

# World Trade Center Health Registry

## Sample Building and Denominator Estimation

**RTI Project Number 0208692**

**Contract No. 200-2002-M-00836**

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## EXECUTIVE SUMMARY

The World Trade Center Health Registry (WTCHR) is a database for following people who were exposed to the disaster of September 11, 2001 (9/11). Hundreds of thousands of people were exposed to the immense cloud of dust and debris, the indoor dust, the fumes from persistent fires, and the mental trauma of the terrorist attacks on the WTC on 9/11. The purpose of the WTCHR is to evaluate the potential short and long term physical and mental health effects of the disaster. It was conceived as an imperative public health response to document and assess the potential impact on physical and mental health resulting from the WTC disaster on large and diverse populations. It is a collaborative scientific effort by the New York City Department of Health and Mental Hygiene (NYCDOHMH), Agency for Toxic Substances and Disease Registry (ATSDR), and external scientific, labor, and community advisors. Funding has been provided by the Federal Emergency Management Agency (FEMA) and ATSDR. WTCHR sample building and baseline data collection activities were conducted by RTI International.

The objectives of the WTCHR are to collect information about physical and mental health effects across a wide range of exposures; to provide data on potential health effects identified by the WTCHR for more in depth

follow-up studies; to provide a means for conducting long term follow-up of a large group of exposed persons; and, to provide data that may assist in the development of screening and intervention programs. Akin to a longitudinal cohort study, the goal of the WTCHR is to follow enrollees for up to 20 years.

Groups most heavily exposed to the WTC disaster were targeted for outreach and recruitment into the WTCHR. Populations were selected for the WTCHR based on the following exposure criteria: exposure to the actual event; exposure to the immediate aftermath of the attack; ongoing exposures related to rescue, recovery and clean-up of the WTC site; or living, working, or attending school in the lower Manhattan area. A map of the target area for the WTCHR is provided in Figure 1. The WTCHR targeted the following populations that met the exposure criteria described above, and are also referred to as “sample types” for classification purposes:

- **Workers and Volunteers:** Workers and volunteers involved in rescue, recovery, clean-up, or other disaster-related activities at the WTC site and/or at the Staten Island Recovery Operations or on transport barges for at least one shift anytime from September 11, 2001 through June 30, 2002.

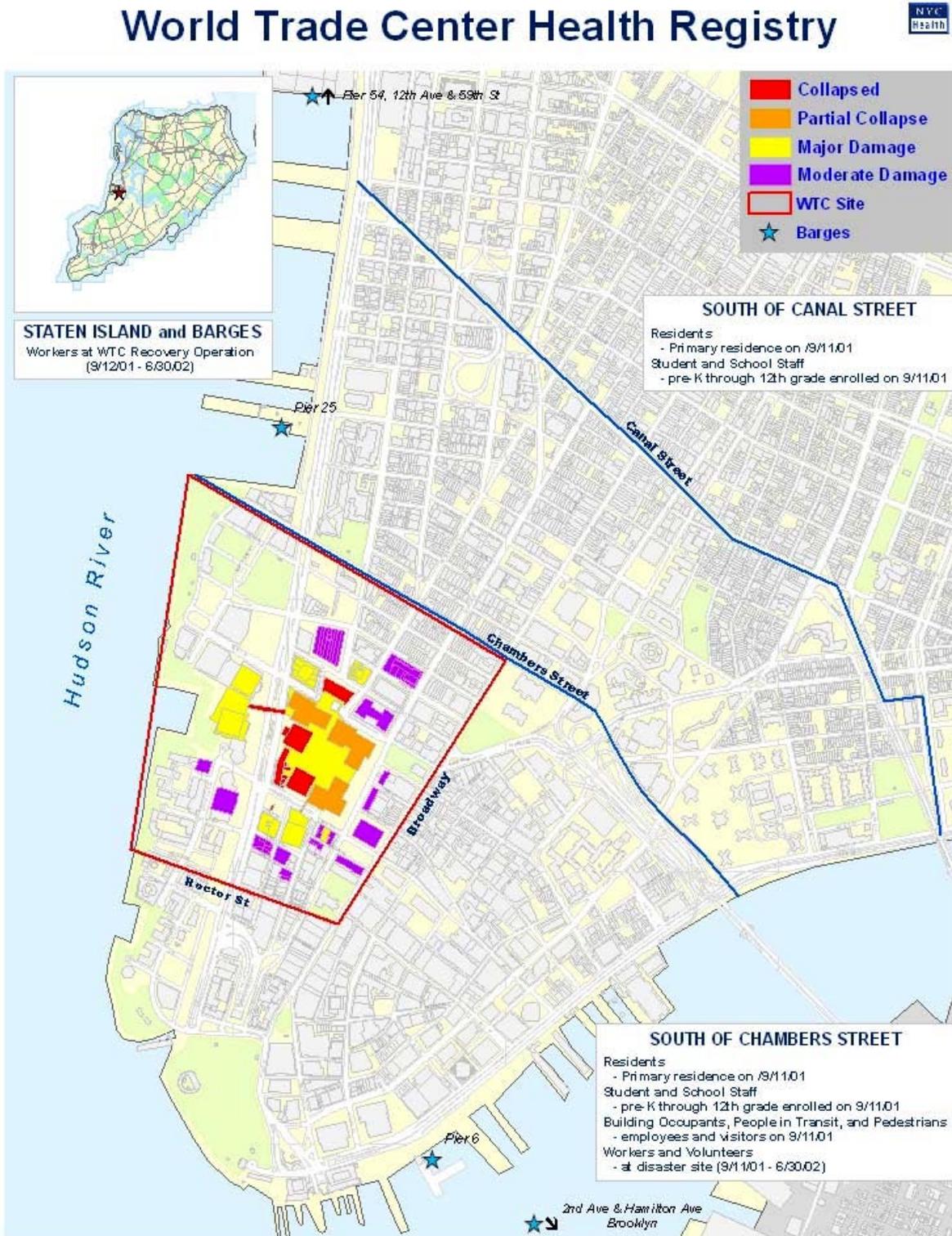
- Residents: Persons whose primary residence was south of Canal Street on September 11, 2001.
- School Students and Staff: Students who were enrolled in a nursery school/daycare, elementary, middle, or high school south of Canal Street on September 11, 2001 and staff persons employed in a nursery school/daycare, elementary, middle, or high school south of Canal Street on September 11, 2001.
- Building Occupants, People in Transit, and Pedestrians: Persons present south of Chambers Street in Manhattan on September 11, 2001 any time between the first plane impact and noon (this includes persons who were in collapsed or damaged buildings, people in other buildings, and people in transit or outdoors).

The purpose of this technical report is to describe in detail the processes undertaken by the WTCHR project team to build a sample of potential registrants and to estimate the total number of eligible individuals, or denominator. Denominator estimation provides information on the extent to which the WTCHR represents the true eligible population. Sample building on the WTCHR project was particularly challenging in that it required the compilation of a comprehensive

list of entities representing people who were exposed to a large-scale, human-made disaster, and communication with these entities in order to outreach to persons eligible for the WTCHR. Similarly, denominator estimation required the enumeration of a retrospective population. The sample building and denominator estimation tasks had three key goals: 1) to identify the universe of eligible entities, 2) to inform eligible individuals within these entities about the WTCHR and encourage them to enroll, and 3) to accurately estimate the total number eligible, or denominator, for each group regardless of enrollment status.

