

## **Proposed Criteria for the Post-Election One Percent Manual Tally in Alameda County**

Prepared for the Alameda County Registrar of Voters Election Advisory Committee  
By Nancy Bickel, Chair, Alameda County Council, League of Women Voters, Judy Bertelsen, M.D., and David Wagner, Assistant Professor of Computer Science, University of California, Berkeley  
With the assistance of Peter J. Bickel, Professor of Statistics, and Arel Cordero, graduate student in Computer Science, University of California, Berkeley  
February 21, 2006

### California Election Code on the One Percent Tally

335.5. The "official canvass" is the public process of processing and tallying all ballots received in an election, including, but not limited to, provisional ballots and absentee ballots not included in the semifinal canvass. The official canvass also includes the process of reconciling ballots, attempting to prohibit duplicate voting by absentee and provisional voters, and performance of the manual tally of 1 percent of all precincts.

336.5. "One percent manual tally" is the public process of manually tallying votes in 1 percent of the precincts, selected at random by the elections official, and in one precinct for each race not included in the randomly selected precincts. This procedure is conducted during the official canvass to verify the accuracy of the automated count.

### **RECOMMENDED PRINCIPLES & CRITERIA FOR 1% MANUAL TALLY FOR FUTURE ELECTIONS IN ALAMEDA COUNTY**

- I. The purpose of the hand count of the 1% sample is "to verify the accuracy of the automated count." We understand this to mean that it should be a genuine and independent test or audit of the accuracy and completeness of the official Statement of the Vote.
- II. The 1% sample should be selected and the audit carried out only after all counting of ballots is complete and a preliminary Statement of Vote is completed. No changes should be made to the Statement of Vote until the 1% audit is completed; the SoV should be "frozen" before the random sample is selected and the audit is begun.
- III. The categories from which the 1% hand count are selected and counted should be exactly the same as the categories reported by the Registrar of Voters in the Election Summary Report and in the preliminary and official Final Reports and Statements of Vote.

In the future, we anticipate that the two distinct categories would be (i) votes cast at the polling place (on touch screens and/or scanned at the polling place) and sorted and stored by precinct; and (ii) paper ballots counted centrally (on central-count optical scan machines) and sorted and stored by batches. Then, each and every vote cast in the election would belong to one of two distinct categories, be reported as belonging to one of these categories and be available to be sampled as a member of one of the two categories.

IV. Every vote cast should have at least a 1% chance of being drawn and hand counted in the sample. Therefore, all ballots cast at the polls and all paper ballots should be sampled.

V. The method of selecting samples should be fair, open to public observation and inspection and easy to understand and verify. It should be random and understood to be so by the general public. This report proposes a process for sample selection based on a public throwing of special dice. The method is described in item 2 below.

VI. The sampling method should be checked and tested for various kinds of potential error before it is applied in drawing the sample.

VII. The actual percentage of precincts sampled and of paper ballots sampled should be reconsidered in the future, after the proposed changes have been applied and tested.

VIII. Changes to the 1% sample or other recommended changes should not conflict with the Election Code.

IX. The Registrar of Votes should consider in advance how to handle any discrepancies that may be discovered during the 1% audit.

### **Applying the New Criteria Improving and Supplementing the Current Method**

1. Expand the hand count in the 1% of polling place precincts to include Voter Verifiable Paper Audit Trails [VVPAT] and Paper Ballots.
2. Pick the samples using three colored 10-sided dice rather than a computer random number generator. Red, white and blue dice with numerals from 0 to 9 are recommended.
3. Publicize the 1% sample process and activities in advance in a variety of ways and make the activities as accessible and understandable as possible to the public. Help public observers understand the process they are observing by providing information in print and computer form in advance and as needed on the particular occasion.
4. Expand the current sample of absentee and other paper ballots to a full 1%.
5. Early Ballots cast electronically and any other categories of ballots not yet included in the two groups sampled as described above should be assigned to the appropriate group or form a separate group to be sampled separately.
6. Formats for Reporting the Statement of Vote and the Summary should be expanded.

Note: This is a summary of the main points of the full document.

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### **Background: How the Election Code Requirement is Carried Out**

The Election Code requires county registrars "to verify the accuracy of the automated counts" by hand counting votes cast at 1% of the precincts and "in one precinct for each race not included in the randomly selected precincts." Exactly what these Election Code requirements mean in practical terms has changed over time.

To understand the process we will identify the three different groups of ballots sampled by the ROV. The ballots selected for hand counting in 1% of precincts, we will refer to as the **1% precinct sample or 1% sample**. The ballots selected for hand counting "in one precinct for each race not included in the randomly selected precincts" we will refer to as the **supplemental 1% precinct sample or supplemental 1% sample**. The ACROV often refers to this as the sample of each ballot type. The third sample taken by the ACROV is a sample of paper ballots, including absentee ballots and provisional ballots. We will refer to this as the **sample of paper ballots**.

In the past, most voting systems in California used punch cards or optically scanned paper ballots or other methods with a paper or cardboard ballot and most voters voted at physical polling places. Then the Election Code provision cited above could be carried out in a straightforward way. The ballots were first read and tallied by machine, then a

sample of precincts was selected and counted by hand. The hand recount of the 1% sample could test if the computers and machines that counted and reported the votes cast in the precincts had made errors in counting the vote.

In the past, testing 1% of precincts was essentially equivalent to testing about 1% of votes. Absentee ballots were only available to invalids or people who would be out of town on Election Day; nearly everyone actually voted in a precinct polling place. In recent years, changes in the Election Code have permitted anyone to sign up as an temporary or permanent absentee voter; the numbers of such voters has grown to approximately half of all voters. Other innovations have included early electronic voting at the Registrar's Office or other locations.

Every registered voter is automatically assigned to a 'home' precinct determined by his or her home address and, in the Statement of Vote at the end of an election, every voter's vote is electronically attributed to his or her precinct. Yet perhaps half or more of the voters in this and future elections will not cast their votes in polling places physically set up in precincts, but will cast them on paper ballots, for example, as absentee ballots sent in before the election, or cast them electronically on touch screen machines at the ROV Office and other locations in "early voting". So, in the following discussions, we will distinguish between precincts and polling places. In this election, only 805 of the 1140 precincts had polling places; voters in the remaining 335 precincts were issued paper mail-in ballots.

