Domestic Revaluation in Northern Ireland

BY ROBERT J. GLOUDEMANS AND ERIN J. MONTGOMERY, D.PHIL.

The recently completed revaluation of approximately 680,000 residential properties in Northern Ireland was a landmark accomplishment, representing the Province's first revaluation based on capital value. The last revaluation, based on net rental values, was completed in the mid-1970s. The current revaluation used the modern mass valuation techniques, including some innovative ones, and achieved high standards for excellence in terms of traditional sales ratio statistics.

The Valuation and Lands Agency (VLA), which has since been amalgamated into the newly created Land and Property Services (LPS) agency, completed the reappraisal over an approximately two-year period. Values were published in the summer of 2006. (The revaluation did not include commercial properties, which are separately appraised approximately every five years based on rental value.)

This paper summarizes the methodology and results of the revaluation, problems encountered, achievements realized, and lessons learned.

Data Preparation and Capacity Building

Core System Replacement

At the commencement of the Domestic Revaluation (DR) project, VLA's core data were stored on a DOS-based database, Valcom, which had been established in 1990 and was overdue for replacement. Although improved functionality was ultimately realized, core system replacement—from Valcom to one based on the NovaLIS Assessment Office (AO) platform—provided an unwelcome backdrop to the DR project. Data preparation for computer-assisted mass appraisal (CAMA) modeling proved to be enormously hindered as AO was embedded within the agency. Ultimately, however, in modeling terms, AO became the repository for all data for unsold, or target, properties.

Sales Inspection Database

A temporary Sales Inspection Database (SID) was custom-built to record domestic sales information, e.g., sale price, sale date, new-build/secondhand sale, and

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the like, until AO was ready. SID was linked to the legacy Valcom database, allowing each sold property's physical characteristics to be copied to it. When a sale was recorded on SID and its associated Valcom characteristics were matched into its SID record, a sales inspection sheet was produced. This formed the basis of a comprehensive sales inspection program. Different levels of inspection ensured that the process was efficient and "desk inspections" were often adequate for new-build sales. Valuers also collected real estate agents' brochures to verify the characteristics of properties offered for sale on the open market.

The data were therefore verified or inaccuracies noted and the details sent back to headquarters for correction on SID. In addition, during the inspections valuers took digital photographs of sold properties, which subsequently became part of the agency's database. Hence, SID became the definitive repository for accurately recording and verifying a property's data characteristics at the sale price on the date of sale.

Preparing Data for CAMA Modeling

VLA established a CAMA modeling team at headquarters in Belfast, which was commissioned with what seemed like an ever-increasing number of tasks as the project progressed. Data preparation was one such case.

The domestic property data stored on Valcom (about 680,000 target records) had never been subjected to a mass analysis. Analyses highlighted patterns of inconsistencies and inaccuracies that had to be addressed. Some records exhibited evidence of data entry shortcuts—enough information was recorded to complete value calculations required for rating purposes but complete data were never collected. The SID database was dependent upon Valcom for obtaining property details while being manually updated with new sales at a fast rate. New sales records were entered at each of the seven VLA district offices dispersed around the length and breadth of Northern Ireland, and as such it was vital to maintain a good communicational link with headquarters in Belfast.

Validation checks were introduced to weed out obvious errors, e.g., sales recorded as <£10,000 or >£10,000,000, sales dates recorded as 1 January 1900, habitable space <15 sq m, and so on. Fortunately a large proportion of the mistakes that would have been significant at the modeling stage were identified by using this simple system of quality assurance (QA) database queries. QA checks were run monthly and the results distributed around each district office for action along with progress reports of work completed and outstanding.

The issue of combining the sold and target records, stored on separate databases, remained. Ultimately a "flat file" incorporating information from both property databases, as well as a third database that recorded geocodes (see below), had to be created. This entailed ensuring that the flat file provided a standardized format for all the fields relevant to CAMA modeling; for example, habitable space was recorded in slightly different formats on SID and AO. This laborious task required weeks of testing before confidence in the usable file was established.