This report will describe the methods and processes used to achieve these goals. It is intended as technical documentation of the methods employed and was cleared through the ATSDR technical review process. A complete evaluation of the methods utilized or a comparison of these methods with alternate techniques used on similar WTC-related projects is outside the scope of the present report. These topics will be addressed in subsequent manuscripts to be submitted to peer review journals. In addition, two other reports are expected to be posted on the WTCHR web site (<http://www.wtcregistry.org>) in early 2006, including: 1) World Trade Center Health Registry Data File User's Manual, and 2) World Trade Center Registry: Explanation and Calculation of Outcome Rates.

Figure 1. Map of Target Area for WTCHR



# Sample Building and Denominator Estimation Methodology Report

## 1.0 OVERVIEW OF THE SAMPLE BUILDING PROCESS

Building the sample for the World Trade Center Registry Health Registry (WTCHR) was an iterative, multi-stage process. The goal was to create a comprehensive and robust cohort given the unique circumstances of this public health initiative. A multi-pronged recruitment strategy was launched in an effort to maximize the number of registrants identified and enrolled. This included community outreach, collection of lists of eligible persons or “list building”, and self-identification through a toll-free number and web site. This recruitment approach allowed potential registrants to be identified from multiple and varied sources, thus maximizing WTCHR coverage. Vital elements of the WTCHR recruitment approach included partnerships with other key agencies and organizations, development of informational messages to present the WTCHR to the intended audience, advertising campaigns to build awareness and communicate the messages, public forums to engage community leaders and potential registrants, establishment of a hotline and a web site to respond to inquiries in multiple languages, and list building. Specific details on the methods of recruitment for the WTCHR are described in the following sections.

### 1.1 Promoting the WTCHR: Community Outreach Campaign

Outreach and media campaigns were mounted during the enrollment phase of the WTCHR to create awareness of the program, encourage

cooperation among those called for their interview, and promote self-identification for enrollment. The primary goals of the community outreach campaign were to inform the target populations of the existence of the WTCHR, provide information about the WTCHR and motivate these populations to enroll, and promote the project to other eligible persons. Additionally, the outreach campaign needed to reach hard-to-find individuals who might not appear on lists (e.g., undocumented workers and residents, visitors to lower Manhattan on 9/11/01), and to be accessible to diverse ethnic and cultural groups.

The plan for outreach was flexible and multi-faceted. A key component of the WTCHR outreach strategy was participation in public forums. Targeted efforts were needed to inform key organizations about the WTCHR and address their concerns. Responding to and meeting with eligible organization members was a significant aspect of outreach for the WTCHR. Forums to describe the WTCHR and answer questions were held with the constituents of both small and large organizations, from parent-teacher associations to large unions. In many cases, leaders of community-based organizations served as important intermediaries to gaining cooperation from their constituents. These leaders were instrumental in promoting the WTCHR through placement of outreach materials, mailings, and even providing community space for meetings, informational outreach booths, or private space for interviewing eligible members.

Another salient component of the outreach strategy was an advertising campaign. The WTCHR received periodic media attention through newspaper, radio, and television articles and announcements throughout the enrollment period, typically following the issuance of press releases. A comprehensive arsenal of WTCHR materials were developed, tested, and distributed to the target populations. All outreach materials were translated into Chinese and Spanish, and all materials provided information on the toll-free number and web site for self-registration. Although outreach campaign materials communicated a uniform, consistent message about the WTCHR, the types of materials and modes of information dissemination were tailored to the diverse sample types eligible for enrollment. Table 1 provides examples of the focused outreach strategies utilized.

## 1.2 Providing Registrants a Means to Self-Enroll in the WTCHR

To maximize the number of eligible enrollees, the WTCHR established a toll-free telephone number (i.e., 1-866-NYC-WTCR) and public web site (<http://www.wtcregistry.org>) to encourage potential registrants to self-identify. The toll-free number was designed and equipped to handle multiple languages. Similarly, the web site was accessible in English, Chinese, and Spanish.

Information on the toll-free number and web site was included on all community outreach and registrant materials (e.g., subway posters, brochures, palm cards, lead letters, etc.) and provided potential registrants another means to enroll. The public web site was opened prior to data collection and included a link to a pre-enrollment contact form where potential enrollees provided their names, addresses,

**Table 1. Registry Outreach Strategies by Sample Type**

Sample Type	Strategies for Information Dissemination
Workers and Volunteers	Subway, bus, newspaper, radio, and ferry advertisements; Email or fax sent to employees/members; Newsletter and trade magazine articles; Presentations at roll calls and to company officials; Electronic bulletin to responders on public health networks; Targeted visits to police and fire houses; Web banner for organization web site; Registration packets distributed to employees/members; Paycheck inserts; Placement of posters/brochures
Residents	Subway, bus, newspaper, radio, and ferry advertisements; Information tables in building lobbies and at health fairs, farmers markets, film festivals; Presentations to community groups and tenant organizations; Placement of posters/brochures in restaurants, dry cleaners, pharmacies, physician offices, grocery stores, and other businesses; Informational letters sent to home addresses
School Students and Staff	Subway, bus, newspaper, radio, and ferry advertisements; Presentations to PTA, principals; Backpack letters sent home with students; Registration packets sent by NYC Department of Education; Information tables before/after school and at sporting events; Placement of posters/brochures in schools and day cares
Building Occupants, People in Transit, and Pedestrians	<p>Building Occupants of 38 Damaged or Destroyed Buildings and Structures:</p> <p>Subway, bus, newspaper, radio, and ferry advertisements; Email sent to employees; Newsletter articles; Registration packets distributed to employees; Paycheck inserts; Presentations to board members and building tenants; Web banner for company web site; Placement of posters/brochures</p> <p>Occupants of Other Buildings, People in Transit, and Pedestrians South of Chambers Street:</p> <p>Subway, bus, newspaper, radio, and ferry advertisements; Information tables at health fairs, farmers markets, and film festivals; Placement of posters/brochures in restaurants, dry cleaners, pharmacies, physician offices, grocery stores, and other businesses</p>

and telephone numbers. The pre-enrollment page on the web site was only accessible in English. The toll-free number and web site were available throughout the duration of the WTCHR. Individuals who called the toll-free number were screened for eligibility, and, if eligible, were administered the health survey. Persons who self-identified through the web site were contacted by telephone, screened for eligibility, and administered the survey if eligible.

The WTCHR toll-free number and web site serve a variety of purposes. Inbound callers utilized the toll-free number to ask questions about the WTCHR, to update their contact information, or to complete an interview. The public web site serves as a repository for current project information, including outreach materials, press releases, quarterly health reports, and links to other health resources. The web site also provides a link for registrants to update their contact information and a forum for individuals to ask questions or provide feedback about the project.

### 1.3 Obtaining Lists of Potential Registrants from Eligible Organizations

The public outreach effort was closely coordinated with an effort to develop comprehensive lists of potential registrants. As part of the list building process, Institutional Contactors (ICs) employed by RTI International contacted representatives of eligible entities to explain the purpose of the WTCHR, confirm eligibility, and obtain a mailing address to send informational materials. Unique call scripts were used for organizations within each sample type in order to confirm eligibility. For example, contacts with businesses sought to confirm 9/11/01 address, while contacts with worker and

volunteer groups involved in rescue, recovery, and clean-up activities sought to confirm work at the WTC site between 9/11/01 and 6/30/02.