#### **Application of the 1% of Precincts Provision**

In the Special Election of November 2005 and other recent elections, the ACROV Office has understood the "**1% of precincts**" requirement to be a test of the accuracy of DRE or electronic voting machines set up in polling places, so when selecting 1% of precincts for hand counting, it has selected and hand counted votes cast electronically in polling places on Election Day. It has not included paper ballots cast by voters in mail-in precincts, paper ballots voted at or absentee ballots delivered to polling places nor absentee ballots sent to the ROV before Election Day. Although it has not included such ballots in the 1% sample of precincts, it has separately sampled nearly 1% of many of these ballots as part of the **sample of paper ballots** mentioned above.

The introduction of electronic voting machines or DREs in the past few elections posed a problem for Registrars of Voters. Since the "ballots" cast in polling places on such machines were only recorded electronically, no paper ballots existed to enable ROVs to comply with the Election Code provision. During the Special Election in November 2005 and earlier elections with these machines, the ACROV created substitute paper ballots.

Here's how it worked. When a voter recorded her vote on a touch screen machine, an image of the whole "ballot" was recorded on the machine's memory and on its memory card. When the memory cards were downloaded, added up and delivered to the central election computer, the image of each individual ballot was transferred to the central election computer. When the ROV Office selected the precincts for the 1% sample, it printed out substitute paper ballots, individual sheets of paper, each with an image of an individual ballot as it had been electronically recorded in the electronic voting machine or DRE. This process created paper "ballots" that could be hand counted and

enabled the ROV to comply, or go through the motions of complying, with the Election Code requirement for a hand count.

Citizen concern about the lack of a “paper trail” of their votes on electronic voting machines has led to new laws. These laws came into force on January 1, 2006. State law now requires electronic election equipment to have a voter verifiable paper audit trail [VVPAT] and requires that these VVPAT paper records be counted in the 1% sample of precincts. Machines used in future elections will include Voter Verifiable Paper Audit Trails [VVPAT], so the hand count will be done using separate paper records which have been confirmed by the voter as accurate at the time of voting.

As soon after January 1, 2006 as the ROV buys and begins to use new election machines that meet new federal and state standards, the hand count will again become a count of paper records of individual votes created and verified by the voter when the voter casts her ballot. The 1% sample will also again be a real test of the accuracy of the election machinery.

For the November 2005 Special Election, the 1% of precincts was selected as described in the section “Current Sampling Method Described & Discussed in Detail” below. Then the images of the ballots cast in those precincts were printed out on 8 1/2 x 11 sheets of paper and counted by hand. Counting the paper images of the electronic ballots is just another way of recounting the electronic records, so in 2005, the hand tally was not an independent check on the accuracy of the electronic and computerized ballot count. The same method of printing and counting was used for the **supplemental precincts** selected as required in the Election Code.

### **ROV Samples Paper Ballots**

Since more and more voters in the County are voting by absentee paper ballot, the ROV Office also samples absentee ballots. Although the ROV does not interpret the Election Code provision cited above as requiring this sampling of absentee or paper ballots, sampling of absentee and paper ballots is in keeping with the stated intent of the provision-- “to verify the accuracy of the automated count.” Paper ballots—whether absentee ballots, provisional ballots or other types—were all counted at the ACROV Office by the same group of automated scanners. The data from these machines were then transferred to the central election computer. This process is also an “automated count” as mentioned in the Election Code provision. It uses different machines and possibly different aspects of the central computer or computer program. This automated system also should be sampled and tested by a hand count.

The sampling method used by the ROV during the November 2005 Special Election selected three boxes of 500 paper ballots. The sample of three boxes of 500 each or 1500 paper ballots recounted by hand did represent nearly 1% percent of all absentee ballots and nearly 1% of all paper ballots. The ROV Office did not attempt to sample every type of paper ballot although several different categories of paper ballots were included.

**BALLOTS CAST IN ALAMEDA COUNTY IN THE NOVEMBER 2005 ELECTION BY TYPE**

	Number	% of total
<u>Electronic ballots</u>		
cast at the polls	189,617	
cast in early voting	1,985	
<b><i>Total of all electronic ballots</i></b>	<b><i>191,602</i></b>	<b><i>50%</i></b>
<u>Paper ballots</u>		
Absentee ballots	177,448	
Provisional ballots cast at polls	16,119	
<b><i>Total of all paper ballots</i></b>	<b><i>193,567</i></b>	<b><i>50%</i></b>
<b><i>TOTAL BALLOTS CAST</i></b>	<b><i>385,169</i></b>	<b><i>100%</i></b>

**Note: Absentee ballot category includes**  
**Mail-in ballots from mail-in precincts**  
**Official ballots cast at polls**  
**Absentee ballots received before Election Day**  
**Absentee ballots delivered to polling places**  
**Absentee ballots from military personnel**  
**Damaged ballots are found in all categories**

**1% of Precincts Drawn from 805 Polling Places**

The California Election Code cited above is understood by the ROV to mean that the one percent for the manual tally—hand recount--should be taken only from electronic votes cast in precincts with polling places. In addition, the provision requires that, if the 1% sample drawn does not include every race run at that election, the ROV select one precinct for each race or ballot type that was not included in the original sample for a hand recount. In the 2005 Special Election, the Alameda County Registrar of Voters Office interpreted these provisions to mean that it would select 1%, that is 8, of the 805 precincts in which polling places were set up with electronic touch screen machines. An additional 335 precincts had too few voters to merit polling places; voters in these precincts were sent paper absentee ballots and voted by mail. These precincts were not included in the 1% precinct sample nor the supplemental 1% precinct sample; they were, presumably, included in the sample of paper ballots.

**Current Sampling Method Described & Discussed in Detail**

In the Special Election of November 2005, the Registrar’s Office used a random number generator that is part of the Diebold DIMS software package to pick the 1% sample. The DIMS software is widely used by the ACROV and many other Registrars to do many different election related tasks.

After the November 2005 election, three of the authors of this report, all citizen members of the ROV’s Election Advisory Committee, watched a staff supervisor go through the routine required to generate a random 1% sample of 805 precincts. This produced eight numbers:

4, 42, 48, 59, 75, 182, 458, 709

The supervisor then took a list of all polling places arranged in numerical order by precinct and found the corresponding poll in the list. In other words, she counted down the list to the 4th precinct, the 42nd precinct and so on until she had marked all eight.

