ± 1.646 million tons in 2010.

Estimation of Changes in Chat Volumes and Masses for 2005 Through 2010

Changes in volume and mass estimates were computed by subtracting the 2005 volume and mass estimates from the

2010 volume and mass estimates (table 2). Negative values indicate a loss in volume and mass during the period 2005 through 2010. The chat-pile footprint areas and base altitudes were not changed for the period 2005 through 2010, so all changes in volume and mass resulted from changes in chat-pile surface altitudes (figs. 4 and 7).

All of the selected chat piles decreased in volume and mass for the period 2005 through 2010 (table 2). Chat piles CP022 (Ottawa property) and CP013 (Sooner property) had some within-property chat-pile redistribution (fig. 4), with both chat piles having net decreases in volume and mass for the period 2005 through 2010 (table 2). The Sooner property and the St. Joe property had the greatest volume (and mass) changes, with 1.266 million yd³ and 0.217 million yd³ (1.432 ± 0.129 million tons and 0.246 ± 0.022 million tons) of chat being removed, respectively (fig. 7, table 2). The chat removed from the Sooner and St. Joe properties accounts for about 78 percent of chat removed from all selected chat piles. The Sooner property had the greatest percent volume change with -21.43 percent change from the 2005 estimated volume (fig. 7, table 2). The Ta Mee Heh, Lucky Bill Humbah, Bird Dog, and St. Louis No. 6 properties had the smallest volume changes, each with less than 0.003 million yd³ of chat being removed (fig. 7, table 2). The total volume and mass removed from all selected chat piles for the period 2005 through 2010 were estimated to be 1.902 million yd³ and 2.151 ± 0.194 million tons, respectively.

