NYSERDA Clean Diesel Technology: Non-Road Field Demonstration Program

New York City Metropolitan Area Construction Equipment Population Survey Report

Final Report 10-17
August 2010

New York State
Energy Research and
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NYSERDA Clean Diesel Technology:
Non-Road Field Demonstration Program
New York City Metropolitan Area Construction
Equipment Population Survey Report

Final Report

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ABSTRACT

The primary goal of NYSERDA's Non-Road Clean Diesel Program is to demonstrate and evaluate the feasibility and performance of commercially available emission control technologies for reduction of particulate matter (PM) and oxides of nitrogen (NOx) emissions. Research and planning activities for these demonstrations included the development of current non-road equipment and emissions inventories for New York State (hereafter "NYS") and the New York City Metropolitan Area (hereafter "NYCMA").

Initially, an emission inventory for the nonroad sector in New York State (NYS) was executed using EPA's NONROAD2004 model (NR2004) for a base year of 2002, with the assistance of the New York State Department of Environmental Conservation (NYSDEC). Of all the non-road equipment subsectors, diesel-fueled construction/mining equipment was identified as the largest non-road source of priority pollutants in the State. The baseline inventory indicated that more that 50% of such emissions were associated with equipment use in the 10 NYS counties that make up the New York City Metropolitan Area (NYCMA). Subsequently, NR2004 was revised to account for regional differences in the cost of construction, a factor used to allocate the national equipment inventory to the state and county level, and re-issued asNONROAD2005 (NR2005), which reduced the emission inventory for this segment by about 33%.

In an attempt to improve the emission inventory for the non-road sector, a survey was designed to estimate construction equipment population and emissions in the NYCMA. Over 8,000 entities were surveyed, with over 350 completed surveys provided. Analysis of the survey data found some diesel construction equipment population and emission inventory estimates to be 10% to 95% lower than that estimated by NR2005 . These survey-based population estimates had relative standard errors of less than 30% at a 95% confidence interval. Similar reductions in population estimates are also observed for other equipment types, however, due to large uncertainties with relative standard errors (from 31% to 68%), use of these estimates are limited.

This initial survey and revised inventory provide an indication of the potential inventory improvements that can be made for critical areas like the NYCMA. Further, more refined and targeted surveys of small fleets and a census of large fleets could significantly improve the non-road construction equipment and emissions inventory for the area. Also, incorporating uncertainty of inventory estimates for equipment population and emissions could lead to improved regulatory and policy development.

ACKNOWLEDGMENTS

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ACRONYMS AND ABBREVIATIONS

CO	carbon monoxide
D&B	Dun & Bradstreet
EF	emission factor = average emission of each pollutant per unit of use for each category of equipment
EPA	United States Environmental Protection Agency
HP	horsepower
hpy	hours per year
NO_x	oxides of nitrogen
NR2004	EPA NONROAD 2004 model
NYCMA	New York City Metropolitan Area
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
PM	particulate matter
PSR	Power Systems Research
QA	quality assurance
RTF	rough terrain forklifts
SCC	source classification code
SIC	Standard Industrial Classification (code)
Southern	Southern Research Institute
tpy	tons per year
U.S.	United States

SUMMARY

NYSERDA initiated a Non-Road, Clean Diesel, in-use testing program in March of 2005. The goal of the program was to evaluate the feasibility and performance of commercially available, emission control technologies in reducing particulate matter (PM) and oxides of nitrogen (NOx) emissions. To maximize the validity of the study, the program conducted demonstrations using in-use field testing approaches on major, non-road, diesel emission sources in NYS and the NYCMA. The in-use field demonstration portion of the project was conducted with the participation of equipment owners and operators in the NYCMA, as well as emission control technology vendors.

NYSERDA's Clean Diesel Program involved the development of a baseline emissions inventory estimates for NYS and the NYCMA. This information was initially established using the EPA's NONROAD2004 model (NR2004). During the course of this project, NONROAD2005 was introduced, which incorporated revised equipment allocation algorithms to correct for regional differences in construction spending, which is used to estimate state-level and county-level equipment population estimates. Although the NR2004 and NR2005 models provided an acceptable baseline, improvements in the accuracy of the equipment estimates for major metropolitan area were sought, as the NR2004 and NR2005 models allocates equipment on the county level using a top-down process based on a single allocation parameter (dollar cost of construction). Due to the unique construction activities in the NYCMA, a more accurate, bottoms-up inventory was sought. An improved inventory would ensure that high priority equipment was targeted for retrofit and demonstration in this program and that future policies and programs were developed based on the most accurate knowledge of local fleets and their impacts.

A random survey was designed covering a wide range of entities that own and operate construction equipment in the NYCMA. The survey collected information regarding the characteristics of fleets and construction projects, including:

- employment or revenue for use in scaling results
- number of diesel equipment owned or leased
- equipment horsepower and model year
- annual and seasonal operating schedules
- annual fuel consumption
- changes in 2004 versus 2002 fleet operations

This report presents the default population and activity data for 2002 as a base year for non-road diesel construction equipment as estimated by the NR2004 model, describes construction survey development and

testing, presents the survey results, presents the refined population and activity data, and the emission estimates based on NR2004 and NR2005.

Several groups of users were identified for inclusion in the construction survey, encompassing all potential major users of construction equipment. They were:

- general contractors
- heavy construction
- concrete
- water well drilling
- miscellaneous special trade contractors
- mining
- rental
- municipal agencies and
- landfills / transfer stations

The survey focused on construction equipment activity within the 10-county NYCMA. Still, it was expected that many businesses located outside of this geographic area may also conduct projects in the 10-county NYCMA. To obtain a representative sample of construction businesses, samples from select groups were also drawn from 19 counties outside of the NYCMA. These included several counties in New Jersey, two in Connecticut, and one in Pennsylvania.

The survey results showed significant decreases in the population and emissions for non-road diesel construction equipment in the NYCMA over that estimated in the EPA's NR2004 and NR2005 models. Table S-1 summarizes population by equipment type as estimated by the NR2004 and NR2005 models and scaled and weighted estimates based on the survey data. Note that for some equipment types, the relative standard error (RSE) exceeds 30%. For these and any associated estimates, data should be considered with caution, and for those with RSE greater than 50%, data should be considered unreliable, but are provided for completeness and informational purposes.

Table S-2 compares the survey-based refined PM and NOx emissions by equipment type to the NR2004 and NR2005 model emission estimates.

A full description of the results of the baseline NR2004 inventory is available in the *NYSERDA Clean Diesel Technology: Non-Road Field Demonstration Program Interim Report*[1].

Table S-1. Population by Non-Road Diesel Equipment Type

Equipment Description	NR2004 Population Estimates	NR2005 Population Estimates	Survey-Based Population Estimates using Scaling Factor Based on Quota Group and Sales Volume		Relative Standard Error
			Mean	95% Confidence Interval	
Diesel Excavators	4,720	3,142	2322	745	16%
Diesel Rubber Tire Loaders	5,223	3,476	3124	1518	25%
Diesel Pavers	839	558	487	244	25%
Diesel Rollers	3,007	2,002	1121	574	26%
Diesel Crawler Tractors	3,627	2,414	628	323	26%
Diesel Rough Terrain Forklifts	4,194	2,792	146	87	30%
SUBTOTAL (RSE <= 30%)	***21,610***	***14,384***	***7828***		
Diesel Bore/Drill Rigs	1,496	996	194	120	31%
Diesel Cranes	1,229	818	294	180	31%
Diesel Tractors/Loaders/Backhoes	12,592	8,381	4754	3627	39%
Diesel Graders	1,125	749	258	204	40%
Diesel Skid Steer Loaders	19,596	13,043	2504	1950	40%
Diesel Off-highway Trucks	593	395	419	350	42%
SUBTOTAL (RSE<=50%)	***36,631***	***24,381***	***8423***		
Diesel Trenchers	2,153	1,433	91	91	62%
Diesel Scrapers	639	425	128	128	66%
SUBTOTAL (RSE>50%)	***2,792***	***1,858***	***219***		
TOTAL	**61,032**	**40,623**	**16,470**		**17%**

Table S-2. PM and NOx Emissions by Non-Road Diesel Equipment Type

Equipment Description	NR2004 Emissions Estimates		NR2005 Emissions Estimates		Survey-Based Scaled Emissions Estimates	
	PM (tpy)	NOx (tpy)	PM (tpy)	NOx (tpy)	PM (tpy)	NOx (tpy)
Diesel Excavators	253	3347	168	2228	124 ± 40	1647 ± 528
Diesel Rubber Tire Loaders	326	4193	217	2791	195 ± 95	2508 ± 1219
Diesel Pavers	31	342	20	227	18 ± 9	198 ± 99
Diesel Rollers	87	853	58	568	32 ± 17	318 ± 163
Diesel Crawler Tractors	268	3654	178	2432	46 ± 24	633 ± 325
Diesel Rough Terrain Forklifts	132	1101	88	733	5 ± 3	38 ± 23
SUBTOTAL (RSE<=30%)	***1096***	***13491***	***729***	***8980***	***420***	***5342***
Diesel Bore/Drill Rigs	43	507	29	338	6 ± 3	66 ± 41
Diesel Cranes	57	934	38	622	14 ± 8	223 ± 137
Diesel Tractors/Loaders/Backhoes	409	2597	273	1729	155 ± 118	981 ± 748
Diesel Graders	61	854	41	568	14 ± 11	196 ± 155
Diesel Skid Steer Loaders	367	1713	244	1140	47 ± 37	219 ± 171
Diesel Off-highway Trucks	199	3195	133	2127	141 ± 118	2258 ± 1887
SUBTOTAL (RSE<=50%)	***1137***	***9800***	***757***	***6523***	***376***	***3943***
Diesel Trenchers	52	400	35	266	2 ± 2	17 ± 17
Diesel Scrapers	69	992	46	660	14 ± 14	199 ± 199
SUBTOTAL (RSE>50%)	***121***	***1392***	***81***	***927***	***16***	***216***
TOTAL	**2354**	**24683**	**1567**	**16429**	**812**	**9501**

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1.0 INTRODUCTION

Diesel engines can be highly energy efficient and durable, yet emissions from diesel engines have historically contributed to a number of serious air pollution problems. Emission reductions from this source category are a necessity for improved air quality in many regions. To address this issue, the U.S. Environmental Protection Agency (EPA) has passed regulations to decrease emissions from ***new*** diesel engines for on-road and non-road applications. These regulations will also require the use of low sulfur diesel fuel and will be phased in from 2006 through 2014 and beyond. Despite this, existing diesel engines will continue to emit higher levels of pollutants such as particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), and air toxics. Within NYS, diesel emissions significantly impact ambient air quality, and contribute to pollution levels that exceed national ambient air quality standards in areas such as the New York City Metropolitan Area (NYCMA), resulting in classification of these areas as "non-attainment." The non-road equipment sector is a major user of diesel fuel within the state and a primary emitter of diesel fuel associated emissions.

The program's goal is to demonstrate and evaluate the feasibility and performance of commercially available emission control technologies in reducing emissions of particulate matter (PM) and oxides of nitrogen (NOx) from the existing diesel fleet. The program conducts demonstrations using field testing procedures focused on the real-world emissions of major, non-road diesel emission sources in NYS and the NYCMA.

An accurate emissions inventory of diesel equipment is needed in developing and assessing the potential impact of policies to reduce diesel emissions. Initially, a baseline non-road diesel emissions and equipment inventory was developed for NYS and for the NYCMA, a major non-attainment area using the EPA's NONROAD2004 model (NR2004). This inventory provided significant insight into equipment distributions and emissions across broad categories of non-road equipment, including construction and mining equipment, locomotive and rail equipment, airport ground support equipment, commercial marine vessels, and other non-road items. In fact, NR2004 shows that diesel powered, non-road equipment operated in New York State (NYS) emits an estimated 91,028 tons per year (tpy) of NOx and 7,311 tpy of PM for a base year of 2002. Diesel-fueled non-road equipment accounts for 77% and 64% of the total statewide non-road NOx and PM emissions, respectively with the remainder contributed by gasoline-powered and non-diesel fueled non-road equipment. Diesel-fueled construction and mining equipment are responsible for the largest percentage of PM (53%) and NOx (45%) emissions statewide and in the NYCMA (62% and 59%, respectively)[1].

NYSDEC determined that the EPA NR2004 model appeared to overestimate the equipment and emissions inventory associated with the construction equipment sector in NYS and the NYCMA. Based, in part, on information supplied by NYSDEC, the EPA acknowledged that the allocation procedures in NR2004 may have overestimated equipment populations in large metropolitan areas due to increased dollar cost of construction in these areas, which is the primary equipment allocation parameter, and produced a revised model – NR2005 – that produced reduced equipment population estimates based on a revised allocation procedure.

In addition to this formal improvement in the model estimates based on cost of construction, a survey of construction equipment users and owners in the NYCMA was developed and implemented to improve the accuracy of the emissions inventory for this nonroad segment. Revised equipment population and activity data from the survey, were used in conjunction with emission factors from the NR2004 model to develop a revised emission inventory for the construction and mining equipment sector in the NYCMA for a baseline year of 2002.

Work related to evaluating and improving activity variables for the construction sector was performed in four phases. Phase I was the preparation of a research plan on construction activity in the NYCMA [1]. Phase II involved an initial evaluation of activity and geographic allocation data in the NR2004 model. Phase III entailed the development and performance of a test survey of construction equipment users in the NYCMA. After conducting the Phase III test survey, a full-scale survey of construction equipment activity was conducted as Phase IV. This report summarizes the work performed under Phases II, III, and IV.

Goals of this work are:

- implement a survey of entities, including private construction contractors and municipal agencies, to collect primary data on dollars spent on and allocation of commercial and residential construction and public works projects in the NYCMA and characteristics of the equipment fleets used in this work
- use survey data to correlate non-road activity levels in the NYCMA with employment, construction cost, revenue, or other surrogate parameters as alternative inputs to the NR2004 model
- develop a refined emission inventory based on the survey results and refined model allocation and fleet characteristics

2.0 NONROAD MODEL CONSTRUCTION ACTIVITY INDICATORS

NR2004 is a tool that estimates pollutant emissions for over 200 non-road equipment types. The model relies on estimates of equipment populations by horsepower (hp), hours of use, load factor, and emission factor to calculate emissions for specified time periods (e.g., daily, monthly, or annually). Default national average values for activity variables are incorporated into the model, but can be replaced with more representative data. For estimating local area or county inventories, the equipment populations are allocated to the county-level using surrogate indicators believed to correlate with equipment populations and activity for specific equipment categories. The EPA provides technical reports that describe the basis for inputs, outputs, and procedures used by NR2004[2].

