A Report for
The Board of Elections in the City of New York

An Analysis of the Number of Voters per Voting Machine

21 August 2006
Engagement: 221001231

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1.0 Introduction

1.1 Voting Device Replacement Mandate

In accordance with the Help America Vote Act (HAVA) and New York State Election Law, the current mechanical full-face lever voting machines used in New York City and elsewhere in New York State, will no longer be permitted for elections conducted in 2007. They will need to be replaced with newer voting technology devices. Current New York State Election Law, however, stipulates that counties must allocate voting machines such that no more than a maximum of 800 registered voters (maximum) are allocated for each voting machine. There are different voting system technologies allowed under New York Election Law with differing processing capacities. Further, the City of New York is interested in determining how many machines, given their differing capacities, it would need to acquire to operate elections efficiently using each of the allowed voting system technologies.

1.2 Report Objectives

The objectives of this report are to:

- **Estimate Number of Machines for NYC** - Estimate the number of machines that will likely be required to accomplish full replacement of the lever machines in NYC. To estimate how many machines are needed for NYC, it will be necessary to estimate rates of voting per type of machine and apply that to NYC voting population and configuration.
- **Estimate Maximum Registered Voters Per Machine for NYS** - Estimate the maximum number of registered voters per machine by type of machine that would be reasonable for New York State. Given that lever voting machines will no longer be permitted in New York State and given that full-face DREs but not other types of DREs will be permitted in NYS, what should the maximum number of registered voters (by type of technology) be for NYS?

1.3 Voting Device Technologies

In order to understand the implications of the replacement of current voting machines in terms of the number of devices required and the maximum number of registered voters per machine, it is first necessary to understand the types of voting technologies.

New York State Election Law permits replacement of current lever machines with either of two major pollsite voting technologies:

- Pollsite Optical Scan Systems
- Direct Recording Electronic (DRE) Systems.

The Federal Election Assistance Commission (EAC) defines these technologies as follows[1]:

1. **Pollsite Optical Scan Voting Systems:** System by which votes are recorded by means of marks made in voting response fields designated on one or both faces of a ballot card [paper] or series of cards. An optical scan system reads and tabulates ballots, usually paper ballots, by scanning the ballot and interpreting the contents. Also known as

[1] EAC Voluntary Voting System Guidelines: Volume I – Voting System Performances Guidelines. Appendix A – Glossary

marksense. A pollsite optical scan system also produces a tabulation of the voting data stored in a removable memory component and in printed hardcopy. Pollsite optical scan systems are allowed in New York by New York State Election Law.

2. **Direct-Recording Electronic (DRE) Voting Systems:** An electronic voting system that utilizes electronic components for the functions of ballot presentation, vote capture, vote recording, and tabulation which are logically and physically integrated into a single unit. A DRE produces a tabulation of the voting data stored in a removable memory component and in printed hardcopy. There are three types of DRE Voting Systems:

   - **Full-Face Paper Ballot Overlay DRE Machines** – These devices rely on pushbutton technology, the front face of the machine is a large printed sheet of paper displaying the entire ballot on its full-face. Next to or under the sheet are electronic push buttons that correspond to the contest or issue in the overlaying printed ballot face. The voter presses the button to make a selection.
   - **Full-Face Touch Screen DRE Systems** – Instead of a printed ballot sheet, there is a large electronic touch screen on which all the contests and issues are displayed on its full-face. The voter touches a selection directly on the screen and their choice is then recorded.
   - **Paging Touch Screen DRE Systems –** In these devices the electronic touch screen is does not display a full-face ballot. The screen is much smaller and the voter has to page or scroll though multiple screens as they make their choices. Note that the use of **paging** DREs is not an option in New York State as State Election Law has been widely interpreted to require DRE systems to display a **full-face**, where the entire ballot is displayed at once on a single face.

1.4 Report Methodology

In order to estimate the number of machines required by NYC and estimate appropriate maximum number of registered voters per machine, we developed an overall approach.

1.4.1 Overall Approach

To accomplish this approach, we performed the following:

1. **Survey of Other Jurisdictions -** Gathered and analyzed empirical evidence from other jurisdictions on the type and number of voting machines used by them.
2. **Estimated Machines Required in NYC -** Performed a calculation (by type of voting machine technology) using information specific to the City of New York to determine estimates of the number of machines (by type of machine technology) that will be needed to replace current NYC's lever machines.
3. **Determination of Maximums -** Determined a reasonable maximum number of registered voters per machines by type of machine given the number of machines required by NYC**.**

1.4.2 Methods of Calculation

We used two general methods of calculation corresponding to the two main technologies, one approach for pollsite optical scan technology and another approach for Direct Recording Electronic (DRE) technology.

1.4.2.1 For Pollsite Optical Scan Technology

1. We gathered empirical data about how many registered voters per machine, on average, are actually operated in other large jurisdictions (on average 1,400 registered voters per scanner)
2. Using the configuration of pollsites in New York City with respect to number of voters and number of election districts (EDs) per pollsite, we applied the average from other jurisdictions to NYC.
3. We then calculated the number of scanners that would be required for NYC.

1.4.2.2 For Direct Recording Electronic (DREs)

1. We started with the current maximum number of registered voters per machine in NYS (800 per machine)
   - Factored in a 50% turnout (400 actual voters per machine)
   - Divided that number into a 15 hour day to determine how many minutes voters are currently provided (2 minutes, 16 seconds per actual voter)
   - Adjusted the number of minutes for the new technology (added about 1 minute for the VVPAT) (3 minutes, 15 seconds/voter)
   - Divided that number of minutes into the 15 hour day to determine how many voters can be accommodated (277 actual voters per machine)
   - And factored in a 50% turnout (554 registered voters per machine)
2. We decided that it would be useful to gather empirical data about how many registered voters per machine (by type of machine) are actually operated in other large jurisdictions, to see if our calculated projection of 554 voters per machine is supported by the empirical data.
3. Finally, once we determined that our projection was supported by the survey data, we used the configuration of Election Districts and pollsites in New York City to calculate the number of full-face ballot overlay DREs, and the number of full-face touch screen DREs that would be required. Note that this calculation needed to be based upon the number of registered voters per Election Districts (precincts) for ballot overlay DREs and on number of registered voters per pollsites for touch screen DREs.

1.5 Parameters to Voting Machine Capacities

There are numerous parameters (factors) that can affect the number of voters that can be processed using a given voting system technology. This report makes assumption for NYC for the first five (5) of these factors. We indicate notes about each of the other factors as shown.

