Mine Specific Sampling Plan

Stratification Guidelines

For the National Survey of the Mining Population, mine-level and employee-level analyses are planned, which require adequate sample sizes of mines and of employees. Because multiple employees are sampled from each responding mine, sample size requirements for mine-level analyses tend to drive the total number of mines that need to be sampled. The sample size for employees is determined by the number of sampled mines responding and the average number of employees sampled per mine. The number of employees sampled per mine is variable, but the expected sample size is restricted to no more than 25 sampled employees per mine.[1]

The competing needs of mine-level analysis versus employee-level analysis require the use of a compromise design that supports the objectives of both types of analyses. For mine-level analyses, the best design is one that selects mines with equal probability, while for employee-level analyses the best design is one that selects mines with probability proportional to the number of employees. The compromise design meets both needs by stratifying by number of employees and then sampling mines with equal probability within strata. Strata associated with large mines (in terms of employment) are given greater selection probabilities than small mines, which facilitates employee-level analyses by making the employee selection probabilities less variable across mines.

Mine size is an important domain for study at the mine level as well as at the employee level. Very small mines with less than ten employees tend to experience proportionately more serious injuries. Mines are also more likely to vary in their training procedures based upon employee size. Small mines may be more likely to use trainers from outside the organization, while large mines may be more likely to rely on in-house trainers. Hence, stratifying by number of employees in sampling mines serves an analytic purpose, as well as its role in facilitating the over-sampling of large mines needed for employee-level analyses.

The probability of selection of an employee is the product of the probability of selection of his/her mine times the conditional probability of selection of the employee given that his/her mine is selected. The conditional probability of selection of an employee is equal within mines, as well as equal across mines whose employment falls within the same size category. The size categories are based upon multiples of 25 and have employee sizes of 1-25, 26-50, 51-75, 76-100, and so forth. These equal employee conditional selection probabilities are the result of fixing the employee sample size at 25 and using an integer as the take-every number in sampling.

From an analysis standpoint, it is also desirable to control for underground versus surface mines, when sampling mines and employees. Underground coal mines, in particular, have higher injury and fatality rates than surface mines. There is substantial diversity in the incidence of

[1] If the frame employee sample size is correct, between 15 and 25 employees will be sampled per mine. When the mine has more employees working than are shown on the frame, the mine may be asked to report for as many as 29 employees or as few as 12 employees. For efficiency in sampling, the strata defined for each commodity need to reflect only one size category, whenever possible. However, very large mines usually have to be combined across size categories because of the small number of mines in the large size categories.

underground versus surface mines across mining sectors. Nearly one-third of coal and metal mines are underground. Less than ten percent of nonmetal and stone mines are underground and sand and gravel mines are surface only. Stratification by underground versus surface mine allows control over sample sizes needed for effective comparisons of underground mines to surface mines.

The cum $\sqrt{f}$ rule is often suggested for use in forming strata for surveys of businesses, which typically have a large number of small businesses with very few employees and a small number of large businesses with quite substantial payrolls.[2] Using this approach, strata are established that have approximately equal sizes in terms of the square root of the size measure. The cum $\sqrt{f}$ rule was used in determining the initial size-based strata for each mining sector with an assumption of about 4-5 strata per sector for underground mines and for surface mines. Except for sand and gravel mines, the large mines account for 25 percent or more of total employment. These initial stratum definitions for each commodity varied somewhat across mining sectors but were similar.

The next step in stratum formation was to recognize that data from the five commodity surveys will be combined to study mining as a whole. Using common definitions for strata across the five commodities facilitates these combined analyses. The initial stratum definitions were compared to determine a common stratification approach. The stratum definitions that meet the needs for all five commodities are formed by the cross of underground versus surface mines with these size groupings of employees: 1-9, 10-25, 26-50, 51-75, 76-100, 101-250, and 251 and up. As explained later, some size strata may need to be collapsed in forming analysis domains for some commodities.