Geocodes

The CAMA techniques employed by VLA relied heavily on the availability of geocodes for every domestic property, particularly in the second stage of modeling, which used spatialest software in a geographic information system (GIS) environment. Prior to model building, geocodes were used to assign properties to neighborhoods and to determine their general location as urban, suburban, or rural. Geocodes were obtained from Northern Ireland's Pointer database, which is intended to be the complete authoritative database of Northern Ireland addresses in one standardized format. In practice, Pointer was still un-

der development for ground validation, QA checking, and so on.

While the majority of geocode data was good, approximately 20 percent was either missing or incorrect. This figure was much too high for successful modeling, and a number of workarounds and fixes were introduced to improve geocode quality. In addition, the algorithm for matching geocodes to individual property records via a unique property reference number (UPRN) suffered from a few teething problems within the new core system. For example, a property addressed Shore Road in County Antrim may have been given the geocode of a property on a different Shore Road in County Down, perhaps 20 miles away.

Hence, interim solutions for these and related problems had to be introduced. For example, based on already established GIS layers, ESRI software (ArcGIS v.8.1) was commissioned to develop an algorithm to tackle properties identified as having incorrect or missing geocodes. To these properties this algorithm allocated an estimated geocode representing the centroid of the street in which they were located or, if that was not possible, a geocode representing the centroid of their electoral ward.

Market Area and Neighborhood Delineation

The decision had been made to divide Northern Ireland into 25 geographical regions, called Market Areas (MAs), for CAMA modeling purposes, each of which was to be delineated into an appropriate number of neighborhoods (NBHDs). NBHD delineation was always recognized as a fundamental task for successful CAMA modeling. Valuers in each of the seven VLA districts were responsible for this endeavor and, after much consultation, were given an already existing geography, namely, Census Output Areas (COAs), as their building blocks for producing neighborhoods. The COAs for the 2001 Census of Population for the United Kingdom were used. They are small geographical regions, typically containing 125 households, and were by and large created by merging post code areas (analogous to zip or postal code areas in the United States and Canada). The Northern Ireland Statistics and Research Agency (NISRA) supplied VLA with the GIS layer of COAs for the whole of Northern Ireland, and by appropriately merging groups of COA polygons using ArcGIS Spatial Analyst software, NBHDs and MAs were created. Although this was a highly technical task, the modeling benefited greatly from the fact that NBHD delineation had been carried out by local valuers.

Training and Software Acquisition

Prior to the DR project, professional valuers within VLA generally had neither a background in statistics nor any practical CAMA experience. VLA assigned a statistician to the project for its duration, but significant training was also required for valuers to attain a solid grounding in statistical methods and data analysis using software pertinent to CAMA.

Initially about a dozen valuers, headquarters and district staff who would be specifically involved in the DR, were enrolled in the RSS (Royal Statistical Society) Basic Statistics course. The course assumed no statistical background and covered topics ranging from basic averages and measures of dispersion to correlation and regression analysis. Aside from two tranches of coursework, the valuers sat a three-hour examination when all course modules were completed. All successfully attained the RSS Ordinary Certificate.

The RSS course had highlighted the need for a basic level of competency using spreadsheet software. In addition, all agency staff had to be trained in the new AO core system. However, a steeper learning curve awaited the DR valuers, who subsequently undertook training in ArcGIS Spatial Analyst, SPSS Statistics, and spatialest software. These three software packages would be fundamental in

the preparation and subsequent analysis of the data required to produce CAMA-based estimates of capital value for all domestic property.

Lisburn Pilot Study

Lisburn, a large provincial city with substantial rural hinterland, was chosen as the market area for a CAMA pilot study. There was one overarching aim: to identify a CAMA process that would produce credible results meeting IAAO standards. Another major objective was to estimate the time and resources required for the actual modeling and review effort.

There were a number of secondary aims as well. One concerned the new NBHDs that had been created by using COAs. Initially a laborious exercise had been completed whereby the Lisburn market area was delineated into NBHDs by replicating valuers' hand-drawn boundaries in GIS. A multiple regression analysis (MRA) model was created which utilized these hand-drawn NBHDs. When a similar model was created t that used the new COA NBHDs, the results actually improved slightly. This provided the required confidence that the NBHDs created by the new faster method were likely to be as good as those drawn from scratch. Because of the time constraints, the new method of NBHD creation was adopted.