This chapter presents the default data used by NR2004 to estimate emissions for diesel construction equipment in the NYCMA. These activity variables include:

- equipment population
- hp distribution of population
- load factor
- annual hours of use
- median engine life
- seasonal activity profiles

For certain variables, the values are specific to the equipment application or source classification code (SCC). For other variables, the values are the same for all equipment within the construction category. These inputs are presented in the sections below. This chapter also discusses the basis of the NR2004 geographic allocation, as well as distributions resulting from the use of alternate surrogate indicator data.

2.1. EQUIPMENT POPULATION

County and state specific populations for diesel construction equipment are based on national construction equipment populations and horsepower distributions available from the market research firm Power Systems Research (PSR). These national equipment estimates are allocated to the county level using data related to the dollar value of construction projects. A more detailed discussion of the county allocation procedures is included in Section 2.3 of this chapter. For all diesel-powered equipment, NR2004 incorporates population counts corresponding to a base year of 2000. Equipment populations are estimated year-to-year and by horsepower classification using a linear extrapolation of available historic diesel engine populations. Table 2-1 presents the NR2004 equipment populations by SCC for each of the 10 NYCMA counties, as well as the total for the metropolitan area. Table 2-2 shows the horsepower distribution by fraction of the total SCC level population in the NYCMA. In the NR2004 model, this horsepower distribution is the same for national, state or county-level construction SCC populations.

Table 2-1. NR2004 Diesel Construction Equipment Populations for 2002 by NYCMA County

SCC	Equipment Description	BRONX	KINGS	NASSAU	NEW YORK	PUTNAM	QUEENS	RICHMOND	ROCKLAND	SUFFOLK	WESTCHESTER	Total NYCMA
2270002003	Diesel Pavers	49	77	57	250	8	178	30	16	89	84	839
2270002006	Diesel Tampers/Rammers	5	9	6	28	1	20	3	2	10	9	93
2270002009	Diesel Plate Compactors	48	75	55	241	7	172	29	16	86	81	809
2270002015	Diesel Rollers	177	278	203	896	28	640	107	59	319	302	3,007
2270002018	Diesel Scrapers	38	4 59	3	190	6	136	23	12	68	64	639
2270002021	Diesel Paving Equipment	17	27	20	88	3	63	10	6	31	29	294
2270002024	Diesel Surfacing Equipment	7	12	9	38	1	27	5	2	13	13	127
2270002027	Diesel Signal Boards	140	219	160	707	22	505	84	46	251	238	2,372
2270002030	Diesel Trenchers	127	199	145	642	420	58	4 77	2	228	216	2,153
2270002033	Diesel Bore/Drill Rigs	88	138	101	446	14	318	53	29	158	150	1,496
2270002036	Diesel Excavators	4278	36	318	1,4407	3	1,004	168	92	4500	473	,720
2270002039	Diesel Concrete/Industrial Saws	14	22	16	72	2	52	9	5	26	24	243
2270002042	Diesel Cement & Mortar Mixers	32	50	36	160	5	114	19	10	57	54	537
2270002045	Diesel Cranes	72	113	83	366	11	261	44	24	130	123	1,229
2270002048	Diesel Graders	66	104	76	336	10	4239	0	22	119	113	1,125
2270002051	Diesel Off-highway Trucks	35	4 55	0	177	5	126	21	12	63	59	593
2270002054	Diesel Crushing/Proc. Equipment	20	31	22	99	3	71	12	6	35	33	333
2270002057	Diesel Rough Terrain Forklifts	247	387	283	1,251	38	892	149	82	444	421	,194
2270002060	Diesel Rubber Tire Loaders	4308	82	352	1,5457	8	1,111	186	102	553	524	5,223
2270002066	Diesel Tractors/Loaders/Backhoes	742	1,162	849	3,754	115	2,679	448	245	1,334	1,263	12,592
2270002069	Diesel Crawler Tractors	214	335	245	1,081	33	772	129	71	384	364	3,627
2270002072	Diesel Skid Steer Loaders	1,154	1,809	1,322	5,842	179	,170	698	381	2,076	1,965	19,596
2270002075	Diesel Off-Highway Tractors	9	14	4 10	6	1	33	5	3	16	15	154
2270002078	Diesel Dumpers/Tenders	9	14	10	44	1	31	5	3	16	15	147
2270002081	Diesel Other Construction Equipment	4 27	2	31	137	4	98	16 4	9	4 9	4 6	59
Total		**3,923**	**6,147**	**4,492**	**19,856**	**609**	**14,171**	**2,371**	**1,296**	**7,056**	**6,679**	**66,600**

Table 2-2. Percentage of NR2004 SCC-Level Diesel Construction Equipment Populations for 2002 by Horsepower

SCC	Equipment Description	3 < HP <= 6	6 < HP <= 11	11 < HP <= 16	16 < HP <= 25	25 < HP <= 40	40 < HP <= 50	50 < HP <= 75	75 < HP <= 100	100 < HP <= 175	175 < HP <= 300	300 < HP <= 600	600 < HP <= 750	750 < HP <= 1000	1000 < HP <= 1200	1200 < HP <= 2000	2000 < HP <= 3000
2270002003	Diesel Pavers	0	0	0	0	11	1	21	13	29	21	3	0	0	0	0	0
2270002006	Diesel Tampers/Rammers	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2270002009	Diesel Plate Compactors	57	26	16	1	0	0	0	0	0	0	0	0	0	0	0	0
2270002015	Diesel Rollers	2	3	4	7	10	9	9	25	23	8	2	0	0	0	0	0
2270002018	Diesel Scrapers	0	0	0	0	0	0	0	0	3	34	43	20	0	0	0	0
2270002021	Diesel Paving Equipment	14	15	1	8	10	0	10	12	22	7	0	0	0	0	0	0
2270002024	Diesel Surfacing Equipment	0	1	2	27	23	8	0	22	7	0	7	3	1	0	0	0
2270002027	Diesel Signal Boards	3	7	4	63	19	0	1	1	1	0	0	0	0	0	0	0
2270002030	Diesel Trenchers	0	0	0	0	10	24	40	16	5	3	2	0	0	0	0	0
2270002033	Diesel Bore/Drill Rigs	0	0	0	0	9	9	14	14	21	18	11	2	1	0	0	0
2270002036	Diesel Excavators	0	0	1	3	6	3	2	10	39	28	8	0	0	0	0	0
2270002039	Diesel Concrete/Industrial Saws	0	5	0	4 8	6	2	15	21	3	0	0	0	0	0	0	0
2270002042	Diesel Cement & Mortar Mixers	3	25	5	4	3	0	5	9	3	1	1	0	0	0	0	0
2270002045	Diesel Cranes	0	0	0	0	2	0	1	9	33	34	21	1	0	0	0	0
2270002048	Diesel Graders	0	0	0	0	0	0	0	3	33	56	6	0	0	0	0	0
2270002051	Diesel Off-highway Trucks	0	0	0	0	0	0	0	0	0	16	34	19	9	3	15	4
2270002054	Diesel Crushing/Proc. Equipment	0	0	0	1	1	4	44	11	17	6	16	1	0	0	0	0
2270002057	Diesel Rough Terrain Forklifts	0	0	0	0	4	5	9	52	27	1	2	0	0	0	0	0
2270002060	Diesel Rubber Tire Loaders	0	0	0	0	2	2	3	12	30	28	21	2	1	0	1	0
2270002066	Diesel Tractors/Loaders/Backhoes	0	0	0	1	1	1	14	50	33	0	0	0	0	0	0	0
2270002069	Diesel Crawler Tractors	0	0	0	0	0	0	1	15	33	29	14	6	1	2	0	0
2270002072	Diesel Skid Steer Loaders	0	0	4	9	17	7	38	25	1	0	0	0	0	0	0	0
2270002075	Diesel Off-Highway Tractors	0	0	0	0	0	0	0	0	0	11	18	44	14	1	11	0
2270002078	Diesel Dumpers/Tenders	0	23	22	15	18	4	2	12	4	0	0	0	0	0	0	0
2270002081	Diesel Other Construction Equipment	0	0	0	1	3	0	3	3	20	48	3	8	0	1	0	0

2.2. ACTIVITY VARIABLES

Once equipment populations and horse power are estimated for each SCC, NR2004 multiplies the population by annual hours of use and a load factor to calculate yearly total activity for each engine type. The model also uses annual hours and load factor in combination with median life to calculate the fleet age distributions for each equipment type as it projects future (or past) engine populations. The activity and load factor values, presented in Table 2-3, are based on national averages as determined from PSR-sponsored user surveys. Median life estimates used by NR2004 in Table 2-4 are based on estimates developed by Air Resources Board for their OFF-ROAD model.

Table 2-3. NR2004 Diesel Construction Equipment Activity for 2002

SCC	Equipment Description	Load Factor (fraction of power)	Activity (hours/year)
2270002003	Diesel Pavers	0.59	821
2270002006	Diesel Tampers/Rammers	0.43	460
2270002009	Diesel Plate Compactors	0.43	484
2270002015	Diesel Rollers	0.59	760
2270002018	Diesel Scrapers	0.59	914
2270002021	Diesel Paving Equipment	0.59	622
2270002024	Diesel Surfacing Equipment	0.59	561
2270002027	Diesel Signal Boards	0.43	535
2270002030	Diesel Trenchers	0.59	593
2270002033	Diesel Bore/Drill Rigs	0.43	466
2270002036	Diesel Excavators	0.59	1,092
2270002039	Diesel Concrete/Industrial Saws	0.59	580
2270002042	Diesel Cement & Mortar Mixers	0.43	275
2270002045	Diesel Cranes	0.43	990
2270002048	Diesel Graders	0.59	962
2270002051	Diesel Off-highway Trucks	0.59	1,641
2270002054	Diesel Crushing/Proc. Equipment	0.43	955
2270002057	Diesel Rough Terrain Forklifts	0.59	662
2270002060	Diesel Rubber Tire Loaders	0.59	761
2270002063	Diesel Rubber Tire Dozers	0.59	899
2270002066	Diesel Tractors/Loaders/Backhoes	0.21	1,135
2270002069	Diesel Crawler Tractors	0.59	936
2270002072	Diesel Skid Steer Loaders	0.21	818
2270002075	Diesel Off-Highway Tractors	0.59	855
2270002078	Diesel Dumpers/Tenders	0.21	566
2270002081	Diesel Other Construction Equipment	0.59	606

Table 2-4. NR2004 Median Life for 2002 Diesel Construction Equipment

HP Range (hp)	Median Life (hours)
3 – 50	2,500
50 – 300	4,667
300 – 3,000	7,000

Monthly activity fractions are the same for all applications within the construction category. Table 2-5 presents the monthly activity percentages, as well as the seasonal activity percentages assumed in NR2004. Note that the activity fractions are the same for all three months in a given season. NR2004 assumes that a higher percentage of construction activity occurs in the summer than in other seasons.

Table 2-5. NR2004 Monthly and Seasonal Activity Percentages

Month/Season	Percentage of Annual Activity
Dec Jan Feb	3%
Mar Apr May	8%
Jun Jul Aug	14%
Sep Oct Nov	8%
Winter	10%
Spring	23%
Summer	43%
Autumn	23%

2.3. GEOGRAPHIC ALLOCATION

For the NR2004 model, national construction equipment populations, available from PSR, are allocated to the county level using data related to the dollar value of construction projects. This data represents the dollar value of residential, commercial, and industrial building construction, as well as road and other public works-related heavy construction. According to a 1998 survey of construction activity in Houston, Texas; road and other types of heavy construction constitute a much larger share of actual equipment activity per dollar valuation compared to the construction of residential, commercial, and industrial buildings. For this reason, the EPA has weighted the various construction categories based on factors developed from the 1998 Houston survey, using the following equation:

$$\text{Allocation Factor}_j = (SFH_j + 3*OBLDG_j + 18.4*R\&B_j + 8.5*PW_j) / (SFH + 3*OBLDG + 18.4*R\&B + 8.5*PW)$$

Where the variables are the dollar valuation for either the county (j) or national total and

SFH	=	single/double-family housing construction
OBLDG	=	other building construction
R&B	=	road and bridge construction
PW	=	public works (sewer, water, and drainage) construction

The EPA reports that the higher weighted value given to road and other types of infrastructure construction generally tends to decrease the allocation of construction equipment to urban counties and increase the allocation to rural counties. This is believed to occur due to road and other infrastructure systems in urban counties being predominantly established, but still being developed in more rural counties where suburban sprawl continues to take place. Nevertheless, due to the relatively high costs of construction in the NYCMA, including those for building, road, and infrastructure projects, the effects of less road and heavy construction may be outweighed by the higher costs for all types of construction in the metropolitan area relative to the rest of the state, as well as the nation.

The dollar valuation of construction for each NYCMA county[3], as well as the fraction of the state total this represents is presented in Table 2-6.

Table 2-6. NR2004 Dollar Value of Construction for NYCMA Counties

County	Dollar Value of Construction[a]	Percent of State Total[a]
Bronx	$3,064,477	4%
Kings	$4,802,571	6%
Nassau	$3,509,035	4%
New York	$15,512,264	19%
Putnam	$475,860	1%
Queens	$11,071,161	14%
Richmond	$1,852,455	2%
Rockland	$1,012,624	1%
Suffolk	$5,512,406	7%
Westchester	$5,218,207	6%
NYCMA Total	*$52,031,058*	*64%*
NYS, excluding the NYCMA	$29,284,950	36%
NYS Total	*$81,316,007*	*100%*
[a] Totals may not add due to rounding		

2.4. ALLOCATIONS BASED ON ALTERNATE SURROGATE DATA

As described in section 2.3, NR2004 uses dollar cost of construction to allocate national equipment populations to state, regional, and county level. As a potential improvement to the default allocation procedures used by NR2004, several other potential allocation procedures were evaluated that use alternate surrogate data. For example, data from Dun & Bradstreet (D&B) employment, sales, or revenues may be used for each Standard Industrial Classification (SIC) code area associated with expected construction equipment users[4] and equipment populations, and activity allocated to the county level based on this information. The SICs that represent potential equipment users covered by the NR2004 construction and mining equipment sector includes:

- General Construction Contractors: SIC 15
- Heavy Construction Contractors: SIC 16
- Specialty Trade Contractors, 4-digit SICs:
    - 1771 - Concrete Work
    - 1794 - Excavation Work
    - 1781 - Water Well Drilling
    - 1795 - Wrecking and Demolition Work
- Rental Equipment: SICs 7353, 7359, 5082
- Landfills: SIC - 4953
- Mining (metals, coal, and nonmetallic): SICs 10, 12, 14

With a few exceptions, these SICs generally correspond to the industry groups surveyed as part of Phases III and IV of this project (Section 3, 4 of this report). Previous studies have investigated the correlation of surrogate data such as human population, employment, and disposable income, to activity for specific non-road equipment categories. In support of the EPA's 1991 Non-road Engine and Vehicle Emission Study5, Environmental Energy Analyses performed a time-series regression analysis of historic construction and mining activity and associated employment for these sectors. This analysis, conducted at the state-level, showed a correlation between employment and construction activity, with an R-squared value of 0.890.