Sample Size Guidelines

The next step was to determine the sample size needed for each commodity survey and to allocate that sample to strata. To determine the stratum sample sizes, we began by looking at precision of percentage estimates under various sample sizes. Table 1 presents the half-length of confidence intervals around an estimated percentage $\hat{P}$ under various sample size and design effects and assuming large population sizes. For this table, the confidence interval was approximated for design purposes as:

$$\hat{P} \pm z_{1-\alpha} \sqrt{Var\,(\hat{P})} \qquad (1)$$

Here $z_{1-\alpha}$ is the value of the critical point x at which the normal cumulative distribution function equals 1-α and $Var\,(\hat{P})$ is the variance of $\hat{P}$. The half-length HL is:

$$HL = z_{1-\alpha} \sqrt{Var\,(\hat{P})}\,. \qquad (2)$$

That is, $\hat{P}$ can be expected to fall within the range [P-HL, P+HL] with 95 percent confidence for the indicted sample sizes.

[2] William G. Cochran (1977). *Sampling Techniques*, 3rd edition, New York: John Wiley & Sons, pp. 127-131.

To determine these half-lengths of confidence intervals, we need to estimate the variance of the estimated percentage $\hat{P}$. Ignoring finite population correction factors, Table 1 models the variance for an estimated percentage $\hat{P}$ as:

$$Var\,(\hat{P}\,) = \frac{P\,(100 - P\,)}{n}\,DEFF \qquad (3)$$

where *n* is the sample size, *P* is the percentage being estimated, and *DEFF* is the design effect. The *design effect* for a survey estimate is defined to be the ratio of the statistic under the actual design divided by the variance that would have been achieved from a simple random sample of the same size. The design effect represents the cumulative effect of design components such as stratification, unequal weighting, and clustering and varies with each design. We expect design effects will be about 1.00 for mine-level and employee-level estimates within strata. Cross cutting estimates are likely to have larger design effects particularly for employee-level estimates. The design effect differs from 1.00 for the cross cutting estimates due to the variation in sampling rates used across strata. Fortunately, these cross cutting estimates often have large sampler sizes due to combining samples across strata.

We began setting sample sizes with the guideline that we wanted the precision for stratum estimates as that shown for sample sizes of 100 in Table 1. Some mine strata have very small population sizes and some mining sectors are small overall. In such situations, the variance as given in equation (3) is reduced by the factor $(N - n)/(N - 1)$, where *n* is the sample size and *N* is the population size. Rather than create versions of Table 1 for all possible population sizes, we developed what we refer to as finite-population-corrected (fpc) sample sizes. An actual sample size of *n* for a population of size *N* is equivalent to the precision achieved with a sample size of $n' = \frac{n(N - 1)}{N - n}$ from a population so large that fpc effects are ignorable. We set initial sample sizes for each stratum so that the finite-population-corrected sample size was about 100 and then inflated these sample sizes to account for the projected 80 percent response rate. These initial sample sizes were then adjusted to prevent excessive variations in the sampling rates across strata for mines and for employees.

Besides the number of mines selected, the employee sample size is affected by the eligibility and response rates for mines and the average number of employees sampled per mine. The average number of employees sampled per mine is usually about 20 employees except for the smallest stratum where around 5 employees tend to be sampled. We assumed that 80 percent of all eligible mines would respond, providing both mine-level and employee-level data. For sample design purposes, we assumed that a variable percentage of mines would be eligible for the survey, depending upon employment size. An eligibility rate of 85 percent was assumed for mines with 1-9 employees. These mines are most likely to shut down operations or go out of business. An eligibility rate of 90 percent was assumed for mines with 10-50 employees, and 95 percent for mines with 51-100 employees. For very large mines with employment of more than 100, an eligibility rate of 99 percent was assumed as they should be most stable in terms of their operations.