Plot size (land area) is a data element missing from VLA data, but it is widely regarded to be significant in estimating capital value. After another substantial GIS exercise, this field was estimated for all properties in the Lisburn pilot study and, as expected, turned out to be statistically significant in the MRA model. Unfortunately, neither the time nor the resources were available to comprehensively collect this information countrywide, either manually or using GIS, so its presence was noted as essential for future revaluations.

Other supplemental data items were introduced for the first time in the Lisburn MA pilot study: grade (quality of construction), external repair (condition), site-positive influences, and site-negative influences. All four were significant in the pilot modeling process. As a result, VLA embarked on a resource-intensive supplemental data collection exercise to glean this information for all target properties (these data were already being collected as standard for sold properties).

Once modeling started, any obvious data errors were reported to the districts for amendment on the new core system. This process was expedited by using a mass update tool, which was available on the new core system, to update many swathes of records for various data errors and inconsistencies.

Beacons

A common problem faced by CAMA modelers is ensuring adequate representation through sales data. In essence, the sample of property sales information should reflect the significant features of the entire housing stock to which CAMA is applied. In general, more sales evidence is required where more properties exist, while less evidence is required in smaller housing areas. An additional consideration for VLA was the fact that property in Northern Ireland is described in terms of primary classification and subclassification (subclass). The four domestic property subclasses are detached, semidetached, terrace, and apartment, although apartments were not included in the CAMA process. The measure of representation adopted considered how many properties of each subclass (excluding apartments) existed in each NBHD (referred to as cells), and depending upon cell size, an appropriate number or an appropriate proportion of sales evidence was deemed necessary. While this exercise occurred simultaneously with NBHD delineation, in those areas where NBHDs were not yet finalized, other known local government boundaries were used as proxy NBHDs to ensure the process continued across the country.

This technique lent itself nicely to the use of a spreadsheet, and as such the Beaconator spreadsheet was developed. When the results were compiled, many areas had sales representation that would fully meet requirements. Cells that required more market evidence were topped up with "beacons," which are an established method in VLA whereby professional valuers complete single-property appraisals in areas where sales evidence is low in order to obtain adequate benchmarks of capital value. In all, approximately 47,000 sales and 11,000 beacons were used in the revaluation. Producing so many beacon values was obviously a substantial additional burden on available resources. Properties that were for sale on the housing market at that time and that were within the required locations were the prime candidates for beacons. Their characteristics could be easily verified from agents' brochures, and the beacon values could, in due course, be verified against the subsequent sale prices.

The final stage of the Lisburn pilot study benefited from beacon collection, which, happily, showed the importance and usefulness of including beacons in the MRA models. The maps in figures 1 and 2 exhibit the unquestionable usefulness of beacons in the overall DR project. Figure 1 pictorially represents sales coverage across Northern Ireland, conspicuous by the dearth of "dots," particularly in the western part of the country. Figure 2 shows how beacon valuations filled in the gaps. Not only were the western areas noticeably better populated, but also the more densely populated regions mostly to the east gained increased representation.

Exploratory Data Analysis and MRA

Models generally used sales from January 2002 through June 2005. Data were imported to SPSS Statistics v.13, in which modeling exercises were performed in preparation for passing the data to the spatialest software for completion of the process.

Data Formatting and Cleanup

As in most modeling exercises, once imported, the data were then reformatted in various ways to expedite modeling. Labels were assigned to categorical variables; out-of-range data were identified and corrected or excluded (e.g., sales before 2002 or construction year prior to 1700); sale year and month were ex-