Table 2-7 shows a summary of how D&B employment data for the SIC categories of construction equipment users predicts county and state-level equipment populations and activity in the NYCMA relative to the NR2004 dollar valuation data. Note that the overall contribution of NYCMA counties to national employment is slightly lower than the contribution of the NR2004 dollar valuation of construction for the NYCMA data (2.8% versus 3.6%) and the contribution to state employment is lower than the contribution of NYCMA dollar cost of construction to the state total (59.7% versus 64%).

Table 2-7. Comparison of NR2004 Data with Dun & Bradstreet Employment and Sales Data

	NR2004			Dun & Bradstreet Employment			Dun & Bradstreet Sales		
County	$ Value of Construction	Percent of National Valuation	Percent of State Valuation	Employees	Percent of National Employees	Percent of State Employees	Sales (Million $)	Percent of National Sales	Percent of State Sales
Bronx	3,064,477	0.2%	3.8%	5,182	0.1%	2.1%	597	0.0%	1.0%
Kings	4,802,571	0.3%	5.9%	13,753	0.3%	5.5%	2,240	0.1%	3.7%
Nassau	3,509,035	0.2%	4.3%	18,814	0.4%	7.5%	5,315	0.3%	8.7%
New York	15,512,264	1.1%	19.1%	25,810	0.5%	10.3%	16,904	0.9%	27.7%
Putnam	475,860	0.0%	0.6%	1,381	0.0%	0.6%	145	0.0%	0.2%
Queens	11,071,161	0.8%	13.6%	22,685	0.4%	9.1%	9,484	0.5%	15.5%
Richmond	1,852,455	0.1%	2.3%	3,206	0.1%	1.3%	465	0.0%	0.8%
Rockland	1,012,624	0.1%	1.2%	3,876	0.1%	1.6%	1,012	0.1%	1.7%
Suffolk	5,512,406	0.4%	6.8%	22,689	0.4%	9.1%	3,719	0.2%	6.1%
Westchester	5,218,207	0.4%	6.4%	31,973	0.6%	12.8%	5,268	0.3%	8.6%
NYCMA Total	52,031,058	3.6%	64.0%	149,369	2.8%	59.7%	45,148	2.4%	74.0%
NYS, not including the NYCMA	29,284,950	2.0%	36.0%	100,664	1.9%	40.3%	15,883	0.8%	26.0%
NYS Total	81,316,007	5.6%	--	250,033	.7%	--	61,031	3.2%	--
U.S. Total	1,451,555,186	--	--	5,345,001	--	--	1,881,206	--	--

Table 2-7 also shows a summary of the distribution of D&B sales data for the NYCMA and its comparison to the national and state level values. Again, note that the overall contribution of NYCMA counties to total national sales is lower than the contribution of the dollar valuation for NYCMA to the national total (2.4% versus 3.6%) but the contribution of the NYCMA D&B sales total for the state sales is larger than the NR2004 model default (2.8% versus 3.6%). These data show that construction equipment activity and emissions will vary, depending on the surrogate chosen to allocate national activity to the state and county levels; but, overall, the use of surrogate data such as employment or sales as a basis for the allocation of non-road construction equipment to the county level provides a reduction in the equipment population estimate for the NYCMA. Still, it is difficult to determine the accuracy of any of these estimates without comparison to a bottoms-up survey of actual equipment use and ownership within the NYCMA.

2.5. NONROAD MODEL INPUTS FOR BASELINE INVENTORY

Emissions from 2-stroke gasoline, 4-stroke gasoline, LPG, CNG and diesel fueled non-road vehicles as well as emissions from recreational marine vessels, were estimated using the 2004 version of the U.S. EPA Draft NONROAD Model. Using the EPA NONROAD Model, non-road emissions from New York were estimated for each individual county for each month of the year, then these spatially and temporally resolved emissions estimates were re-aggregated into annual NYCMA emissions.

Temperature data for 2002 was acquired from the National Oceanic and Atmospheric Administration, which included historical weather data from thirty-three airport locations across the State of New York as well as surrounding locations. This information was used to develop average high and low temperatures for each month on a county-by-county basis. The results were input into the NONROAD model.

Fuels blend data for 2002 was acquired from the New York State Department of Agriculture and Markets. This data is based on thousands of samples collected across the state from fueling stations and retention areas. These samples are then analyzed for many profiles including oxygen content, Reid Vapor Pressure (RVP) and sulfur content. The data provided average monthly fuels profiles on a county-by-county basis. The results were input into the NONROAD Model.

Aside from the changes indicated above, the NR2004 default inputs were used for all baseline model runs.

3.0 SURVEY DEVELOPMENT AND TESTING

3.1. SAMPLE FRAME

To develop a more accurate estimation of the actual numbers and activity of construction equipment in use in the NYCMA, a statistically valid random survey of construction equipment users in the NYCMA was performed. Analysts identified the groups of construction equipment users shown in Table 3-1 for inclusion in the NYCMA survey. These users were established based primarily on the respondents surveyed for other related construction equipment studies and the expected activities in the NYCMA. In addition, these categories of users are likely to use equipment that was determined to be priority equipment according to a preliminary NR2004 emissions analysis[1]. Respondent groups were assigned a quota group number, which was used to track data for all data analyses within these groups.

Table 3-1. Respondent Groups and Associated SICs

Quota Group Number	Respondent Group	SIC Code
1	General Contractors	1521, 1522, 1531, 1541, 1542
2	Heavy Construction	1611, 1622, 1623, 1629
3	Concrete	1771
4	Water Well Drilling	1781
5	Miscellaneous Special Trade Contractors[a]	1791, 1794, 1795, 1796
6	Mining	10,12,14
7	Rental	5082, 7353, 7359
8	Municipal Agencies	Not applicable
9	Landfills/Transfer Stations	Not applicable

[a] Includes Structural Steel Erection; Excavation; Wrecking and Demolition; and Installation/Erection of Building Equipment, NEC

Another important aspect of the sampling design was determining the geographic area from which to survey potential users. The analysis focused on construction equipment activity within the 10-county NYCMA. Table 3-2 shows the counties comprising the NYCMA that were used to conduct the survey.

Table 3-2. Counties in New York City Metropolitan Area

County Name	Federal Information Processing Standards Code
Bronx	36005
Kings	36047
Nassau	36059
New York	36061
Putnam	36079
Queens	36081
Richmond	36085
Rockland	36087
Suffolk	36103
Westchester	36119

It can be expected that many businesses located outside of this geographic area may conduct projects in the 10-county NYCMA. To obtain a representative sample of construction businesses, the sample for select SIC groups was drawn from the New York Consolidated Metropolitan Statistical Area, which includes 19 counties outside of the NYCMA, including several counties in New Jersey, two in Connecticut, and one in Pennsylvania. Figure 3-1 shows the New York Consolidated Metropolitan Statistical Area.

Figure 3-1. New York Consolidated Metropolitan Statistical Area[6]

For each county, an estimate of the potential equipment owners and users was obtained to estimate the potential sample size for each SIC category in each county. Table 3-3 shows the potential sample for each respondent, SIC group, and county. In addition, to obtain a statistically valid survey, with a prescribed degree of accuracy for the resultant data, a certain number of valid, complete survey results must be obtained within each category. For the purposes of this survey, a target confidence interval of 12% was established at a 95% confidence level as the goal. Based on this goal, the targeted number of complete surveys required to attain the prescribed confidence level was also calculated and is provided in Table 3-3. Note that for Mining, Rental, Municipal Agencies, and Landfills/Transfer Stations, the sample was only drawn from the NYCMA. These categories of construction equipment users were expected to be located primarily inside of the NYCMA area.

SIC-based listings and contact information were purchased by Population Research Systems from their sample vendor, Marketing Systems Group. An alternate source of listings was used, however, for the municipal agencies and the landfills category.

A listing of city and county agencies expected to operate publicly owned equipment fleets (e.g., sanitation, public works, and transportation departments), was compiled from the D&B 2002 Marketplace listings[5] and a review of establishment listings classified as SICs 91 through 97 (Division J - Public Administration). Including all listings in these SIC classifications would result in calling many offices not involved with construction or operational activities. As such, relevant listings were identified for each county and survey analysts extracted the contact information to form the basis of a contact list.

A listing of permitted waste transfer stations and seven municipal solid waste landfills was provided by NYSDEC. The list of permitted waste transfer stations included 66 listings. Still, complete addresses were not available, and a manual look-up of phone numbers for these facilities yielded only 33 potential contacts. Subsequently, survey analysts obtained a listing called “New York State Department of Environmental Conservation Division of Solid & Hazardous Materials - Active Transfer Stations” that provided additional phone numbers for the remaining transfer stations.

Based on the estimated sample size and required number of complete surveys, a sample file was purchased for each SIC group. In some cases, the actual sample obtained was the full available sample. In other cases (i.e. general contractors), only a portion of the potential sample was required. Finally, in other cases, the full sample was purchased, but turned out to be larger than the initial estimate of sample size available.

Table 3-3. Sample Size Calculations and Completes

County Name	State	FIPS Code	Respondent Category/SIC Total Sample Size									
			General Contractors	Heavy Construction	Concrete	Water Well Drilling	Miscellaneous Special Trade Contractors	Mining	Rental	Municipal Agencies	Landfills/ Transfer Stations	
			1521, 1522, 1531, 1541, 1542	1611, 1622, 1623, 1629	1771	1781	1791, 1794, 1795, 1796	10,12,14	5082, 7353, 7359	NA[a]	NA[a]	
Nassau	NY	36059	1,371	164	80	6	85	4	132			
Suffolk	NY	36103	1,852	339	137	23	172	25	178			
Bronx	NY	36005	443	23	18	1	53	4	2	1		
Kings	NY	36047	1,287	4	72	0	3	74	15	127		
New York	NY	36061	4	1,636	8	15	2	4	72	2	166	
Putnam	NY	36079	132	30	3	8	24	3	13			
Queens	NY	36081	1,443	92	58	7	80	11	108			
Richmond	NY	4	36085	28	2	2	0	2	0	25		
Rockland	NY	36087	317	5	15	2	35	9	27			
Westchester	NY	36119	1,075	143	31	5	107	15	96			
Bergen	NJ	34003	959	182	36	6	108					
Hudson	NJ	34017	374	50	14	1	33					
Passaic	NJ	34031	506	85	27	4	70					
Middlesex	NJ	34023	580	104	54	3	73					
Monmouth	NJ	34025	1,028	4	179	2	18	98				
Ocean	NJ	34029	659	4	160	0	20	66				
Somerset	NJ	34035	323	56	12	6	2					
Essex	NJ	34013	711	4	115	2	7					
Hunterdon	NJ	34019	355	1	15	14	70					
Morris	NJ	34027	667	145	22	9	105					
Sussex	NJ	34037	293	52	9	14	87					
Union	NJ	34039	518	94	26	1	55					
Pike	PA	42103	103	7	2	4	27					
Fairfield	CT	09001	1,373	155	59	18	183					
New Haven	CT	09009	903	145	64	19	182					
Dutchess	NY	36027	352	70	16	6	85					
Orange	NY	4	36071	94	148	29	23	97				
Mercer	NJ	34021	354	50	22	5	34					
Warren	NJ	34041	179	9	6	5	34					Total
Estimated Sample Size			**20,715**	**2,885**	**963**	**235**	**2,240**	**126**	**913**	**100**	**73**	**28,250**
Actual Sample Loaded			**2,200**	**1,848**	**1,283**	**235**	**1,300**	**125**	**915**	**100**	**39**	**8,045**
Targeted No. of Completes[b]			**66**	**65**	**62**	**52**	**65**	**44**	**62**	**40**	**35**	**491**
Actual No. of Completes			**38**	**69**	**33**	**23**	**75**	**5**	**62**	**15**	**32**	**352**

[a] For municipal agencies and landfills, sample was obtained for NYCMA counties only from alternate listings, not SIC based.
[b] Assumed 95% Confidence Level, 12% Confidence Interval for respective sample size.

3.2. SURVEY INSTRUMENT

The project team developed a list of questions for the NYCMA survey, designed to obtain sufficient information regarding diesel equipment populations and activity to meet the objectives of this project and provide an improved equipment and emissions inventory for the region. In general, the survey requested the following information from each survey respondent:

- employment or revenue for use in scaling results
- number of diesel equipment owned or leased by type
- equipment horsepower and model year
- annual and seasonal operating schedules
- annual fuel consumption
- a comparison of 2004 vs. 2002 operations

The complete survey questionnaire is provided in Appendix A of this report. For the equipment rental companies, questions concerning fuel consumption and seasonal operations were not included. The list of equipment types, or SCCs, determined to be priority equipment in the NYCMA, along with a description of the SCCs, are listed in Table 3-4.

The base year of interest was 2002, but it was anticipated that respondents might have difficulty providing reliable information for 2002 at the time of the survey (2005). As such, the survey asked for data relating to operations in 2004. Additional questions on the fleet make-up in 2004 relative to 2002 were then asked at the end of the survey to allow for correlations back to the baseline year of 2002, the year for which baseline data was provided in NR2004, and 2005.