After informational materials were mailed to organizations, ICs recontacted representatives of these entities to request that a list of all potentially eligible persons (to include their current contact information) be submitted to the WTCHR. In addition to requesting a list, ICs also confirmed the total number of persons eligible for the WTCHR, as that number may differ from the number of individuals included on the list, if a list was provided. ICs also collected information on business size, when possible, and recorded the number of WTCHR self-registration packets or brochures requested by the organization. Contact information and relevant notes for all entities were captured in an electronic List Building System (LBS) developed specifically to capture and organize WTCHR contacting efforts. Figure 2 displays the screen where ICs accessed representatives of eligible entities and recorded new information. The process employed to identify eligible organizations and entities for inclusion in list building differed by sample type. Each is described in the following sections.

#### 1.3.1 Lists of Workers and Volunteers Involved in Rescue, Recovery, and Clean-up

Workers and volunteers at the WTC site and/or the WTC Recovery Operations site on Staten Island during the period of 9/11/01 through 6/30/02 were eligible for the WTCHR. Creating a comprehensive list of the various rescue, clean-up, construction, and volunteer organizations who worked at the WTC site and/or Staten Island Recovery Operations required information from a variety of unique data sources. Responders to the WTC disaster comprise a diverse and

geographically dispersed group. While many companies were found on lists of credentialed or documented responder organizations, many were not and required additional research to identify. Several of the organizations that responded to the WTC disaster are well known and were contacted directly, including FDNY, NYPD, NYC Department of Sanitation, NYC Department of Design and Construction, Port Authority of New York and New Jersey, Federal Emergency Management Agency (FEMA), American Red Cross, Salvation Army, and the construction companies responsible for the four quadrants of the WTC site. The primary method of list building and outreach utilized ICs who contacted each rescue, recovery, and clean-up entity to determine eligibility, and, if eligible, to offer participation in the WTCHR.

WTCHR staff collaborated with city, state, and federal agency officials, as well as union officials, to compile lists of additional responding organizations and subcontractors. Potentially eligible worker and volunteer organizations were obtained from various sources. For example, a list of 206 subcontractors working at the WTC site were received from the New York City Department of Design and Construction (DDC). The New York Governor's Office of Employee Relations supplied a list of eligible state agencies. Unions and associations, many of which were city and state-affiliated unions, were also provided by NYCDOHMH. FEMA provided information on 22 Urban Search and Rescue (US&R) teams which were deployed to the WTC area. The list of additional federal agencies to be contacted

**Figure 2. List Building System**

The screenshot displays the 'WTC Health Registry' web application interface. The page title is 'WTC Health Registry' with the subtitle 'World Trade Center Health Registry'. The date and time are 'Tuesday, February 15, 2005 3:47:43 PM'. The main heading is 'Edit Contact Information'. The form contains the following fields and values:

- Name: (First) Jane, (Last) Smith
- Contact Title: HR Director
- Contact Phone: 800.555.2222
- Organization: Acme Company
- Organization Type: BUSINESS (dropdown)
- Source of Contact: LOCATING VENDOR (dropdown), Other/Specify: [empty]
- Address1: 123 Spring
- Address2: [empty]
- City: New York
- State: New York (dropdown), Country: [empty]
- Zip: 10001 - [empty]
- Address911: World Trade Center 1 (dropdown), School 911 Address: [empty]
- Business Size: 500, No. of Brochures: 0
- Number Eligible: 280, No. of Self-Registration Packets: 0, Language: English (dropdown)

was obtained from NYCDOHMH and ATSDR. The Federal Executive Board assisted with the identification of additional eligible federal agencies and provided us with names and addresses of agency heads.

All rescue, recovery, and clean-up organizations that participated in the WTCHR—via outreach or list submission—were asked if they were aware of any other eligible organization(s) that should be contacted and offered participation. The List Building System (LBS) developed for the WTCHR allowed for snowball sampling, whereby a new contact could be “spawned” from an original contact. In these cases, the new record is automatically linked to the original record for documentation purposes. These new entities were contacted and folded into the list building process throughout the sample building period. Snowball sampling was particularly effective with this sample type (e.g., one of the main construction firms working on the WTC pile provided a list of 88 subcontractors who also supplied workers to the site).

RTI utilized its in-house Call Center tracing services capabilities to conduct batch and intensive tracing on any entities that could not be located. All unlocatable entities were submitted to three locating vendors for batch tracing before being released to tracing staff: National Change of Address (NCOA), Telematch, and Lexis-Nexis. NCOA is a database consisting of change of address data submitted to the U.S. Postal Service. Telematch is a computerized telephone number service consisting of over 63 million listings, over 1 million not-yet-published numbers of new movers, and over 10 million businesses. Lexis-Nexis offers electronic access to company data, legal information, and public records.

In addition to formal tracing and locating strategies, Internet searches were conducted using sites that allow business name searches, such as [www.Hoovers.com](http://www.Hoovers.com), and yellow pages services such as [www.theultimates.com](http://www.theultimates.com). RTI utilized its tracing services unit to locate over 40 worker and volunteer entities.

Several additional sources of information were consulted to build the cohort of worker and volunteer organizations active in 9/11 efforts, including:

- **Published Sources.** Internet data sources were useful in identifying additional worker and volunteer teams. Additional sources include: 1) the monograph *American Ground: Unbuilding the World Trade Center* (Langewiesche, 2002), and 2) information and articles posted on the New York Construction News web site (<http://newyork.construction.com/news/>), particularly *Heroes from Ground Zero* (2002).
- **WTC-related Research Studies.** Because many of the workers involved in 9/11/01 efforts have been targeted for other research studies, WTCHR project staff collaborated with other study investigators to further identify groups eligible for WTCHR participation.
- **St. Paul’s Chapel.** St. Paul’s Chapel is located directly across from Ground Zero and served as a respite and assembly area for rescue, recovery, and clean-up workers and volunteers. Teams donated patches with their insignia as a way to show respect and indicate that their organization had donated time. Teams traveled to the WTC site from many states

across the nation and mainly consisted of police, fire, and volunteer groups. RTI gained permission to view and photograph these patches. A database was created and 160 organizations were folded into list building production. To locate these cases, online directory assistance services ([www.theultimates.com](http://www.theultimates.com)) were utilized as well as more specific entities such as [www.the911site.com](http://www.the911site.com) for the fire and rescue teams.

A total of 670 worker and volunteer agencies were identified. Of these, 553 were contacted by mail and telephone and 117 by mail only.

### 1.3.2 Lists of Residents

Individuals whose primary residence was south of Canal Street on 9/11/01 were eligible for enrollment in the WTCHR. To develop a sample of residents, RTI purchased lists of potentially eligible residents. Lists of residents living in the catchment areas on 9/11/01 were provided primarily from sample files purchased from Genesys Sampling Systems. Genesys' primary source of data is Info-USA, which is a compilation of White Pages listings and other public sources. Two lists were purchased based on proximity of residence to the WTC site: 1) residents south of Chambers Street, and 2) residents south of Canal Street, but north of Chambers Street. These lists were supplemented by lists received from targeted tenant organizations organized in residential buildings within the eligibility boundaries.

