



# Audits: The After-Math of Elections

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# Outline

Risk-Limiting Audits

California AB 2023

Orange County, 2011

Matching ballots to CVRs

Statutory Audit

Risk-Limiting Audit



# Risk-Limiting Audits

- What do we want audits to do?
- Many things, but ensure apparent winners really won
- To correct a wrong outcome requires full hand count
- Risk-limiting audit guarantees a large (pre-specified) chance of correcting wrong outcomes



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## Contest summary

	Ballots cast	Yes	No	undervotes & overvotes	precincts
Total	17,823	7,624	10,170	29	26
VBM	12,180	5,137	7,031	12	25
In-person	5,643	2,487	3,139	17	26

San Clemente Measure A, Playa del Norte Commercial Development Project. There were 41,332 registered voters eligible to vote in the contest.



## Ballot Accounting and Sanity Checks

Check count of pollbook signatures against ballots cast by precinct.  
Match VBM batches to electronic scan records: every physical batch has a unique scan record; every scan record has a corresponding unique physical batch. Batch sizes range from 1 to 153 ballots with a median of 26. Few batches have more than 100 ballots; most have 12–75.

Ballots have non-unique serial numbers: 1–2500. Ballots in individual scan batches likely to have unique numbers. Facilitates finding individual ballots.



## Getting machine-level results

Backup using I/O port. Generate .xls file. Copy to USB drive. Put on my computer. Cut and paste to create usable .csv file; cross check totals with official results.



## Tabulation checks

Independently sum in-person and VBM results by precinct to confirm they add to the reported election totals.

Independently sum number of ballots cast on each machine and VBMs to confirm they match the total number of ballots cast, accounting for spoiled ballots, under- and over-voted ballots, and rejected provisional ballots.