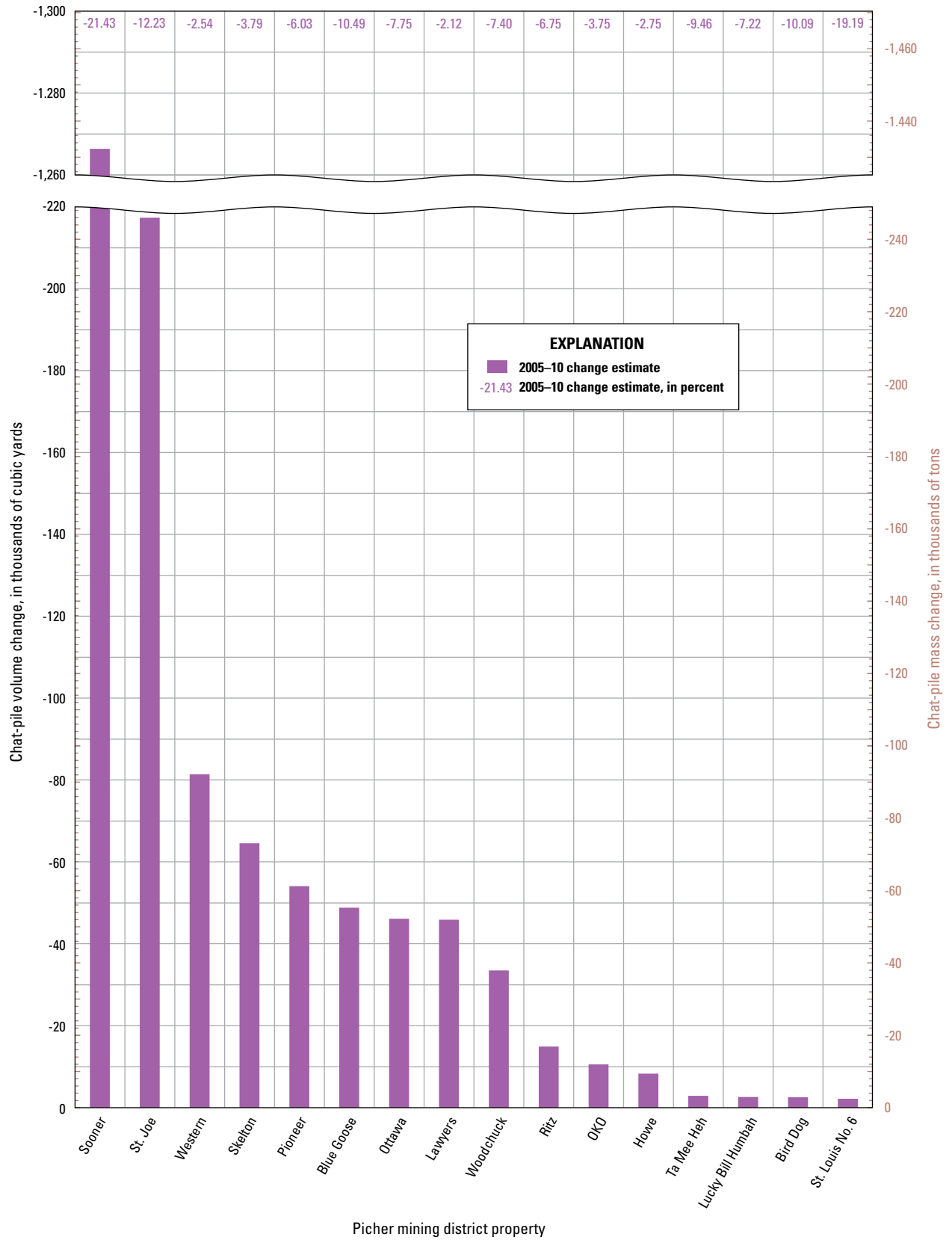


Figure 7. Estimates of volume and mass changes for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.

Summary

From the 1890s through the 1970s the Picher mining district (PMD) in northeastern Ottawa County, Oklahoma, was the site of mining and processing of lead and zinc ore. When mining ceased in about 1979, as much as 165–300 million tons of mine tailings, locally referred to as “chat,” remained in the PMD. Since 1979, some chat piles have been mined for aggregate materials and have decreased in volume and mass. Currently (2013), thousands of acres of land surface in the PMD are covered by chat, much of which remains on Indian trust land owned by allottees. The Bureau of Indian Affairs (BIA) manages these allotted lands and oversees the sale and removal of chat from these properties. To help the BIA better manage the sale and removal of chat, the U.S. Geological Survey (USGS), in cooperation with the BIA, estimated the 2005 and 2010 volumes and masses of selected chat piles remaining on allotted lands in the Picher mining district. The USGS also estimated the changes in volume and mass of these chat piles for the period 2005 through 2010.

Several datasets were needed to estimate the volume and mass of the selected chat piles. Required datasets were (1) digital elevation models (DEMs) of the land surface in 2005 and 2010, (2) footprints of the selected chat piles, (3) the chat-pile average altitude in each footprint, (4) the base altitude of each chat pile, and (5) the bulk density measurements of the chat piles. The volumes of selected chat piles were computed as the chat-pile average height (the chat-pile average altitude minus the chat-pile base altitude) times the chat-pile footprint area. The masses of selected chat piles were computed as the chat-pile volume times the average chat-pile bulk density.

The 2005 and 2010 chat-pile volume and mass estimates were computed for 34 selected chat piles on 16 properties in the study area. All computations of volume and mass were performed on individual chat piles and on groups of chat piles in the same property. The Sooner property (chat pile CP013) had the greatest estimated volume (4.644 million cubic yards [yd^3]) and mass (5.253 ± 0.473 million tons) of chat in 2010. Five of the selected properties (Sooner, Western, Lawyers, Skelton, and St. Joe) contained estimated chat volumes exceeding 1 million yd^3 and estimated chat masses exceeding 1 million tons in 2010. Four of the selected properties (Lucky Bill Humbah, Ta Mee Heh, Bird Dog, and St. Louis No. 6) contained estimated chat volumes of less than 0.1 million yd^3 and estimated chat masses of less than 0.1 million tons in 2010. The total volume of all selected chat piles was estimated to be 18.073 million yd^3 in 2005 and 16.171 million yd^3 in 2010. The total mass of all selected chat piles was estimated to be 20.445 ± 1.840 million tons in 2005 and 18.294 ± 1.646 million tons in 2010.