Figure 1. Distribution of sales

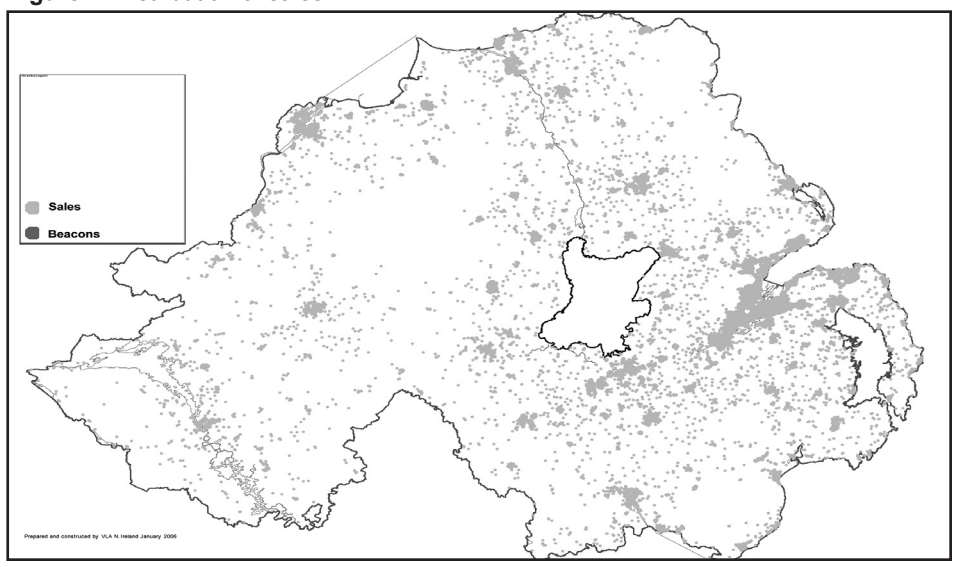
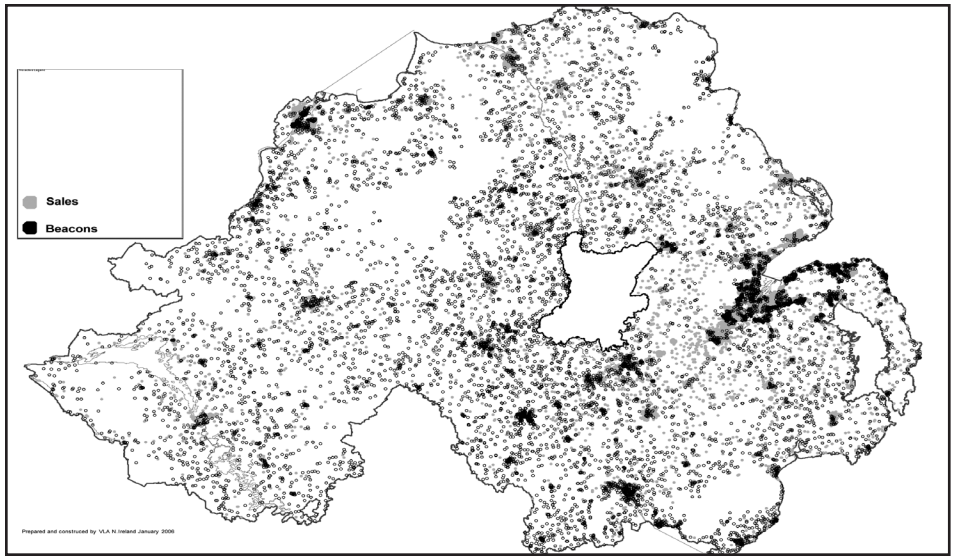


Figure 2. Distribution of sales and beacons



tracted from sale date; and resales were identified, in which case only the most recent sale was retained.

Preliminary Time Trend Analysis

Initial attempts to identify outliers were frustrated by wide variations in price over the 42-month modeling period. Consequently, a preliminary time trend analysis was performed by regressing sale price per square meter on sale month (1 to 42) and extracting the indicated rates of change. Tests were made for variations in price trends between private- and public-built housing, as well as among the three property subclasses mentioned above (detached, semidetached, and terrace), although only one rate of change was deemed sufficient in the majority of market areas. Price trends in the various market areas ranged from 0.5 to 1.5 percent per month, with the largest trends observed in coastal areas and areas of high population growth.

After sales were adjusted to the required valuation date (1 January 2005), outlier analyses could be more meaningfully conducted. The mainstay of this analysis was a graph of sale price against habitable space, color-coded by subclass for each neighborhood. Outliers were flagged and removed. Although well less than 1 percent of sales were removed in any market area, this process served to eliminate the potentially most problematic sales prior to modeling.