Table 3-4. Equipment Types Included in the Survey

SCC	SCC Name	Equipment Description
2270002003	Pavers	Large and small (such as for curbs) primarily self-propelled pavers
2270002015	Rollers	Rollers include smooth and knobby (such as used in landfills and called “compactors” not to be confused with smaller Plate Compacters) self-propelled rollers
2270002018	Scrapers	Special equipment type that is an off-highway tractor with a mid-frame bucket that lowers to scrape loose material (dirt) into the bucket to carry to another part of the job site to dump; sometimes converted to a waterwagon
2270002036	Excavators	Single purpose wheeled or tracked excavators (backhoe) distinct of multipurpose tractor/backhoe/loaders
2270002048	Graders	Called road or motor graders often used to prepare a site, especially a road, for paving. A blade is mid-frame mounted with equipment having a long wheel base
2270002060	Rubber tire loaders	Bucket loaders or front-end loaders with a front mounted bucket for scooping though other attachments can be used instead of a bucket
2270002066	Tractors/loaders/backhoes	Common and ubiquitous multipurpose equipment type that is most often referred to as a “backhoe” but include the combined functions of loading and a backhoe in one unit. Agricultural tractors with alternative attachments may be used for similar purposes
2270002069	Crawler tractor/dozers	Tracked (not wheeled) loaders and dozers
2270002072	Skid steer loaders	Smaller (able to be ‘skid’ mounted to transport to job site) loaders that may have alternative attachments than a bucket for loading
2270002030	Trenchers	Large and small trenchers typically using a rotating front mounted rotating ‘blade’ to pull material from trench and distribute it to the side
2270002033	Bore/drill rigs	Drills or boring rigs of all types that are skid mounted, trailer mounted, or self-propelled; not to be confused with highway trucks with drill attachments running off the highway engine, though mounted non-road engines\equipment exist
2270002045	Cranes	Self-propelled typically cable hoists; not to be confused with highway trucks with crane attachments running off the highway engine, though truck mounted non-road engines\equipment exist
2270002057	Rough terrain forklifts	Rough terrain forklifts (RTFs) can be confused with typical forklifts but have larger knobby off-road wheels and can be confused with rubber tire loaders, but are specifically designed for handling palettes. RTFs include telescoping lift trucks called telescopic handlers often used in building construction.
2270002051	Off-highway trucks	Large off-highway dump trucks not certified for highway use
2270006005	Generators	Trailer or skid mounted self contained engine\electric generator designed to supply electrical power at a job site
2270002081	Other diesel construction equipment	Miscellaneous category for equipment not categorized above

3.3. SURVEY TESTING

Initially, a pilot group of equipment owners was identified from NYSERDA's Clean Diesel Program participants and stakeholders. The primary goal of this phase was to determine if respondents could understand the survey directions and provide the requested data. The results from the pilot survey did not represent a large sample and were not gathered for the purpose of statistical analyses or to draw conclusions related to the primary goals of the survey.

Several respondents included in the survey indicated the time required to complete the portion concerning fleet characterization via telephone was prohibitive due to fleet size. As a result, the telephone survey was converted into a questionnaire that could be e-mailed and completed electronically. This option was then made available to all respondents during the full-scale survey.

No other significant changes were made to the questionnaire based on results from the pilot survey.

4.0 SURVEY RESULTS

A summary report of the survey implementation and results is presented in Appendix B of this report. In performing the full-scale survey, the following is worth noting:

- The survey started on November 4, 2005 by calling businesses in the 10 NYCMA counties and the 19-county surrounding geographic area
- When contacted, many respondents, especially those with addresses outside of the 10-county NYCMA, were discovered to be ineligible to participate in the full-scale survey since they did not conduct business within the 10-county NYCMA.
- Subsequently, all available listings for businesses with addresses inside the 10-county NYCMA were purchased;
    - Additional sample was only available for SIC quota groups 1, 2, and 5
- The survey was completed on January 13, 2006 after all available listings had been dialed.
    - 352 surveys were completed
    - The number of completes obtained during the survey per SIC group are provided in Table 3-2 and in the report presented in Appendix B

4.1. QUALITY ASSURANCE AND RESULTS PROCESSING

Prior to analyzing the data, the following processing steps and quality assurance (QA) were performed. The survey results were converted from the initial database structure (with each separate question and associated equipment application as a separate field) to a form more conducive to analysis. For each respondent, equipment type was converted into a separate record along with the following variables:

- number of equipment owned
- number of equipment leased
- number of equipment by horsepower range
- number of equipment by model year
- hours of operation per week
- weeks of operation per year
- seasonal operation percentages
- number of equipment purchased or sold since 2002

All other respondent information that was not specific to the equipment type was also carried forward. This includes information such as contact name, SIC group, employment, revenue, and fuel consumption. These manipulations were then cross-checked against the original database of responses for accuracy. Additional manipulations prior to analysis included:

- excluding responses coded as "Refused" or "Don't Know"
- using 2004 employment data from D&B for respondents that did not provide 2004 employment data, but provided equipment fleet information
- confirming with several rental firms in Quota Group 7 reporting data under the "number of equipment owned" field that these should be reported as the "number of pieces rented"
- moving all responses for Quota Group 7 businesses to the "number of pieces rented" field

4.2. EQUIPMENT POPULATIONS

The survey included questions on the number of diesel equipment owned and rented in 2004. To estimate the total refined equipment populations for the entire NYCMA, scaling factors were used, based on the following general steps:

1. Development of a sample weight, defined as the inverse of the probability of selection. For example, if $1/10^{th}$ of the population was surveyed, the sample weight for each completed survey would be 10.
2. Development of an adjustment factor to account for non-response to the survey (e.g., if only 50% of the eligible survey sample responded, the non-response adjustment factor would be two).
3. Assess control total adjustments, such as employment or economic activity, which may improve the representativeness of the sample. For example, if the weighted total employment for surveyed businesses is 10% higher than reported employment totals, one might add an employment adjustment factor of 0.9.
4. Develop a weighting factor for the responses of surveyed entities by combining the above scaling factors.
5. Estimate refined total population for each equipment type by multiplying the weighting factor by the population reported by survey respondents.

When computing the total eligible population, we assume that the eligibility rate among the companies that responded to the survey is the same among the companies who have not responded. The scaling factor for each respondent represents the number of companies that perform work using diesel equipment or who rent diesel equipment in the New York metropolitan area "represented" by this respondent. For example, Table

4-1 shows that there are 1,363 eligible general contractors, and 38 interviews were completed for this group. Therefore, each respondent represents itself and about 35 other general contractors.

4.2.1. Primary Scaling Factors

Raw sample data were analyzed using the following steps, to develop initial scaling factors:

1. In estimating the total number of eligible entities, all businesses in the survey sample were classified as either:

   - Eligible (E): those businesses performing construction work with diesel equipment in the NYCMA
   - Not Eligible (NE): businesses with no diesel equipment
   - Eligibility Unknown (DKE): businesses that either refused to participate in the survey or did not answer when called
   - Not In Business (NIB): businesses with a non-working, disconnected, or incorrect phone number
   - Not Contacted (NC): potentially eligible businesses that were not contacted because the quota was full

2. To determine total eligibility, estimated eligibility was calculated based on those entities that were classified as eligibility unknown. An eligibility rate (ER) was calculated using the following formula:

   $$ER = E / (E + NE)$$

   The estimated eligible entities based on those that were unknown (EE1) were then calculated as:

   $$EE1 = ER * DKE$$

   Estimated eligibility was calculated based on those entities that were not contacted. An in-business rate (BR) was calculated using the following formula:

   $$BR = (E + DKE + NE) / (E + DKE + NE + NIB)$$

   The estimated eligible entities based on those that were not contacted (EE2) were then calculated as:

   $$EE2 = ER * BR * NC$$

Finally, total survey eligibility (TE) was calculated as:

TE = E + EE1 + EE2

3. The scaling factor is calculated by dividing the total survey eligibility (TE) by the number of completed surveys for each quota group (COMPLETES):

Scaling Factor = TE / COMPLETES

Scaling factors developed to estimate total equipment populations based on the survey results are provided for each quota group in Table 4-1.

Table 4-1. Scaling Factors

Quota	Total Eligible Population	# of Completed Interviews	Scaling Factor
General Contractors	1,363	38	35.86
Heavy Construction Contractors	651	69	9.43
Concrete Work	116	33	3.51
Water Well Drilling	58	23	2.52
Select Miscellaneous Special Trade Contractors	516	75	6.88
Mining	12	5	2.37
Rental Equipment	206	62	3.33
Municipal Agencies	24	15	1.63
Landfills/Transfer Solutions	62	32	1.93
TOTAL	3,008	352	N/A

4.2.2. Scaling Factor Adjustments

To scale the survey population results to the entire NYCMA, equipment populations were estimated based on scaling factors derived from the survey results. Since the use of heavy diesel equipment may vary by firm size, these scaling factors have been adjusted by segmenting the eligible population by sales volume to develop a presumably better estimate of the population totals of heavy diesel equipment. Three sales volume groups have been used:

- Group 1 – Sales Volume < $1 Million
- Group 2 – Sales Volume >=$1 Million & Sales Volume <$ 10 Million
- Group 3 –Sales Volume >=$ 10 Million

Some sales volume groups have been merged because there was no, or a very small number of completes in these groups.

For example, Table 4-2 shows that there are 820 eligible general contractors with sales volume of less than 1 million dollars, and 19 interviews were completed for this group. Each respondent represents itself and about 42 other general contractors in this group. There are 443 eligible general contractors with sales volume between 1 million and 10 million dollars, and 16 interviews were completed for this group. In this group, each respondent represents itself and about 27 other general contractors. Since relatively fewer interviews were completed with contractors in Sales Volume Group #1 than those in Group #2, the scaling factor is larger for Sales Volume Group #1 than that for Group #2.

Table 4-2. Adjusted Scaling Factors

Quota	Sales Volume Group	Total Eligible Population	# of Completed Interviews	Adjusted Scaling Factor
General Contractors	1	820	19	43.16
General Contractors	2	443	16	27.69
General Contractors	3	80	3	26.75
Heavy Construction Contractors	1	217	20	10.85
Heavy Construction Contractors	2	413	46	8.97
Heavy Construction Contractors	3	24	3	8.15
Concrete Work	1	76	23	3.32
Concrete Work	2	36	9	3.97
Concrete Work	3	3	1	2.73
Water Well Drilling	1	38	13	2.89
Water Well Drilling	2	18	9	1.97
Water Well Drilling	3	1	1	1
Misc. Special Trade Contractors	1	378	53	7.13
Misc. Special Trade Contractors	2	147	22	6.67
Mining	2	12	5	2.37
Rental Equipment	1	85	27	3.14
Rental Equipment	2	120	35	3.43
Municipal Agencies	1	24	15	1.63
Landfills/Transfer Solutions	1	62	32	1.93
TOTAL	N/A	3,008	352	N/A

4.2.3. Scaled Equipment Totals, Uncertainty, and Confidence Interval Calculations

The adjusted scaling factors were used in the estimation of the total number of each type of diesel equipment in the New York Metropolitan area and the corresponding confidence intervals. Stata was used as the statistical software for the variance and confidence intervals calculations. Stata is a general statistical software package that includes a comprehensive set of procedures to analyze sample survey data. The survey analysis procedures use the Taylor series expansion method to estimate sampling errors of estimators based on complex sample designs. This method obtains a linear approximation of an estimator based on a Taylor series expansion and then estimates the variance of this approximation.

There is potential for bias in the survey, or significant uncertainty in certain estimates, due to the impact of, for example, a single large fleet owner that responds to the survey, which is not representative of the general population. Calculations of the Relative Standard Error and 95% confidence interval associated with each of the scaled, survey-based equipment populations were completed to determine the uncertainty of the estimates.

Table 4-3 provides the list of equipment types, populations, and the associated relative error for each estimate. For equipment types with population estimates, and with errors above 50%, the data provided by the survey should be considered unreliable and should be used for informational purposes only. For equipment types with errors from 30-50%, data should be used with caution and acknowledgement of the uncertainty of estimates based on the survey data. For those estimates with errors less than 30%, data should be considered reliable.

An additional summary of the survey data is provided in Appendix C. The summary tables provide the frequency distributions for survey responses for each equipment type as well as the total number of each equipment type provided by survey respondents. In addition, in the frequency distribution summaries, the maximum number of each equipment type indicated by any individual respondent is provided. This gives an indication of the potential for bias in a specific category due to a single respondent's impact. For example, for rubber tire loaders, a total population of 787 loaders was tabulated in the survey responses. Still, a single entity reported ownership of 300 of those 787 cranes. Finally, the mean number of each equipment type owned by an entity within each SIC quota group was calculated, and the 95% confidence interval and RSE reported in the summary tables. The uncertainty in estimates of individual equipment populations can become very large due primarily to the variability in the survey responses, and in many cases, can be the impact of an individual or small group of respondents that are at the tails of a normal distribution.

Table 4-3. Equipment Totals and Relative Standard Error of Equipment Population Estimates

Equipment Description	Survey-Based Population Estimates using Weighting Factor Based on Quota Group and Sales Volume		Relative Standard Error
	Mean	95% Confidence Interval	
Diesel Excavators	2322	745	16%
Diesel Pavers	487	244	25%
Diesel Rubber Tire Loaders	3124	1518	25%
Diesel Rollers	1121	574	26%
Diesel Crawler Tractors	628	323	26%
Diesel Rough Terrain Forklifts	146	87	30%
Diesel Bore/Drill Rigs	194	120	31%
Diesel Cranes	294	180	31%
Diesel Tractors/Loaders/Backhoes	4754	3627	39%
Diesel Graders	258	204	40%
Diesel Skid Steer Loaders	2504	1950	40%
Diesel Off-highway Trucks	419	350	42%
Diesel Trenchers	91	91	62%
Diesel Scrapers	128	128	66%

4.2.4. Estimated Equipment Populations

Table 4-4 provides a comparison of equipment populations as estimated by NR2004 and NR2005 versus those estimated by the NYCMA construction equipment survey. The survey-estimated populations are based on the scaling factors developed using the quota group and sales volume (in Table 4-2).

Table 4-4 shows that for all equipment types, the survey-based population estimates are lower than the estimates made by NR2004 and NR2005. Diesel rough terrain forklifts decreased by the largest percentage, followed by trenchers and skid steers. The average reduction in equipment population was 73% when compared to NR2004 numbers and 59% when compared to NR2005.

As discussed in Section 4.2.3, users must note the 95% confidence levels on the revised population estimates and ensure that these values are taken into account when using the survey equipment populations. In some cases, due to lack of survey response, bias, or limited sample, the confidence intervals are quite large, and the estimated range of populations can double as a worst case.