All of the selected chat piles decreased in volume and mass for the period 2005 through 2010. Chat piles CP022 (Ottawa property) and CP013 (Sooner property) had some within-property chat-pile redistribution, with both chat piles having net decreases in volume and mass for the period 2005 through 2010. The Sooner property and the St. Joe property

had the greatest volume (and mass) changes, with 1.266 million yd^3 and 0.217 million yd^3 (1.432 ± 0.129 million tons and 0.246 ± 0.022 million tons) of chat being removed, respectively. The chat removed from the Sooner and St. Joe properties accounts for about 78 percent of chat removed from all selected chat piles. The total volume and mass removed from all selected chat piles for the period 2005 through 2010 were estimated to be 1.902 million yd^3 and 2.151 ± 0.194 million tons, respectively.

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Table 1. Characteristics of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, and altitude statistics for selected chat piles, 2005 and 2010.

[BIA, Bureau of Indian Affairs; yd², square yards; ft, feet; --, none]

BIA-approved property name	Alternate property name (AATA International, Inc., 2005)	Chat-pile identification number ¹	Legal description (section-township-range)	Chat-pile footprint area		Chat-pile altitude 2010 (Photo Science, Inc., 2010)		
				(acres)	(yd ²)	Minimum (ft)	Maximum (ft)	Average (ft)
Bird Dog	--	CP004	13-T29N-R22E	1.80	8,716	831.37	865.96	846.41
Blue Goose	--	CP072A	30-T29N-R23E	29.39	142,246	829.08	886.03	846.28
Blue Goose	--	CP072B	30-T29N-R23E	4.12	19,923	836.99	857.99	844.29
Blue Goose	--	CP079	30-T29N-R23E	0.19	934	832.61	842.76	837.54
Blue Goose	--	CP080	30-T29N-R23E	0.13	622	835.51	847.16	839.56
Blue Goose subtotal				33.83	163,725			
Howe	--	CP021	17-T29N-R23E	10.37	50,174	811.78	872.20	834.03
Howe	--	CP025	17-T29N-R23E	0.93	4,511	818.48	842.33	827.53
Howe subtotal				11.30	54,685			
Lawyers	--	CP061	28-T29N-R23E	28.67	138,765	825.46	966.34	878.80
Lucky Bill Humbah	--	CP077	30-T29N-R23E	3.03	14,649	811.84	840.21	823.49
OKO	--	CP036	20-T29N-R23E	7.72	37,357	806.40	877.92	832.78
Ottawa	--	CP020	17-T29N-R23E	12.45	60,258	833.37	848.71	841.31
Ottawa	--	² CP022	17-T29N-R23E	13.48	65,247	841.92	918.04	865.67
Ottawa	--	CP023	17-T29N-R23E	2.32	11,222	836.44	878.48	851.19
Ottawa	--	CP024	17-T29N-R23E	1.38	6,680	840.31	886.99	850.75
Ottawa subtotal				29.63	143,406			
Pioneer	--	CP006A	25-T29N-R22E	14.36	69,509	822.21	887.75	845.69
Pioneer	--	CP006B	25-T29N-R22E	5.66	27,372	828.50	893.13	859.44
Pioneer	--	CP006C	25-T29N-R22E	5.06	24,493	829.93	846.65	838.67
Pioneer	--	CP006D	25-T29N-R22E	3.33	16,122	832.89	906.62	866.13
Pioneer	--	CP006E	25-T29N-R22E	3.17	15,348	833.37	882.41	856.33
Pioneer subtotal				31.58	152,844			

Table 1. Characteristics of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, and altitude statistics for selected chat piles, 2005 and 2010.—Continued

[BIA, Bureau of Indian Affairs; yd², square yards; ft, feet; --, none]