These factors include:

1. **Duration of Election Day** - The number of hours polls are open on Election Day (varies by jurisdiction). For New York City this is 15 hours.
2. **Voter Turn-out** – The greater the voter turn-out, the more voters need to be processed within the Election Day duration and the deployed pollsite voting systems. Predicting turn-out is not an exact science. We assumed through-out a 50% voter turn-out.
3. **Voter Wait Time Tolerance** - The acceptable wait time for voting for a given population. We calculated the actual vote time in NYC to average 2 minutes and 15 seconds.

4. **Voters Per Election District** - The number of registered voters per precinct (Election District). We used voter registration numbers for 2004 (4,494,421) and assumed 6,100 EDs (737 Registered Voters per ED).
5. **Pollsite/ Election District Configuration** - The configuration of Election Districts (precincts) to polling sites (the more Election Districts per pollsite, the greater opportunity to leverage multiple ED machine capabilities and device availability – i.e. go to next available machine in a bank teller line). We assumed the current BOE in NYC configuration.
6. **Machine ED Capacity** - The degree to which pollsite voting system can support more than one Election District (precinct). We estimated these by type of machine.
7. **Degree & Type of Disability Voting** - The degree to which disability voting occurs on the same or different machines than regular voting and the degree to which audio ballots are used. The degree & type of disability voting is unknown at this time, since it has not specifically occurred in NYC in the past (no special Ballot Marking Device or voting machine designed for it).
8. **Under-voting Alert** - For optical scan, whether the alert for under-voting is disabled (to speed processing). It is believed that most of the survey jurisdictions that use pollsite optical scan systems disable the under-voting alert since many voters routinely and purposely under-vote. It is believed that New York State Election Law requires the use of the under-vote alert. Therefore, projections derived from data gathered from jurisdictions where the alert is disabled will be low. Scanning times can be expected to be longer in New York State.
9. **Ballot Contest Size** - The number of races, candidates and propositions on the ballot for a given election. Ballot contest size varies by type and year of election. No assumptions were made about ballot size other than that future ballot sizes would not vary from past ballot sizes.
10. **Capacity to Store Votes** - The capacity of pollsite voting systems in terms of votes cast. Optical scan machines have limitations on the number of paper ballots that can be store (bin size) and DRE technologies have electronic storage limitations. It was assumed that these limitations were not exceeded in this analysis.

1.6 Limited Report Scope

This report is intended to estimate the number of voting machines by type of machine that will be required by NYC for 2007 and to determine a reasonable maximum number of registered voters per machines (by machine type).

The number of machines required by NYC is <u>only one</u> of the factors that need to be considered when selecting new voting machines. Other factors that should affect the selection which are <u>not</u> considered in this report include:

- Ease of Use by Voters
- Ease of Use by Pollworkers
- Ease of Administration by BOE in NYC
- Long-term cost of operation
- Vendor Viability
- Maintenance and warranty

- Change Management Impact

The reader is cautioned to not extrapolate from the results of this report that one type of technology is more suitable or less costly than another. Such conclusions are not warranted and are beyond the scope of this report.

2.0 Survey of Other Jurisdictions

2.1 Survey Methodology

To determine how many voting machines are actually used, by type of machine, in other jurisdictions, we did the following:

- Examined published data on the subject and the assumptions and quality of that data.
- Conducted telephone interviews with most of the 30 largest election jurisdictions in the US.
- Conducted telephone interviews with other election jurisdictions known to use full-face technologies since few of the largest jurisdictions do so.
- Analyzed the results of the published and surveyed data
- Estimated the average number of registered voters per machine by type of machine based on the data

2.2 Published Data

We found that the most directly useful information was available on the Election Assistance Commission Website: http://www.eac.gov/ under 2004 Election Day Survey Results. The Introduction to this report states that:

> "In the fall of 2004, the U.S. Election Assistance Commission (EAC) distributed the first-ever Election Day Survey, requesting voting and elections information from election officials throughout the country. Collecting this information is part of EAC's mission to provide resources and guidance to policy makers and election officials as we work together to make sure every vote is counted fairly and accurately.
>
> The 2004 Election Day Survey is the largest and most comprehensive survey on election administration ever conducted by a U.S. governmental organization, and we thank the nation's secretaries of state and state and local elections officials for their cooperation and contribution."

The report was developed by Election Data Services, Inc. (EDS), a Washington, DC-based consulting firm that specializes in a variety of election administration issues, along with redistricting and the Census. The published data, however, is for all counties in the United States. For this analysis, we concentrated on the data for the largest 20-30 counties in the US which would be more reflective of conditions in the City of New York. This data for the 30 largest counties in the country represented 20% of the registered voters in the US in 2004.

Data for the largest 20-30 counties, however, was not publicly available, so Gartner contacted EDS and acquired that data in its raw form for this report. We found that some of the data was missing (e.g., the county involved had not reported the data to EDS), some data was skewed (Los Angeles County reported its central count optical scan as pollsite optical scan equipment), and there were other small discrepancies which we worked with EDS to resolve. Finally, almost all of the largest counties do not use full-face DRE devices, so we examined data from additional jurisdictions that use these technologies.

2.3 Telephone Survey

We identified a knowledgeable contact for each of the largest counties and conducted telephone interviews with them primarily to:

- Obtain the missing data
- Understand why there would be significant differences in the number of voting devices per registered voters in jurisdictions using the same type of voting devices.

Finally, we re-compiled the data and analyzed the results.