The ROV’s list of precincts is organized in numerical order by precinct number. Precinct numbers have been assigned roughly geographically starting with Berkeley in the north and continuing roughly south. On closer observation, we see that the first five precincts picked are all in Berkeley, the next in Piedmont, the next in Hayward and the last in Fremont.

**Table Comparing Cities Drawn in 1% Sample**

[Note: populations are from websites; data may not be from same year or same source]

	Population	Registered Voters	Cards [Ballots] Cast
<b>Alameda County</b>	<b>1,444,656</b>	<b>704,036</b>	<b>385,169</b>
Berkeley	102,743 est.		
Piedmont	10,952, est.		
Hayward	146,027 est.		
Fremont	84,575 est.		

**A Poor Sample**

The distribution of the sample described above does not look very fair in the everyday non-technical sense. Six of the eight sample precincts are in the north county. The biggest city in the county, Oakland, is not in the sample at all. We consulted a statistician about whether this sample looked like a fair sample. Peter Bickel, professor of statistics at the University of California at Berkeley, observed that the sample was an unlikely, but not impossible, random sample.

Computers do not generate “real“ random samples; they are machines programmed to simulate random samples, Bickel pointed out. Some programs do a better job; some do a worse job. Studies have shown that many random number generators are poorly programmed and do not pick good or fair random samples. He suggested using either a better random number generator or some other fair method of picking the sample. This report will propose a new method for picking the sample.

**Supplemental Precincts Picked**

In the 2005 Special Election, the ROV staff noted that the random sample turned out to include only two of the seven ballot types, or groups of election races, voted on in the county, since, in this election, Berkeley, Piedmont and Fremont voted only on the state ballot propositions. Hayward had school district elections. To comply with the Election Code provision cited above, the Registrar’s staff picked one supplemental precinct from each of the ballot types in the following five cities: Albany, Castro Valley, Emeryville, Livermore, Newark. Each of these races or ballot types was voted on in very few

precincts, ranging from five precincts in Emeryville to 50 precincts in Livermore. The DIMS software was not able to select random 1% samples from groups smaller than 100, so ROV staff drew paper slips from a container to pick an supplemental sample precinct from each ballot type or race.

Picking the supplemental samples for each race or ballot type, as required by the Election Code, seems, in an informal sense, to compensate somewhat for the unevenness of the geographical and population distribution of the original sample of eight precincts. In primary and general elections, many more community and special districts elect local and regional offices and vote on local ballot measures. With many more local elections and many more different ballot types, the selection of supplemental samples for each type of race or ballot would be likely to spread the samples picked more evenly geographically across the county.

It should be noted, that, in the supplemental precincts, the ROV protocol only requires a count of the as-yet-unsampled races, not all the races on the entire ballot. In other words, only the local offices are usually counted on the ballots drawn in supplemental sample.

### **ROV Selects About 1% of Paper Ballots**

As mentioned above, the ROV Office already does a hand count of absentee and paper ballots. In the most recent election, the ROV did a hand count of 1500 absentee and other ballots. One percent of the 193,567 paper ballots would have been 1936 paper ballots. So the ROV sampled close to 1% of the paper ballots. However, not all types of paper ballots had an equal chance of being included in the sample.

The ROV selected three boxes, each containing roughly 500 paper ballots for a hand count. Although we did not observe the selection, we understand that the boxes were selected after Election Day, taken off the long shelves where signed and sealed boxes of paper ballots are stored after counting. The selection and counting took place during the period when some categories of paper ballots were still been processed—being checked for signatures or sorted—and some still awaited processing. Damaged ballots, for example, are often the last to be processed and counted. So some categories of ballots had not yet been scanned, counted and packed up into boxes of 500 and were not available for sampling.

This report will propose selecting the sample only after all paper ballots have been processed and counted and will propose a method of selection that will be more likely to include all types of paper ballots.

### **How the Manual Tally Was Done**

After the precincts for the 1% sample have been picked, the ROV staff printed out images of every single ballot cast in each precinct, a timeconsuming process. Then the ROV was ready to do the manual count. . [Three of the authors of this report observed the process.] The ACROV's protocol specifies that each precinct is counted by a group of staff members forming a three member recount board.

One member read the vote on each ballot aloud and the other two marked two separate tally sheets which listed the names of the candidates and measures being recounted. Recount board members sorted the ballots into stacks as follows: in a Vote for One contest, one stack for each candidate or for the yes and the no on a measure and one stack for undervotes, where no vote is indicated. [The voting machine software did not permit the voter to “overvote” to vote for more than one candidate in a one member race.]

The Registrar’s protocol specifies how the board members mark the tally sheet. When the board finished counting the contest, the supervisor of the recount compared the recount results with the actual election night results for that contest. If the results were the same, the supervisor initialed the recount results on the tally sheet. If the numbers were different, ballots were resorted and recounted in groups of 10. If the results were the same after the second recount, the supervisor initials the results and shows the + or – difference. Recounts were repeated until the totals agree.

In a vote for two, the board counted all of the votes for the first candidate in the list of candidates, then counted all the votes for the second name in the list and so on until all votes counted.

The protocol requires that three staffers stay with the ballots during breaks and lunches. At the end of the work day, ballots and tally sheets are secured in the vote count room, which is locked. When the recount of the precinct is completed, the tally sheets and ballots are stored in the Vote Count Room.

The protocols for counting the actual paper ballots—absentee, provisional etc.- are the same as the protocols for the manual tally described above.

**Reporting Formats Surveyed**

Election Summary Report SPECIAL STATEWIDE ELECTION NOVEMBER 8, 2005 Summary For Jurisdiction Wide, All Counties, All Races ALAMEDA COUNTY OFFICIAL FINAL	Date: 11/29/05 Time: 16:30:03 Page: 1 of 2
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Registered Voters 704036 - Cards Cast 385169 54.71%      Num. Report Precinct 1140 - Num. Reporting 1140 100.00%

GOVERNING BOARD MEMBER, HAYWARD USD		
	Total	
Number of Precincts	127	
Precincts Reporting	127	100.0 %
Vote For	2	
Total Votes	37778	
MYRNA TRUEHILL	15846	41.95%
PAUL FRUMKIN, III	9744	25.79%
CHUCK HORNER	7984	21.13%
ROGER TRESKUNOFF	3884	10.28%
Write-in Votes	320	0.85%

FOR MAYOR, NEWARK		
	Total	
Number of Precincts	28	
Precincts Reporting	28	100.0 %
Vote For	1	
Total Votes	7869	
DAVID W. SMITH	7698	97.83%
Write-in Votes	171	2.17%