In designing the commodity samples, we sought to minimize the design effects for mine-level and employee-level analyses. In particular, we sought to achieve design effects of 1.0 for within-stratum estimates and design effects of 2.0 or less for cross-cutting estimates. Following

standard practice, we modeled the design effect *DEFF* as the product of the design effect associated with unequal weighting D_w and the design effect for clustering D_c, that is $DEFF = D_w * D_c$. A simple random sample has both design effect components equal to one so DEFF=1.

Both mine-level and employee-level estimates could potentially be subject to an unequal weighting effect greater than one, particularly for cross cutting estimates that combine data from multiple strata. The design effect for unequal weighting can be estimated as:

$$D_w = \frac{n\sum_{i=1}^{n} W_i^2}{\left(\sum_{i=1}^{n} W_i\right)^2} \qquad (4)$$

where n is the total sample size and W_i is the weight for the i^{th} observation. When the weights (the inverse of the selection probabilities) are equal for all selections, D_w=1. For mines, D_w=1 within all strata for the proposed designs and often only slightly greater than one across strata. For employees, D_w=1 except for the two largest strata that collapse employee size categories. These strata tend to have all mines selected with certainty, so the only way to reduce D_w is to increase the number of employees sampled per mine from 25 to 50. Adjusting the sample size for the very large mines can even out the employee-level weights within these strata and across strata. However, the increase in employee sample size also increases the burden for the mine respondent and it increases the design effect for clustering.

The design effect associated with clustering measures the loss of precision of a clustered sample as compared with a simple random sample. Clustered samples tend to have less precision than simple random samples of the same size, because units within the same cluster usually are more homogeneous than units from different clusters. The design effect for clustering can be estimated as:

$$D_c = 1 + \rho(b - 1) \qquad (5)$$

where ρ is the intracluster correlation coefficient and b is the cluster size. Because stratified simple random sampling will be used to select mines, the mines will not be clustered (b=1) and mine-level estimates will not be subject to a clustering effect (D_c=1). However, multiple employees will be selected from each mine, so employee-level estimates will be subject to a design effect due to clustering. For the purpose of modeling the clustering design effect, we assumed variable values for ρ based upon the size of the mine. Employees within small mines with 1 to 50 employees were expected to be more homogeneous so a value of ρ = 5 percent was assumed. Medium size mines were assumed to be less homogeneous so a value of ρ = 3 percent was assumed. Large mines with more than 100 employees were expected to be quite diverse so a value of ρ =1 percent was assumed. A value of ρ = 3 percent was assumed for estimates compiled across strata.

The remainder of this appendix presents the stratification and sample size allocation plan for each major mining sector for the main survey. These plans were developed using MSHA data for the second quarter of 2002. The number of actual employees was used to develop these designs rather than the number of full time equivalent (FTE) employees, because the mine operator will be sampling based upon counts of actual employees not FTEs. Mines were

classified as surface or underground based upon MSHA subunit codes. Mines reporting any employment at underground work locations were classified as underground mining operations.

Table 1. The Half Length of 95% Confidence Intervals in Percentage Points for Various Percentages Being Estimated for Domains of Various Sizes with Various Design Effects

Design		Domain Sample Size (Completed Interviews)								
Effect	Percent									
DEFF	*P*	50	75	100	150	200	250	350	400	500
1.00	10	8	7	6	5	4	4	3	3	3
	20	11	9	8	6	6	5	4	4	4
	25	12	10	8	7	6	5	5	4	4
	30	13	10	9	7	6	6	5	4	4
	40	14	11	10	8	7	6	5	5	4
	50	14	11	10	8	7	6	5	5	4
1.25	10	9	8	7	5	5	4	4	3	3
	20	12	10	9	7	6	6	5	4	4
	25	13	11	9	8	7	6	5	5	4
	30	14	12	10	8	7	6	5	5	4
	40	15	12	11	9	8	7	6	5	5
	50	15	13	11	9	8	7	6	5	5
1.50	10	10	8	7	6	5	5	4	4	3
	20	14	11	10	8	7	6	5	5	4
	25	15	12	10	8	7	7	6	5	5
	30	16	13	11	9	8	7	6	6	5
	40	17	14	12	10	8	7	6	6	5
	50	17	14	12	10	8	8	6	6	5
2.00	10	12	10	8	7	6	5	4	4	4
	20	16	13	11	9	8	7	6	6	5
	25	17	14	12	10	8	8	6	6	5
	30	18	15	13	10	9	8	7	6	6
	40	19	16	14	11	10	9	7	7	6
	50	20	16	14	11	10	9	7	7	6
3.00	10	12	10	8	7	6	5	4	4	4
	20	16	13	11	9	8	7	6	6	5
	25	17	14	12	10	8	8	6	6	5
	30	18	15	13	10	9	8	7	6	6
	40	19	16	14	11	10	9	7	7	6
	50	20	16	14	11	10	9	7	7	6