### 1.3.3 Lists of School Students and Staff

Students enrolled and staff working at schools or day care centers south of Canal Street on 9/11/01 were eligible for enrollment in the WTCHR. Public and private school data for the 2000–2001 school year are publicly

available from the National Center for Education Statistics (NCES). Public school enrollment and staff data are available for all public schools in the catchment area from the Common Core of Data (CCD). Private school data come from the Private School Survey (PSS). Each school in the eligible ZIP codes in lower Manhattan was mapped to determine whether or not it fell within the catchment area. Preschools and day care centers within the catchment area were identified through information from the NYC Bureau of Day Care. These data sources were the primary means used to identify public and private schools and preschools to be contacted for lists of eligible students and staff.

Five private schools and 22 day cares and preschools were identified and contacted directly. The 14 public schools identified were not contacted through list building. A research protocol was submitted to the Institutional Review Board (IRB) at the NYC Department of Education. The NYC Department of Education's IRB determined that a list of parental contact information could not be released to the WTCHR. Instead, they agreed to conduct a mailout to parents on behalf of the WTCHR. RTI worked with the NYC Department of Education, which created a database of eligible parents and printed address labels. Over 12,000 letters were mailed to all parents of students meeting WTCHR eligibility—that is, enrolled in public schools south of Canal Street on 9/11/01. Additionally, approximately four months after the large mailout was sent, a backpack letter describing the WTCHR was sent home with students in nine of 14 public schools where the principal gave consent and agreed to distribute those materials. This letter was intended to be a second reminder to parents to enroll their

children in the WTCHR before the deadline to register. Language-appropriate letters were sent to parents. Each packet contained a letter printed in English and Spanish text (front and back), and an additional letter translated in Chinese.

### 1.3.4 Lists of Building Occupants

Organizations were eligible for inclusion in the WTCHR if they occupied space in one of 38 buildings and structures identified by the New York City Department of Buildings as buildings that could not be occupied after the 9/11/01 attacks and collapse of the WTC towers. Appendix A lists the 38 building addresses (i.e., 35 buildings, one concourse, and two pedestrian bridges) and their damaged or destroyed status, as categorized by FEMA (2002). It should be noted that the complete FEMA list contained 55 buildings and structures, but was published subsequent to the initiation of list building and data collection activities on the WTCHR. Of the 55 buildings and structures determined by FEMA engineers to have sustained damage, 38 were consistent with the original data supplied by the New York City Department of Buildings. All buildings and structures that FEMA determined to have fully collapsed, partially collapsed, or sustained major damage were covered in the original data supplied by the New York City Department of Buildings.

Eligible building occupants were identified using employee lists collected from businesses and employers in the targeted 38 damaged or destroyed buildings and structures. The first step in this process involved defining the universe of businesses retrospectively. The primary source of businesses to be contacted for the WTCHR was a list purchased from a sample vendor—Genesys Sampling Systems.

Genesys was provided with specifications that included all address permutations and building names for the 38 damaged or destroyed buildings and structures. Genesys searched their business database, primarily driven by InfoUSA, for all records with an address at one of the damaged or destroyed buildings as of 9/10/2001. Business names, contact information as of 9/10/01, and business size were compiled and sent to the WTCHR team. Genesys provided contact information for a total of 906 businesses.

To maximize coverage for businesses, two additional sources were identified and obtained. The Downtown Alliance, a community organization that provides information and services for residents of lower Manhattan, provided the WTCHR team two lists, including: 1) A list of 587 businesses derived from Dun & Bradstreet listings as of August 2001—just prior to the 9/11 attacks. This file included information on businesses south of Murray Street in lower Manhattan, with the exception of those located in Battery Park City, and 2) A list of retail businesses in the same area compiled by the Downtown Alliance that were in business on or around 9/11/01.

Records that had an address in one of the 38 damaged or destroyed buildings and structures were selected from each list. Then, the lists were merged and deduplicated to create a new list of businesses to be contacted.

Another key source for identification of businesses was the New York Metropolitan Transportation Council (NYMTC) report entitled “Post September 11th Impacts: Inventory of Affected Businesses.” The businesses listed in the NYMTC report lost space in the World Trade Center and

adjacent properties destroyed and damaged on September 11, 2001. Some, but not all, of the damaged or destroyed buildings identified for the WTCHR are included in the NYMTC report. The NYMTC report identifies 879 businesses, but there is significant overlap with the Genesys and Downtown Alliance lists.

The purpose of including the three aforementioned list sources for the building occupants sample was to represent as many unique businesses as possible. Since many businesses are included on two or three of the above list sources, deduplication was necessary to eliminate duplicate business-level records. This process was accomplished through programmatic (via SAS) and manual (via Excel) deduplication as follows:

**Step 1:** The Genesys, Downtown Alliance, and NYMTC lists were compared in SAS with an algorithm that identifies duplicate businesses across the lists based on business name and September 11, 2001 address. Any businesses that matched exactly on name and address were merged, thereby eliminating duplicate information. Business name suffixes, such as “INC,” “CORP,” or “INTL” were ignored in the match process to minimize duplicate records due to variations on business name or address across lists. For instance, if the Genesys list included ACME BUSINESS, INC. at 1 WORLD TRADE CENTER and the Downtown Alliance list included ACME BUSINESS at 1 WTC, the SAS algorithm would have reformatted the entries to code them both as ACME BUSINESS at 1 WORLD TRADE CENTER. At this point, the values of the business name and address fields would be equal for these records,

and the business would show up only once in the resulting list of unique businesses.

**Step 2:** This list of businesses was imported into an Excel spreadsheet for further review. This spreadsheet was sortable by business name, address, and source identifying it (Genesys, Downtown Alliance, and/or NYMTC). The entries in this list were manually reviewed to identify additional duplicates not accounted for in the SAS process. The duplicate records were dropped to ensure that each business/location was included only once in the sample. The Genesys list took precedence over the Downtown Alliance list; the Downtown Alliance list took precedence over the NYMTC list such that:

- a. Genesys and NYMTC portions of the list were compared and duplicates were removed from the NYMTC list.
- b. Genesys and Downtown Alliance portions of the list were compared and duplicates were removed from the Downtown Alliance list.
- c. Downtown Alliance and NYMTC portions of the list were compared and duplicates were removed from the NYMTC list.

The hierarchy determined for the three list sources was based upon the fact that Genesys had been provided with specifications with which they queried their retrospective database for the exact buildings and date of interest. Downtown Alliance had information for a similar time period and was relatively

complete, while NYMTC did not include information on all buildings of interest.

**Step3:** In some cases, business names on the three lists were similar, but not exact matches (e.g., Acme, Inc. and Acme Tents, Inc.). In these situations, further investigation via Internet sources and telephone contacts were conducted to determine if the two records were a match or if they represented separate entities.

Other resources were also used to identify potentially eligible businesses. For example, list of businesses that were WTC tenant lists were compiled by several organizations, including CNN and the *Wall Street Journal*, and the DRI-WEFA (formerly Data Resources Inc., and Wharton Econometric Forecasting Associates, respectively) report to Congress noted the various businesses that were impacted financially by the attacks. Building management lists, such as a listing of the businesses and retail shops located in the World Financial Center, were also examined for additional eligible entities. In addition, all businesses that participated in the WTCHR—via outreach or list submission—were asked if they were aware of any other eligible organization(s) that should be contacted and offered participation. These new entities were contacted and folded into the list building process throughout the sample building period.