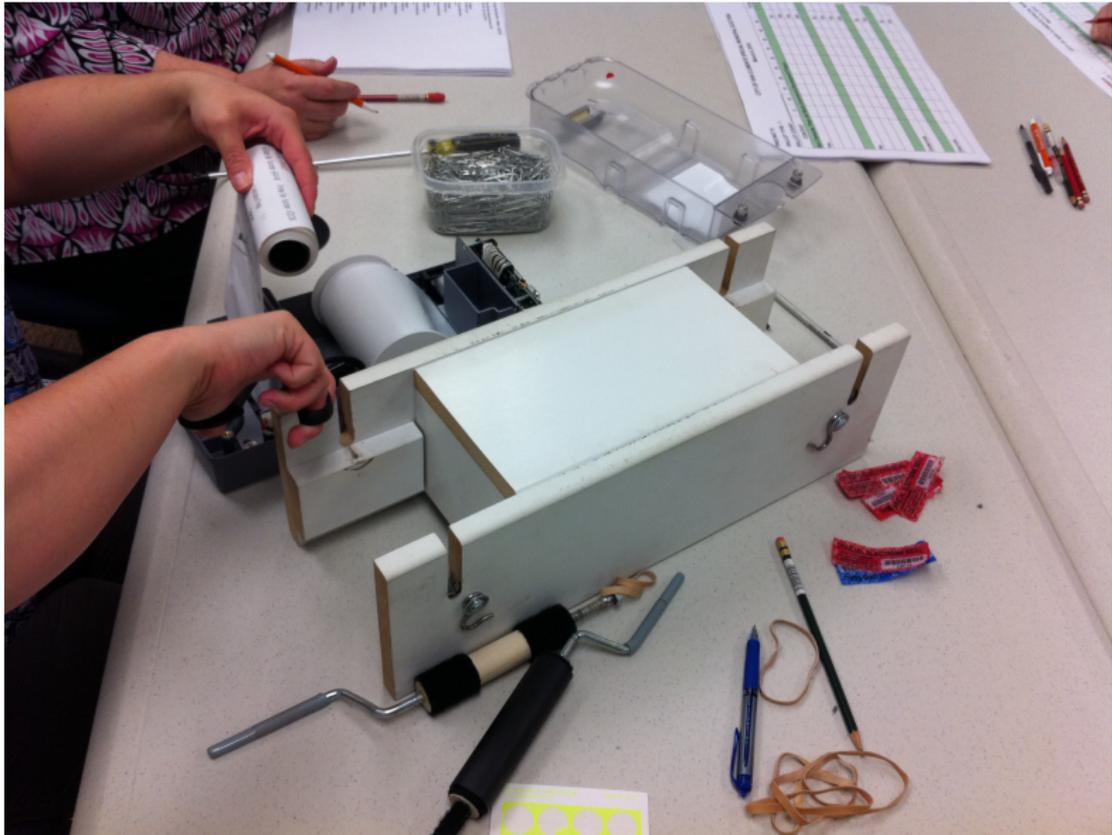




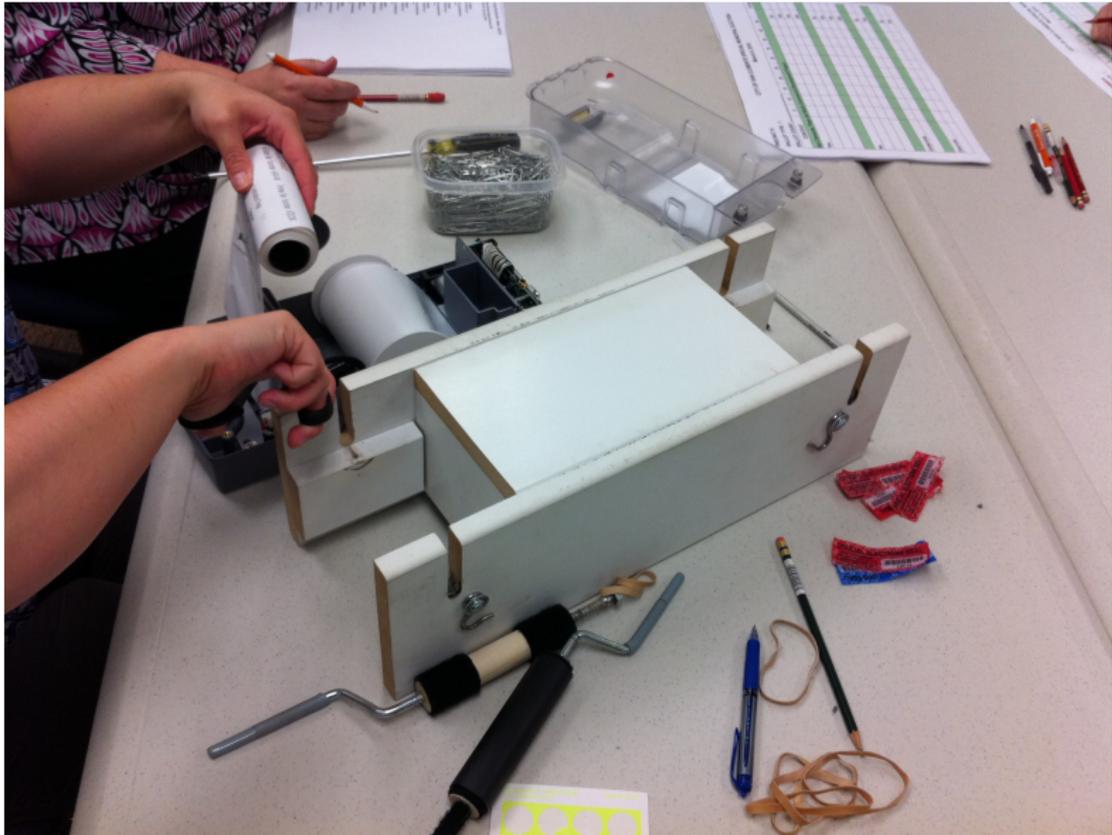






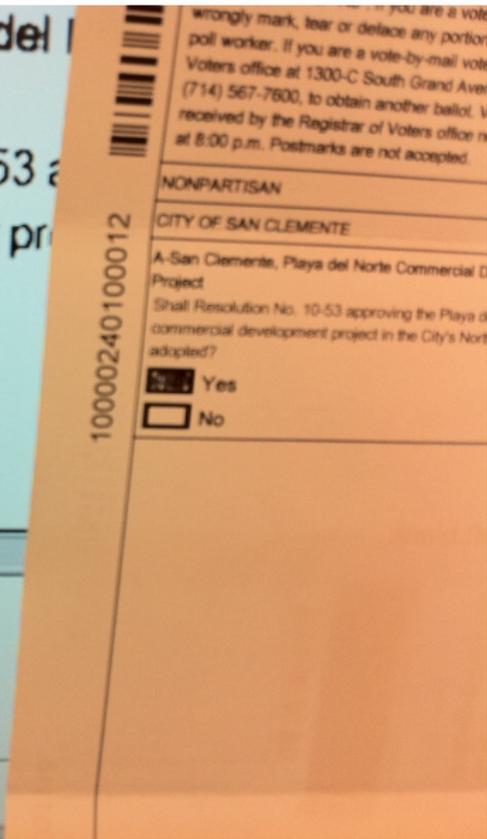
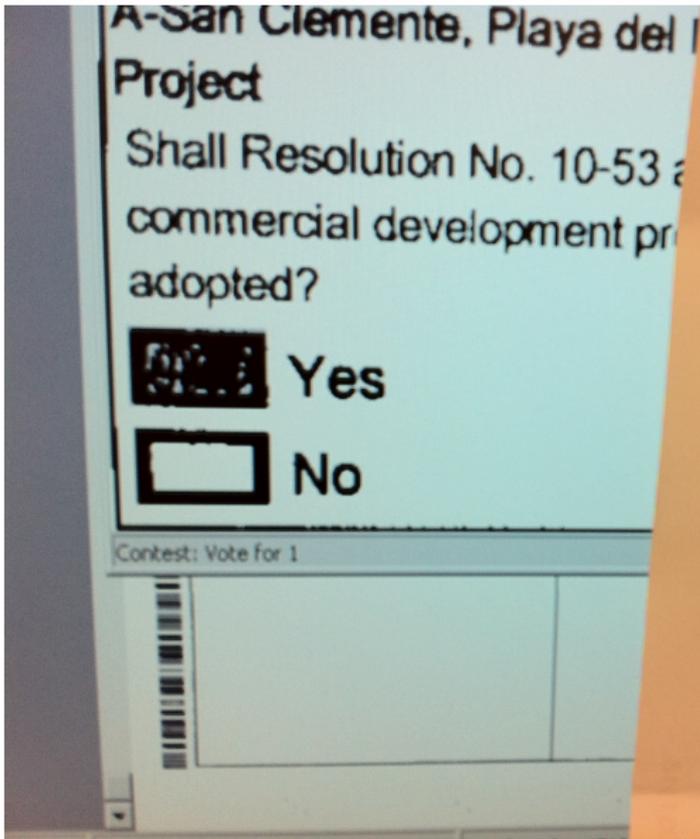














**Project**

Shall Resolution No. 10-53 approving commercial development project in the City of San Clemente be adopted?

Yes

No

Contest: Vote for 1

received by the Registrar of Voters at 8:00 p.m. Postmarks are not accepted.