Sampling Plan for Coal Mines

The proposed stratification scheme and sample size allocation for coal mines is presented in Table 2. One-third of the 1,666 coal mines were underground mines. Small operations with 1-25 employees accounted for 46 percent of underground coal mines and 69 percent of surface mines but accounted for only 8 percent and 18 percent of the associated employment for underground and surface mines respectively. Very large operations with more than 100 employees accounted for only 15 percent of underground mines and 7 percent of surface mines but employed 62 percent of underground workers and 48 percent of surface workers. The sample for coal mines was allocated under the assumption that separate estimation capability was needed for mines with 1-9 employees, 10-25 employees, 26-50 employees, 51-100 employees, 101-250 employees, and more than 250 employees. A total of 331 underground mines are expected to need to be sampled to yield 244 responding eligible underground mines. These mines are expected to report for 4,366 sampled employees. Another 391 surface mines are expected to need to be sampled to yield 285 responding eligible surface mines, who are expected to report for 4,549 employees.

Table 2. Sample Allocation for Coal Mines

Stratum	Number of Mines	Percent of Total Mines	Number of Employees	Percent of Total Employees	Sample Mines	Eligibility Rate	Response Rate	Responding Eligible Mines
Coal Underground								
1-9	102	19%	461	1%	56	85%	80%	38
10-25	149	27%	2,589	7%	68	90%	80%	49
26-50	146	26%	5,206	15%	67	90%	80%	48
51-75	49	9%	3,098	9%	35	95%	80%	27
76-100	22	4%	1,917	5%	22	95%	80%	17
101-250	49	9%	8,301	24%	49	99%	80%	39
251+	34	6%	13,477	38%	34	99%	80%	27
TOTAL	551	100%	35,049	100%	331			244
Coal Surface								
1-9	518	46%	2193	6%	101	85%	80%	69
10-25	252	23%	4166	12%	84	90%	80%	60
26-50	188	17%	6860	19%	75	90%	80%	54
51-75	58	5%	3500	10%	36	95%	80%	27
76-100	24	2%	2068	6%	20	95%	80%	15
101-250	52	5%	8114	23%	52	99%	80%	41
251+	23	2%	8823	25%	23	99%	80%	18
TOTAL	1,115	100%	35,724	100%	391			285

Table 2 (continued). Sample Allocation for Coal Mines

Stratum	Employees Sampled Per Mine	Total Sample Employees	Nonresponse Adjusted Mine Weight	Average Employee Weight	Mine *DEFF*	Employee D_w	Employee ρ	Employee D_c	Employee *DEFF*
Coal Underground									
1-9	5	172	2.3	2.3	1.0	1.0	5%	1.2	1.2
10-25	17	851	2.7	2.7	1.0	1.0	5%	1.8	1.8
26-50	18	860	2.7	5.4	1.0	1.0	5%	1.8	1.8
51-75	21	561	1.8	5.3	1.0	1.0	3%	1.6	1.6
76-100	22	364	1.3	5.0	1.0	1.0	3%	1.6	1.6
101-250	23	908	1.3	9.1	1.0	1.0	1%	1.2	1.3
251+	24	651	1.3	20.5	1.0	1.1	1%	1.2	1.3
TOTAL		4,366			1.1	1.6	3%	1.5	2.5
Coal Surface									
1-9	4	291	6.4	6.4	1.0	1.0	5%	1.2	1.2
10-25	17	1,000	3.8	3.8	1.0	1.0	5%	1.8	1.8
26-50	18	985	3.1	6.3	1.0	1.0	5%	1.9	1.9
51-75	20	550	2.0	6.0	1.0	1.0	3%	1.6	1.6
76-100	22	327	1.5	6.0	1.0	1.0	3%	1.6	1.6
101-250	23	935	1.3	8.6	1.0	1.1	1%	1.2	1.3
251+	25	461	1.3	19.0	1.0	1.1	1%	1.2	1.4
TOTAL		4,549			1.3	1.4	5%	1.7	2.4