Table 4-4. Comparison of NR2004, NR2005 and Surveyed 2002 NYCMA Equipment Populations

Equipment Description	NR2004 Population Estimates	NR2005 Population Estimates	Survey-Based Population Estimates using Scaling Factor Based on Quota Group and Sales Volume		Relative Standard Error
			Mean	95% Confidence Interval	
Diesel Excavators	4,720	3,142	2322	745	16%
Diesel Rubber Tire Loaders	5,223	3,476	3124	1518	25%
Diesel Pavers	839	558	487	244	25%
Diesel Rollers	3,007	2,002	1121	574	26%
Diesel Crawler Tractors	3,627	2,414	628	323	26%
Diesel Rough Terrain Forklifts	4,194	2,792	146	87	30%
SUBTOTAL (RSE <= 30%)	***21,610***	***14,384***	***7828***		
Diesel Bore/Drill Rigs	1,496	996	194	120	31%
Diesel Cranes	1,229	818	294	180	31%
Diesel Tractors/Loaders/Backhoes	12,592	8,381	4754	3627	39%
Diesel Graders	1,125	749	258	204	40%
Diesel Skid Steer Loaders	19,596	13,043	2504	1950	40%
Diesel Off-highway Trucks	593	395	419	350	42%
SUBTOTAL (RSE<=50%)	***36,631***	***24,381***	***8423***		
Diesel Trenchers	2,153	1,433	91	91	62%
Diesel Scrapers	639	425	128	128	66%
SUBTOTAL (RSE>50%)	***2,792***	***1,858***	***219***		
TOTAL	**61,032**	**40,623**	**16,470**		**17%**

4.3. REVISED **EMISSION** ESTIMATES

To determine a revised estimate of PM and NOx emissions for each equipment type based on the survey population estimates, analysts used the emission factors for PM and NOx (tpy/vehicle), calculated based on the NR2004 and NR2005 emissions for calendar year 2002, and applied these factors to the revised equipment populations. This method assumes that the equipment activity, age, and horsepower distributions remain the same as those used in NR2004. Table 4-5 shows a comparison between NR2004, NR2005 and the scaled, survey-based emissions.

Table 4-5. NR2004, NR2005, and Survey-Based Refined Emission Estimates for Non-Road Diesel Construction Equipment in the NYCMA

Equipment Description	NR2004 Emissions Estimates		NR2005 Emissions Estimates		Survey-Based Scaled Emissions Estimates					
	PM (tpy)	NOx (tpy)	PM (tpy)	NOx (tpy)	PM (tpy)			NOx (tpy)		
Diesel Excavators	253	3347	168	2228	124	±	40	1647	±	528
Diesel Rubber Tire Loaders	326	4193	217	2791	195	±	95	2508	±	1219
Diesel Pavers	31	342	20	227	18	±	9	198	±	99
Diesel Rollers	87	853	58	568	32	±	17	318	±	163
Diesel Crawler Tractors	268	3654	178	2432	46	±	24	633	±	325
Diesel Rough Terrain Forklifts	132	1101	88	733	5	±	3	38	±	23
SUBTOTAL (RSE<=30%)	***1096***	***13491***	***729***	***8980***	***420***			***5342***		
Diesel Bore/Drill Rigs	43	507	29	338	6	±	3	66	±	41
Diesel Cranes	57	934	38	622	14	±	8	223	±	137
Diesel Tractors/Loaders/Backhoes	409	2597	273	1729	155	±	118	981	±	748
Diesel Graders	61	854	41	568	14	±	11	196	±	155
Diesel Skid Steer Loaders	367	1713	244	1140	47	±	37	219	±	171
Diesel Off-highway Trucks	199	3195	133	2127	141	±	118	2258	±	1887
SUBTOTAL (RSE<=50%)	***1137***	***9800***	***757***	***6523***	***376***			***3943***		
Diesel Trenchers	52	400	35	266	2	±	2	17	±	17
Diesel Scrapers	69	992	46	660	14	±	14	199	±	199
SUBTOTAL (RSE>50%)	***121***	***1392***	***81***	***927***	***16***			***216***		
TOTAL	**2354**	**24683**	**1567**	**16429**	**812**			**9501**		

4.4. ADDITIONAL DATA

In addition to the primary objective of obtaining revised equipment population data for the NYCMA, the survey respondents were also asked about equipment activity and other characteristics, including estimated hours of use per year, estimated fleet/equipment age, equipment horsepower ranges, and other information. Unfortunately, due to the limited sample sizes and number of completes, any statistically valid analysis of this data and incorporation of the data for use in revision of the equipment and emissions inventories is limited. As a result, survey results for these questions are reported for informational purposes only in Appendix D, as summarized below. Caution should be used in analysis or use of this data, as it may not be representative of the actual equipment population.

4.4.1. Equipment Activity

Questions on annual and seasonal usage, equipment populations, equipment horsepower, model year, and fuel consumption were asked for each of the 16 types of equipment. Average values for annual and seasonal usage were calculated taking into account each respondent's reported equipment population and the respondent size. Responses were weighted by the number of pieces of equipment for which respondents were providing information, as well as by a weighting factor of the surveyed to the regional employment of their SIC grouping. Responses for all equipment owners and renters performing work in the NYCMA, including those located in the 19 surrounding counties, were used in calculating these average values.

4.4.1.1. Annual Hours of Use

Equipment-specific annual hours of use were estimated by multiplying hours of operation per week, (OWNQ9, RENTQ8) by weeks of operation per year (OWNQ10, RENTQ9). Table D-1 lists the average hours of operation per year (hpy) by equipment type as estimated by NR2004 and the survey, as well as the number of pieces of equipment to which the values correspond. The survey results show significant increases in usage for pavers, bore/drill rigs, rubber tire loaders, and rollers, but showed decreases in activity for cranes, off-highway trucks, and crawler tractor/dozers.

4.4.1.2. Seasonal Usage

Based on responses to questions concerning operation during the four seasons of the year (OWNQ11), the average seasonal percentages for each equipment type were estimated, shown in Table D-2.

The NR2004 model includes a single seasonal allocation for all construction equipment, regardless of engine or application. The final aggregate profile based on the survey results is shown in Figure D-1, along with the NR2004 seasonal profile. The survey results show comparatively less activity in the summer and autumn months, but more activity in the winter and spring than NR2004.

4.4.2. Engine Horsepower and Model Year

Equipment populations are reported by engine horsepower range in NR2004. The NYCMA survey requested equipment populations by horsepower range for each owned or rented equipment type. Table D-3 and Table D-4 list the total equipment populations, populations by horsepower range, and populations by model year for equipment owners and equipment renters, respectively, as determined from the survey.

Because equipment populations in the NR2004 model are reported for up to 16 hp bins (see Table 2-2), the NR2004 populations were aggregated into five broader horsepower bins to match the survey horsepower bins. The NR2004 and the survey populations by horsepower range were then converted to horsepower range percentages, so that they could be compared to each other. This comparison is shown in Table D-5. Based on the small number of survey results for equipment corresponding to some of the individual horsepower ranges, a valid comparison of these data sets is questionable, but is provided for completeness.

4.4.3. Fuel Consumption

Fuel consumption for the entire operating fleet was requested of equipment owners only (OWNQ12). A total of 133 equipment owners provided estimates of fuel consumed during 2004. Total fuel consumed for all equipment users that responded was 2,560,792,096 gallons. The NR2004 model calculates SCC-level fuel consumption by multiplying brake-specific fuel consumption (i.e., gallons per horsepower-hour) to equipment populations by engine size and their associated hours of use. Because the survey did not relate the fuel consumption to specific equipment types or horsepower size, a comparison on this basis could not be made.

5.0 CONCLUSIONS AND RECOMMENDATIONS

A survey of equipment owners and operators in the NYCMA area was successfully completed. Analysts surveyed 8,045 equipment owners and operators with the goal of completing a total of approximately 490 surveys. Because it was thought that companies located outside the 10-county area would conduct business in the NYCMA, this sample was drawn from 19 surrounding counties in addition to the 10-counties of interest. Yet, in surveying outside the NYCMA, in this survey, it was found that many businesses were not eligible for the survey. Of those surveyed, 647 did not conduct business in the NYCMA, 2,176 did not own or operate any diesel equipment, and 727 refused to participate in the survey. Ultimately, analysts decided to focus only on the 10 counties in the NYCMA, and obtained a total of 352 complete surveys. As a result of the reduced participation in the survey, several of the revised equipment population estimates, although still useful, must be used while keeping the 95% confidence interval strongly in mind, as it can significantly impact the accuracy of the estimate and its utility.

Equipment populations were estimated by weighting the surveyed populations based on survey eligibility broken down by quota group and sales volume. In all cases, equipment population estimates based on the survey data were lower than those estimated by NR2004. PM and NOx emissions for each equipment type were estimated by scaling the NR2004 emission estimates by the survey-based population estimates. As with population, PM and NOx emissions decreased for all equipment types when compared to NR2004.

It should be noted that the EPA released an updated version of the NR2004 model (NONROAD2005) that uses a revised methodology for allocating county-level construction activity to counties. For this updated version of the model, construction activity is allocated based on dollar valuation, but an adjustment is made to account for variations in the cost of construction, which would result in a relatively higher or lower dollar valuation. Even then, based on the survey results, the models appear to overestimate the populations, and therefore, the emissions of construction equipment used in the NYCMA. A comparison of the revised equipment populations using NONROAD2005, alternate surrogate parameters, as discussed in Section 2, and survey data discussed in Section 4, can be further analyzed, researched, and refined to determine how additional changes in allocation procedures can impact and improve the equipment populations and emissions estimates for the NYCMA.

The survey was designed to obtain certain statistical precision for a given respondent group, not by equipment type. This was done since known data about the populations, on which a survey design could be based, was available for business entities, and not for equipment populations. Nevertheless, now that initial estimates of equipment populations are available from this survey, the potential exists for the development of an expanded survey with a known required number of completed surveys of each equipment type to determine equipment populations within a smaller confidence interval at a 95% confidence level. Still, as shown in Section 3 and 4, there are several SICs for which the surveyors contacted the entire sample and

did not receive sufficient valid complete surveys to achieve the desired confidence level. For these groups, there is little hope that any improved accuracy could be obtained with additional survey efforts.

In addition, the survey respondent groups were not stratified by business size (revenues or sales) to provide a more accurate representation of the broader equipment population. This can lead to potential biases or improper scale up due to the survey of mean equipment populations being skewed by a single large equipment owner. This was not done in this survey since previous data to support such stratification was not available, and budget limitations did not allow for the collection of a preliminary sample and subsequent revision to the survey design based on initial results to account for stratification. Further analysis of the survey data and number of respondents could be completed to determine the potential bias and impacts of these specific survey results on emissions, population, and activity. An initial estimate of the impacts of such biases can be observed in part by evaluating the confidence intervals reported in Table 4-4. Larger confidence intervals are an indication of a highly variable response to the survey questions regarding equipment populations, which could be an indication of a wide distribution of equipment ownership (i.e. one entity owns two vehicles and another entity owns 300). It is also possible that the sample for certain equipment types and categories is not representative, given the low number of respondents in certain SIC quota groups.

To further improve the equipment and emissions inventory, it is recommended that additional surveys be completed in the future, and that they be designed to account for stratification of owners by different business sizes and focusing on the distribution of equipment by equipment type instead of SIC category. This could be accomplished by developing a focused survey of small to medium sized entities, with an effort focused on obtaining adequate response to characterize the equipment populations with a RSE of less than 30%. For the relatively small number of larger entities that may own large equipment fleets, a census of equipment ownership by each entity should be completed to obtain the most accurate overall population estimates. Such an effort would require the cooperation of fleet owners, industry trade groups, and others to identify these large fleet owners and encourage their participation.

In addition, information regarding fleet equipment horsepower, model year, and activity was also obtained in this survey. Still, because of the limited quantity of data obtained in these areas, the utility of the data in estimating more accurate emissions is limited. The data obtained under this survey could also be used to design future surveys that target these specific variables in the overall emissions-inventory picture.

APPENDIX A – CONSTRUCTION EQUIPMENT ACTIVITY QUESTIONNAIRE

PROJECT 1105 Pechan
Equipment Owner Survey Questions

INTRO1

Hello, my name is _____. I'm calling on behalf of The New York State Energy Research & Development Authority also known as NYSERDA.

Q1
Our records show that your company deals with diesel construction equipment. Is the equipment mostly for your company's own construction projects or are they rented out?

5.1.1.

1. Own (ask the OWN series of questions)
2. Rent (ask the RENT series of questions)
3. Both (ask the OWN series of questions)
4. We do not deal with diesel construction equipment at all
8. DK
9. REF

IF (ANS = 4)
IF ANS > 4, go to TERM 1 (end of document)

INTRO1a
I would like to speak with your director of operations, fleet manager, or the person who would be most knowledgeable about your company's day-to-day construction activities and equipment.

1. Person on the phone/coming to the phone (Continue with intro before going to next screen)
2. The person is not available right now
3. No, you CANNOT call us again
8. DK
9. REF

IF ANS = 2, go to CB
IF ANS = 3, go to TERM1

Your business has been randomly selected to participate in an important study about diesel construction equipment use in the New York City Metropolitan Area. Participation in this study will help NYSERDA evaluate the population and activity of off-road diesel engines and select the types of equipment to be used in evaluating retrofit emission control technologies in a real-world demonstration program. Participation could help guide future programs and regulations that may benefit or impact users of off-road construction equipment.

INTRO1c
This survey should take approximately _____ minutes and will require that you have information available regarding your diesel construction equipment fleet and usage during 2002 and 2004.

All information obtained during this survey will be treated as confidential and will only be presented in a summary or aggregated format, without identifying individual businesses and their assets, sales, or other confidential business information.

Is it okay for me to start the interview?
1. Yes
2. No, call back later

3. No, I DO NOT want to participate
8. DK
9. REF

IF ANS = 1, go to OWNQ2
IF ANS = 2, go to CB
IF ANS > 2, go to TERM 1

CB
When will be a good time to call back and who should we ask for?

Record name and callback time and date in CATI

IF Q1 = 1 or 3, continue
IF Q1 = 2, go to RENTQ2

OWNQ2
In 2004, did you participate in construction projects in any of the following 10 New York City Metropolitan Area Counties, including Bronx, Kings, Nassau, New York, Putnam, Queens, Richmond, Rockland, Suffolk or Westchester?

1. Yes
2. No
8. DK
9. REF

OWNQ3A
In 2004, how many part-time and full-time employees did your company have?

_____ number of employees (2004)
8888. DK
9999. REF

OWNQ3B
In 2002, how many part-time and full-time employees did your company have?

_____ number of employees (2002)
8888. DK
9999. REF

OWNQ4
Which of the following ranges best describes your 2004 revenues? (select one)

1. Less than 1 million
2. From 1 to under 6 million
3. From 6 to under 15 million
4. From 15 to under 28.5 million
5. 28.5 million or more
88. DK
99. REF

IF OWNQ2 > 2, go to Thank you

For the rest of the questions, we want you to focus only on construction projects that your company participated in within the 10-county NYCMA in 2004 in which diesel-powered construction equipment that you owned, leased, or rented were used (do not include subcontractors equipment).