BIA-approved property name	Alternate property name (AATA International, Inc., 2005)	Chat-pile identification number ¹	Legal description (section-township-range)	Chat-pile footprint area		Chat-pile altitude 2010 (Photo Science, Inc., 2010)		
				(acres)	(yd ²)	Minimum (ft)	Maximum (ft)	Average (ft)
Ritz	--	CP073	30-T29N-R23E	8.72	42,193	827.24	877.57	847.98
Skelton	--	CP066	29-T29N-R23E	31.15	150,750	817.65	960.09	857.86
Sooner	--	² CP013	16-T29N-R23E	97.37	471,287	828.92	967.88	869.53
St. Joe	--	CP033	20-T29N-R23E	24.75	119,807	822.49	952.10	859.58
St. Joe	Slim Jim	CP037	20-T29N-R23E	3.34	16,179	814.01	895.99	838.45
St. Joe	Premier	CP039	20-T29N-R23E	2.96	14,319	814.12	893.37	844.85
St. Joe	Vintage (East)	CP038	20-T29N-R23E	3.17	15,349	825.02	882.02	847.63
St. Joe	Vintage (West)	CP041	20-T29N-R23E	1.71	8,257	825.94	887.97	844.40
St. Joe subtotal				35.93	173,911			
St. Louis No. 6	--	³ CP200	17-T29N-R23E	0.93	4,512	827.47	840.26	833.05
St. Louis No. 6	--	³ CP201	17-T29N-R23E	0.53	2,552	825.44	858.96	834.83
St. Louis No. 6 subtotal				1.46	7,063			
Ta Mee Heh	Tam-ah-hah	CP008	36-T29N-R22E	4.70	22,746	821.93	845.38	829.44
Western	Anna Beaver	CP029A	19-T29N-R23E	43.87	212,349	827.93	1,007.09	879.77
Woodchuck	--	CP074	30-T29N-R23E	7.30	35,323	810.62	895.25	841.17
Woodchuck	--	CP076	30-T29N-R23E	4.19	20,268	812.80	886.78	835.28
Woodchuck	--	CP075	30-T29N-R23E	0.78	3,796	822.85	874.18	837.95
Woodchuck subtotal				12.27	59,387			
TOTAL				383.02	1,853,834			

Table 1. Characteristics of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, and altitude statistics for selected chat piles, 2005 and 2010.—Continued

[BIA, Bureau of Indian Affairs; yd², square yards; ft, feet; --, none]

BIA-approved property name	Chat-pile identification number ¹	Chat-pile altitude 2005 (Aero-Metric, Inc., 2005)			Chat-pile relief (ft) 2010	Chat-pile buffer altitude					
		Minimum (ft)	Maximum (ft)	Average (ft)		2010 (Photo Science, Inc., 2010)			2005 (Aero-Metric, Inc., 2005)		
						Minimum (ft)	Maximum (ft)	Average (ft)	Minimum (ft)	Maximum (ft)	Average (ft)
Bird Dog	CP004	831.54	866.73	847.28	34.59	830.47	849.29	838.67	830.78	850.41	839.25
Blue Goose	CP072A	828.15	886.69	847.14	56.95	827.36	856.03	837.61	828.28	869.11	838.40
Blue Goose	CP072B	838.00	860.08	845.41	21.00	835.27	858.87	843.73	836.63	859.83	844.77
Blue Goose	CP079	832.98	844.66	838.31	10.15	832.24	841.89	833.52	832.71	843.69	834.40
Blue Goose	CP080	835.75	854.73	841.34	11.65	835.11	837.59	836.15	835.17	840.63	836.85
Howe	CP021	811.34	872.00	834.43	60.42	810.35	860.07	817.07	810.26	860.12	817.25
Howe	CP025	819.38	842.78	828.57	23.85	818.41	826.92	821.54	818.73	833.14	822.25
Lawyers	CP061	825.15	967.46	879.79	140.88	823.63	876.90	833.00	823.85	877.58	833.69
Lucky Bill Humbah	CP077	812.01	840.61	824.02	28.36	811.77	823.12	816.70	811.61	824.51	817.36
OKO	CP036	806.62	878.39	833.63	71.52	805.77	817.57	811.02	806.31	820.29	811.69
Ottawa	CP020	833.51	849.10	841.63	15.35	833.17	845.33	837.42	833.26	845.20	837.78
Ottawa	² CP022	842.14	918.94	867.13	76.12	840.80	858.79	846.52	840.74	859.40	846.23
Ottawa	CP023	836.57	879.19	852.24	42.04	836.28	848.08	841.10	836.23	850.22	841.36
Ottawa	CP024	840.44	887.12	852.52	46.68	839.97	850.14	843.26	840.21	851.94	843.72
Pioneer	CP006A	823.14	887.62	846.42	65.54	819.99	844.64	828.40	820.18	844.91	828.76
Pioneer	CP006B	828.30	894.03	860.16	64.63	827.65	859.75	839.36	827.81	859.52	839.55
Pioneer	CP006C	830.60	846.52	838.80	16.72	829.71	840.94	833.04	829.52	840.71	832.94
Pioneer	CP006D	831.40	906.92	870.08	73.73	830.30	882.37	841.74	829.87	884.92	841.72
Pioneer	CP006E	833.59	882.76	857.95	49.04	833.05	858.98	840.26	833.43	859.63	841.38