Sampling Plan for Metal Mines

The proposed stratification scheme and sample size allocation for metal mine is presented in Table 3. As of the second quarter of 2002, there were 212 metal mines, of which 51 were underground mines. Again, small operations with 1-25 employees accounted for 49 percent of underground metal mines and 51 percent of surface mines but accounted for only 4 percent and 3 percent of the associated employment. Very large operations with more than 100 employees accounted for 34 percent of underground mines and 31 percent of surface mines but employed 85 percent of underground workers and 89 percent of surface workers. Initially, sample allocations were developed for each stratum accounting for the small populations of metal mines in each stratum. But these derived sample sizes were so close to the total population sizes that a decision was made to take all mines with certainty from every stratum. The 51 underground metal mines are expected to yield 37 eligible responding underground mines reporting for themselves and for 613 employees. The 161 surface metal mines are expected to yield 118 responding eligible metal surface mines reporting for themselves and for 1,886 employees.

Table 3. Sample Allocation for Metal Mines

Stratum	Number of Mines	Percent of Total Mines	Number of Employees	Percent of Total Employees	Sample Mines	Eligibility Rate	Response Rate	Responding Eligible Mines
Metal Underground								
1-9	18	35%	92	2%	18	85%	80%	12
10-25	7	14%	123	2%	7	90%	80%	5
26-50	4	8%	171	3%	4	90%	80%	3
51-75	2	4%	125	2%	2	95%	80%	2
76-100	3	6%	264	5%	3	95%	80%	2
101-250	12	24%	1844	36%	12	99%	80%	10
251+	5	10%	2476	49%	5	99%	80%	4
TOTAL	51	100%	5,095	100%	51			37
Metal Surface								
1-9	54	34%	235	1%	54	85%	80%	37
10-25	27	17%	438	2%	27	90%	80%	19
26-50	10	6%	356	2%	10	90%	80%	7
51-75	9	6%	591	3%	9	95%	80%	7
76-100	12	7%	1,094	5%	12	95%	80%	9
101-250	19	12%	2,959	13%	19	99%	80%	15
251+	30	19%	17,703	76%	30	99%	80%	24
TOTAL	161	100%	23,376	100%	161			118

Table 3 (continued). Sample Allocation for Metal Mines

Stratum	Employees Sampled Per Mine	Total Sample Employees	Nonresponse Adjusted Mine Weight	Average Employee Weight	Mine *DEFF*	Employee D_w	Employee ρ	Employee D_c	Employee *DEFF*
Metal Underground									
1-9	5	63	1.3	1.3	1.0	1.0	5%	1.2	1.2
10-25	18	89	1.3	1.3	1.0	1.0	5%	1.8	1.8
26-50	21	62	1.3	2.5	1.0	1.0	5%	2.0	2.0
51-75	21	32	1.3	3.8	1.0	1.0	3%	1.6	1.6
76-100	22	50	1.3	5.0	1.0	1.0	3%	1.6	1.6
101-250	23	222	1.3	8.2	1.0	1.1	1%	1.2	1.3
251+	24	96	1.3	25.4	1.0	1.4	1%	1.2	1.7
TOTAL		613			1.0	2.5	3%	1.5	3.7
Metal Surface									
1-9	4	160	1.3	1.3	1.0	1.0	5%	1.2	1.2
10-25	16	315	1.3	1.3	1.0	1.0	5%	1.8	1.8
26-50	18	128	1.3	2.5	1.0	1.0	5%	1.8	1.8
51-75	22	150	1.3	3.8	1.0	1.0	3%	1.6	1.6
76-100	23	208	1.3	5.0	1.0	1.0	3%	1.7	1.7
101-250	23	344	1.3	8.5	1.0	1.1	1%	1.2	1.3
251+	24	581	1.3	30.2	1.0	1.4	1%	1.2	1.7
TOTAL		1,886			1.0	2.7	3%	1.4	3.9