The counties that were examined are as follows:

Rank out of Top 30 Counties	County / Jurisdiction	Registered Voters	Early Voting	Device Type	Number of Machines	Average Number of Reg. Voters per Machine
Largest Counties with Optical Scan Machines						
2	Suburban Cook County	1,378,159	Yes	Optical scan	2,100	656
4	Maricopa County	1,552,421	Yes	Optical scan	1,275	1,218
5	San Diego County	1,513,300	Yes	Optical scan	1,750	865
7	Wayne County	1,412,388	No	Optical scan	1,160	1,218
12	King County	1,082,406	No	Optical scan	525	2,062
23	Oakland County	889,642	Yes	Optical scan	600	1,483
22	State of Wisconsin	4,179,774	No	Optical scan	3,563	1,173
9	Dallas County	1,231,291	Yes	Optical scan	485	2,539
Largest Counties with Paging DRE Machines						
3	Harris County	1,937,072	Yes	Paging DRE	10,000	194
6	Orange County	1,495,824	Yes	Paging DRE	9,000	166
14	Miami-Dade County	1,058,801	Yes	Paging DRE	7,200	147
15	Broward County	1,058,069	Yes	Paging DRE	6,000	176
16	Cuyahoga County	1,005,807	No	Paging DRE	5,407	186
18	Allegheny County	918,877	No	Paging DRE	4,700	196
22	Bexar County	908,466	Yes	Paging DRE	2,317	392
24	Santa Clara County	865,271	Yes	Paging DRE	5,500	157
25	Franklin County	845,720	No	Paging DRE	2,818	300
26	Riverside County	769,328	Yes	Paging DRE	3,747	205
30	Palm Beach County	729,575	Yes	Paging DRE	4,900	149
31	San Bernardino County	727138	Yes	Paging DRE	4,000	182
Counties with Full-Face Paper Overlay Machines (** County is not in the top 30)						
13	Philadelphia County, PA	1,062,439	No	Full-Face DRE	3,536	300
**	Delaware State	550,110	No	Full-Face DRE	1,242	443
**	Clark County, NV	684,313	Yes	Full-Face DRE	2,926	234
**	Ocean County, NJ	353,085	No	Full-Face DRE	704	502
**	Bergen County, NJ	522,750	No	Full-Face DRE	1,200	436
**	Montgomery County, PA	564,958	No	Full-Face DRE	1,050	538

Rank out of Top 30 Counties	County / Jurisdiction	Registered Voters	Early Voting	Device Type	Number of Machines	Average Number of Reg. Voters per Machine
**	City of Denver, CO	382,710	Yes	Full-Face DRE	1,184	323
**	Orleans County, LA	320,253	Yes	Full-Face DRE	894	358
**	Jefferson County, LA	287,300	Yes	Full-Face DRE	728	395
**	East Baton Rouge County	262,784	Yes	Full-Face DRE	680	386
Counties with Insufficient Data on Data Not Applicable						
1	Los Angeles County	3,972,738	InkaVote - Unique Technology, not included in survey sample			
10	New York County	1,110,217	Lever, New York, not included in survey sample			
11	Queens County	1,092,384	Lever, New York, not included in survey sample			
8	King County (Brooklyn)	1,082,406	Lever, New York, not included in survey sample			
17	Suffolk County	933,561	Lever, New York, not included in survey sample			
19	Tarrant County	918,656	Mixed Technology Systems, not included in survey sample			
20	Middlesex County	915,575	Mixed Technology Systems, not included in survey sample			
21	Nassau County	914,553	Lever, New York, not included in survey sample			
27	Milwaukee County	754,413	Optical Scan Included in Wisconsin Data			
28	Alameda County	742,258	In the middle of equipment procurement, could not verify data			
29	St. Louis County	736,709	Mixed Technology Systems, not included in survey sample			

2.4 Average Number of Registered Voters Based on Survey

Based on the data collected from the counties, Gartner was able to determine the average number of registered voters per voting device in all these counties. Note that other factors such as the number of precincts and pollsites, voter turn-out and machine capacity are all used in determining the number of machines required by a jurisdiction, however the average ratio of registered voters to machines gives us a consistent measure to use across all the counties and enables us to objectively examine how devices are deployed in these counties.

2.4.1 Average Registered Voters per Optical Scan Voting Machine

The following table displays the data findings from the largest counties in the country that use pollsite optical scan systems.

Rank out of Largest Counties	County / Jurisdiction	Number of Precincts	Registered Voters	Device Type	Total Units	Average # of Machines Per Precinct	Average Voter Reg. Per Machine
2	Suburban Cook County	2,400	1,378,159	Optical scan	2,100	1	656
4	Maricopa County	1,058	1,552,421	Optical scan	1,275	1	1,218
5	San Diego County	1,864	1,513,300	Optical scan	1,750	1	865
7	Wayne County	1,160	1,412,388	Optical scan	1,160	1	1,218
12	King County	540	1,082,406	Optical scan	525	1	2,062
23	Oakland County	581	889,642	Optical scan	600	1	1,483
22	State of Wisconsin	3,563	4,179,774	Optical scan	3,563	1	1,173
9	Dallas County	672	1,231,291	Optical scan	485	1	2,539
					AVERAGE	**1**	**1,402**

The counties listed above have an average of one optical scan machine for every 1,402 registered voters or **a ratio of about 1:1,400.**

2.4.2 Average Registered Voters per Paging Touch Screen DRE

Rank out of largest Counties	County / Jurisdiction	Number of Precincts	Registered Voters	Device Type	Total Units	Average # of Machines Per Precinct	Average Voter Reg. Per Machine
3	Harris County	885	1,937,072	DRE Paging	10,000	11	194
6	Orange County	2,055	1,495,824	DRE Paging	9,000	4	166
14	Miami-Dade County	749	1,058,801	DRE Paging	7,200	10	147
15	Broward County	777	1,058,069	DRE Paging	6,000	8	176
16	Cuyahoga County	1,451	1,005,807	DRE Paging	5,407	4	186
18	Allegheny County	1,314	918,877	DRE Paging	4,700	4	196
22	Bexar County	619	908,466	DRE Paging	2,317	4	392
24	Santa Clara County	1,029	865,271	DRE Paging	5,500	5	157
25	Franklin County	828	845,720	DRE Paging	2,818	3	300
26	Riverside County	872	769,328	DRE Paging	3,747	4	205
30	Palm Beach County	692	729,575	DRE Paging	4,900	7	149
31	San Bernardino County	819	727138	DRE Paging	4,000	5	182
					AVERAGE	**6**	**204**

The counties listed above have an average of one paging DRE machine for every 204 registered voters **or a ratio of about 1:200**.