NONPARTISAN

CITY OF SAN CLEMENTE

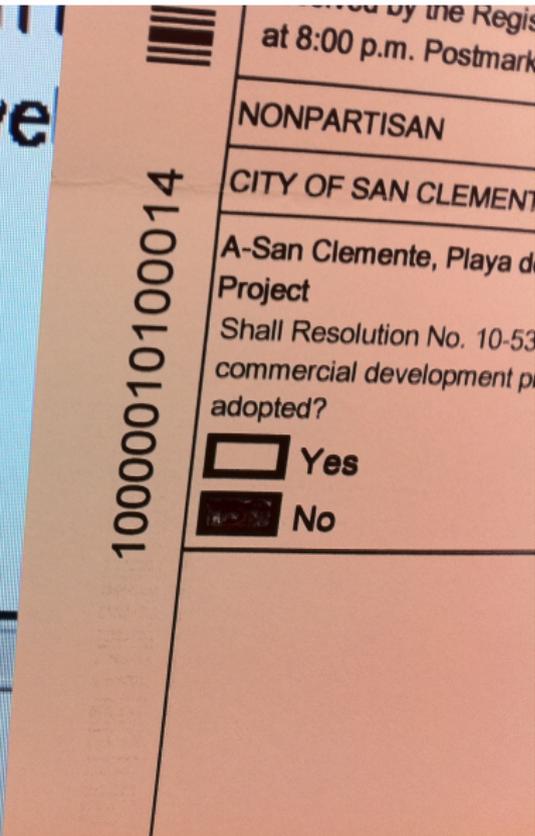
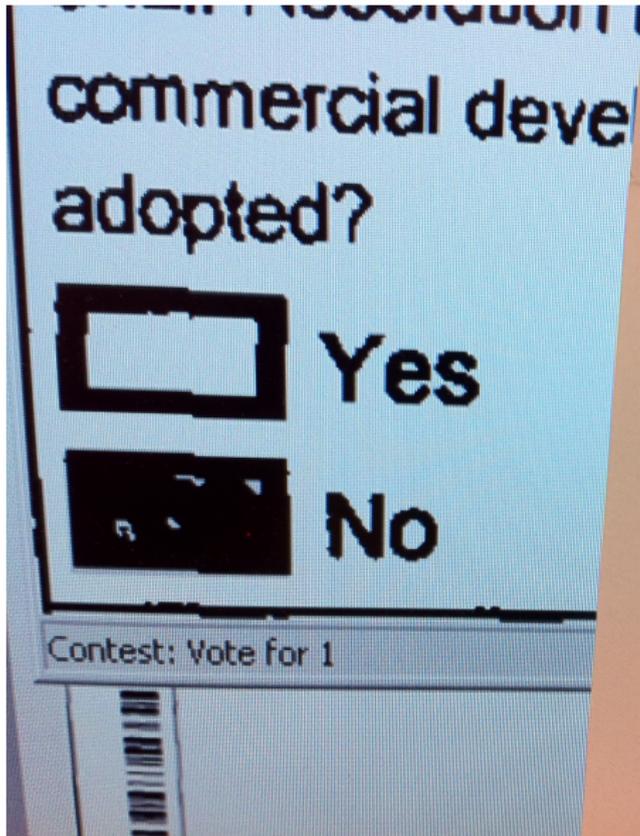
A-San Clemente, Playa del Norte Commercial Project