Sampling Plan for Nonmetal Mines

The proposed stratification scheme and sample size allocation for nonmetal mines is presented in Table 4. Only 41 of the 691 nonmetal mines were underground. Small operations with 1-25 employees accounted for 34 percent of underground nonmetal mines and 74 percent of surface mines but accounted for only 2 percent of underground employment and 20 percent of surface mine employment. Very large operations with more than 100 employees accounted for 34 percent of underground mines and 6 percent of surface mines but employed 85 percent of underground workers and 42 percent of surface workers. Because of the small number of underground nonmetal mines, all underground mines were included in the sample. The 41 underground nonmetal mines are expected to yield 30 responding eligible underground mines, who report for 504 employees. The sample for surface mines was allocated under the assumption that separate estimation capability was needed for mines with 1-9 employees, 10-25 employees, 26-50 employees, 51-75 employees, 76-100 employees, 101-250 employees, and more than 250 employees. A total of 286 surface mines are expected to need to be sampled to yield 207 responding eligible surface mines. These mines are expected to report for 3,023 surface nonmetal mine employees.

Table 4. Sample Allocation for Nonmetal Mines

Stratum	Number of Mines	Percent of Total Mines	Number of Employees	Percent of Total Employees	Average Employee Per Mine	Sample Mines	Eligibility Rate	Response Rate	Eligible Mines	Responding Eligible Mines
Nonmetal Underground										
1-9	12	29%	50	1%	4	12	85%	80%	10	8
10-25	2	5%	38	1%	19	2	90%	80%	2	1
26-50	8	20%	290	6%	36	8	90%	80%	7	6
51-75	4	10%	232	5%	58	4	95%	80%	4	3
76-100	1	2%	80	2%	80	1	95%	80%	1	1
101-250	9	22%	1634	34%	182	9	99%	80%	9	7
251+	5	12%	2431	51%	486	5	99%	80%	5	4
TOTAL	41	100%	4,755	100%	116	41			38	30
Nonmetal Surface										
1-9	347	53%	1454	8%	4	92	85%	80%	78	63
10-25	136	21%	2094	12%	15	65	90%	80%	59	47
26-50	73	11%	2768	15%	38	46	90%	80%	41	33
51-75	45	7%	2799	16%	62	34	95%	80%	32	26
76-100	14	2%	1191	7%	85	14	99%	80%	14	11
101-250	25	4%	3790	21%	152	25	99%	80%	25	20
251+	10	2%	3785	21%	379	10	99%	80%	10	8
TOTAL	650	100%	17881	100%		286			259	207