Because businesses dissolved or merged with other companies during the time period between September 11, 2001 and our contacting effort which began in April 2003, it was necessary to trace many entities in order to obtain current information. Both formal and informal tracing and locating mechanisms were utilized. RTI's in-house Call Center tracing services conducted batch

and intensive tracing on businesses that could not be located. All unlocatable entities were submitted to three vendors (i.e., NCOA, Telematch, and Lexis-Nexis) for batch tracing before being released to tracing staff: RTI sent over 1,100 identified business cases to batch tracing via Lexis-Nexis and 100 cases through intensive tracing. Intensive tracing refers to the second phase of location, during which tracers receive the remaining unverified cases from batch tracing, or cases that have proven to be unreachable with current information, and begin more exhaustive efforts. Interactive consumer databases and credit bureau reports serve as our primary resources for acquiring new information.

In addition, Internet searches were conducted using sites such as Hoovers (i.e., business name search engine) and TenantWise (i.e., site providing information on where WTC complex tenants relocated) and yellow pages services such as [www.theultimates.com](http://www.theultimates.com). Several sources that provided a list of WTC complex tenants or a search engine based on business name (see Table 2) were used regularly to locate current information on organizations, such as phone number, address, and status (e.g., mergers, companies out of business). These resources often provided additional information on businesses, such as business size or square feet of office space leased.

A total of 1,518 potentially eligible businesses were identified. Due to resource constraints, the WTCHR team could not directly contact over 1,500 businesses, in addition to the hundreds of rescue, recovery, and clean-up, and school entities that required contacting. Telephone contacting was prioritized by business size. In order to maximize outreach, we opted to contact approximately 470 small

businesses via a mailout. In total, contact was attempted with 862 businesses with known telephone and/or address information via telephone and mail (n=392) or by mail only (n=470). Those businesses with the fewest number of employees were contacted via mail only. Attempts to locate the remaining 656 businesses were unsuccessful. This set underwent tracing and locating using the aforementioned vendors but any leads that were returned did not result in an accurate address or phone number.

## 2.0 DENOMINATOR ESTIMATION

As briefly described in the Sample Building section, the List Building System (LBS) served as a repository for key characteristics of each eligible entity, including: number of

individuals eligible for the WTCHR; business size; number of brochures or self-registration packets requested for employees; and number of individuals on lists submitted to the WTCHR. While denominator estimation from an informant was the preferred method for determining a final number eligible, this method was constrained by several factors. A subset of the organizations that were contacted either refused or were unable to provide the information requested. Further, many entities were unlocatable after tracing efforts, had gone out of business since 9/11, or were only contacted via mail due to resource constraints.

In such instances, estimating the denominator required an examination of supplemental data. In cases where business size was not collected from an informant at the business, it was frequently available in the Genesys

**Table 2. Sources of Additional Information on Businesses**

Source	Web Address
CNN web site	<a href="http://www.cnn.com/SPECIALS/2001/trade.center/tenants1.html">http://www.cnn.com/SPECIALS/2001/trade.center/tenants1.html</a>
Crain's NY Business (Co-Star provided)	<a href="http://www.craainsny.com/page.cms?pagelid=333">http://www.craainsny.com/page.cms?pagelid=333</a>
DRI-WEFA report	Financial Impact of the World Trade Center Attack. Prepared for the New York State Senate Finance Committee. January 2002: <a href="http://www.senate.state.ny.us/Docs/sfc0102.pdf">http://www.senate.state.ny.us/Docs/sfc0102.pdf</a>
Forbes.com	<a href="http://www.forbes.com/2001/09/14/wtcreatenants.html">http://www.forbes.com/2001/09/14/wtcreatenants.html</a>
Hoovers: A D&B Company	<a href="http://www.hoovers.com/free/">http://www.hoovers.com/free/</a>
ReferenceUSA	<a href="http://www.referenceusa.com/">http://www.referenceusa.com/</a>
New York Disaster Information and People Exchange	<a href="http://www.newyorkrelief.com/Tenants.cfm">http://www.newyorkrelief.com/Tenants.cfm</a>
New York State web site	<a href="http://www.state.ny.us/">http://www.state.ny.us/</a>
On Island Communications	<a href="http://www.onisland.com/wtc/">http://www.onisland.com/wtc/</a>
TenantWise WTC Relocation Survey	<a href="http://www.tenantwise.com/">http://www.tenantwise.com/</a>
UnBlinking Compilation of Businesses in the WTC Complex	<a href="http://www.tbtf.com/unblinking/arc/2001-09a.htm">http://www.tbtf.com/unblinking/arc/2001-09a.htm</a>
Wall Street Journal web site	<a href="http://www.interactive.wsj.com/public/resources/documents/Tenant-List.htm">http://www.interactive.wsj.com/public/resources/documents/Tenant-List.htm</a>
World Trade Aftermath.com	<a href="http://worldtradeaftermath.com/wta/contacts/companies.asp">http://worldtradeaftermath.com/wta/contacts/companies.asp</a>

sample file or could be found through Internet searches. Additionally, 232 organizations submitted lists of eligible employees to the WTCHR. The number of individuals on these lists could also be used to supplement those cases where number eligible was not provided by an informant. WTCHR self-registration packets were an alternative to list submission and contained printed materials designed to encourage individuals to enroll in the WTCHR via the self-registration web site. Employers were asked to distribute one packet per eligible individual. This number could however either underestimate or overestimate the number eligible in cases where eligible individuals no longer working for the employer were excluded, or where packets were distributed to all employees regardless of eligibility.

The following sections describe the process utilized to estimate the denominators for each sample type. Because of the multiple populations pursued (workers and volunteers, residents, school students and staff, and building occupants), several approaches were required to determine the total number eligible. For some sample types, such as residents, lists of households or individuals were much easier to acquire than for others, such as building occupants. The denominator estimation approach employed is based in Census methodology (Sudman & Kalton, 1986; U.S. Bureau of the Census 2001, 2003; Wolter, 1986) and was customized to fit the specific nature of this population and the many unique and varied components of the WTCHR.

### 2.1 Workers and Volunteers Involved in Rescue, Recovery, and Clean-up Denominator

A total of 488 organizations involved in rescue, recovery, and clean-up efforts at the WTC site or Recovery Operations on Staten

Island remained after removing 182 of the 670 total cases that were confirmed ineligible (i.e., not involved in rescue, recovery, and clean-up efforts). The breakdown of cases by organization type is provided in Table 3. Note that the Port Authority is listed separately due to its potential categorization as both a city and state-affiliated agency.

**Table 3. Worker and Volunteer Entities by Subtype**

Worker and Volunteer Subtype	N Entities
Rescue, Recovery, and Clean-up Organizations	238
Federal Agencies	31
Unions/Associations	62
State Agencies	46
City Agencies	36
FEMA Teams	22
Volunteer Organizations	13
Port Authority	1

In the first stage of the denominator estimation process for workers and volunteers, key variables were exported from the List Building System (LBS) and the resulting file was examined for completeness. Cases which were incomplete, or contained questionable or discrepant information, were further researched. This research was conducted by reviewing case notes captured in the LBS, making follow-up calls to organizations in question, conducting Internet searches, and consulting NYCDOHMH. The variables of interest were as follows:

- Name of organization
- Organization type
- Number eligible (according to informant)
- Business size

- If self-registration packets selected as participation option, number of self-registration packets from field in LBS
- Final status code
- If list submitted, number of individuals on the list

This information was placed into a spreadsheet and evaluated for completeness. A final number eligible was assigned to cases in the following order: 1) number eligible per the informant, as recorded in the LBS; 2) when number eligible from the LBS was missing, the number of individuals on a list submitted was used; 3) when neither the number eligible from the LBS was available nor a list submitted, the number of self-registration packets requested was used.