List of Equipment
1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other diesel construction equipment

OWNQ5.1 – OWNQ5.16
How many diesel powered [equipment] did you use in 2004?
_____ pieces (0 – 2000)
8888. DK
9999. REF
IF ANS = 0, 8888 or 9999, go to next Equipment

OWNQ6.1 – OWNQ6.16
How many of the diesel [equipment] you used in 2004 were leased or rented?
_____ pieces (0 – 2000)
8888. DK
9999. REF

OWNQ7.1.1 – OWNQ7.16.5
How many of the total diesel [equipment] fall into the following horsepower ranges?
1. 100 or lower _____
2. 101-175 _____
3. 176-300 _____
4. 301-600 _____
5. Higher than 600 _____
8888. DK
9999. REF

OWNQ8.1.1 – OWNQ8.16.4
How many of the total diesel [equipment] falls into the following model year ranges?
1. 2003-2006 _____
2. 2000-2002 _____
3. 1996-1999 _____
4. Pre-1996 _____
8888. DK
9999. REF

OWNQ9.1 – OWNQ9.16
In 2004, about how many weeks did your company use [equipment]?
_____ (0 to 52)
8888. DK
9999. REF

OWNQ10.1 – OWNQ10.16
On average, how many hours per week did you use [equipment] in 2004?

_____ (0 to 168)
8888. DK
9999. REF

OWNQ11.1.a – OWNQ11.16.d
In 2004, what percent of the [equipment] were used each season?

a. Winter (Dec-Feb) _____% (888. DK, 999. REF)
b. Spring (Mar-May) _____% (888. DK, 999. REF)
c. Summer (Jun-Aug) _____% (888. DK, 999. REF)
d. Fall (Sep-Nov) _____% (888. DK, 999. REF)

OWNQ12
For the following questions, please respond for all equipment types in your fleet.
How many gallons of diesel fuel do you estimate were consumed by your non-road equipment fleet in 2004? Please include all that is owned, rented and leased.

_____ gallons
888888. DK
999999. REF

OWNQ13
Which year has a larger fleet size?

1. 2002
2. 2004
3. Same size for both years
8. DK
9. REF

OWNQ14
Did you buy any new fleet equipment since 2002?

1. Yes
2. No
8. DK
9. REF

IF ANS = 1, ask OWNQ14a
IF ANS > 1, go to OWNQ15

OWN14a. What did you buy?

1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks

15. Generators
16. Other (specify) _____

IF SELECTED, ask OWN14a1 through OWN14c as many times as needed

OWN14a1. How many RECALL answers in OWN14a did you buy?

_____
888. DK
999. REF

IF ANS = 1, go to OWN14b
IF ANS 1 <> 888, go to OWN14a2

OWN14a2

SHOW answer in OWN14a1 and answer in OWN14a

Ask until the total in the table below equals answer in OWN14a1

What model year is that?	What is the horsepower?	How many fall into this model year and horsepower?

OWN14b. What model year is that?
_____ (YYYY)
8888. DK
9999. REF

OWN14c. And what is the horsepower?

_____
8888. DK
9999. REF

OWNQ15
Did you reduce your fleet size since 2002?
1. Yes
2. No
8. DK
9. REF

IF ANS = 1, ask OWN15a

OWN15a. What equipment did you stop using?

1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs

12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other (specify) _____

IF SELECTED, ask OWN15a1 through OWN15c as many times as needed

OWN15a1. How many RECALL answers in OWN15a did you stop using?

_____
888. DK
999. REF

IF ANS = 1, go to OWN15b
IF ANS 1 <> 888, go to OWN15a2

OWN15a2
SHOW answer in OWN15a1 and answer in OWN15a

Ask until the total in the table below equals answer in OWN15a1

What model year is that?	What is the horsepower?	How many fall into this model year and horsepower?

OWN15b. What model year was that RECALL answers in 15a?
_____ (YYYY)
8888. DK
9999. REF

OWN15c. And what was the horsepower?

_____
8888. DK
9999. REF

GO TO QName

RENTQ2
In 2004, did you rent construction equipment for projects located in any of the following 10 New York City Metropolitan Area Counties, including Bronx, Kings, Nassau, New York, Putnam, Queens, Richmond, Rockland, Suffolk or Westchester?
1. Yes
2. No
8. DK
9. REF

RENTQ3A
In 2004, how many part-time and full-time employees did your company have?
_____ number of employees (2004)
8888. DK
9999. REF

RENTQ3B

In 2002, how many part-time and full-time employees did your company have?

_____ number of employees (2004)

8888. DK

9999. REF

RENTQ4

Which of the following ranges best describes your 2004 revenues? (select one)

1. Less than 1 million
2. From 1 to under 6 million
3. From 6 to under 15 million
4. 15 million or more

88. DK

99. REF

IF RENTQ2 > 2, go to Thank you

Let's talk about the equipment that you rent.

List of Equipment

1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other diesel construction equipment

RENTQ5.1 – RENTQ5.16

How many diesel [equipment] did you rent in 2004?

_____ pieces (0 – 2000)

8888. DK

9999. REF

IF ANS = 0, 8888 or 9999, go to next Equipment

RENTQ6.1.1– RENTQ6.16.5

How many of the total diesel [equipment] fall into the following horsepower ranges?

1. _____ 100 or lower
2. _____ 101-175
3. _____ 176-300
4. _____ 301-600
5. _____ Higher than 600

8888. DK

9999. REF

RENTQ7.1.1 – RENTQ7.16.4

How many of the total diesel [equipment] fall into the following model year ranges?

1. 2003-2006 _____

2. 2000-2002 _____
3. 1996-1999 _____
4. Pre-1996 _____
8888. DK
9999. REF

RENTQ8.1 – RENTQ8.16
In 2004, about how many weeks did your company rent [equipment]?
_____ (0 to 52)
8888. DK
9999. REF

RENTQ9.1 – RENTQ9.16
On average, how many hours per week was/were the rented [equipment] used in 2004?
_____ (0 to 168)
8888. DK
9999. REF

RENTQ10
For the following questions, please respond for all equipment types in your fleet.

Which year has a larger fleet size?
1. 2002
2. 2004
3. Same size for both years
8. DK
9. REF

RENTQ11
Did you buy any new fleet equipment since 2002?
1. Yes
2. No
8. DK
9. REF
IF ANS = 1, ask RENTQ11a
IF ANS > 1, go to RENTQ12

RENT11a. What did you buy?
1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other (specify) _____
IF SELECTED, ask RENT11a1 and RENT11c as many times as needed

RENT11a1. How many RECALL answers in RENT11a did you buy?

_____
888. DK
999. REF

IF ANS = 1, go to RENT11b
IF ANS 1 <> 888, go to RENT11a2

RENT11a2

SHOW answer in RENT11a1 and answer in RENT11a
Ask until the total in the table below equals answer in RENT11a1

What model year is that?	What is the horsepower?	How many fall into this model year and horsepower?

RENT11b. What model year is that RECALL answers in RENT11a?

_____ (YYYY) (1900 – 2005)
8888. DK
9999. REF

RENT11c. And what is the horsepower?

_____
8888. DK
9999. REF

RENTQ12
Did you reduce your fleet size since 2002?

1. Yes
2. No
8. DK
9. REF

IF ANS = 1, ask RENTQ12a

RENT12a. What did you stop renting?

1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other (specify) _____

IF SELECTED, ask RENT12a1 through RENT12c as many times as needed

RENT12a1. How many pieces of RECALL answers in RENT12a did you stop renting?

_____
888. DK
999. REF

IF ANS = 1, go to RENT12b
IF ANS 1 <> 888, go to RENT12a2

RENT12a2

SHOW answer in RENT12a1 and answer in RENT12a

Ask until the total in the table below equals answer in RENT12a1

What model year is that?	What is the horsepower?	How many fall into this model year and horsepower

RENT12b. What model year was that RECALL answers in RENT12a?

_____ (YYYY) (1900 – 2005)
8888. DK
9999. REF

RENT12c. And what was the horsepower?

_____
8888. DK
9999. REF

QName
Can I please have your name?

_____ (open end)

9. Refused

Thank you.
Thank you. Those are all the questions I have for you. Have a great day.

Enter Interviewer ID

POPULATION RESEARCH SYSTEMS

A MEMBER OF THE FSC GROUP

APPENDIX B – FINAL SAMPLE REPORT

This Appendix presents PRS's final report of the NYCMA survey effort. Appendix A to the report is also included. Note that PRS prepared additional Appendices B – E, which contain the telephone interview, frequencies for each survey question, a data dictionary for the survey database, and a CD-ROM of project files. These appendices are not reproduced in this version of the report, but can be made available upon request. Some formatting modifications have been made to the report.

Final Report prepared for E.H. Pechan & Associates

New York Metropolitan Area Heavy Diesel Equipment Study

Project 1105

January 2005

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INTRODUCTION

Population Research Systems (PRS), a division of Freeman, Sullivan & Co., launched the New York Metropolitan Area Heavy Diesel Equipment Study in November 2005 on behalf of E.H. Pechan & Associates, in collaboration with the Southern Research Institute (Southern) in North Carolina. The project, which was sponsored by the New York State Energy Research & Development Authority, was designed to collect construction heavy diesel equipment usage data from construction and related companies and construction equipment rental companies located in the New York State counties of: Nassau, Suffolk, Bronx, Kings, New York, Putnam, Queens, Richmond, Rockland and Westchester.

Pechan, Southern and PRS collaborated on the development of the business telephone interview (Appendix B) used for this project. PRS was responsible for programming the interview for use by the PRS computer-assisted telephone interviewing (CATI) laboratory located in San Francisco.

This final report is organized to include the first section, which describes the study methods and the second section, which contains the report appendices. These appendices include:

- Appendix A – the sample disposition report
- Appendix B – the study interview
- Appendix C – the frequencies of the collected data
- Appendix D – the data dictionary, which outlines the data variables and data columns
- Appendix E – a CD containing project files and an electronic version of this report

METHODS

A. Sample

PRS purchased 8,180 commercially available sample points based on SIC codes and the targeted geographic area from Marketing Systems Group (MSG), a sampling vendor located in Fort Washington, Pennsylvania. The sample was purged by MSG to eliminate incorrect and disconnected telephone numbers, as well as fax and modem numbers, prior to delivery to PRS.

The sample frame consisted of all listed business within the states of Indiana, Illinois, Michigan, Ohio, and Wisconsin that corresponded to the following nine categories: general contractors, heavy construction contractors, concrete work, water well drilling, select miscellaneous special trade contractors, mining, rental equipment, municipal agencies and landfill/transfer stations. The selected SIC codes that correspond to the nine quota categories are displayed in Table 1.

The samples for the Municipal Agencies and the landfill transfer stations were derived from the internet and/or were provided by the project client. A total of 100 municipal agency records and 35 landfill records was generated.

PRS's goal was to complete a sufficient number of telephone interviews to achieve a confidence interval of $\pm$12 for the collected data. The number of completes to achieve that goal, as well as the number of available sample records are also shown in Table 1. Overall, PRS's objective was to complete a total of 491 interviews.

Table 1. Quota cell counts for desired confidence interval

Quota Classification by Business and SIC codes	Required Interviews:	Available Sample:
General Contractors (SIC codes 1521, 1522, 1531, 1541, 1542)	66	2,200
Heavy Construction Contractors (SIC codes: 1611, 1622, 1623, 1629)	65	1,848
Concrete Work (SIC code 1771)	62	1283
Water Well Drilling (SIC code 1781)	52	235
Select Miscellaneous Special Trade Contractors (SIC codes 1791, 1794, 1795, 1796)	65	1300
Mining (SIC codes: 10, 12, 14)	44	125
Rental Equipment (SIC codes: 7353, 7359, 5082)	62	915
Municipal Agencies (no SIC codes)	40	100
Landfills/Transfer Stations (no SIC codes)	35	39
Total	**491**	**8,045**

The geographic target for this project was the 10-County New York Metropolitan area. Still, to ensure that companies and organizations located outside of, but doing business within this targeted area, were included

in the surveyed population, additional counties were added to the sample plan. Table 2. shows the list and FIPS codes of the counties included. The area highlighted in yellow indicates the targeted geographic area.

Table 2. List of FIPS codes of counties included in sample plan

Metropolitan Division	State	County Name	FIPS Code
Nassau-Suffolk, NY	NY	NASSAU	36059
Nassau-Suffolk, NY	NY	SUFFOLK	36103
New York-White Plains-Wayne, NY-NJ	NY	BRONX	36005
New York-White Plains-Wayne, NY-NJ	NY	KINGS	36047
New York-White Plains-Wayne, NY-NJ	NY	NEW YORK	36061
New York-White Plains-Wayne, NY-NJ	NY	PUTNAM	36079
New York-White Plains-Wayne, NY-NJ	NY	QUEENS	36081
New York-White Plains-Wayne, NY-NJ	NY	RICHMOND	36085
New York-White Plains-Wayne, NY-NJ	NY	ROCKLAND	36087
New York-White Plains-Wayne, NY-NJ	NY	WESTCHESTER	36119
New York-White Plains-Wayne, NY-NJ	NJ	BERGEN	34003
New York-White Plains-Wayne, NY-NJ	NJ	HUDSON	34017
New York-White Plains-Wayne, NY-NJ	NJ	PASSAIC	34031
Edison, NJ	NJ	MIDDLESEX	34023
Edison, NJ	NJ	MONMOUTH	34025
Edison, NJ	NJ	OCEAN	34029
Edison, NJ	NJ	SOMERSET	34035
Newark-Union, NJ-PA	NJ	ESSEX	34013
Newark-Union, NJ-PA	NJ	HUNTERDON	34019
Newark-Union, NJ-PA	NJ	MORRIS	34027
Newark-Union, NJ-PA	NJ	SUSSEX	34037
Newark-Union, NJ-PA	NJ	UNION	34039
Newark-Union, NJ-PA	PA	PIKE	42103
Not part of MET division	CT	FAIRFIELD	09001
Not part of MET division	CT	NEW HAVEN	09009
Not part of MET division	NY	DUTCHESS	36027
Not part of MET division	NY	ORANGE	36071
Not part of MET division	NJ	MERCER	34021
Not part of MET division	NJ	WARREN	34041

B. Screening and Respondent Selection

Only companies that perform work using diesel equipment or who rent diesel construction equipment in the 10 counties of interest (e.g. Nassau, Suffolk, Bronx, Kings, New York, Putnam, Queens, Richmond, Rockland and Westchester) were eligible to participate in the study. It was also determined that the most appropriate respondents for these companies were directors of operations, fleet managers or persons who were most knowledgeable about their company's day-to-day activities. As a result, when calling, PRS interviewers asked to speak to someone in the company who filled one of these specific positions.