Table 1. Characteristics of selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, and altitude statistics for selected chat piles, 2005 and 2010.—Continued[BIA, Bureau of Indian Affairs; yd², square yards; ft, feet; --, none]

BIA-approved property name	Chat-pile identification number ¹	Chat-pile altitude 2005 (Aero-Metric, Inc., 2005)			Chat-pile relief (ft) 2010	Chat-pile buffer altitude					
		Minimum (ft)	Maximum (ft)	Average (ft)		2010 (Photo Science, Inc., 2010)			2005 (Aero-Metric, Inc., 2005)		
						Minimum (ft)	Maximum (ft)	Average (ft)	Minimum (ft)	Maximum (ft)	Average (ft)
Ritz	CP073	827.56	878.18	849.04	50.33	826.59	856.47	833.35	826.97	857.42	834.34
Skelton	CP066	818.15	960.92	859.15	142.44	813.99	857.18	825.27	816.41	857.83	826.27
Sooner	² CP013	828.71	975.99	877.59	138.96	828.77	855.69	839.97	827.53	856.13	840.17
St. Joe	CP033	822.33	971.20	862.51	129.61	820.53	855.58	829.90	820.88	854.53	830.29
St. Joe	CP037	813.93	896.84	839.38	81.98	813.62	835.65	818.91	813.77	840.42	819.83
St. Joe	CP039	814.48	893.69	846.84	79.25	812.14	857.49	820.06	812.30	858.80	820.86
St. Joe	CP038	823.75	914.37	863.68	57.00	822.68	835.13	826.62	822.83	838.38	826.99
St. Joe	CP041	826.55	887.89	845.75	62.03	825.48	833.77	828.66	825.85	834.44	828.93
St. Louis No. 6	³ CP200	827.76	840.64	833.54	12.79	826.87	835.23	830.64	827.62	835.57	831.02
St. Louis No. 6	³ CP201	826.28	859.57	836.48	33.52	824.72	833.06	828.47	825.02	833.49	828.71
Ta Mee Heh	CP008	822.23	845.61	829.82	23.45	821.71	836.95	825.80	822.07	837.26	826.07
Western	CP029A	828.67	1,008.20	880.92	179.16	826.71	846.17	835.67	827.41	846.54	836.28
Woodchuck	CP074	811.62	895.98	843.02	84.63	809.09	849.43	818.00	809.41	849.73	818.63
Woodchuck	CP076	811.26	887.42	836.63	73.98	812.60	825.15	815.56	811.49	825.46	816.35
Woodchuck	CP075	824.00	877.75	840.00	51.33	821.71	831.34	827.38	822.43	831.50	828.15

¹Chat-pile identification number from AATA International, Inc. (2005), unless otherwise noted.²Chat-pile boundary modified from AATA International, Inc. (2005).³New chat-pile identification number and boundary were generated for this report.

Table 2. Estimates of volume, mass, and change in volume and mass for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.