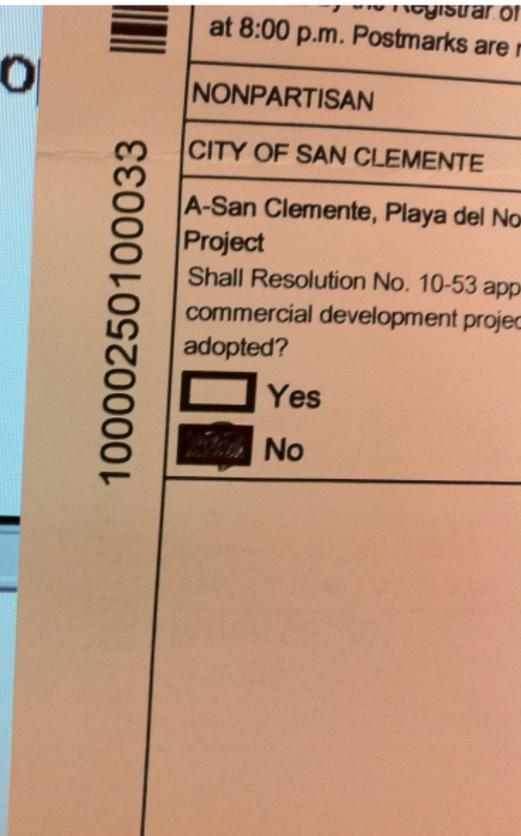
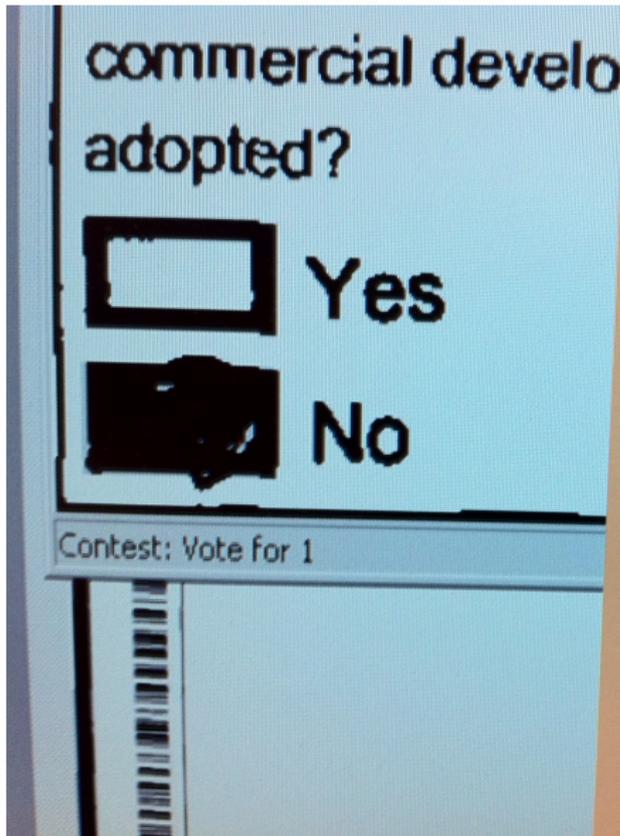
Shall Resolution No. 10-53 approving commercial development project in the City of San Clemente be adopted?

Yes

No

10000010100014







commercial deve  
adopted?