Table 4 (continued). Sample Allocation for Nonmetal Mines

Stratum	Employees Sampled Per Mine	Total Sample Employees	No response Adjusted Mine Weight	Average Employee Weight	Mine *DEFF*	Employee D_w	Employee ρ	Employee D_c	Employee *DEFF*
Nonmetal Underground									
1-9	4	34	1.25	1.3	1.0	1.00	5%	1.2	1.2
10-25	19	27	1.25	1.3	1.0	1.00	5%	1.9	1.9
26-50	18	104	1.25	2.5	1.0	1.00	5%	1.9	1.9
51-75	19	59	1.25	3.8	1.0	1.00	3%	1.6	1.6
76-100	20	15	1.25	5.0	1.0	1.00	3%	1.6	1.6
101-250	24	169	1.25	9.6	1.0	1.03	1%	1.2	1.3
251+	24	96	1.25	25.1	1.0	1.26	1%	1.2	1.5
TOTAL		504			1.0	2.18	3%	1.1	2.4
Nonmetal Surface									
1-9	4	262	4.71	4.7	1.0	1.00	5%	1.2	1.2
10-25	15	721	2.62	2.6	1.0	1.00	5%	1.7	1.7
26-50	19	628	1.98	4.0	1.0	1.00	5%	1.9	1.9
51-75	21	536	1.65	5.0	1.0	1.00	3%	1.6	1.6
76-100	21	236	1.25	5.0	1.0	1.00	3%	1.6	1.6
101-250	23	450	1.25	8.3	1.0	1.04	1%	1.2	1.3
251+	24	191	1.25	19.6	1.0	1.15	1%	1.2	1.4
TOTAL		3023			1.2	1.65	3%	1.0	1.6

Sampling Plan for Stone Mines

The proposed stratification scheme and sample size allocation for stone mines is presented in Table 5. Only 111 of the total 3,803 stone mines were underground mines. Small operations with 1-25 employees accounted for 61 percent of underground stone mines and 81 percent of surface mines but accounted for only 25 percent of underground employment and 39 percent of the surface employment. Very large operations with more than 100 employees accounted for only 4 percent of underground mines and 3 percent of surface mines but employed 29 percent of underground workers and 26 percent of surface workers. The sample for stone mines was allocated under the assumption that separate estimation capability was needed for mines with 1-9 employees, 10-25 employees, 26-50 employees, 51-100 employees, and more than 100 employees. A total of 93 underground mines are expected to need to be sampled to yield 67 responding eligible underground mines, reporting for 998 employees. Another 479 surface mines are expected to need to be sampled to yield 349 responding eligible surface mines, who are expected to report for 5,453 employees.

Table 5. Sample Allocation for Stone Mines

Stratum	Number of Mines	Percent of Total Mines	Number of Employees	Percent of Total Employees	Sample Mines	Eligibility Rate	Response Rate	Responding Eligible Mines
Stone Underground								
1-9	20	18%	102	3%	20	85%	80%	14
10-25	48	43%	766	22%	35	90%	80%	25
26-50	28	25%	955	27%	23	90%	80%	17
51-75	10	9%	610	17%	10	95%	80%	8
76-100	1	1%	91	3%	1	95%	80%	1
101-250	3	3%	377	11%	3	99%	80%	2
250+	1	1%	637	18%	1	99%	80%	1
TOTAL	111	100%	3,538	100%	93			67
Stone Surface								
1-9	1,698	46%	8,067	11%	116	85%	80%	79
10-25	1,304	35%	20,497	28%	114	90%	80%	82
26-50	402	11%	13,862	19%	95	90%	80%	68
51-75	104	3%	6,356	9%	51	95%	80%	39
76-100	54	1%	4,704	6%	35	95%	80%	27
101-250	124	3%	17,528	24%	62	99%	80%	49
250+	6	0%	1,796	2%	6	99%	80%	5
TOTAL	3,692	100%	72,810	100%	479			349