Depending upon the entity involved, the following steps were taken to obtain information on any remaining worker and volunteer organizations missing denominator information: 1) the WTCHR Principal Investigator contacted enrolled respondents from the organization to gain an estimate; 2) in-person visits were made to organizations; 3) additional follow-up calls were made; and 4) a list of subcontractors received from Bovis Lend Lease was consulted. Outside sources were also consulted to confirm denominators for key responder groups such as FDNY and NYPD. These sources include: 1) GAO Testimony: September 11: Health Effects in the Aftermath of the World Trade Center Attack; and 2) The 9/11 Commission Report.

An estimated number eligible was imputed from business size for five city, state, and federal agencies, using the same process developed for estimating the number eligible in

buildings within the targeted geographic area (i.e., south of Chambers Street) and detailed in Appendix B. A multiplier was applied to business size to estimate the number eligible.

For four remaining construction/supplier cases where a true number eligible could not be collected from an informant or other aforementioned method, the number of individuals from the organization who enrolled in the WTCHR was used as an estimate of the denominator. These cases represented companies known to have been eligible for the WTCHR under the rescue, recovery, and clean-up criteria. Rather than omit these organizations from the denominator, we opted to include the number of eligible, enrolled workers. Without any additional information on these entities, this method was selected to ensure that the registrants were counted, but the denominator was not inadvertently inflated.

### 2.1.1 Adjustments to City, State, and Federal Agency Denominators

Individuals can be eligible for the WTCHR under more than one categorization (e.g., a city worker and a rescue, recovery, and clean-up volunteer), and, as such, can contribute to more than one denominator estimate. Ten of the city, state, and federal agencies that were eligible due to their contribution to 9/11 rescue, recovery, and clean-up efforts were also housed in one of the 38 damaged or destroyed buildings and structures—making their employees eligible under both sample groups. The 10 agencies involved included four city agencies, four state agencies, one federal agency, and the Port Authority. As a result, the number eligible estimates for these 10 agencies were counted in both the worker and volunteer, and the occupants of collapsed and damaged buildings denominators.

Attempts were made to accurately estimate the proportion of the total number eligible from these agencies that should be retained in the worker denominator. A confirmed estimate of the number of rescue, recovery, and clean-up workers was collected for the Port Authority. To estimate the proportion of individuals from the remaining nine agencies who may also be eligible as workers, worker list eligibility rates (i.e., the proportion of individuals from each agency list that were confirmed eligible as workers) were computed separately for each agency submitting a list. The average proportion of individuals on lists who were eligible as workers and volunteers was computed for each agency type. Average worker list eligibility rates for city, state, and federal agencies were 19.93%, 44.78%, and 44.74%, respectively. An estimate of the number of eligible workers within each agency was derived by: 1) applying the agency-specific worker list eligibility rate to the total number eligible for agencies that submitted a list (n=2 cases), or 2) applying the agency average worker list eligibility rate to the total number eligible for agencies that did not submit a list (n=7 cases). For example, an agency that submitted a list of 100 persons and had a worker list eligibility rate of 5% would have an estimated worker denominator of 5 individuals. The agency total of 100 eligible persons would also be maintained in the building occupants denominator.

The denominator for one additional federal agency was adjusted using the average worker list eligibility rate for federal agencies. This agency provided the total number of employees in a region, rather than the number who were deployed after 9/11/01 as rescue, recovery and clean-up workers.

During contacting efforts, it was determined that many of the city agencies provided total number of employees, rather than total number of eligible employees, as a denominator. In addition, the majority of city agencies had offices south of Chambers Street, making their employees potentially eligible as Group 2 building occupants (e.g., people who were in a building, on the street, or on the subway south of Chambers Street on 9/11/01) and/or workers and volunteers. Because the denominator estimates provided for the majority of city agencies reflected both sample types, further adjustment of city agency denominators was necessary to achieve worker-only estimates.

Of the 36 eligible city agencies, four were adjusted based on the aforementioned method involving the building occupants denominator. The number of employees involved in rescue, recovery, and clean-up work was confirmed for 16 cases and no further adjustments were made. For the remaining 16 agencies, worker list eligibility rates were computed and used to adjust the denominators. Estimates of the proportion of individuals eligible as workers within each agency was computed by: 1) applying the agency-specific worker list eligibility rate to the total number eligible for agencies that submitted a list (n=8 cases), or 2) applying the average worker list eligibility rate for all city agencies to the total number eligible for agencies that did not submit a list (n=8 cases). As previously mentioned, the average worker list eligibility rate for city agencies was 19.93%. City agency worker list eligibility rates ranged from 0.0% to 55.34%.

### 2.2.2 Adjustments to Union Denominators

To account for possible inflation in denominator estimates, potential overlap among city agencies and unions was

considered. Most city agency employees also belong to unions or employee associations (e.g., NYPD and the Patrolmen's Benevolent Association); the numbers eligible for these entities should be counted only once. All city agency and union cases were examined for possible overlap and denominators adjusted accordingly.

### 2.2.3 Adjustments to Volunteer Organization Denominators

Further adjustments were also made to account for inflation in the denominator estimates for volunteer organizations. The majority of volunteer organizations were only able to estimate the total number of volunteers that assisted in 9/11/01 related efforts in New York, rather than the number of volunteers that worked within the WTC site boundaries specified for eligibility. A list of 11,051 volunteers supplied by the Salvation Army was used to approximate the number of likely eligibles from the other volunteer groups. Specifically, interview data on Salvation Army volunteers contacted for the WTCHR was used to better estimate an accurate denominator for other volunteer groups. Analyses indicated that 96% of confirmed eligible individuals on the Salvation Army list were classified as rescue, recovery, and clean-up workers. Of these, 72.52% were eligible for the WTCHR. This percentage was applied to the estimated denominators for each of the volunteer groups in order to arrive at a final number eligible estimate for each organization. The adjustment made to the denominator of the remaining 12 volunteer groups was designed to reduce the likelihood of inflation or overestimation of the number eligible in those organizations. Similar to the Salvation Army, it is likely that other volunteer groups deployed a set of volunteers to assist in 9/11 efforts, but that only a proportion

of those deployed would actually be eligible under the WTCHR criteria due to the location, duties, or time of their service.

## 2.2 Residents Denominator

The most recent U.S. Census of Population and Housing was conducted on April 1, 2000—a little over a year prior to the September 11, 2001 terrorist attacks on the WTC. The decennial census collects a limited number of data elements on every person and housing unit in the United States, including age, sex, race/ethnicity, tenure (whether the home is owned or rented) and vacancy characteristics (Census 2001, 1). Summary data are available down to the block level, but are also available at the block group, tract, and ZIP Code Tabulation Area (ZCTA) level. Census tracts are especially attractive as geographic strata, since they generally include between 1,500 and 8,000 persons and are designed to be homogeneous with respect to population characteristics, economic status, and living conditions. While Census data are subject to a small amount of under or overcoverage (estimated between .12% undercoverage to .50% overcoverage nationwide—Census 2001, 2; Census 2003) they provide the most timely and accurate estimates of the residential population south of Canal Street in lower Manhattan on September 11, 2001.