FOR MEMBER OF CITY COUNCIL, EMERYVILLE		
	Total	
Number of Precincts	5	
Precincts Reporting	5	100.0 %
Vote For	2	
Total Votes	3409	
DICK KASSIS	1220	35.79%

FOR MEMBER OF CITY COUNCIL, NEWARK		
	Total	
Number of Precincts	28	
Precincts Reporting	28	100.0 %
Vote For	2	
Total Votes	14291	
ALAN L. NAGY	5221	36.53%
ANA APODACA	4710	32.96%
BOB MARSHALL	4293	30.04%
Write-in Votes	67	0.47%

**The Election Summary Report above does not distinguish between the 50% of votes actually cast at the polls on electronic machines or by another method and the 50% of votes cast on paper by mail as Absentee Ballots or by other methods.** In the Summary above, the ROV adds together the votes from all categories of votes and assigns each vote to its ‘home’ precinct, that is, the precinct where the voter is registered to vote. The Summary does not indicate how many votes were actually cast at polling places on electronic machines, on paper ballots, on provisional ballots nor what percentage of the vote in individual races or in the total election they represent. Similarly, precincts where voters were required to vote by mail are not distinguished from precincts with actual polling places.

To obtain these totals, the ROV does not physically sort the different paper ballots into separate piles for each of the 1140 precincts. Paper ballots are processed and counted more or less in the order they come into the ROV Office. Instead, each of the paper ballots has a machine-readable identification of the precinct that the voter belongs to, but not of the identity of the individual voter, according to the ROV Office. So the GEMS system, the computer program that counts the votes, is able to assign each ballot to its correct precinct. This enables the program to assign correctly, for example, an Emeryville voter’s vote for school board members to the candidates selected by that voter.

The current format for reporting the Summary Election Results seen above is outdated. It does not do a good job of reflecting current voting patterns. Like the 1% sample provisions of the Election Code, it might be taken to imply that all votes are cast in and counted by polling place. This does not reflect the current voting patterns, counting patterns or sampling patterns in Alameda County.

**The full Statement of Vote does include a breakdown into categories of polling, absentee, provisional, and early voting for the county as a whole.** These categories are also reported by measure or race, for each precinct and for each voting district. However, the Statement of Vote is an unwieldy large electronic or print document. Accordingly, we recommend that the summary totals for different categories ( e.g., votes cast the the polling place, absentee votes and others) should be available in an easily accessible summary document We recognize that it may not be possible to modify the format of the Summary Election Results report; in this case, we recommend that the ACROV produce supplemental election summary reports that do provide summary totals broken down by the the different ways that votes are cast.

## **RECOMMENDED PRINCIPLES & CRITERIA FOR 1% MANUAL TALLY FOR FUTURE ELECTIONS IN ALAMEDA COUNTY**

**I. The purpose of the hand count of the 1% sample is “to verify the accuracy of the automated count.” We understand this to mean that it should be a genuine and independent test or audit of the accuracy and completeness of the official Statement of the Vote.** It should be an independent test of the original electronic counts and the original reports of the election. It should test all the elements of the election systems—the people, the machines, the computers, the software at the polling places, at the ROV Office and in between. In so far as a sample of this size and type can do so, the sample should verify that there are no systematic errors or evidence of cheating; it should reveal systematic errors or cheating if they have taken place.

### **Discussion**

The ROV currently counts ballots in two different ways—the touch screen electronic voting and reporting system used at polling places and the vote scanning system used for paper ballots of all kinds at the ROV Office. In future, the ROV plans to count ballots in a third way—through scanners that will read paper ballots at each polling place. Each type of ballot, each type of election equipment and each method of counting ballots may be subject to different types of error. These errors could be accidental or done on purpose. The types of error or cheating could be very different in polling places vs ROV Office or with different equipment with touch screen machines at polling places, scanners in polling places, or scanners at the ROV Office. Different scanners for paper ballots could have different mechanical problems. Different voting machines or sections of software programs in the central computer could have different kinds of programming errors. Different election workers at different locations could also make different kinds of errors.

**II. The 1% sample should be selected and the audit carried out only after all counting of ballots is complete and a preliminary Statement of Vote is completed.**

**No changes should be made to the Statement of Vote until the 1% audit is completed; the SoV should be “frozen” before the random sample is selected and the audit is begun.**

Electronic and paper copies of the preliminary Statement of Vote [SoV] should be available to and distributed to observers at least a day before the 1% sample is drawn. If the 1% audit confirms the Statement of Vote, the preliminary SoV becomes the final, official, certified SoV without further changes. If the ROV finds that changes are necessary, the audit process should be re-run on the new SoV or the portion of the SoV potentially affected by the changes as discussed in Recommendation VIII below

### **Discussion**

One purpose of the 1% audit is to enable observers and third parties to verify the correctness of the official Statement of Vote. If it were possible to change the contents of the SoV after the 1% audit, then of course those changes would not have been subject to audit and it might be difficult for third parties to tell whether those changes were accurate. Likewise, if someone could change the contents of the SoV after they knew which precincts had been selected to be recounted as part of the 1% audit, they might be able to fraudulently modify vote totals for precincts that were not selected, free in the knowledge that their fraud would not be detected by the 1% audit. Therefore, we recommend that the contents of the SoV be “frozen” before the 1% sample is selected and the 1% audit takes place.

The principle is that we want to be auditing what is reported. If observers are given a preliminary SoV report, then the 1% audit process lets them check that the SoV in their hand matches the paper ballots or records in storage. This means that the SoV report that the observers have in their hand at the time of the audit can be verified to be correct. However, if the final version of the SoV that is certified differs from the version of the SoV that was verified to be accurate by the 1% audit process, then the audit process doesn't necessarily say anything about the final results. It is the final results that we want to verify correct, so that is why changes should not be allowed after the start of the 1% audit process.

For a similar reason, the ROV should not start the 1% audit (not even the random selection of precincts to be sampled) until all the ballots have been counted and the preliminary SoV is finalized.

If it is not already their practice, ROV staff should create an electronic copy of the preliminary SoV to read-only media (e.g., CD-ROM, DVD-R) before the 1% audit process is begun. When they prepare the final version of the SoV, they should do the same. This will provide an audit trail, and will make it possible to compare the two (if there is any question about whether they matched), even if there is some bug or fraud in the GEMS server. Once data is on read-only media, even a malicious computer cannot change it.