Yes

No

Contest: Vote for 1



10000110100030

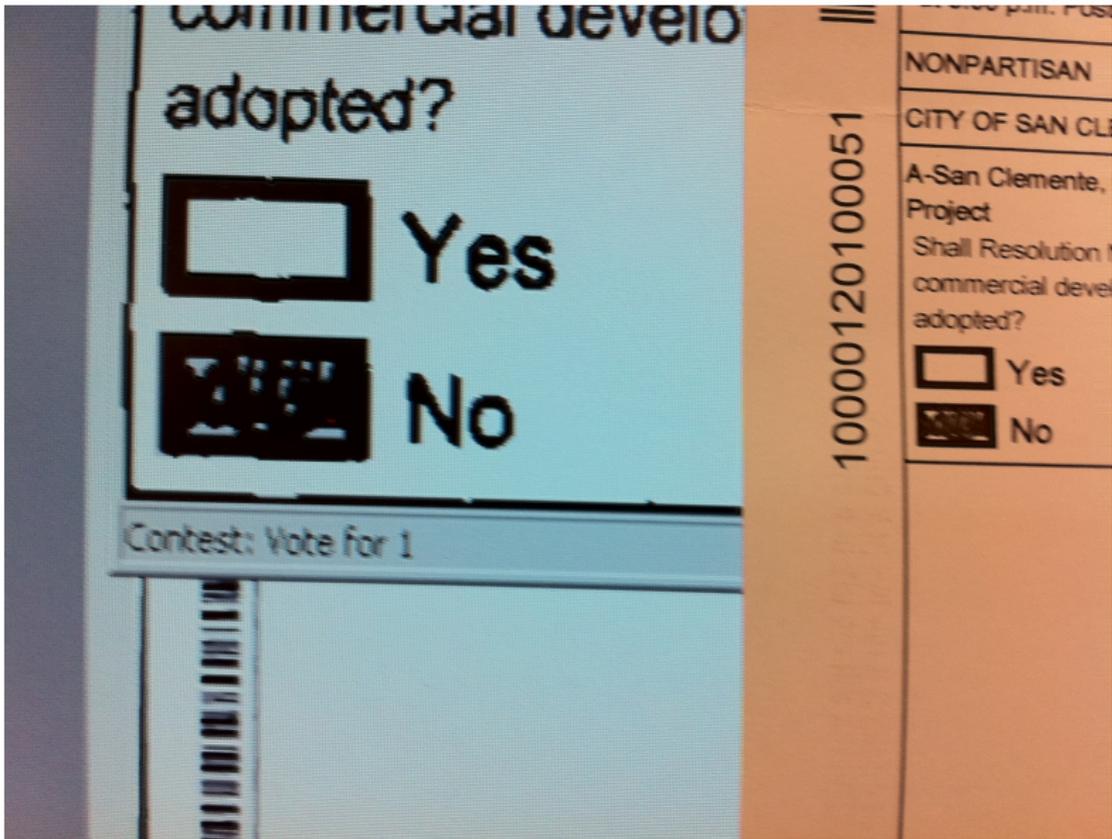
CITY OF SAN CLEMENTE

A-San Clemente, Playa del  
Project

Shall Resolution No. 10-53,  
commercial development pr  
adopted?

Yes

No





commercial develop  
adopted?

Yes

No

Contest: Vote for 1



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NONPARTISAN

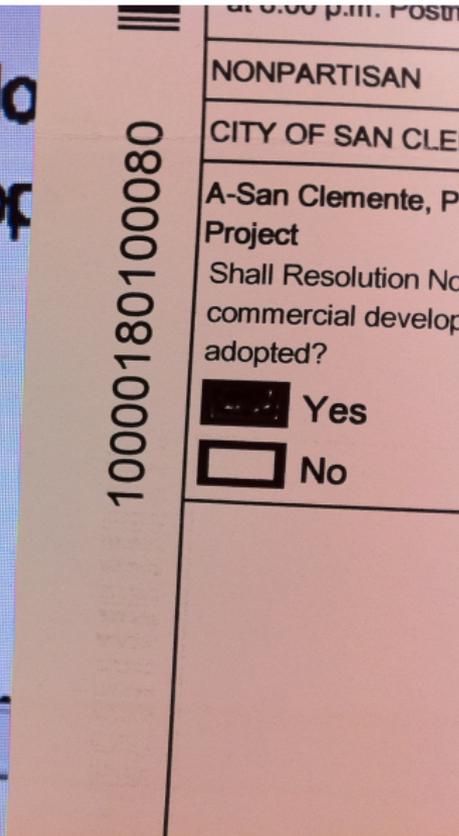
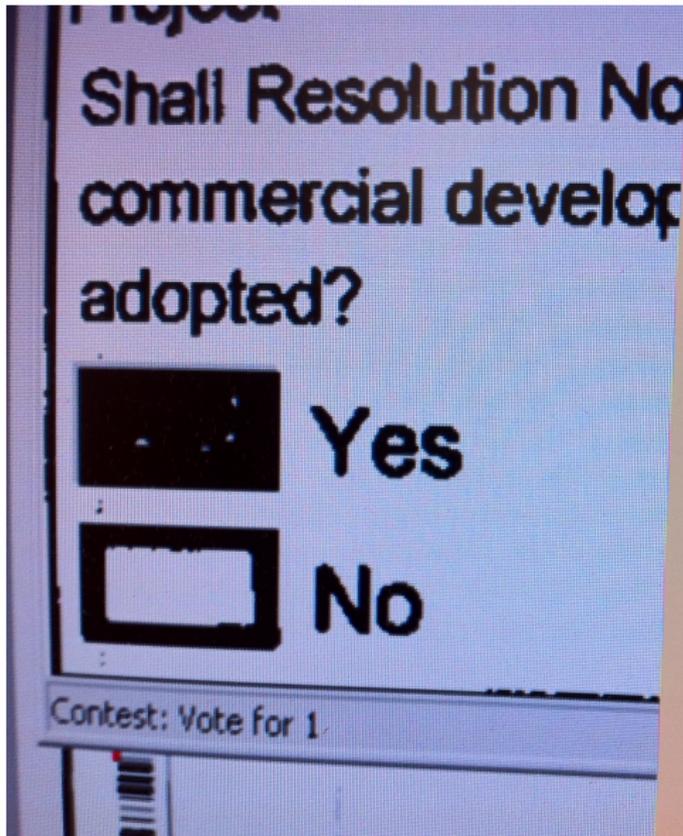
CITY OF SAN CLEM