Because of the short amount of time between the Census and WTC tragedy, and their high level of coverage, Census data are used as the primary source for calculating the resident portion of the denominator. Census data are publicly and freely available from the U.S. Census Bureau.

### 2.3 School Students and Staff Denominator

Because the NCES 2000–2001 data provided numbers of students enrolled and staff employed at the 14 eligible public schools, these numbers were used for the denominator. Denominator information for private schools, preschools, and day cares was collected during telephone contacts and/or in-person visits with the school representatives. Five private schools were included in the schools denominator. After removing four cases that were found to be ineligible during telephone contacts (i.e., not a preschool on 9/11, not located south of Canal on 9/11), 18 preschools and day cares remained in the denominator.

### 2.4 Occupants of Collapsed and Damaged Buildings Denominator

A total of 1,419 businesses remained after removing cases that were confirmed ineligible (i.e., not located in a target building on 9/11/01; not a unique entity; no one at work on 9/11/01, etc.). An additional 217 unlocatable cases that could not be confirmed as eligible were removed from the denominator estimates, leaving a total of 1,202 businesses included in the denominator.

In the first stage of the denominator estimation process for building occupants, key variables were exported from the List Building System (LBS) and the resulting file was examined for completeness. Cases which were incomplete, or contained questionable or discrepant information, were further researched. This research was conducted by reviewing case notes captured in the LBS, making follow-up calls to organizations in question, conducting Internet searches, and consulting NYCDOHMH. The variables of interest were as follows:

- Name of organization
- Number eligible (according to informant)
- Business size
- If self-registration packets selected as participation option, number of self-registration packets from field in LBS
- Final status code
- 9/11 Address
- If list submitted, number of individuals on the list

After examining the information, it was possible to assign a final number eligible for 239 of the 1,202 total businesses providing a count. These cases did not require estimation, but rather the final number was assigned based on existing data in the following order: 1) number eligible per an informant, as recorded in the LBS; 2) when number eligible from the LBS was missing, the number of individuals on a list submitted was used; 3) when neither the number eligible from the LBS was available nor a list submitted, the number of self-registration packets requested was used as the number eligible.

A total of 963 cases (80.1%) required estimation of number eligible. As previously mentioned, an imputation plan was designed to estimate missing data from existing data based on business size. A multiplier was applied to business size to estimate the number eligible. Information about square footage of office space leased was also utilized. This variable was converted into business size so that imputation could be conducted. The details of the steps, process, and multipliers are shown in Appendix B.

After the imputation process was applied to cases that contained business size or square feet leased, 100 cases remained that were missing number eligible and also any auxiliary information on business sizes or square feet of office space leased. These cases were researched further via Internet searches (using many of the sources shown in Table 2), follow-up calls to informants, or in-person visits to the businesses by NYCDOHMH, in an effort to determine number eligible, business size, or square footage leased. No additional information was found.

The list of tenants in the WTC complex provided by the Port Authority to NYCDOHMH (n=950 companies represented) was reviewed to determine an appropriate estimated business size for the remaining 100 businesses. An examination of business size across WTC tenants indicated that 40% of companies had 5 or fewer employees and 56% of companies had a business size of 10 or fewer. The list was further searched for the names of the 100 companies missing information. Twelve businesses were listed on the Port Authority list. Of these, the company size ranged from 1 to 15 and the mean company size was 4.6. Based on this information, a business size of 5 was estimated for the last 100 cases. The number eligible was then imputed using the multiplier for businesses in the bottom quartile (see Appendix B for further detail on imputation). Table 4 summarizes the denominator estimation strategy employed for each of the 1,202 businesses.

**Table 4. Breakdown of Denominator Estimation Strategy for Businesses**

Category	N Entities
Businesses with Complete Data	239
Businesses Imputed Based on Business Size or Number Eligible	863
Businesses Imputed Based on Port Authority Data	100
Total Number of Eligible Businesses	1,202

## 2.5 Final Denominator Estimates by Group

The final denominator estimates for occupants of collapsed and damaged buildings, rescue, recovery, and clean-up workers, students and school staff, and residents south of Canal Street are presented in Table 5. A breakdown of the building occupants denominator by WTC 1, WTC 2, and non-Tower damaged and destroyed buildings is provided in Table 6. Of the estimated 62,092 total building occupants, an estimated total of 24,015 individuals were in WTC Towers 1 and 2.

## 3.0 SUMMARY

The sample building effort for the WTCHR resulted in the identification of over 2,200 entities across the four sample types pursued and a sample of over 197,952 names of potentially eligible respondents. Of the 197,952 preregistrants identified, 135,553 originated from lists sent to the WTCHR, 36,847 from inbound calls, and 25,552 from web site self-registrations. Of these, interviews were completed with 71,437 eligible individuals. Each of the sample building modes significantly contributed to the total number of completed interviews, with 28,581 originating with an inbound call to the WTCHR, 22,039 from list cases, and 20,817 from web site self-registrations.

**Table 5. Sample Type and Number Eligible**

Sample Type	Subtype	N of Entities	Estimated N of Persons Eligible for the WTCHR
Workers and Volunteers	Construction Firms/Laborers	238	20,397
	City Agencies (includes FDNY, NYPD)	36	26,659
	State Agencies	46	8,897
	Federal Agencies	31	5,122
	FEMA Teams	22	3,499
	Unions	62	15
	Volunteer Organizations	13	26,480
	Port Authority	1	400
	<b>TOTAL</b>	<b>449</b>	<b>91,469</b>
Residents	Group 1- south of Chambers Street	n/a	21,926
	Group 2 - south of Canal Street	n/a	35,585
	<b>TOTAL</b>	<b>n/a</b>	<b>57,511</b>
School Students and Staff	Public Schools	14	12,623
	Private Schools	5	847
	Preschools	18	1,727
	<b>TOTAL</b>	<b>37</b>	<b>15,197</b>
Occupants of Collapsed and Damaged Buildings	<b>TOTAL</b>	<b>1,212</b>	<b>62,092</b>

Sample building and denominator estimation for the WTCHR posed a unique challenge given the sheer magnitude of organizations to be identified and contacted, as well as the need to reconstruct the sample of eligible entities retrospectively. Denominator estimation indicated that as many as 62,092 building occupants, 91,469 workers, 15,197 students and school staff, 21,926 residents south of Chambers Street, and 35,585 residents south of Canal Street may represent the true eligible population for the WTCHR. These data will be used to examine outcomes rates and coverage rates on the WTCHR.

**Table 6. Breakdown of Building Occupants Denominator**

Building	Estimated N of Persons Eligible for the WTCHR
WTC 1	12,074
WTC 2	11,941
WTC Towers combined	24,015
Non-Tower damaged/ destroyed buildings	38,077
<b>TOTAL</b>	<b>62,092</b>

## Notes

Results presented in this technical report are based on World Trade Center Registry data as of November 2005.