**III. The categories from which the 1% hand count are selected and counted should be exactly the same as the categories reported by the Registrar of Voters in the**

## **Election Summary Report and in the preliminary and official Final Reports and Statements of Vote.**

**In the future, we anticipate that the two distinct categories would be (i) votes cast at the polling place (on touch screens and/or scanned at the polling place) and sorted and stored by precinct; and (ii) paper ballots counted centrally (on central-count optical scan machines) and sorted and stored by batches, Then, each and every vote cast in the election would belong to one of two distinct categories, be reported as belonging to one of these categories and be available to be sampled as a member of one of the two categories.** This would enable the voter to understand unambiguously that the 1% audit covers all ballots and every type of ballot and that the accuracy and reliability of the SoV had been independently tested.

### **Discussion**

The need for two categories is due to the way that paper records (i.e., paper ballots and VVPAT records) are sorted and stored by the ACROV. Some votes—notably the VVPAT records for votes cast at the polling place on a touch screen machine, and the paper ballots for votes cast and scanned at the polling place on a precinct-count optical scan machine—are sorted by precinct and stored by precinct. We assume for this discussion that the VVPAT records will have been recorded on large adding machine type continuous rolls of paper are stored in canisters. So, for instance, VVPAT records would be grouped by canister, where each canister stores records for a single touch screen (DRE) machine. Paper ballots cast and scanned at the polling place would be received in a ballot box associated with that polling place and be stored by precinct.

In contrast, other ballots—such as absentee ballots, provision ballots, military ballots, and other types of centrally scanned ballots—are not sorted or stored by precinct. Absentee and mail-in precinct ballots are delivered by mail to the ROV Office before Election Day; absentee ballots may be delivered by hand to polling places in absentee ballot envelopes or filled out at the polling place and deposited in the ballot box by the voter or filled out by the voter at the polling place and placed in provisional ballot envelopes. Military ballots are mailed in to the ROV Office. Each of these categories of paper ballots is processed in similar, although not identical, ways by the ROV. They are received at county headquarters, grouped into decks of 50 ballots, and then scanned using a central-count optical scan machine. Then, ten decks are accumulated to form a box of 500 ballots and stored by the box.

The 1% audit process, in its simplest form, involves selecting a sample of precincts and manually recounting all the ballots and VVPAT records received for those precincts. This works well for votes cast at the polling place (i.e., votes in our first category), because those paper ballots and VVPAT records are sorted and stored by precinct. However, this does not work well for centrally scanned ballots (i.e., votes in our second category), since they are not sorted or stored by precinct. Since centrally counted ballots are typically processed more or less as they arrive, the ballots in these boxes are not sorted or stored by precinct. If we wanted to manually recount a single precinct, it would be very difficult to track down all the centrally scanned paper ballots associated with that precinct. It is because of the two different methods of counting and storing ballots that the ACROV currently samples the precincts and the paper ballots in two separate samples.

Consequently, we are proposing a two-stage audit process. First, a random sample containing 1% of the precincts is selected. We then find and manually recount all ballots and VVPAT records that were cast at the polling place on touch screens or precinct-count optical scan machines. In other words, we manually recount all votes that fall in our first category and that are associated with the selected precinct. Second, a random sample of 1% of the boxes or decks is selected. The boxes and decks have been numbered in advance of the selection. We then find and manually recount all ballots in those decks or boxes. Note that the first stage of this process covers all ballots cast and scanned/recorded at the polling place, while the second stage covers all ballots received and scanned/counted centrally. Consequently, this ensures that the 1% audit covers all votes, without changing the way that ballots are received, processed, sorted, or stored.

This two-stage audit process affects how votes must be reported in the Statement of Vote. The last stage in a 1% audit, after manually recounting each precinct or box, is to compare the manual tallies with the totals printed in the Statement of Vote. Of course, to do this comparison, we need these totals to appear somewhere in the official Statement of Vote. Therefore, the SoV must contain, for each precinct and each candidate, a total of the number of category-(i) votes for that candidate in that precinct (i.e. including only ballots stored with that precinct and excluding any centrally scanned ballot stored by boxes). The SoV must also contain, for each box and each candidate, a total of the number of category-(ii) votes for that candidate in that box (i.e., including only centrally scanned ballots in that box, and excluding any ballots cast and scanned at the polling place and excluding any ballots cast on a touch screen at the polling place). The former totals will be used during the first stage of the 1% audit and the latter totals will be used during the second stage of the 1% audit. This ensures that the manual numbers can be meaningfully compared to corresponding electronic counts reported in the Statement of Vote.

Currently, the Statement of Vote does contain the information about votes cast at the polling place that would be needed during the first stage of the audit. The SoV also contains information about other votes (e.g., provisionals and absentees), but that information is broken down by precinct, whereas the above discussion makes clear that the 1% audit process requires this information broken down by deck or box. We recommend that the SoV be augmented to also report vote tallies for centrally scanned (category-(ii)) ballots, broken down by deck or box. This might involve adding an extra section or appendix to the Statement of Vote for this additional information

**What about “Early Voting?”** Voters are now given the opportunity to vote several weeks before Election Day on touch screen machines exactly like those used in polling places. These machines are available in the ROV Office and sometimes at other locations around the county, for example, the offices of local City Clerks. Since every vote cast must be available to be audited, these votes should be included in one of the two proposed categories, or be treated as a separate and separately sampled category. We are not clear on how the paper records for early votes are accumulated and stored. If the early voting paper ballots and VVPAT records are sorted and stored by precinct, then it would be natural to include them in category (i) and to associate them with all other ballots cast and scanned/recorded at the polling place. If early voting ballots and VVPAT

records are sorted and stored by “box”, then it would be natural to include them in category (ii) and to associate them with other centrally scanned ballots. Any other categories of votes that have not been mentioned here, for example, provisional ballots which require the ROV to go to court to get authorization to count them should also be included in one or another group to be reported and sampled.

**IV. Every vote cast should have at least a 1% chance of being drawn and hand counted in the sample.** The goal is that every voter, voting by any method, should be able to verify that her or his vote has at least a 1% chance of being picked in the 1% sample to be counted by hand.