Table 5 (continued). Sample Allocation for Stone Mines

Stratum	Employees Sampled Per Mine	Total Sample Employees	No response Adjusted Mine Weight	Average Employee Weight	Mine *DEFF*	Employee D_w	Employee ρ	Employee D_c	Employee *DEFF*
Stone Underground									
1-9	5	69	1.3	1.3	1.0	1.000	5%	1.2	1.2
10-25	16	402	1.7	1.7	1.0	1.000	5%	1.7	1.7
26-50	17	282	1.5	3.0	1.0	1.000	5%	1.8	1.8
51-75	20	155	1.3	3.8	1.0	1.000	3%	1.6	1.6
76-100	23	17	1.3	5.0	1.0	1.000	3%	1.7	1.7
101-250	22	53	1.3	7.1	1.0	1.007	1%	1.2	1.2
250+	25	19	1.3	32.5	1.0	1.000	1%	1.2	1.2
TOTAL		998			1.0	2.710	3%	1.0	2.6
Stone Surface									
1-9	5	375	18.3	18.3	1.0	1.000	5%	1.2	1.2
10-25	16	1,290	14.3	14.3	1.0	1.000	5%	1.7	1.7
26-50	17	1,179	5.3	10.6	1.0	1.000	5%	1.8	1.8
51-75	20	790	2.5	7.6	1.0	1.000	3%	1.6	1.6
76-100	22	579	1.9	7.7	1.0	1.000	3%	1.6	1.6
101-250	23	1,126	2.5	15.4	1.0	1.046	1%	1.2	1.3
250+	24	114	1.3	15.7	1.0	1.028	1%	1.2	1.3
TOTAL		5,453			1.5	1.092	3%	1.0	1.1

Sampling Plan for Sand and Gravel Mines

The proposed stratification scheme and sample size allocation for stone mines is presented in Table 6. All of the 6,074 sand and gravel mines are surface mines. Unlike the other mining commodity sectors, sand and gravel mines tend to be dominated by small mines. Small operations with 1-25 employees accounted for 97 percent of sand and gravel mines and 80 percent of total employment. There were very few large operations with more than 100 employees and they accounted for less than 2 percent of sand and gravel mine employment. The sample for stone mines was allocated under the assumption that separate estimation capability was needed for mines with 1-3 employees, 4-9 employees, 10-25 employees, and 26 or more employees. A total of 439 sand and gravel mines are expected to need to be sampled to yield 311 responding eligible mines, reporting for 3,060 employees.

Table 6. Sample Allocation for Sand & Gravel Mines

Stratum	Number of Mines	Percent of Total Mines	Number of Employees	Percent of Total Employees	Sample Mines	Eligibility Rate	Response Rate	Responding Eligible Mines
Sand & Gravel Surface								
1-3	2,589	42.6%	5,504	13.3%	119	85%	80%	81
4-6	1,572	25.9%	7,570	18.4%	80	85%	80%	54
7-9	748	12.3%	5,872	14.2%	37	85%	80%	25
10-25	963	15.9%	13,995	33.9%	110	90%	80%	79
26-50	168	2.8%	5,743	13.9%	70	95%	80%	53
51-75	27	0.4%	1,607	3.9%	16	95%	80%	12
76-100	3	0.0%	264	0.6%	3	99%	80%	2
101-250	4	0.1%	683	1.7%	4	99%	80%	3
250+	0	0.0%	0	0.0%	---	---	---	---
TOTAL	6,074	100.0%	41,238	100%	439			311

Table 6 (continued). Sample Allocation for Sand & Gravel Mines

Stratum	Employees Sampled Per Mine	Total Sample Employees	Nonresponse Adjusted Mine Weight	Average Employee Weight	Mine *DEFF*	Employee D_w	Employee ρ	Employee D_c	Employee *DEFF*
Sand & Gravel Surface									
1-3	2	172	27	27	1.00	1.00	5%	1.1	1.06
4-6	5	262	25	25	1.00	1.00	5%	1.2	1.19
7-9	8	198	25	25	1.00	1.00	5%	1.3	1.34
10-25	15	1,151	11	11	1.00	1.00	5%	1.7	1.68
26-50	17	909	3	6	1.00	1.00	5%	1.8	1.80
51-75	20	241	2	6	1.00	1.00	3%	1.6	1.57
76-100	22	52	1	5	1.00	1.00	3%	1.6	1.63
101-250	24	75	1	9	1.00	1.01	1%	1.2	1.24
250+	---	---	---	---	---	---	---	---	---
TOTAL		3,060			1.35	1.37	5%	1.0	1.30