2.4.3 Average Registered Voters per Full-Face Paper Overlay DRE

County / Jurisdiction	Number of Precincts	Registered Voters	Device Model	Total Units	Average # of Machines Per Precinct	Average Voter Reg. Per Machine
Philadelphia County, PA	1,681	1,062,439	Danaher ELECTronic 1242	3,536	2.10	300
Delaware State	437	550,110	Danaher ELECTronic 1242	1,242	2.84	443
Clark County, NV	1,042	684,313	Sequoia AVC Advantage	2,926	2.81	234
Ocean County, NJ	346	353,085	Sequoia AVC Advantage	704	2.03	502
Bergen County, NJ	557	522,750	Sequoia AVC Advantage	1,200	2.15	436
Montgomery County, PA	400	564,958	Sequoia AVC Advantage	1,050	2.63	538
City of Denver, CO	420	382,710	Sequoia AVC Advantage	1,184	2.82	323
Orleans County, LA	442	320,253	Sequoia AVC Advantage	894	2.02	358
Jefferson County, LA	267	287,300	Sequoia AVC Advantage	687	2.58	395
E. Baton Rouge County, LA	300	262,784	Sequoia AVC Advantage	680	2.27	386
				AVERAGE	**2**	**394**

The counties listed above have an average of one full-face paper overlay DRE machine for every 394 registered voters **or a ratio of about 1:400**.

2.4.4 Average Registered Voters per Full-Face Touch Screen DRE

There are no statistics for the use of full-face touch screen DRE machines. This is because these machines have not been used in any jurisdiction as of the time the survey was conducted.

2.5 Survey Key Findings

Based on the results of the County surveys above, the following key findings were determined:

- **Average Number of Registered Voters Per Machine –** For the jurisdictions surveyed the results show the following:

Type of Machine	Survey Average Number of Registered Voters Per Machine (rounded)
Full-Face Paper Ballot Overlay DRE	1:400
Full-Face Touch Screen DRE	N/A – Not used elsewhere in the Country
Paging DRE	Not permitted in New York State
Pollsite Optical Scan	1:1,400

- **Multiple ED Capability:** Note that full-face touch screen DRE machines have the capability of storing and bringing up different ballot types, therefore a single machine can serve multiple EDs if they are located in a single pollsite (as opposed to printed ballot overlay DREs which can only serve one ED due to the static nature of the printed face ballot). This factor may reduce the number of full-face touch screen DRE machines required at a pollsite over that currently required for lever machines.
- **Average Voter Machine Time Utilization** – Survey results indicate that on average, optical scan machines are approximately six times as fast as paging touch-screen DRE machines and about three times as fast as full-face DRE machines in processing voters on Election Day. Most of the voter's time is spent filling-out the paper ballot and not interacting with the optical scanner so that time at the scanner is minimal. Still, this is true when the under-vote alert is disabled. Employing the under-vote alert in New York State would likely significantly increase the amount of time required for each voter to complete his or her session at the scanner.
- **Average Number of Machines Per Precinct –** One optical scan machine is typically deployed to a single precinct. The survey shows that on average two full-face printed DRE machines are typically deployed to a single precinct.

2.6 Survey Data Assumptions

Conclusions drawn from the survey data should be placed within the context of the known limitations of the data as listed below.

1) **Data Collected from Other Jurisdictions was Average Number of Voters per Machine** – Data regarding the maximum number of voters per machine is inconsistent across the counties surveyed. Some may have legislation that controls the maximum number. The most consistent measure available was the average number of registered voters per machine. The "average" number of machines per registered voter should not necessarily become the "maximum" number of registered voters per machine.

2) **Early Voting** – Some of the jurisdictions surveyed conduct early voting. Early voting reduces the number of actual voters using machines at pollsites on Election Day and thus potentially increases the average number of voters per machine[1]. The absence of early voting in NYC means that the actual average number of registered voters per machine may be less than that which is calculated. See the table in Section 2.3 for the list of jurisdictions that conduct early voting.

3) **Distribution of Voting Machines to Pollsites –** Jurisdictions varied in their method for determining the number of machines to deploy at pollsites. They generally do not do so based on an average number of voters per machine but rather on their prior experience with each pollsite and the type of technology they deploy. Some precincts have historically high or low turn-out while others have high or low early voting, etc. Use of historical data by precinct helps them determine the number of machines to deploy to each pollsite.

4) **Under Voting Alert for Optical Scan** – Some jurisdictions turn off the feature that alerts voters of under votes on optical scan systems. If this feature is turned on, it increases the time required for a voter to complete the voting process because the paper ballot will get rejected more often since many voters deliberately under-vote. Once alerted, the voter has the option to complete his or her selection or to scan the ballot again knowing that they have under-voted on some contests. It is believed that many of the jurisdictions surveyed had turned-off the under-voting alert.

5) **Accessible Devices for Optical Scan Solution –** DRE voting devices are designed to enable the disabled to vote independently and with privacy. Optical scan technology machines read and count marked paper ballots but do not themselves assist the disabled to vote independently and with privacy. Accordingly, other devices such as ballot marking devices or phone systems are deployed specifically to assist the disabled in precincts in which optical scan machines are the mode of vote counting. These devices do not present the ballot to the voter in full-face format as New York State Law is widely interpreted to require. Thus, when optical scan machine counts are examined, they do not include counts of these additional machines for voters with disabilities. HAVA requires that at least one machine accessible to voters with disabilities be provided at each pollsite, if the machines are ordered before the end of 2006. If the machines are ordered after 2006, <u>each</u> machine must be accessible to voters with disabilities.

6) **Voter Verifiable Paper Audit Trail (VVPAT)** – VVPAT on Full-face DRE (required in New York State) is not deployed elsewhere in the country. Accordingly, the impact this will have on voting time (the assumption of 1 minute) is an estimate. There is no data upon which this can be determined at this time.

3.0 Estimation of Machines Required in NYC

Based on the different ratios of the average registered voters to voting machines and taking into consideration the number of registered voters, the number of pollsites and the number of Election Districts (EDs) in New York City as of June 2006, estimations by type of technology can be made of the number of voting machines required for NYC.

[1] Early voting was distributed fairly evenly across types of technology in this survey, so that its existence does not appear to favor the numbers for one or another technology. Because the percentage of early voting is not consistent across the jurisdictions, and because its use does not appear to favor one or another technology, the potential effect of early voting is not factored into the data used in this report.

3.1 Current NYC Data & Average Registered Voters per Lever Machine

NYC Parameters	Value	Comments
Election Districts (precincts)	6,101	Some EDs require more than 1 machine
Pollsites	1,357	Pollsite are voting locations for one or more EDs. Pollsites vary in the number of registered voters supported from as few as 100 to as many as 13,700.
Lever Machines	7,531	Current lever machines are limited to supporting at least 1 ED per machine.

New York City currently has a total of 7,531 Lever Machines. Using 2004 total voter registration of 4,494,421, the average ratio of registered voters to current Lever Machines is 597 voters per machine (**average of about 600 registered voters per machine**).