C. Telephone Interview

Once a respondent agreed to participate, and it was verified that business was conducted within the 10-county target area in the State of New York, they were guided through a series of closed-ended and open-ended questions concerning construction or mining activities, landfill activities, or rental equipment activities in 2004, relevant to their business in the geographic target area.

Respondents were also asked to define their diesel equipment from a programmed list of diesel equipment types. Table 3. shows the list of diesel equipment types used for this study.

Table 3. List of diesel equipment types

1. Pavers
2. Rollers
3. Scrapers
4. Excavators
5. Graders
6. Rubber tire loaders
7. Tractors/loaders/backhoes
8. Crawler tractor/dozers
9. Skid steer loaders
10. Trenchers
11. Bore/drill rigs
12. Cranes
13. Rough terrain forklifts
14. Off-highway trucks
15. Generators
16. Other diesel construction equipment

All companies were asked to provide the number of part-time and full-time employees in 2002 and 2004 as well as their estimated annual revenue for the year 2004.

Additional questionnaire items concerned the number of pieces of diesel equipment per type, their respective horsepower, model year, and average weekly and seasonal use. Questions were aimed at the determination of differences in the investigated variables and the overall fleet between 2002 and 2004.

Companies that did not conduct any business in the ten targeted counties were only asked the number of full-time and part-time employees in 2002 and 2004, and the estimated revenue for the year 2004.

A copy of the business interview is presented in Appendix B.

D. Interview Period, Times, and Duration

Commercial data collection took place from November 3, 2005 through January 16, 2006. Telephone interviews were conducted using trained PRS CATI laboratory interviewers and were conducted weekdays between the hours of 6:00 A.M. and 5:00 P.M. Pacific Standard Time. At a respondent's request, PRS scheduled callback appointments at a more convenient time for the respondent even if the scheduled callback appointment was outside of these interviewing hours.

Because of the limited amount of sample available, at least ten call attempts were made to each business, if necessary. One refusal conversion was used to convince eligible respondents to participate in the study. The interviews, which were administered in English, took on average 13 minutes to complete. Respondents were not paid an incentive for participating in the study.

PRS completed a total of 352 commercial interviews and an additional 647 short screeners (i.e. data from respondents who were not eligible for the full survey because they did not conduct business in the 10-county target area). In total, PRS delivered 999 data records to the client. Table 4 outlines the number and percent of completed interviews per quota. (The number of employees and annual revenue information from the short screeners was also included in the final data set.)

Table4. Number of Completed Surveys and Screener by Quota

Quota Classification by Business and SIC codes	Completed Interviews:	Completed Screeners:
General Contractors (SIC codes 1521, 1522, 1531, 1541, 1542)	38	71
Heavy Construction Contractors (SIC codes: 1611, 1622, 1623, 1629)	69	199
Concrete Work (SIC code 1771)	33	78
Water Well Drilling (SIC code 1781)	23	46
Select Miscellaneous Special Trade Contractors (SIC codes 1791, 1794, 1795, 1796)	75	202
Mining (SIC codes: 10, 12, 14)	5	5
Rental Equipment (SIC codes: 7353, 7359, 5082)	62	30
Municipal Agencies (no SIC codes)	15	10
Landfills/Transfer Stations (no SIC codes)	32	6
Total	**352**	**647**

E. Staff Training

PRS trained seven CATI interviewers and two CATI laboratory supervisors for the study. Pechan and PRS jointly conducted the training session. The purpose of the training was to familiarize PRS interviewers and supervisors with the project, the research goals, project procedures, and content of the telephone interview. Pechan provided background information concerning the project and PRS generated a handout detailing the types of diesel equipment being studied.

The training included a question-by-question review of the instrument. Interviewers then role-played to become familiar with the instrument. During the role-play, each interviewer was observed by a supervisor and approved for interviewing only after the supervisor was confident that the questionnaire and study protocol had been mastered.

F. Telephone Contact Outcomes

Of the 8,045 commercial records dialed, 3,559 telephone numbers (44.2% of the dialed sample) were disconnected or no longer working; connected to beepers, fax machines, or modems; connected to residences; connected to businesses with a potential respondent who could not participate due to a language barrier or physical impairment; or those who do not own or operate any diesel equipment. As a result 4,486 records, or 55.8% of the total sample, were usable (See Appendix A).

G. Response and Refusal Rates

Response and refusal rates were as follows:

- The overall refusal rate for this dialing effort, including refusals without determining eligibility, was 9%, or 727 records.
- The adjusted refusal rate of the usable sample (excluding all numbers that are not part of the survey population) was 16.2%.
- The overall completion rate, including the screener-completes with respondents who did not conduct business in the 10-county target area, was 12.4%.
- The completion rate for the completed surveys only was 4.4% (352 completes).
- The completion rate for completed surveys for the adjusted survey population was 7.8%.

A final sample disposition report for the commercial records attempted is included in Appendix A.

H. Data Analysis

Upon client request, PRS recalculated the confidence interval for the completed surveys based on the numbers of completes by quota cell. Table 5. shows the original assumptions for a confidence interval of $\pm$12 as well as the recalculated confidence intervals for each quota. The overall confidence interval for all 352 completes combined is $\pm$5.2.

Table 5. Original and recalculated confidence interval of +12 per quota

	General Contractors	Heavy Construction	Concrete	Water Well Drilling	Select Miscellaneous Special Trade Contractors	Mining	Rental	Municipal Agencies	Landfills / Transfer Stations
Total Estimated Sample Size:	20715	2885	963	235	2240	126	913	100	73
Sample Loaded:	2200	1848	1283	235	1300	125	915	100	39
Assumed: 95% Confidence Level, Confidence Interval for Estimated Total Sample Size									
12% Completes Needed:	66	65	62	52	65	44	62	40	35
Actual Surveys Completed:	38	69	33	23	75	5	62	15	32
Calculated Confidence Interval Based on Completed Surveys (based on 50% Answers)									
Actual Confidence Interval:	15.9	11.7	16.8	19.5	11.1	43.1	12.0	23.5	7.4
Overall Calculated Confidence Interval:	5.2								

Frequencies (counts and percentages), which were run for all studied variables together with selected cross-tabs, are contained within Appendix C.

APPENDIX A

PECHAN NYSERDA

Project #1105 Heavy Diesel Equipment Study

Final Sample Disposition Report

Date of Report: 1/26/06

DISPOSITION	TOTAL SAMPLE		USABLE SAMPLE	
	FREQUENCY	PERCENT OF TOTAL SAMPLE	FREQUENCY	PERCENT OF USABLE SAMPLE
NOT PART OF SURVEY POPULATION	**3559**	**44.2%**		
Number Not Working	479	6.0%		
Beeper/Fax/Modem	271	3.4%		
Language Barrier	9	0.1%		
Wrong Number	132	1.6%		
Disconnected	436	5.4%		
Residential Household	55	0.7%		
No Diesel Equipment	2176	27.0%		
Ill/Hard of Hearing	1	0.0%		
ELIGIBILITY UNKNOWN	**784**	**9.7%**	**784**	**17.5%**
No Answer	299	3.7%	299	6.7%
Busy	28	0.3%	28	0.6%
Answering Machine	457	5.7%	457	10.2%
REFUSALS	**727**	**9.0%**	**727**	**16.2%**
Refusal Eligible Respondent	323	4.0%	323	7.2%
Unknown Elig. Refusal/No Scrnr	404	9.0%	404	9.0%
ELIGIBILITY KNOWN	**1976**	**24.6%**	**1976**	**44.0%**
Callback English	166	2.1%	166	3.7%
Quota filled	1810	22.5%	1810	40.3%
COMPLETED INTERVIEWS	**999**	**12.4%**	**999**	**22.3%**
Completed Interviews	352	4.4%	352	7.8%
Completed Screener (no biz in NY area)	647	8.0%	647	14.4%
SAMPLE TOTAL	**8045**	**100%**		
USABLE SAMPLE	**4486**	**55.8%**		
TOTAL SAMPLE LOADED	**8045**	**100.0%**		
TOTAL SAMPLE ATTEMPTED	**8045**	**100.0%**		
NOT ATTEMPTED	**0**	**0.0%**		

APPENDIX C – SURVEY DATA SUMMARIES

Summary of Survey Results - Frequencies for Each Equipment Type - Total (Owned plus Rented)

(OWNQ5 minus OWNQ6) + RENTQ5

OWRENT1 How many diesel powered pavers did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	322	91.5	91.5	91.5
	1	15	4.3	4.3	95.7
	2	9	2.6	2.6	98.3
	3	3	0.9	0.9	99.2
	4	2	0.6	0.6	99.7
	10	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	60	[95% Conf. Interval]	RSE
Weighted Total	487	[243 731]	25%

OWRENT2 How many diesel powered rollers did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	300	85.2	85.2	85.2
	1	22	6.3	6.3	91.5
	2	16	4.6	4.6	96.0
	3	6	1.7	1.7	97.7
	4	1	0.3	0.3	98.0
	5	3	0.9	0.9	98.9
	6	1	0.3	0.3	99.2
	12	2	0.6	0.6	99.7
	30	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	151	[95% Conf. Interval]	RSE
Weighted Total	1,121	[547 1,696]	26%

OWRENT3 How many diesel powered scrapers did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	345	98.0	98.0	98.0
	1	4	1.1	1.1	99.2
	2	2	0.6	0.6	99.7
	10	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	18	[95% Conf. Interval]	RSE
Weighted Total	128	[0 294]	66%

OWRENT4 How many diesel powered excavators did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	247	70.2	70.2	70.2
	1	47	13.4	13.4	83.5
	2	29	8.2	8.2	91.8
	3	7	2.0	2.0	93.8
	4	4	1.1	1.1	94.9
	5	4	1.1	1.1	96.0
	6	5	1.4	1.4	97.4
	7	3	0.9	0.9	98.3
	8	1	0.3	0.3	98.6
	9	1	0.3	0.3	98.9
	10	3	0.9	0.9	99.7
	30	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	290	[95% Conf. Interval]	RSE
Weighted Total	2,322	[1,577 3,067]	16%

OWRENT5 How many diesel powered graders did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	333	94.6	94.6	94.6
	1	11	3.1	3.1	97.7
	2	6	1.7	1.7	99.4
	4	1	0.3	0.3	99.7
	10	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	37	[95% Conf. Interval]	RSE
Weighted Total	258	[54 463]	40%

OWRENT6 How many diesel powered rubber tire loaders did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	260	73.9	73.9	73.9
	1	19	5.4	5.4	79.3
	2	24	6.8	6.8	86.1
	3	16	4.6	4.6	90.6
	4	7	2.0	2.0	92.6
	5	5	1.4	1.4	94.0
	6	7	2.0	2.0	96.0
	9	2	0.6	0.6	96.6
	10	3	0.9	0.9	97.4
	14	1	0.3	0.3	97.7
	15	1	0.3	0.3	98.0
	20	1	0.3	0.3	98.3
	28	1	0.3	0.3	98.6
	30	1	0.3	0.3	98.9
	33	1	0.3	0.3	99.2
	39	1	0.3	0.3	99.4
	50	1	0.3	0.3	99.7
	300	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	787	[95% Conf. Interval]	RSE
Weighted Total	3,124	[1,606 4,642]	25%

OWRENT7 How many diesel powered tractors/loaders/backhoes did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	228	64.8	64.8	64.8
	1	55	15.6	15.6	80.4
	2	33	9.4	9.4	89.8
	3	11	3.1	3.1	92.9
	4	6	1.7	1.7	94.6
	5	2	0.6	0.6	95.2
	6	2	0.6	0.6	95.7
	7	2	0.6	0.6	96.3
	8	3	0.9	0.9	97.2
	10	3	0.9	0.9	98.0
	11	2	0.6	0.6	98.6
	17	1	0.3	0.3	98.9
	18	1	0.3	0.3	99.2
	20	1	0.3	0.3	99.4
	40	1	0.3	0.3	99.7
	50	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	435	[95% Conf. Interval]	RSE
Weighted Total	4,754	[1,127 8,381]	39%

OWRENT8 How many diesel powered crawler tractor/dozers did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	312	88.6	88.6	88.6
	1	20	5.7	5.7	94.3
	2	5	1.4	1.4	95.7
	3	3	0.9	0.9	96.6
	4	7	2.0	2.0	98.6
	5	3	0.9	0.9	99.4
	7	1	0.3	0.3	99.7
	12	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	101	[95% Conf. Interval]	RSE
Weighted Total	628	[305 952]	26%

OWRENT9 How many diesel powered skid steer loaders did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	263	74.7	74.7	74.7
	1	41	11.7	11.7	86.4
	2	18	5.1	5.1	91.5
	3	11	3.1	3.1	94.6
	4	6	1.7	1.7	96.3
	5	6	1.7	1.7	98.0
	6	2	0.6	0.6	98.6
	8	2	0.6	0.6	99.2
	9	1	0.3	0.3	99.4
	100	1	0.3	0.3	99.7
	300	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	601	[95% Conf. Interval]	RSE
Weighted Total	2,504	[554 4,453]	40%

OWRENT10 How many diesel powered trenchers did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	345	98.0	98.0	98.0
	1	3	0.9	0.9	98.9
	2	3	0.9	0.9	99.7
	5	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	14	[95% Conf. Interval]	RSE
Weighted Total	91	[0 202]	62%

OWRENT11 How many diesel powered bore/drill rigs did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	333	94.6	94.6	94.6
	1	8	2.3	2.3	96.9
	2	1	0.3	0.3	97.2
	3	3	0.9	0.9	98.0
	4	2	0.6	0.6	98.6
	5	1	0.3	0.3	98.9
	9	1	0.3	0.3	99.2
	12	1	0.3	0.3	99.4
	15	1	0.3	0.3	99.7
	20	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	88	[95% Conf. Interval]	RSE
Weighted Total	194	[74 313]	31%

OWRENT12 How many diesel powered cranes did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	336	95.5	95.5	95.5
	1	4	1.1	1.1	96.6
	2	3	0.9	0.9	97.4
	3	3	0.9	0.9	98.3
	4	3	0.9	0.9	99.2
	5	1	0.3	0.3	99.4
	6	2	0.6	0.6	100.0
	Total	352	100.0	100.0	

Unweighted Total	48	[95% Conf. Interval]	RSE
Weighted Total	294	[114 473]	31%

OWRENT13 How many diesel powered rough terrain forklifts did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	336	95.5	95.5	95.5
	1	8	2.3	2.3	97.7
	2	4	1.1	1.1	98.9
	3	2	0.6	0.6	99.4
	4	1	0.3	0.3	99.7
	6	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	32	[95% Conf. Interval]	RSE
Weighted Total	146	[59 232]	30%