**Therefore, all ballots cast at the polls and all paper ballots should be sampled.** Every type of ballot cast at various places and times and by various methods should have a chance to be sampled. Both electronic ballots and official paper ballots cast at the polls should be sampled. In addition, all categories of paper ballots should be sampled, including mail-in ballots from mail-in precincts, absentee ballots received before election day, absentee ballots delivered to polling places, absentee ballots from military personnel, provisional ballots cast at the polls, and damaged ballots in all categories, early votes cast electronically.

**V. The method of selecting samples should be fair, open to public observation and inspection and easy to understand and verify. It should be random and understood to be so by the general public. This report proposes a process for sample selection based on a public throwing of special dice. The method is described in item 2 below and in Appendix I.**

**VI. The sampling method should be checked and tested for various kinds of potential error** before it is applied in drawing the sample. In its first or first few applications, the method should be checked and tested after the sample is drawn to make sure the assumptions of randomness proved correct.

**VII. The actual percentage of precincts sampled and of paper ballots sampled should be reconsidered in the future, after the proposed changes have been applied and tested.** Is one percent large enough to catch all important or significant sources of error or fraud? Is it too large? Too small? We are not addressing these questions in this report. Since the Election Code requires 1% of precincts, we have used 1% for both the sample of precincts and of paper ballots. This report suggests ways to assure that that number is applied as randomly and fairly as possible. We would like to point out that we tend to assume that 1% of precincts is equivalent to 1% of votes, which might not be true if the numbers of voters per precinct varied widely in some significant way. In a selection that includes only eight precincts, various machine or human errors might not be identified. We also point out that the actual percentage of precincts sampled is larger than 1% because of the additional precincts added to include all ballot types; however, only the races unique to those additional precincts may be sampled at present.

**VIII. Changes to the 1% sample or other recommended changes should not conflict with the Election Code.**

The ROV's first obligation is to conform to the Election Code and to report the vote in the format required by the Secretary of State. Any changes recommended here that would bring the ROV into conflict with the Election Code or requirements of the Secretary of State should be modified to preserve their intent while keeping in compliance with laws and regulations. Should our proposed changes prove useful, the Committee and the ROV might consider recommending them to the state as a whole.

**IX. The Registrar of Votes should consider in advance how to handle any discrepancies that may be discovered during the 1% audit.** Suppose that the 1% audit discovers discrepancies between the manual tallies and the electronic tallies. What happens then? Obviously, any confirmed errors that are discovered in the electronic tallies need to be corrected, but it is not enough just to correct those errors that were discovered during the 1% audit—some kind of further investigation, and possibly further corrective action, may well be needed.

If any discrepancies are discovered, there are likely to be many possible causes. One possibility is that the manual tally was erroneous; if so, no corrective action is needed. Errors in the manual count should be easy to detect and rule out with standard methods (e.g., by having two or three independent teams separately count the paper records; if both teams obtain the same manual count, then probably the error is in the electronic tally rather than in the manual tally). Another possibility is that the discrepancy was due to an isolated error in the electronic tallies; if so, it is enough to fix that isolated error. However, a third possibility is that the discrepancy may represent systematic errors or fraud in the electronic tallies, and in that case, more sweeping corrective action will be needed. Some kind of detailed investigation will likely be needed to distinguish between the latter two cases.

As a general principle, if a discrepancy is detected, we recommend that the ACROV investigate the potential causes of this discrepancy and make public the results of this investigation. If the ROV staff are able to determine with confidence the cause of the discrepancy and the extent to which this fault may have affected other votes, then it will be possible to take action to correct all affected votes. For instance, if it is determined that an optical scanner was out of calibration, it would be possible to manually recount all ballots processed by that scanner (or to re-scan those ballots with another properly calibrated optical scan machine, and to perform a new 1% manual recount of those new results). On the other hand, if it is not possible to determine the cause or extent of the discrepancy with confidence, or if there is any uncertainty or lingering doubt about the diagnosis, then more sweeping measures will be needed. Because any unexplained discrepancy discovered during the 1% audit could raise suspicions of systematic error or fraud and could call into question the entire election, in these cases it may be necessary to perform a more extensive audit (e.g., a manual recount of 5% or 10% of the votes) to determine the extent of the error, or it may even be necessary to perform a complete manual recount. After all errors are corrected, it may be appropriate in some cases to perform another 1% audit, using the same rules and process for the second audit as for the first one.

We do not take a position on exactly what the procedures for handling discrepancies should be. However, we do suggest that the Registrar of Voters consider in advance how

discrepancies will be handled. If unexplained discrepancies are detected during a close or hotly contested election, any kind of political controversy could raise the stakes and make it more difficult to develop an appropriate response on the fly and under time pressure. In a heated, politically charged atmosphere, disputes over how to resolve discrepancies could harm public confidence. Therefore, it may be useful to have a pre-existing set of procedures to point to. We suggest that the ACROV may want to consider developing a protocol or set of guidelines for how any discrepancies will be handled.

## **Applying the New Criteria Improving and Supplementing the Current Method**

### **1. Expand the hand count in the 1% of polling place precincts to include Voter Verifiable Paper Audit Trails [VVPAT] and Paper Ballots**

#### **Discussion**

The Election Code will probably not change in the near future. The ROV Office may continue to interpret the Election Code requirement to mean that it should take a 1% sample of precincts with actual polling places, where votes are cast, reported and counted electronically. In future elections, each polling place may be equipped with both touch screen electronic machines and electronic scanning machines that will count paper ballots voted at the polling place. Both types of ballots will be processed and reported by the ROV on Election Night. We assume the ROV will include in the subsequent 1% hand count both the Voter Verifiable Paper Audit Trails [VVPAT], that is, the paper records of the electronically cast ballots, and also the paper ballots voted at the polls.

This expansion will, of course, increase the number of ballots to be counted by hand and therefore the labor and time of the temporary staff who do the hand counting. We believe the expansion will improve the usefulness of the sample. It will also contribute to increasing public trust in the election results.

### **2. Pick the samples using three colored 10-sided dice rather than a computer random number generator. Red, white and blue dice with numerals from 0 to 9 are recommended.**

#### **Discussion**

An underlying purpose of improving the sampling for the hand count is to validate the election results in an open and visible way. If the test confirms the results, public confidence in the election system will grow. The counting of the whole election vote is done by computer. Many recent examples of errors in election equipment and officials—in Florida and Ohio, for example—have given the public good reasons to mistrust computer counts of the vote. As we saw in the bad sample discussed above, computer generated random samples can have many actual or apparent flaws.