The findings in this report have undergone external peer review as required by ATSDR policy and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

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## Appendix A

### World Trade Center Health Registry: List of Collapsed or Damaged Buildings and Structures

Status According to FEMA WTC Building Performance Study	Collapsed or Damaged Buildings and Structures*
Collapse	WTC 1/North Tower
Collapse	WTC 2/North Tower
Collapse	WTC 3
Collapse	WTC 7
Collapse	North Bridge
Collapse	St. Nicholas Greek Orthodox Church
Partial Collapse	WTC 4
Partial Collapse	WTC 5
Partial Collapse	WTC 6
Partial Collapse	WTC Concourse
Major Damage	West Street Building/Coal and Iron Exchange
Major Damage	Bankers Trust/Deutsche Bank/130 Liberty St.
Major Damage	Fiterman Hall
Major Damage	Verizon Building
Major Damage	2 WFC/Tower B
Major Damage	3 WFC/Tower C Annex
Major Damage	NYFD Ladder 10
Major Damage	120 Cedar St.
Major Damage	Winter Garden
Major Damage	Green Exchange Building
Major Damage	45 Park Place
Major Damage	Engineering Building
Moderate Damage	South Bridge
Moderate Damage	Bank of New York
Moderate Damage	Bankers Trust/Deutsche Bank/123 Washington St.
Moderate Damage	RR Donnelly and Sons Company
Moderate Damage	WFC 1/Tower A
Moderate Damage	110 Liberty St.
Moderate Damage	Century 21 Department Store
Moderate Damage	Federal Office Building/Post Office
Moderate Damage	Gateway Plaza
Moderate Damage	110 Greenwich St.
Moderate Damage	114 Greenwich St.
Moderate Damage	One Liberty Plaza
Moderate Damage	Marriott Hotel
Moderate Damage	Millennium Hotel
Moderate Damage	110-120 Church St.
Moderate Damage	Trinity and US Realty Buildings

\*Note. Many of the collapsed or damaged buildings have multiple street addresses, though only one address is provided in Appendix A.

## Appendix B

### World Trade Center Health Registry Denominator Estimation Task Imputation Plan for Cases Missing Number Eligible

In order to estimate the total number of true eligible persons within an eligible organization, an organized hierarchical process was followed. This document details the rationale and results of that process.

#### Step 1: Secured an Estimate of Business Size

Where available, an estimate of business size was extrapolated using data from the following sources (in order of priority):

- List Building System (LBS)
- DOHMH estimate from denominator files sent to RTI
- Genesys
- Downtown Alliance (DA) database
- New York Metropolitan Transportation Council (NYMTC) database

Table 1 provides the percentage of business case record matches for Genesys, Downtown Alliance, and NYMTC, respectively.

**Table 1. Percentage of Case Record Matches by Source**

Genesys	Downtown Alliance	NYMTC
55.4%	24.6%	14.5%

Note that these are not mutually exclusive. One case record could have information from all three sources, two, one, or none. Table 2 presents the overlap of business case record matches for Genesys, Downtown Alliance, and NYMTC.

#### Step 2: Determined Multipliers to Compute Number Eligible from Business Size

A total count of 30,913 eligible registrants was obtained from the 239 (19.9%) businesses providing a count. For the remaining 963 (80.1%) businesses, no information on the number of persons present on 9/11/01 was directly obtained. This is primarily due to the fact that many organizations could not be located (e.g.,

**Table 2. Business Case Record Match Overlap by Source**

Genesys	Downtown Alliance	NYMTC	N	Percent
Yes	No	No	510	42.4%
No	Yes	No	197	16.4%
No	No	Yes	76	6.3%
Yes	Yes	No	71	5.9%
Yes	No	Yes	70	5.8%
No	Yes	Yes	12	1.0%
Yes	Yes	Yes	16	1.3%
No	No	No	250	20.7%
<b>TOTAL</b>			<b>1,202</b>	<b>100.0%</b>

out of business, tracing unsuccessful) or were only contacted by mail due to resource constraints. Estimates of the total number of employees (i.e., business size) were present for many of these cases, however. The proportion of total employees who may be eligible was estimated by creating a multiplier that was applied to business size.

The relationship between number eligible obtained from an informant for businesses we reached by telephone, and business size was examined. An analysis of 157 cases with existing LBS data for both number eligible and business size indicated a correlation of  $r = .93$ . Scatterplots revealed a linear relationship between number eligible and business size, particularly at the lower to middle range of the continuum (e.g., smaller number eligible, smaller business size).

The following steps were conducted to determine appropriate multipliers to compute number eligible from business size. First, the hierarchy of business size source (as noted in Step 1) and number eligible source (e.g., number eligible estimate from informant, number on list, and number of self-registration packets) was applied to get single estimates for each business. Next, cases with data on both business size and number eligible, where business size was greater than number eligible, were selected. Cases were then divided into quartiles to determine whether the relationship between business size and number eligible was different at different levels of business size. The sum of number eligible was divided by the sum of business size within each quartile. Results indicated that eligibility rates were slightly lower for smaller businesses than for larger businesses, as follows:

- The bottom quartile:  $0 < \text{Business size} \leq 18.5$ ; Multiplier = .429952
- The middle quartiles:  $18.5 < \text{Business size} \leq 174$ ; Multiplier = .458833
- The top quartile:  $174 < \text{Business size}$ ; Multiplier = .541082

The three multipliers were applied to the business size of those cases missing number eligible. The multiplier selected was based on the appropriate business size of the case.

### **Step 3:** For Cases Missing Business Size, Estimated Business Size from Square Feet of Office Space Leased

Square feet of office space leased is a variable included in the NYMTC database. An analysis of 126 cases with both square footage and business size information indicates a correlation of  $r = .82$  for these variables. A scatterplot revealed a linear relationship between business size and square footage, particularly at the lower end of the continuum (e.g., smaller business size, less square footage leased). Given this relationship, square feet of office space leased was used to estimate business size for those cases where only square footage was present.

The approach described in Step 2 was employed to determine appropriate multipliers to compute business size from square feet of space. Cases with data on both square feet of space leased and business size were selected. Cases were then divided into quartiles to determine whether the relationship between square feet of space leased and business size was different at different levels of business size. The sum of business size was divided by the

sum of square feet leased within each quartile. Results indicated that smaller businesses were more densely populated with higher numbers of employees per square feet of office space leased. Multipliers for number of employees per square feet were as follows:

- The bottom quartile: Square feet leased  $\leq 800$ ; Multiplier = .00648
- The middle quartiles:  $800 < \text{Square feet leased} \leq 10,000$ ; Multiplier = .00268
- The top quartile:  $10,000 < \text{Square feet leased}$ ; Multiplier = .00135

These multipliers represent number of people per 1 square foot of space. The inverse of this figure (1 square foot/multiplier) is the number of square feet per person (e.g., the bottom quartile businesses have an average of 154 square feet per person, while the top quartile businesses have 740).

The three multipliers were applied to the square feet leased variable for those cases missing business size. The multiplier selected was based on the square feet of office space leased in each case.

**Step 4:** Applied a Multiplier to Compute Number Eligible from the Estimated Business Size (based on Square Footage)

After computing a business size for each case in Step 3, the three multipliers noted in Step 2 (i.e., .43, .46, and .54) were applied to the business size to estimate number eligible. The multiplier selected was based on the appropriate business size of the case.