OWRENT14 How many diesel powered off-highway trucks did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	331	94.0	94.0	94.0
	1	7	2.0	2.0	96.0
	2	7	2.0	2.0	98.0
	3	1	0.3	0.3	98.3
	4	2	0.6	0.6	98.9
	5	1	0.3	0.3	99.2
	6	2	0.6	0.6	99.7
	8	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	57	[95% Conf. Interval]	RSE
Weighted Total	419	[69 769]	42%

OWRENT15 How many diesel powered generators, air compressors and pumps did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	290	82.4	82.4	82.4
	1	26	7.4	7.4	89.8
	2	13	3.7	3.7	93.5
	3	7	2.0	2.0	95.5
	4	3	0.9	0.9	96.3
	5	4	1.1	1.1	97.4
	6	1	0.3	0.3	97.7
	8	2	0.6	0.6	98.3
	12	2	0.6	0.6	98.9
	15	2	0.6	0.6	99.4
	22	1	0.3	0.3	99.7
	24	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	227	[95% Conf. Interval]	RSE
Weighted Total	1,383	[732 2,034]	24%

OWRENT16 How many other diesel powered items did you use in 2004?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	198	56.3	56.3	56.3
	1	42	11.9	11.9	68.2
	2	30	8.5	8.5	76.7
	3	18	5.1	5.1	81.8
	4	10	2.8	2.8	84.7
	5	7	2.0	2.0	86.7
	6	7	2.0	2.0	88.6
	7	2	0.6	0.6	89.2
	8	2	0.6	0.6	89.8
	9	2	0.6	0.6	90.3
	10	7	2.0	2.0	92.3
	11	1	0.3	0.3	92.6
	12	3	0.9	0.9	93.5
	13	1	0.3	0.3	93.8
	15	1	0.3	0.3	94.0
	16	2	0.6	0.6	94.6
	18	1	0.3	0.3	94.9
	20	3	0.9	0.9	95.7
	21	1	0.3	0.3	96.0
	23	1	0.3	0.3	96.3
	25	1	0.3	0.3	96.6
	29	1	0.3	0.3	96.9
	30	1	0.3	0.3	97.2
	40	2	0.6	0.6	97.7
	50	1	0.3	0.3	98.0
	55	1	0.3	0.3	98.3
	80	1	0.3	0.3	98.6
	89	1	0.3	0.3	98.9
	128	1	0.3	0.3	99.2
	150	2	0.6	0.6	99.7
	500	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	1,986	[95% Conf. Interval]	RSE
Weighted Total	8,261	[4,685 11,837]	22%

OWRENT_1 through 14 Total # of equipment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	117	33.2	33.2	33.2
	1	31	8.8	8.8	42.1
	2	39	11.1	11.1	53.1
	3	25	7.1	7.1	60.2
	4	28	8.0	8.0	68.2
	5	10	2.8	2.8	71.0
	6	14	4.0	4.0	75.0
	7	9	2.6	2.6	77.6
	8	7	2.0	2.0	79.6
	9	9	2.6	2.6	82.1
	10	5	1.4	1.4	83.5
	11	9	2.6	2.6	86.1
	12	2	0.6	0.6	86.7
	13	6	1.7	1.7	88.4
	14	1	0.3	0.3	88.6
	15	3	0.9	0.9	89.5
	16	3	0.9	0.9	90.3
	17	3	0.9	0.9	91.2
	18	1	0.3	0.3	91.5
	19	1	0.3	0.3	91.8
	20	3	0.9	0.9	92.6
	21	1	0.3	0.3	92.9
	22	3	0.9	0.9	93.8
	23	1	0.3	0.3	94.0
	24	3	0.9	0.9	94.9
	25	2	0.6	0.6	95.5
	27	1	0.3	0.3	95.7
	28	2	0.6	0.6	96.3
	30	1	0.3	0.3	96.6
	31	1	0.3	0.3	96.9
	40	1	0.3	0.3	97.2
	41	1	0.3	0.3	97.4
	43	1	0.3	0.3	97.7
	50	1	0.3	0.3	98.0
	53	1	0.3	0.3	98.3
	54	1	0.3	0.3	98.6
	56	1	0.3	0.3	98.9
	59	1	0.3	0.3	99.2
	73	1	0.3	0.3	99.4
	338	1	0.3	0.3	99.7
	400	1	0.3	0.3	100.0
	Total	352	100.0	100.0	

Unweighted Total	2,719	[95% Conf. Interval]	RSE
Weighted Total	16,469	[10,982 21,957]	17%

APPENDIX D – SURVEY ACTIVITY, HP, AND MODEL YEAR DATA

Table D-1. Hours of Operation per Year by Equipment Type

SCC	Equipment Type	NR2004 hr/yr	Survey Average hr/yr	Difference in hr/yr
2270002003	Diesel Pavers	821	1,470	649
2270002015	Diesel Rollers	760	1,098	338
2270002018	Diesel Scrapers	914	1,008	94
2270002030	Diesel Trenchers	593	707	114
2270002033	Diesel Bore/Drill Rigs	466	831	365
2270002036	Diesel Excavators	1,092	1,122	30
2270002045	Diesel Cranes	990	190	(800)
2270002048	Diesel Graders	962	605	(357)
2270002051	Diesel Off-highway Trucks	1,641	713	(928)
2270002057	Diesel Rough Terrain Forklifts	662	500	(162)
2270002060	Diesel Rubber Tire Loaders	761	1,116	355
2270002066	Diesel Tractors/Loaders/Backhoes	1,135	1,105	(30)
2270002069	Diesel Crawler Tractor/Dozers	936	374	(562)
2270002072	Diesel Skid Steer Loaders	818	920	102
2270002081	Diesel Other	606	1,286	680

Table D-2. Survey Seasonal Allocation Percentages by Equipment Type

Diesel Equipment Type	Winter Percentage	Spring Percentage	Summer Percentage	Fall Percentage
Pavers	6	30	43	21
Trenchers	22	26	27	26
Bore/drill rigs	3	43	42	12
Cranes	46	4	47	3
Rough terrain forklifts	4	33	34	29
Off-highway trucks	23	26	27	25
Rollers	6	32	40	22
Scrapers	11	27	43	18
Excavators	17	29	32	22
Graders	10	33	29	28
Rubber tire loaders	20	25	30	25
Tractors/loaders/backhoes	11	29	31	29
Crawler tractor/dozers	15	23	32	30
Skid steer loaders	39	19	25	17
Other	22	25	29	24
Average	**17**	**27**	**34**	**22**

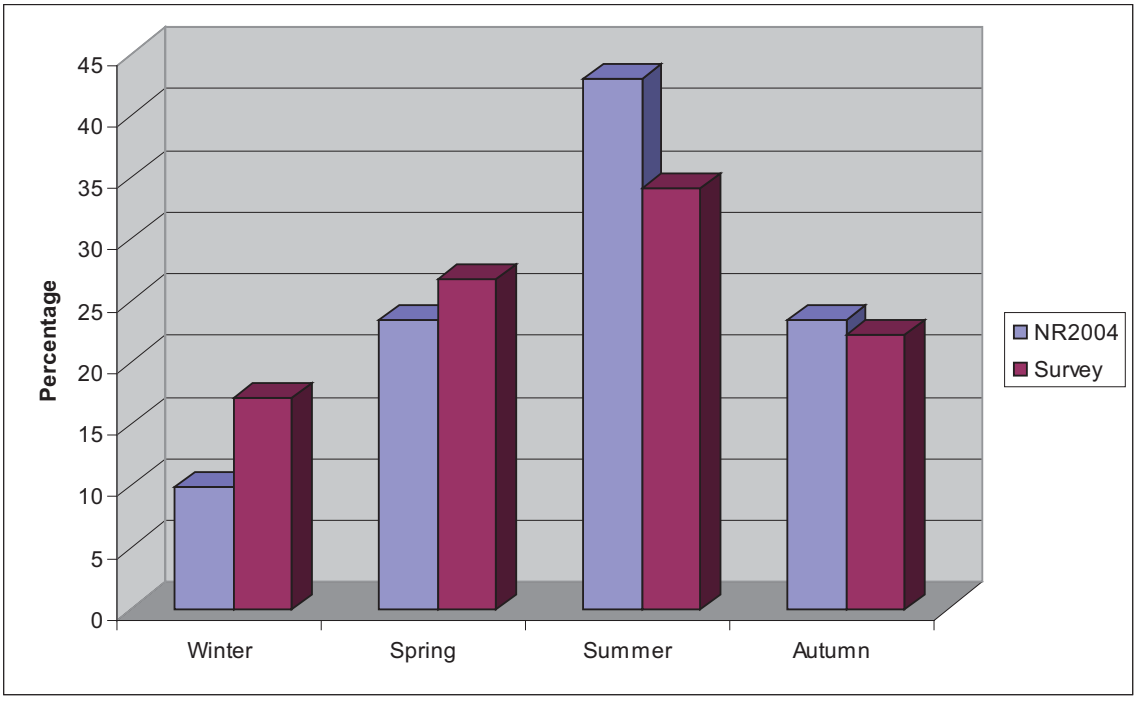

Figure D-1. Seasonal Allocation Percentages for All Equipment Types

Table D-3. Survey-Based Equipment Population by Horsepower and Model Year for Equipment Owner SICs

Equipment Code	Equipment Type	2004 # of Equipment Used	HP 100 or less	HP 101-175	HP 176-300	HP 301-600	HP 600 or greater	TOTAL Reported by HP[a]	Model 2003-2006	Model 2000-2002	Model 1996-1999	Model 1996 or earlier	TOTAL Reported by MY[a]
1	Pavers	77	14	14	13	7	0	8	18	19	21	10	68
2	Rollers	163	53	1	17	1	4	116	31	27	18	34	110
3	Scrapers	19	4	1	11	1	0	17	4	2	0	2	8
4	Excavators	368	3	98	53	35	15	244	187	72	33	66	358
5	Graders	34	5	6	15	3	0	29	4	0	1	14	19
6	Rubber tire loaders	787	52	148	109	81	17	07	104	117	372	132	725
7	Tractors/loaders/ Backhoes	437	110	62	34	30	4	240	89	78	78	121	366
8	Crawler tractor/Dozers	132	26	25	21	16	8	96	55	10	13	9	127
9	Skid steer loaders	275	74	39	22	2	0	137	62	38	35	126	261
10	Trenchers	13	9	0	3	0	0	12	1	9	3	0	13
11	Bore/drill rigs	90	8	20	8	6	20	62	10	17	13	50	90
12	Cranes	137	15	106	3	2	0	126	103	2	9	17	131
13	Rough terrain forklifts	25	12	4	2	0	0	18	7	8	2	4	21
14	Off-highway trucks	66	0	10	16	13	8	7	28	10	12	16	66
15	Generators	188	72	39	12	5	9	137	2	14	41	79	176
16	Other[b]	1722	78	57	262	263	5	665	270	612	126	327	1335

[a] Horsepower and model year were not reported for all equipment types, therefore the totals in these columns will not equal the total # of equipment used
[b] "Other" Equipment Type not specified

Table D-4. Survey-Based Equipment Population by Horsepower and Model Year for Equipment Rental SICs

Equipment Code	Equipment Type	2004 # of Equipment Rented	HP 100 or less	HP 101-175	HP 176-300	HP 301-600	HP 600 or greater	TOTAL Reported by HP[a]	Model 2003-2006	Model 2000-2002	Model 1996-1999	Model 1996 or earlier	TOTAL Reported by MY[a]
1	Pavers	14	10					10	8	2			10
2	Rollers	33	3	0	1			4	0	0	1	3	4
3	Scrapers	0						0					0
4	Excavators	90	21	2	4			27	10	9	7		26
5	Graders	4	2	0	2			4	2	0	0	2	4
6	Rubber tire loaders	9	12					12	12				12
7	Tractors/loaders/ backhoes	33	6					6	4	2			6
8	Crawler tractor/dozers	7	0	0	4			4	2	0	2		4
9	Skid steer loaders	191	38					38	23	15			38
10	Trenchers	1						0					0
11	Bore/drill rigs	0						0					0
12	Cranes	16	0	6	0	5	1	12	0	0	6	6	12
13	Rough terrain forklifts	12	2					2	0	0	1		1
14	Off-highway trucks	10						0					0
15	Generators	59	17	3	2	1		23	2	6	14		22
16	Other[b]	372	27	1	3			31	18	6	11	3	38

[a] Horsepower and model year were not reported for all equipment types, therefore the totals in these columns will not equal the total # of equipment used
[b] "Other" Equipment Type not specified

Table D-5. Percentage of Total Equipment Populations by Horsepower Range

		NR2004 HP Distribution					NYCMA Survey HP Distribution					Difference in Percent HP Distribution				
SCC	Diesel Equipment Type	HP <= 100	HP 101-175	HP 176-300	HP 301-600	HP > 600	HP <= 100	HP 101-175	HP 176-300	HP 301-600	HP > 600	HP <= 100	HP 101-175	HP 176-300	HP 301-600	HP > 600
2270002003	Pavers	8	29	21	3	0	2	23	24	11	0	-6	-7	4	9	0
2270002015	Rollers	67	23	8	2	0	50	31	16	1	3	-17	8	8	-2	3
2270002018	Scrapers	0	3	34	43	20	24	6	65	6	0	23	3	31	-38	-20
2270002030	Trenchers	90	5	3	2	0	77	0	23	0	0	-13	-5	20	-2	0
2270002033	Bore/drill rigs	6	21	18	11	4	13	32	13	10	32	-33	11	-5	-1	28
2270002036	Excavators	25	39	28	8	1	3	27	16	10	4	18	-11	-12	2	3
2270002045	Cranes	11	33	34	21	1	11	79	3	6	1	-1	6	-31	-14	0
2270002048	Graders	4	33	56	6	0	21	18	52	9	0	17	-15	-4	3	0
2270002051	Off-highway trucks	0	0	16	34	50	5	18	29	33	15	5	18	13	-1	-35
2270002057	Rough terrain forklifts	70	27	1	2	0	73	13	7	7	0	3	-13	5	5	0
2270002060	Rubber tire loaders	18	30	28	21	3	19	34	25	18	4	1	4	-3	-3	0
2270002066	Tractors/loaders/backhoes	67	33	0	0	0	8	25	13	12	1	-18	-8	13	12	1
2270002069	Crawler tractor/dozers	15	33	29	14	9	27	24	25	16	8	12	-9	-3	1	-1
2270002072	Skid steer loaders	99	1	0	0	0	89	7	4	0	0	-10	6	4	0	0
2270002081	Other	10	20	48	3	8	17	12	34	34	3	7	-8	16	-9	-5
NOTE: Total differences may not add due to rounding																

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