For these reasons, it make sense to use a method other than a computer to select the 1% sample for the hand count. The hand count is intended to test the computer vote count. It will count paper records of the votes that were created at the same time as the electronic records, but were independently confirmed as accurate by each voter. Teams of three

people will, as they do now, do the counting instead of machines and computers. The public will continue to have the right to observe this process.

To make every element of the process fair, open to public observation and inspection and easy to understand and verify as well as random, a method of picking the sample that is visible and physical makes good sense. Tossing dice is something that the public could observe and readily understand. Tossing dice, of course, has potential problems of its own; dice can be unbalanced; ways of tossing dice can look fair, but actually be unfair. So, the sampling method should be checked for various kinds of potential error both before and after each election where it is applied.

Ten sided dice include the numerals 0 to 9. Red, white and blue dice would easily determine the order in which the numerals would be read to form a number. Tossing three 10 sided dice will generate a three digit number and thus can accommodate selected from up to 1000 precincts. When the toss gives a number higher than the number of any actual precinct, that toss would be ignored. Practically speaking, probably no more than about 20 tosses would be required to select 8 precincts. [Appendix 1 will describe the proposed method in detail.]

**3. Publicize the 1% sample process and activities in advance in a variety of ways and make the activities as accessible and understandable as possible to the public. Help public observers understand the process they are observing by providing information in print and computer form in advance and as needed on the particular occasion.**

- **Create a public event or ceremony of the selection of the 1% sample to publicize that the vote totals are checked by a careful and carefully selected hand count.** One suggestion would be to hold a competition for school children to write a short essay about why our votes are important and should be counted correctly. The winner or winners would actually throw the dice to pick the sample or would be present at the event and get a reward or award. The dice throw could be videotaped and put on the ROV website, explained and publicized in various ways in advance and after the event, on the ROV webpage and elsewhere.
- **Give notice** at least one week in advance of the date and time when the random sample selection and the rest of the recount will be held, so that others can attend.
- **Provide information about the process.** The procedures to be used in the 1% audit process should be posted publicly (e.g., on the ROV web site) in advance so that potential observers can know what to anticipate.
- **Post the preliminary Statement of Vote.** The preliminary SoV should be posted publicly in electronic form (e.g. on the ROV web site and in .csv format) at least one day in advance, so that observers can download it and bring it with them to the audit (including on a laptop, if they wish).
- During the hand count process, provide summary sheets of each precinct that is to be recounted, with a list of all the data to be checked, to public observers as well as to staff.

This would enable observers to follow the hand count process in detail.

**4. Expand the current sample of absentee and other paper ballots to a full 1%.** We suggest selecting a sample of % of the decks or 1% of the boxes to be recounted. If feasible, it is better to sample these ballots using the deck of 50 rather than the box of 500 as the sampling unit.

The ROV Office already does a hand count of a sample of absentee and other paper ballots. In the most recent election, the ROV did a hand count of 1500 absentee and other ballots. One percent of the 193,567 paper ballots would be 1936 paper ballots, so the ROV sampled close to 1% of the paper ballots. However, not all types of paper ballots had an equal chance of being included in the sample.

For the November 2005 election, the ROV selected three boxes each containing 500 paper ballots for a hand count. Two boxes were absentee ballots and one box was provisional and official ballots cast at the polls. Although we did not observe the selection, we understand that the boxes were selected after Election Day, taken off the long shelves where boxes of paper ballots are stored after counting, during the period when some categories of paper ballots were still been processed—being checked for signatures or sorted—and some still awaited processing. Damaged ballots, for example, are often the last to be processed and counted. This means that some categories of ballots had not yet been scanned, counted and packed up into boxes of 500 and were not available for sampling at that time. Consequently, the counting and tallying of those ballots was not checked by the manual recount; any errors or fraud that affected those subsequently counted ballots would not be detected by the 1% audit.

During the Post-Election Canvass, which includes the processing and counting of all paper ballots, the paper ballots are prepared in batches or decks of 50. Each set of 10 decks is combined to make a pile of 500 ballots. Each pile of 500 ballots is brought to a electronic scanner operated by a staffer. The staffer take each batch or deck of 50 ballots and runs it through the scanner. When the staffer has completed the scanning of 500 ballots they are placed in a box, sealed and stored on a shelf.

**The Improved Process.** As we recommend for the selection of 1% of precincts described above, the ROV would complete the counting of all paper ballots that are processed and counted at the ROV office. A preliminary Statement of Vote that included all and only the categories of paper ballots so counted would be finalized and published.

The ROV Office would then publicly throwdice to select 1% of paper ballots previously processed and counted at the ROV office for a hand recount. We recommend that the ROV select 1% of decks, rather than boxes, if this is technically feasible. Selecting 1% of boxes might result only in the selection of 3 or 4 boxes; selecting 1% of decks would mean a sample of 30 or 40 decks or units, which would be more effective at detecting errors or fraud. The sample selection and manual recounting of these centrally counted ballots should be public and open to observation, just as the sample selection and recounting of ballots cast at the polls is. Preferably, the 1% sample of precincts and the 1% sample of decks/boxes would happen at the same time to make it easy for observers to observe both processes. **[Details for this method are described in Appendix 2.]**

**5. Early Ballots cast electronically and any other categories of ballots not yet included in the two groups sampled as described above should be assigned to the appropriate group or form a separate group to be sampled separately.**

**6. Formats for Reporting the Statement of Vote and the Summary should be expanded.** The Statement of Vote should be expanded so it is not only broken down by polling, absentee, provisional, early voting, but also by box/deck. This detailed information should be provided in both PDF and comma-delimited (.csv) format on the ACROV web site. For the Nov 2005 election, the ACROV published a PDF version of the SoV that contains the data broken down by those four categories. The ACROV also published a .csv version of the SoV, but the .csv had only aggregate numbers and didn't break the vote totals down according to these four categories (polling, absentee, provisional, and early voting). In the future the .csv version should also include the more detailed data as broken down into categories.

### **Appendix 1: Procedure For 1% Random Audit Selection**

#### **SUMMARY**

This document covers a procedure and explanation for conducting a fair and publicly observable selection for a *1% random audit* of voting precincts. For every ballot type, a consecutively numbered list of precincts is prepared. Dice are used to select 1% of the total number of precincts. In addition, as per California law, one precinct from any unrepresented ballot type is selected using the same procedure.