[BIA, Bureau of Indian Affairs; yd², square yards; yd³, cubic yards; ft, feet; --, none; ±, plus or minus]

BIA-approved property name	Alternate property name (AATA International, Inc., 2005)	Chat-pile identification number ¹	Legal description (section-township-range)	Chat-pile footprint area		Bulk density (AATA International, Inc., 2005) average (ton/yd ³)	Estimates of volume and mass 2005			
				(acres)	(yd ²)		Average height (ft)	Volume (yd ³)	Mass (tons)	
Bird Dog	--	CP004	13-T29N-R22E	1.80	8,716	1.1313	8.61	25,020	28,305	± 2,547
Blue Goose	--	CP072A	30-T29N-R23E	29.39	142,246	1.1313	9.53	451,850	511,178	± 46,006
Blue Goose	--	CP072B	30-T29N-R23E	4.12	19,923	1.1313	1.68	11,150	12,614	± 1,135
Blue Goose	--	CP079	30-T29N-R23E	0.19	934	1.1313	4.79	1,492	1,687	± 152
Blue Goose	--	CP080	30-T29N-R23E	0.13	622	1.1313	5.19	1,078	1,219	± 110
Blue Goose subtotal				33.83	163,725			465,569	526,699	± 47,403
Howe	--	CP021	17-T29N-R23E	10.37	50,174	1.1313	17.36	290,333	328,453	± 29,561
Howe	--	CP025	17-T29N-R23E	0.93	4,511	1.1313	7.04	10,578	11,967	± 1,077
Howe subtotal				11.30	54,685			300,911	340,421	± 30,638
Lawyers	--	CP061	28-T29N-R23E	28.67	138,765	1.1313	46.80	2,164,522	2,448,724	± 220,385
Lucky Bill Humbah	--	CP077	30-T29N-R23E	3.03	14,649	1.1313	7.32	35,747	40,440	± 3,640
OKO	--	CP036	20-T29N-R23E	7.72	37,357	1.1313	22.60	281,461	318,417	± 28,657
Ottawa	--	CP020	17-T29N-R23E	12.45	60,258	1.1313	4.22	84,725	95,850	± 8,626
Ottawa	--	² CP022	17-T29N-R23E	13.48	65,247	1.1313	20.61	448,287	507,147	± 45,643
Ottawa	--	CP023	17-T29N-R23E	2.32	11,222	1.1313	11.14	41,673	47,145	± 4,243
Ottawa	--	CP024	17-T29N-R23E	1.38	6,680	1.1313	9.26	20,612	23,318	± 2,099
Ottawa subtotal				29.63	143,406			595,297	673,460	± 60,611
Pioneer	--	CP006A	25-T29N-R22E	14.36	69,509	1.1313	18.02	417,496	472,314	± 42,508
Pioneer	--	CP006B	25-T29N-R22E	5.66	27,372	1.1313	20.80	189,796	214,716	± 19,324
Pioneer	--	CP006C	25-T29N-R22E	5.06	24,493	1.1313	5.76	46,991	53,161	± 4,784
Pioneer	--	CP006D	25-T29N-R22E	3.33	16,122	1.1313	28.34	152,304	172,301	± 15,507
Pioneer	--	CP006E	25-T29N-R22E	3.17	15,348	1.1313	17.69	90,491	102,372	± 9,213
Pioneer subtotal				31.58	152,844			897,078	1,014,864	± 91,338

Table 2. Estimates of volume, mass, and change in volume and mass for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.—Continued[BIA, Bureau of Indian Affairs; yd², square yards; yd³, cubic yards; ft, feet; --, none; ±, plus or minus]