Current lever machines can support only one Election District (ED) per machine, because a paper ballot must be overlaid on the front panel of the machine, restricting its operation that day to the ballot on the paper. Accordingly, a calculation based upon Election Districts and the number of registered voters served by each ED is required to determine the number of machines required for this technology. The calculation using the 6,100 Election Districts of NYC was performed using the NYC CPESS System. The results of that calculation resulted in a requirement of **7,531** lever machines for NYC.

3.2 Pollsite Optical Scan Machines

3.2.1 Calculation of Optical Scan Machines Required in NYC

The survey showed that pollsite optical scan machines are deployed among the survey jurisdictions at the rate of 1,400 registered voters per machine. We can use that ratio as the basis to calculate the number of these machines needed for NYC.

Appendix A - Detail by Pollsite of Voting Machine Calculations for NYC, shows a calculation of machines required based upon a ratio of 1,400 registered voters per machine. The calculation is based upon the current NYC count of pollsites, the number of machines used at each pollsite and the number of registered voters served by each pollsite. If we used this method of calculation as shown in Appendix A, at the low end, there are, for example, 29 NYC pollsites that each support 100 registered voters. To accommodate these 2,900 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 1,400 registered voters (1:1,400) for pollsite optical scan machines, will require 29 optical scan machines.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:1,400	Total Number of Machines Required
100	29	2,900	1	29

Similarly, again looking at Appendix A, at the high end, there is, for example, 1 NYC pollsite that supports 13,700 registered voters. To accommodate these 13,700 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 1,400

registered voters (1:1,400) for pollsite optical scan machines, will require 10 optical scan machines.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:1,400	Total Number of Machines Required
13,700	1	13,700	10	10

Using this method, NYC will require **3,341** pollsite optical scan machines. Because these would be optical scan machines and because HAVA requires a disability accessible machine in every pollsite, NYC will also require a minimum of 1,357 Ballot Marking Devices for a total of 4,698 devices.

3.2.2 Key Assumptions

- **That A Minimum of 1 Machine is Required Per Pollsite –** A minimum of one machine is required per pollsite. Each of these machines can serve more than one ED. Therefore for NYC one machine can be allocated to more than one ED as long as all the EDs are in the same pollsite. Should this minimum be increased to two machines per pollsite, a total of 3,692 machines would be required which is an addition of 351 more machines (3,341 + 351 = 3,692).
- **That NYC will Not Substantially Revise its Pollsite Configuration –** Current NYC pollsite configuration is based on the current limitation of lever voting machines to support 1 ED per machine but also on historical tradition and physical limitations of pollsite availability. Technologies which support multiple EDs per machine offer opportunities that can most effectively be exploited with revisions to the current pollsite configuration. DREs that can support more than one ED's ballot can be effectively employed in most of NYC's pollsites.
- **That Survey Jurisdiction Ratio for Optical Scan Applies to NYC -** New York City has not used precinct pollsite optical scanners or similar technology before, the average number of registered voters per machine determined from the survey jurisdictions was used as the ratio for an estimation of the number of machines required in NYC. The impact of early voting in other jurisdictions may affect that ratio as well as the degree to which the under-voting alert is disabled by them.
- **That Additional Accessibility Devices Will Be Required –** Additional disabled accessible machines (at least one per pollsite) will be required to meet the accessibility requirements for HAVA, if ordered before the end of 2006. Subsequently, every device must be accessible.
- **That Extra Machines are Not Included in this Calculation –** This number does not include the number of extra machines required for training, public demonstrations, back-ups, spares, etc.

3.3 Full-Face Paper Ballot Overlay DRE Machines

The survey showed that full-face paper ballot overlay DRE machines are deployed among the survey jurisdictions at the rate of 400 registered voters per machine. We can use that ratio as the basis to calculate the number of these machines needed for NYC.

Again, Appendix A - Detail by Pollsite of Voting Machine Calculations for NYC, shows a calculation of machines required based upon a ratio of 400 registered voters per machine. The

calculation is based upon the current NYC count of pollsites, the number of machines used at each pollsite and the number of registered voters served by each pollsite. If we used this method of calculation as shown in Appendix A, at the low end, there are, for example, 29 NYC pollsite that each support 100 registered voters. To accommodate these 2,900 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 400 registered voters (1:400) for paper ballot overlay DRE machines, 29 such DRE machines would be required.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:400	Total Number of Machines Required
100	29	2,900	1	29

Similarly, again looking at Appendix A, at the high end, there is, for example, 1 NYC pollsite that supports 13,700 registered voters. To accommodate these 13,700 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 400 registered voters (1:400) for paper ballot overlay DRE machines, will require 35 such DRE machines. Using this method, NYC would require 9,921 paper ballot overlay DRE machines.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:400	Total Number of achines Required
13,700	1	13,700	35	35

Full-face paper ballot overlay DRE machines, however, like current lever machines, can only support one Election District (ED) per machine, because a paper ballot must be overlaid on the front panel of the machine, restricting its operation that day to the ballot on the paper. Thus, a calculation based upon pollsites though useful for calculations for other voting system technologies, is not valid for full-face paper ballot overlay DRE machines. Instead, a calculation based upon Election Districts and the number of registered voters served by each ED is required for the calculation of number of machines required for this technology. Further, we decided to not use 400 registered voters per machine (based upon the survey) but instead, decided to determine how many voters could actually vote using this technology based upon our experience with lever voting machines.

The current average time per registered voter needed to vote using full-face lever machines in New York City is:

- 2 minutes and 16 seconds

This was calculated as follows:

- A maximum of 1 machine for every 800 registered voters
- A 15 hour Election Day (15*60*60) = 54,000 seconds
- 54,000/800 = 68 seconds per registered voter
- If we assume a 50% voter turn out of registered voters, we would double this time for the actual voter as follows.
- 68 seconds*2 = 2 min 16 seconds per actual voter

We then assumed:

- About 1 additional minute per voter for the review of the required voter verifiable paper record.