A-San Clemente, Play  
Project

Shall Resolution No. 1  
commercial developm  
adopted?

Yes

No





## Audit design and sample

Left provisionals in machine ballot counts for error bounds. 5523 total.

One VBM-only precinct with 119 ballots. 158 election-day paper ballots. 38 rejected provisional ballots

Used a deck of cards to pick a 9-digit seed: shuffled cards well, counted Ace as 1, etc., 10 as 0, and ignored face cards, dealt until we had 9 digits. Used R implementation of Mersenne Twister.

Sample gave 12 eSlate machines with a total of 446 ballots, and 21 individual ballots. Total sample size 467 ballots (expected size was 384.8 ballots). One of the eSlates had already been audited as part of the statutory 1% audit.



Ordered ballots canonically: scanner A, B, C. which scanner, which batch, which ballot in the batch. from that, could look up a serial number for the ballot image use barcode scanner to verify that we had the right ballot then compare the ballot image (with that serial number) with the physical ballot to verify identity of ballot then confirm that the CVR matched our interpretation



## 1% Statutory Audit

Votes in one precinct counted by hand. No errors found.

Chance the 1% audit would find no errors even if the outcome is wrong could be over 88%.

Statutory audit does little to limit risk, even if it required a full hand count if errors were found.



## Special steps

Pollworkers instructed to spread voters across machines (roughly 10 per precinct) so that machine batch sizes would be comparable and small.

Unable to export of subtotals by machine from the vote tabulation system. Downloaded counts of voters from each of 200 eSlates to determine sampling weights; about 2 hours work.



## Initial sample sizes for various batching rules

### San Clemente Measure A, 3/8/2011

batching rule	draws	expected batches	expected ballots
VBM by precinct	18	14.7	6370.2
IP by precinct			
VBM by ballot	28	27.4	1192.9
IP by precinct			
VBM by ballot	32	31.7	376.6
IP by machine			
SS: VBM by ballot	47	46.9	46.9
IP by ballot			
KM: VBM by ballot	33	33.0	33.0
IP by ballot			

Expected counting burden, 10% risk limit, no overstatement errors. All based on PPEB sampling using KM inequality. “By ballot” includes error bound “headroom” of 5% (2.1 vote maximum error per ballot). “By machine” error bound is twice the number of ballots. SS: “super-simple” method. Sample size 6.638/margin. KM: Kaplan-Markov using error bound of 2.1 votes per ballot.



## Risk-limiting Audits: Costs

San Clemente Measure A, 3/8/2011

1% Statutory Audit: \$257.68

Scales as the size of the contest: a contest twice as large would cost about twice as much to audit.

Risk-limiting: \$483.79 (does not include my time or airfare)

Would have cost essentially the same for any contest with the same percentage margin, no matter how large the contest.