BIA-approved property name	Alternate property name (AATA International, Inc., 2005)	Chat-pile identification number ¹	Legal description (section-township-range)	Chat-pile footprint area		Bulk density (AATA International, Inc., 2005) average (ton/yd ³)	Estimates of volume and mass 2005			
				(acres)	(yd ²)		Average height (ft)	Volume (yd ³)	Mass (tons)	
Ritz	--	CP073	30-T29N-R23E	8.72	42,193	1.1313	15.69	220,711	249,690	± 22,472
Skelton	--	CP066	29-T29N-R23E	31.15	150,750	1.1313	33.87	1,702,074	1,925,557	± 173,300
Sooner	--	² CP013	16-T29N-R23E	97.37	471,287	1.1313	37.62	5,909,666	6,685,605	± 601,704
St. Joe	--	CP033	20-T29N-R23E	24.75	119,807	1.1313	32.61	1,302,327	1,473,322	± 132,599
St. Joe	Slim Jim	CP037	20-T29N-R23E	3.34	16,179	1.1313	20.47	110,403	124,899	± 11,241
St. Joe	Premier	CP039	20-T29N-R23E	2.96	14,319	1.1313	26.78	127,844	144,630	± 13,017
St. Joe	Vintage (East)	CP038	20-T29N-R23E	3.17	15,349	1.1313	37.06	189,625	214,522	± 19,307
St. Joe	Vintage (West)	CP041	20-T29N-R23E	1.71	8,257	1.1313	17.09	47,039	53,215	± 4,789
St. Joe subtotal				35.93	173,911			1,777,237	2,010,588	± 180,953
St. Louis No. 6	--	³ CP200	17-T29N-R23E	0.93	4,512	1.1313	2.90	4,360	4,932	± 444
St. Louis No. 6	--	³ CP201	17-T29N-R23E	0.53	2,552	1.1313	8.02	6,818	7,713	± 694
St. Louis No. 6 subtotal				1.46	7,063			11,177	12,645	± 1,138
Ta Mee Heh	Tam-ah-hah	CP008	36-T29N-R22E	4.70	22,746	1.1313	4.02	30,461	34,460	± 3,101
Western	Anna Beaver	CP029A	19-T29N-R23E	43.87	212,349	1.1313	45.25	3,202,672	3,623,183	± 326,086
Woodchuck	--	CP074	30-T29N-R23E	7.30	35,323	1.1313	25.02	294,596	333,276	± 29,995
Woodchuck	--	CP076	30-T29N-R23E	4.19	20,268	1.1313	21.07	142,365	161,058	± 14,495
Woodchuck	--	CP075	30-T29N-R23E	0.78	3,796	1.1313	12.62	15,974	18,072	± 1,626
Woodchuck subtotal				12.27	59,387			452,935	512,406	± 46,117
TOTAL				383.02	1,853,834			18,072,538	20,445,462	± 1,840,092

Table 2. Estimates of volume, mass, and change in volume and mass for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.—Continued

[BIA, Bureau of Indian Affairs; yd², square yards; yd³, cubic yards; ft, feet; --, none; ±, plus or minus]

BIA-approved property name	Chat-pile identification number ¹	Estimates of volume and mass 2010				Estimates of changes in volume and mass 2005–10			
		Average height (ft)	Volume (yd ³)	Mass (tons)		Volume		Mass (tons)	
						(yd ³)	(percent)		
Bird Dog	CP004	7.74	22,495	25,449	± 2,290	-2,524	-10.09	-2,856	± 257
Blue Goose	CP072A	8.67	411,073	465,047	± 41,854	-40,777	-9.02	-46,131	± 4,152
Blue Goose	CP072B	0.56	3,712	4,199	± 378	-7,438	-66.71	-8,415	± 757
Blue Goose	CP079	4.02	1,252	1,417	± 128	-239	-16.04	-271	± 24
Blue Goose	CP080	3.42	709	802	± 72	-369	-34.21	-417	± 38
Blue Goose subtotal			416,746	471,465	± 42,432	-48,823	-10.49	-55,234	± 4,971
Howe	CP021	16.96	283,611	320,849	± 28,876	-6,722	-2.32	-7,605	± 684
Howe	CP025	5.99	9,014	10,198	± 918	-1,564	-14.79	-1,769	± 159
Howe subtotal			292,625	331,047	± 29,794	-8,286	-2.75	-9,374	± 844
Lawyers	CP061	45.80	2,118,645	2,396,824	± 215,714	-45,877	-2.12	-51,900	± 4,671
Lucky Bill Humbah	CP077	6.79	33,165	37,519	± 3,377	-2,582	-7.22	-2,921	± 263
OKO	CP036	21.76	270,918	306,490	± 27,584	-10,542	-3.75	-11,927	± 1,073
Ottawa	CP020	3.89	78,222	88,492	± 7,964	-6,504	-7.68	-7,358	± 662
Ottawa	² CP022	19.15	416,533	471,224	± 42,410	-31,753	-7.08	-35,923	± 3,233
Ottawa	CP023	10.09	37,743	42,699	± 3,843	-3,930	-9.43	-4,446	± 400
Ottawa	CP024	7.49	16,671	18,860	± 1,697	-3,941	-19.12	-4,458	± 401
Ottawa subtotal			549,169	621,275	± 55,915	-46,128	-7.75	-52,185	± 4,697
Pioneer	CP006A	17.29	400,583	453,179	± 40,786	-16,914	-4.05	-19,135	± 1,722
Pioneer	CP006B	20.08	183,203	207,257	± 18,653	-6,593	-3.47	-7,459	± 671
Pioneer	CP006C	5.63	45,952	51,986	± 4,679	-1,039	-2.21	-1,175	± 106
Pioneer	CP006D	24.39	131,045	148,252	± 13,343	-21,258	-13.96	-24,050	± 2,164
Pioneer	CP006E	16.07	82,198	92,991	± 8,369	-8,292	-9.16	-9,381	± 844
Pioneer subtotal			842,981	953,664	± 85,830	-54,097	-6.03	-61,200	± 5,508