This results in an estimated average time required to vote using full-face touch screen DRE technology in New York City of:

- 3 min. and 15 seconds

Based on this average voting time of 3 min. and 15 seconds per actual voter and assuming the following:

- A 15 hour Election Day (15*60*60) = 54,000 seconds
- 3 min 15 seconds per voter = 195 seconds
- 54,000 /195 = 277 actual voters per machine
- If we assume a 50% voter turn out of registered voters, we would double the voters per machine to represent registered voters per machine.
- 277*2 = 554 registered voters per machine (maximum)

If we use 554 registered voters per machine (ratio of 1:554) and we apply the assumption of using the current actual distribution of machines to the 6,100 EDs, we can use the NYC CPESS System to perform the calculation. The result of this calculation is a requirement of **10,331** paper ballot overlay DRE machines for NYC.

3.3.1 Key Assumptions

- **That A Minimum of 1 Machine per ED is Required –** A minimum of one machine is required per ED. Should this minimum be increased to two machines per ED (for redundancy), a total of 12,269 would be required which is an addition of 1,938 more machines though this does not seem likely.
- **That Extra Machines are Not Included in this Calculation –** This number does not include the number of extra machines required for training, public demonstrations, back-ups, spares, etc.
- **That 1 Minute will be Required for VVPAT –** The assumption is that about 1 minute will be required due to the Voter Verifiable Paper Audit Trail that is required in New York State. There is no jurisdiction known that requires VVPAT on Full-face DRE machines, so this estimate, though perhaps reasonable, is conjecture.

3.4 Full-Face Touch Screen DRE Machines

There were no full-face touch screen DRE machines in use by any of the surveyed jurisdictions. Accordingly, we were unable to extrapolate the number of machines required for NYC of this type of technology from the survey data.

We have thus assumed that the time to vote on a full-face touch screen DRE machine would be similar to that required to vote on today's full-face paper overlay lever machines with the exception that the now required printed voter verifiable paper record would add time to the voting process (as voters may spend time reviewing it before casting their ballot).

The current average time per registered voter needed to vote using full-face lever machines in New York City is:

- 2 minutes and 16 seconds

The calculation in the prior section yielded:

- 2 min 16 seconds per actual voter

We then assumed:

- About 1 additional minute per voter for the review of the required voter verifiable paper record.

This results in an estimated average time required to vote using full-face touch screen DRE technology in New York City of:

- 3 min. and 15 seconds

Based on this average voting time of 3 min. and 15 seconds per actual voter and assuming the following, we again have:

- A 15 hour Election Day (15*60*60) = 54,000 seconds
- 3 min 15 seconds per voter = 195 seconds
- 54,000 /195 = 277 actual voters per machine
- If we assume a 50% voter turn out of registered voters, we would double the voters per machine to represent total registered voters per machine.
- 277*2 = 554 registered voters per machine (maximum)

If we use 554 registered voters per machine (ratio of 1:554) and we apply the same assumption of using the current actual distribution of machines to pollsites, the calculation is as follows (See Appendix A - Detail by Pollsite of Voting Machine Calculations for NYC for full calculation):

At the low end, there are, for example, 29 NYC pollsite that each support 100 registered voters. To accommodate these 2,900 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 554 registered voters (1:554) for full-face touch screen DRE machines, will require 29 such DRE machines.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:554	Total Number of Machines Required
100	29	2,900	1	29

At the high end, there is, for example, 1 NYC pollsite that supports 13,700 registered voters. To accommodate these 13,700 registered voters (without altering the pollsite configuration), using the survey results ratio of one machine for every 554 registered voters (1:554) for full-face touch screen DRE machines, will require 25 such DRE machines.

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:554	Total Number of Machines Required
13,700	1	13,700	25	25

Using this method, NYC will require **7,486** full-face touch screen DRE machines.

3.4.1 Key Assumptions

- **That NYC will Not Substantially Revise its Pollsite Configuration –** Current NYC pollsite configuration is based on the current limitation of lever voting machines to

support 1 ED per machine but also on historical tradition and physical limitations of pollsite availability. DREs that can provide more than one ED's ballot can be effectively employed in most of NYC's pollsites.

- **That A Minimum of 1 Machines is Required Per Pollsite –** A minimum of one machine is required per pollsite. The reason the number is lower for these machines is because one machine can serve more than one ED. Therefore for NYC one machine can be allocated to more than one ED as long as all the EDs are in the same pollsite. Should this minimum be increased to two machines per pollsite (for redundancy), a total of 7,571 would be required which is an addition of 85 more machines.
- **That Extra Machines are Not Included in this Calculation –** This number does not include the number of extra machines required for training, public demonstrations, back-ups, spares, etc.
- **That 1 Minute will be Required for VVPAT –** The assumption is that about 1 minute will be required due to the Voter Verifiable Paper Audit Trail that is required in New York State. There is no jurisdiction known that requires VVPAT on Full-face DRE machines, so this estimate, though perhaps reasonable, is conjecture.

3.5 Summary of Machines Required

The summary of the survey of average registered voters per machine, the number of machines required by NYC by type and the average number of registered voters per machine for NYC are shown below:

Type of Machine	Survey Average # of Registered Voters Per Machine	NYC Registered Voters (2004)	NYC Maximum Registered Voters Per Machine	NYC Number of Machines Required	NYC Average # of Registered Voters Per Machine
Lever Machines in NYC	N/A	4,494,421	800	7,531	597
Pollsite Optical Scan, + accessible devices	1,400	4,494,421	1,400	3,341 + 1,362	1,345
Full-face Paper Ballot Overlay DRE (per ED)	400	4,494,421	554	10,311[1]	435
Full-face Touch Screen DRE	N/A	4,494,421	554	7,486[2]	600

Note that the table above shows average number of registered voters per machine and not maximum number of registered voters per machine.

Note that pollsite optical scan technology would require the addition of one disability accessible device for each pollsite for a total of 4,698 devices (3,341+1,362=4,698).

The results above indicate that the average number of registered voters for each type of technology for which there are comparable numbers, the required number of machines for NYC results in an average registered voters per machine that is similar to that shown to be used by other jurisdictions (in the survey) for that type of machine. Specifically, the survey jurisdiction ratio for optical scan was 1,400: 1 while NYC's average would be 1,345:1. Again, for full-face

[1] Minimum of 1 per Election District (precinct)
[2] Minimum of 1 per pollsite

paper ballot overlay, the survey jurisdiction ratio was 400:1, while the NYC average would be 435:1.

4.0 Determination of the Maximums

4.1 Introduction

Given the average number of machines by type of technology that is being used in other jurisdictions as shown in the survey and the number of machines that would be required by type of technology in NYC to replace its current lever machines, what should be the maximum number of registered voters per machine? Maximum number of machines would be the legal limit of registered voters per machine that would be allowed. If there were more than that number of registered machines in a given Election District (precinct), then an additional machine would be required to be added to that ED. The notion behind a maximum is to ensure that voters are not unduly delayed waiting for other voters in the course of Election Day.