**Figure 1** An example of a 10-sided die, a tumbler, and a rolling surface.

#### **ASSUMPTION**

This procedure assumes the number of precincts being selected from is fewer than 1000. (Note: this assumption is made for simplicity, the same procedure can be extended for larger drawings, though care must be taken for efficiency).

#### **MATERIALS**

- At least three (3) new translucent 10-sided dice<sup>1</sup>: one tinted red, one clear and one blue, and kept in original packaging (see figure 1).

- A ribbed tumbler (or dice cup)
- A hard, flat rolling surface with edges (or dice tray)
- Pen and paper to record rolls

### STEP 1: PREPARATION

- a. Prepare a sequentially numbered list, starting with one (1), which includes every precinct to be part of the audit<sup>ii</sup>. The list should be numbered 1, 2, 3, etc., up to the total number of precincts. Print this list, and make it available on the County web site in advance of the audit.
- b. Next, for each distinct ballot type, print a sequentially numbered list of every precinct where that ballot type appears, again starting with one (1), numbered from one to the number of precincts using that ballot type. Print and make it available on the County web site.
- c. Make copies of above lists to be given to observers<sup>iii</sup>.
- d. Calculate the number of precincts to select. (1% of total number of precincts, rounded up<sup>iv</sup>.)

$$[ ] [ ] [ ] \times 0.01 = [ ] . [ ] [ ] \text{ rounded up} = [ ]$$

For example, 1% of 877 is  $877 \times 0.01 = 8.77$ , rounded up = 9.

### STEP 2: SELECTION

- a. Hand out printouts from step 1c to all observers<sup>v</sup>.
- b. Open the packaging on the dice in front of observers.
- c. Determine how many dice to use:
  - If the number of precincts is between 1 and 9 only use only the red die.
  - If the number of precincts is between 10 and 99 use the red and white dice.
  - If the number of precincts is between 100 and 999 use the red, white, and blue dice.
- d. Roll the three dice using the tumbler onto the rolling surface: repeat until 1% (from step 1d) of precincts are selected.
  - Read off the rolled digits in the following order: *red, white, blue*.
  - After the roll and before anyone touches the dice, let observers satisfy themselves with the result.
  - Write the resulting number down. If it corresponds to a precinct on the list not already included in the sample, circle this number and count the precinct as one of the selected 1%.
- e. Check each ballot type for inclusion in the selection.

If all ballot types are represented in the selection, you are done!  
Otherwise,  
Otherwise, for each excluded ballot type, select one precinct at random from the corresponding numbered list for that ballot type (repeating steps 2c and 2d) to perform the random selection).

## **Appendix 2: Selecting 1% of absentee and other paper ballots**

Paper ballots counted at the ROV office are batched up into decks of 50 ballots. Then 10 decks are placed in a box of 500 ballots. Each deck is scanned as a group. As we understand it, the GEMS server is able to record, along with each electronic ballot image, the deck it was associated with. The boxes and decks are clearly numbered in sequence as they are scanned.

After all the votes have been completely counted (including all the absentees and all the touch screen vote), ROV staff should freeze the database and print a preliminary (unofficial) Statement of Vote. The SoV would be augmented to add a listing of just the centrally scanned votes, broken down by deck: e.g., for each contest, there would be a table listing the set of candidates/options horizontally, with one row per deck showing the total number of votes for each candidate within that deck of 50 ballots. This is analogous to the current SoV format, except that currently the SoV is broken down by precinct instead of by deck.

We suggest that the SoV contain two sections: the first section would be broken down by precinct (i.e., exactly as is already done in the current SoV format); the second section lists just centrally scanned (i.e., category-(ii)) votes, and is broken down by deck.

After the votes are counted, the database is frozen, and the preliminary SoV is printed, it is time to draw a random sample. ROV staff would randomly choose 1% of the decks using the process described in Appendix 1. For instance, if there are 3000 decks, then ROV staff would choose 30 decks at random, using the same process used to select 1% of the precincts. These decks would be pulled from storage. Here we have assumed that records are kept, or the decks are numbered in some kind of order and stored in that order, so that ROV staff can quickly find the paper ballots for any particular deck.

Finally, ROV staff would manually recount each of those selected decks and compare the manual tallies against the numbers in the second section of the SoV. This step verifies that the electronic tallies in the second section of the SoV are accurate. Interested observers can later, if they want, check on their own that the individual counts in the SoV have been summed up correctly and match the Summary Election Results report.

If the GEMS server only remembers which box each ballot was associated with, but doesn't remember which of the 10 decks it came from, then we can do the same as above, replacing "decks" by "boxes" throughout.

With this method, it is not possible to begin the manual recount until all the absentees and other categories of paper ballots have been counted. It will still be possible to perform the 1% audit of the centrally scanned ballots (e.g., absentees) at the same time as the 1% audit of the ballots cast at the polling place (e.g., touch screen votes and precinct-count optical scanned ballots).

The benefit of this method is that it introduces an end-to-end audit of *all* votes—including absentee ballots. Even if there is something wrong in the optical scanners used

to scan the absentees, or something wrong with the GEMS server/tabulator, or the GEMS server gets hacked, or some individual tries to defraud the system electronically, we will still stand a good chance of detecting it(if it affects many ballots).

For instance, this would address concerns raised by some critics that it would be too easy for the operator of the central tabulator to change the electronic tallies illicitly. With these audit procedures, if anyone tried to do that, they'd risk being caught during the 1% audit. If anyone made illicit changes that affected many precincts, there is a good chance they'd be caught. Therefore, if everything matches during the 1% audit process, then voters and skeptics can have reason to be confident that there was no large-scale fraud, even if they do not trust the equipment vendor.

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<sup>i</sup> The 10-sided dice should have faces ranging from 0 to 9.

<sup>ii</sup> The order of the precincts does not matter as long as the list is comprehensive. Also, for this selection procedure, it does not matter if the list begins with 1 or 0. If there are 100 precincts, it makes more sense to number from 0 to 99 so two dice can be used instead of three.

<sup>iii</sup> For example, if there are 10 distinct ballot types, there should be 11 lists printed, one for each ballot type plus the main list that includes all precincts.

<sup>iv</sup> It is important that we round up. Otherwise, fewer than 1% of precincts will be sampled, inconsistent with California law.

<sup>v</sup> The copies are intended for observers to keep and inspect to their satisfaction that all precincts were listed and numbered correctly.