Table 2. Estimates of volume, mass, and change in volume and mass for selected chat piles on properties in the Picher mining district, Ottawa County, Oklahoma, 2005 through 2010.—Continued

[BIA, Bureau of Indian Affairs; yd², square yards; yd³, cubic yards; ft, feet; --, none; ±, plus or minus]

BIA-approved property name	Chat-pile identification number ¹	Estimates of volume and mass 2010				Estimates of changes in volume and mass 2005–10			
		Average height (ft)	Volume (yd ³)	Mass (tons)		Volume		Mass (tons)	
						(yd ³)	(percent)		
Ritz	CP073	14.63	205,803	232,824	± 20,954	-14,908	-6.75	-16,866	± 1,518
Skelton	CP066	32.59	1,637,529	1,852,537	± 166,728	-64,545	-3.79	-73,020	± 6,572
Sooner	² CP013	29.56	4,643,474	5,253,163	± 472,785	-1,266,191	-21.43	-1,432,442	± 128,920
St. Joe	CP033	29.68	1,185,315	1,340,947	± 120,685	-117,011	-8.98	-132,375	± 11,914
St. Joe	CP037	19.54	105,400	119,239	± 10,732	-5,003	-4.53	-5,660	± 509
St. Joe	CP039	24.79	118,346	133,885	± 12,050	-9,498	-7.43	-10,745	± 967
St. Joe	CP038	21.01	107,508	121,624	± 10,946	-82,117	-43.30	-92,899	± 8,361
St. Joe	CP041	15.74	43,321	49,009	± 4,411	-3,718	-7.90	-4,206	± 379
St. Joe subtotal			1,559,890	1,764,704	± 158,823	-217,347	-12.23	-245,884	± 22,130
St. Louis No. 6	³ CP200	2.41	3,619	4,094	± 368	-741	-16.99	-838	± 75
St. Louis No. 6	³ CP201	6.36	5,414	6,124	± 551	-1,404	-20.59	-1,588	± 143
St. Louis No. 6 subtotal			9,033	10,219	± 920	-2,145	-19.19	-2,426	± 218
Ta Mee Heh	CP008	3.64	27,580	31,201	± 2,808	-2,881	-9.46	-3,259	± 293
Western	CP029A	44.10	3,121,272	3,531,095	± 317,799	-81,400	-2.54	-92,088	± 8,288
Woodchuck	CP074	23.17	272,851	308,677	± 27,781	-21,745	-7.38	-24,600	± 2,214
Woodchuck	CP076	19.72	133,194	150,682	± 13,561	-9,171	-6.44	-10,376	± 934
Woodchuck	CP075	10.57	13,382	15,139	± 1,363	-2,592	-16.23	-2,933	± 264
Woodchuck subtotal			419,427	474,498	± 42,705	-33,509	-7.40	-37,908	± 3,412
TOTAL			16,170,752	18,293,972	± 1,646,457	-1,901,786		-2,151,490	± 193,634

¹Chat-pile identification number from AATA International, Inc. (2005), unless otherwise noted.

²Chat-pile boundary modified from AATA International, Inc. (2005).

³New chat-pile identification number and boundary were generated for this report.

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