Currently, there is a maximum number of registered voters per machine stipulated in New York State Election Law (800) while we have seen that on average there are 597 registered voters per lever machine in NYC. This would indicate that:

- NYC operates within the state requirements
- NYC average is well below (600 vs 800) the maximum.

On Election Day, there are “peaks and valleys” of usage by voters depending upon the time of day, the weather, traffic and other variables outside of the control of election staff. Thus there will always be times when voters are waiting, but on the whole, there should be some insurance that waits will not be over long durations throughout the day and that on the whole, voting can be accomplished expeditiously. If we make the assumption that on the whole elections are conducted expeditiously by the survey jurisdictions, than a maximum that is at, or somewhat higher than, the average by type of technology should be a reasonable maximum for New York.

4.2 Pollsite Optical Scan Machines

In accordance with the above analysis, we find that optical scan technology among the survey jurisdictions operates at 1,400 registered voters per pollsite optical scan machine. This is an average of 36 seconds of machine use per register voter (72 seconds for each actual voter assuming a 50% turnout).

Consider what is involved.

- The voter submits his or her ballot for scanning
- If there on no over-vote or under-vote conditions, the scanner can read the ballot in as little as 3 or 4 seconds.
- If under-voting is turned off (which it frequently is, though not likely to be permitted in NYS), it will have little or no effect on the time to vote.
- The remainder of the time required may be consumed by over-vote conditions and the necessity for the voter to correct or spoil the ballot and submit his or her vote again.

Accordingly, a maximum of 1,400 registered voters per pollsite optical scan machine would appear to be a reasonable limit.

4.3 Full-Face Paper Ballot Overlay DRE Machines

Our analysis showed that based upon the requirement that there be 1 full-face paper ballot overlay DRE per Election District (ED), that 10,311 machines would be required to replace the current lever machines. This is an average of 435 registered voters per machine. The jurisdiction survey indicated that jurisdictions with this type of technology average 400 registered voters per machine, but these jurisdictions have not implemented a voter verifiable paper audit. Based upon our prior calculations, this technology will allow 4 min and 32 second per registered voter, meaning that each actual voter will have 2 minutes and 16 seconds. If about 1 additional minute is added for the voter verifiable audit, each actual voter will have, on average, 3 minutes and 15 seconds in which to vote. This is the same time duration as was established for full-face touch screen DRE machines and thus the same number of registered voters (554) can be accommodated per machine. This implies that the same maximum number of voters per machine should be applied to paper ballot overlay DRE as would be applied to touch screen DRE.

Reducing the maximum number of voters per device by half, e.g., from 800 to 400 does not double the number of machines required (7,000 to 14,000) because the number of machines required is influenced more by the number of pollsites and EDs in the City.

4.4 Full-Face Touch Screen DRE Machines

Full face touch screen DRE machine technology would require 7,486 machines for NYC under the current configuration of pollsites and EDs. This results in a ratio of 554 registered voters per machine. A reasonable maximum then would be 554 registered voters per machine for this technology.

5.0 Summary

5.1 Summary of Survey of Average Number of Registered Voter per Machine

In order to understand how other jurisdictions have deployed similar voting machines, Gartner did a national survey of the 30 largest counties in the country to determine the average number of registered voters per voting machine by type of machine technology. This was done by reviewing published information and validating this data by conducting a telephone survey with these jurisdictions.

For the jurisdictions surveyed the results show the following:

Type of Machine	Average Number of Registered Voters Per Machine
Pollsite Optical Scan	1,400:1
Full-Face Printed Ballot Overlay DRE	400:1
Full-Face Touch Screen DRE	N/A – Not used else where in the Country

5.2 Summary of Analysis Results

The table below shows the estimated number of machines required by type of machine and by different measures used. This estimated number does not include the number of back up machines, number of machines for training demonstration, etc.

Type of Machine	Survey Average # of Registered Voters Per Machine	NYC Registered Voters (2004)	NYC Number of Machines Required	NYC Average # of Registered Voters Per Machine	NYC Maximum # of Reg. Voters Per Machine
Lever Machines in NYC	N/A	4,494,421	7,531	597	800
Pollsite Optical Scan, + accessible devices	1,400:1	4,494,421	3,341 + 1,362[1]	1,345	1,400
Full-Face Paper DRE	400:1	4,494,421	10,311[2]	435	554
Full-Face Touch Screen DRE	N/A	4,494,421	7,486[3]	600	554

5.3 Final Observations

5.3.1 NYC Average Number of Voters Per ED is Lower Than Other Jurisdictions

We observed that most of the jurisdictions had an average number of registered voters per precinct that was higher than the average number of voter per Election District in NYC. Some of the NYC Election Districts had as few as 100 registered voters. This would indicate that consolidation of some EDs would provide more efficient election operations and better use of new voting system technology.

5.3.2 NYC ED & Pollsite Configuration Optimized for Current Lever Machines

Though we have determined the maximum number of registered voters per machine advisable for NYC by type of machine, it is clear from this analysis that there are inter-relationships between the maximum number of machines by type of machine and other pollsite configuration parameters. We have calculated the maximum assuming that the present NYC pollsite election configuration (number of EDs per pollsite, number of pollsite, space per pollsite) will be unchanged (either because they cannot be changed or because they cannot be changed in time for the 2007 elections).

The closer replacement machines are technologically to current lever machines, the easier the transition will be and the closer the number of machines will be to present counts. As the choice of technology moves away from the current technology without a change to the current pollsite configuration, the less appropriate the current pollsite configuration becomes. As that move occurs (from lever machines to full-face paper ballot overlay DRE to full-face touch screen DRE to pollsite optical scan), without re-configuration of pollsites, the more the advantages of these alternative technologies will be under-realized.

[1] Minimum of 1 accessible device per pollsites, 1,362 pollsites
[2] Minimum of 1 per Election District
[3] Minimum of 1 per pollsite

6.0 Appendix A – Voting Machine Pollsite Calculations for NYC

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:400	Total Number of Machines Required	Number of Machines 1:1400	Total Number of Machines Required	Number of Machines 1:800	Total Number of Machines Required	Number of Machines 1:554	Total Number of Machines Required
100	29	2,900	1	29	1	29	1	29	1	29
200	11	2,200	1	11	1	11	1	11	1	11
300	5	1,500	1	5	1	5	1	5	1	5
400	11	4,400	1	11	1	11	1	11	1	11
500	29	14,500	2	58	1	29	1	29	1	29
600	35	21,000	2	70	1	35	1	35	2	70
700	42	29,400	2	84	1	42	1	42	2	84
800	27	21,600	2	54	1	27	1	27	2	54
900	26	23,400	3	78	1	26	2	52	2	52
1,000	25	25,000	3	75	1	25	2	50	2	50
1,100	16	17,600	3	48	1	16	2	32	2	32
1,200	32	38,400	3	96	1	32	2	64	3	96
1,300	35	45,500	4	140	1	35	2	70	3	105
1,400	28	39,200	4	112	1	28	2	56	3	84
1,500	37	55,500	4	148	2	74	2	74	3	111
1,600	29	46,400	4	116	2	58	2	58	3	87
1,700	31	52,700	5	155	2	62	3	93	4	124
1,800	36	64,800	5	180	2	72	3	108	4	144
1,900	34	64,600	5	170	2	68	3	102	4	136
2,000	42	84,000	5	210	2	84	3	126	4	168
2,100	37	77,700	6	222	2	74	3	111	4	148
2,200	33	72,600	6	198	2	66	3	99	4	132
2,300	31	71,300	6	186	2	62	3	93	5	155
2,400	35	84,000	6	210	2	70	3	105	5	175
2,500	26	65,000	7	182	2	52	4	104	5	130
2,600	23	59,800	7	161	2	46	4	92	5	115
2,700	29	78,300	7	203	2	58	4	116	5	145
2,800	25	70,000	7	175	2	50	4	100	6	150
2,900	37	107,300	8	296	3	111	4	148	6	222
3,000	20	60,000	8	160	3	60	4	80	6	120
3,100	18	55,800	8	144	3	54	4	72	6	108
3,200	17	54,400	8	136	3	51	4	68	6	102
3,300	22	72,600	9	198	3	66	5	110	6	132
3,400	25	85,000	9	225	3	75	5	125	7	175
3,500	24	84,000	9	216	3	72	5	120	7	168
3,600	22	79,200	9	198	3	66	5	110	7	154
3,700	14	51,800	10	140	3	42	5	70	7	98
3,800	22	83,600	10	220	3	66	5	110	7	154
3,900	18	70,200	10	180	3	54	5	90	8	144
4,000	14	56,000	10	140	3	42	5	70	8	112
4,100	19	77,900	11	209	3	57	6	114	8	152
4,200	20	84,000	11	220	3	60	6	120	8	160

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:400	Total Number of Machines Required	Number of Machines 1:1400	Total Number of Machines Required	Number of Machines 1:800	Total Number of Machines Required	Number of Machines 1:554	Total Number of Machines Required
4,300	20	86,000	11	220	4	80	6	120	8	160
4,400	9	39,600	11	99	4	36	6	54	8	72
4,500	12	54,000	12	144	4	48	6	72	9	108
4,600	13	59,800	12	156	4	52	6	78	9	117
4,700	13	61,100	12	156	4	52	6	78	9	117
4,800	16	76,800	12	192	4	64	6	96	9	144
4,900	12	58,800	13	156	4	48	7	84	9	108
5,000	15	75,000	13	195	4	60	7	105	10	150
5,100	9	45,900	13	117	4	36	7	63	10	90
5,200	21	109,200	13	273	4	84	7	147	10	210
5,300	6	31,800	14	84	4	24	7	42	10	60
5,400	5	27,000	14	70	4	20	7	35	10	50
5,500	9	49,500	14	126	4	36	7	63	10	90
5,600	5	28,000	14	70	4	20	7	35	11	55
5,700	7	39,900	15	105	5	35	8	56	11	77
5,800	6	34,800	15	90	5	30	8	48	11	66
5,900	12	70,800	15	180	5	60	8	96	11	132
6,000	6	36,000	15	90	5	30	8	48	11	66
6,100	4	24,400	16	64	5	20	8	32	12	48
6,200	5	31,000	16	80	5	25	8	40	12	60
6,300	6	37,800	16	96	5	30	8	48	12	72
6,400	7	44,800	16	112	5	35	8	56	12	84
6,500	3	19,500	17	51	5	15	9	27	12	36
6,600	5	33,000	17	85	5	25	9	45	12	60
6,700	4	26,800	17	68	5	20	9	36	13	52
6,800	4	27,200	17	68	5	20	9	36	13	52
7,000	2	14,000	18	36	5	10	9	18	13	26
7,100	1	7,100	18	18	6	6	9	9	13	13
7,300	2	14,600	19	38	6	12	10	20	14	28
7,400	2	14,800	19	38	6	12	10	20	14	28
7,500	1	7,500	19	19	6	6	10	10	14	14
7,600	1	7,600	19	19	6	6	10	10	14	14
7,700	2	15,400	20	40	6	12	10	20	14	28
7,800	3	23,400	20	60	6	18	10	30	15	45
7,900	2	15,800	20	40	6	12	10	20	15	30
8,000	1	8,000	20	20	6	6	10	10	15	15
8,100	2	16,200	21	42	6	12	11	22	15	30
8,400	1	8,400	21	21	6	6	11	11	16	16
8,500	3	25,500	22	66	7	21	11	33	16	48
8,600	1	8,600	22	22	7	7	11	11	16	16
9,800	1	9,800	25	25	7	7	13	13	18	18
10,000	1	10,000	25	25	8	8	13	13	19	19
10,200	1	10,200	26	26	8	8	13	13	19	19
10,800	1	10,800	27	27	8	8	14	14	20	20
11,200	1	11,200	28	28	8	8	14	14	21	21

Number of Voters	Number of Pollsites	Total Number of Voters	Number of Machines 1:400	Total Number of Machines Required	Number of Machines 1:1400	Total Number of Machines Required	Number of Machines 1:800	Total Number of Machines Required	Number of Machines 1:554	Total Number of Machines Required
11,400	1	11,400	29	29	9	9	15	15	21	21
12,300	1	12,300	31	31	9	9	16	16	23	23
13,700	1	13,700	35	35	10	10	18	18	25	25
	1,357	**3,759,900**		**9,921**		**3,341**		**5,301**	**0**	**7,486**