Base, Exploratory, and Final Models

The Lisburn pilot study had revealed that multiplicative models were clearly more accurate; hence they were used for the entire DR project.

The first model developed in each market area was a base model that incorporated variables for habitable space, property type, grade, construction era (based on year built ranges), neighborhood, location (urban, suburban, rural village, and rural district as applicable), and time of sale. The time variable was segmented into two splines—one for public-built and one for private-built housing—although, as was the case with preliminary time analyses, differences were typically small and in most cases discarded in final models. In addition, base models included binary variables for first-time sales (new construction) and beacon properties. The latter served to adjust for any differences in capital value proxies observed between sales and beacon valuations, which generally proved to

be small or statistically insignificant.

Next, additional variables were added for stories, heating type, repair/condition, relevant site-positive and site-negative features (which differed among market areas), ancillary areas not included in habitable space, garages, sewer/septic, water, power, difficult access (yes/no), and outbuildings. Several iterations were run to identify the optimal variable set and respecify or constrain any misbehaving variables. Also at this point the worst outliers (typically only about 0.1 percent of cases) were identified and excluded. Based on rates of change indicated by the time variables, sales prices were adjusted to the valuation date and the model rerun a final time without the time variables.

Tables 1–4 contain an example of a final model from one market area. Because this is a multiplicative model, the constant and coefficients for the binary variables are in log format, while those for continuous variables (habitable space, ancillary area, and outbuildings) are exponents. The coefficient (exponent) for habitable space reflects the expected economies of scale and those for ancillary area and outbuildings reflect lower contributory value relative to main living area. The negative coefficients for property types 2 and 3 reflect the lower value of private-built semidetached and terraced housing relative to detached housing (base). The still lower coefficients for property types 5 and 6 reflect public-built semidetached and terraced housing. The grade variables show the expected progression relative to grade C (average), the base grade in the model. Additional adjustments are made for construction era (age capped at 30 years), stories (two story is base), no or partial heating, no power (rare), no sewer or septic (also rare), poor state of repair, single and double garages, various site-positive and site-negative attributes (sea frontage, represented by sitepositive__1, exhibits a particularly strong coefficient), neighborhood binaries (only the first three and last four neighborhoods are displayed), and rural districts and villages versus urban areas (which may partially reflect differences in open space and lot sizes).

The final coefficient of dispersion (COD) is 11.0. Note the similar medians for the sale and beacon properties, indicating that their appraisals are centered near market value as of the valuation date to which sales prices were adjusted. The somewhat higher COD for the beacons likely indicates that they represent less typical properties for which the market is comparatively thin.

After final sales ratio testing for equity among each property group, the MRA model was saved and applied to the universe of target properties in SPSS Statistics. Although not the final values for rating (assessment) purposes, these values served as an important comparison with values calculated in subsequent analyses (see below).

Spatialest

The spatialest software is a statistical geographic-oriented comparable sales program, developed by Causeway Data Communications (CDC) of Northern Ireland, that can work with SPSS Statistics to produce value estimates rooted in both an underlying MRA model (either additive or multiplicative) and the most comparable sales (or beacons) identified for each subject property. Comparability is defined on both physical similarity and geographic proximity, with the user assigning a relative weight to each.

Interface with SPSS Statistics

Although MRA models were of course based on sales and beacon properties only, all target properties in AO were downloaded for valuation with SPSS Statistics. Thus, the data files saved at the termination of MRA modeling for each market area contained both sold and target properties. These files were saved in "dat" format for input to spatialest software. Coefficient files were also saved

in the same format, again for input to spatialest software. These two files constituted the starting point for valuation with spatialest software. Importantly, the data files contained *x-y* coordinates for use in determining geographic proximity.

Table 1. Model summary*

		Adjusted	Std. Error of
.932	.868	.865	.14828

** Dependent Variable: LN_ADJ_PRICE*

Property Characteristic Weights

A universal problem in comparable

Table 2. Variables included in final model

	Unstandardized		Standardized		
(Constant)	8.327	.065		128.092	.000
LN_HabitableSpace	.712	.013	.575	55.827	.000
LN_ANCILLARY_RATIO	.580	.274	.015	2.112	.035
PROPTYPE_2	–.126	.009	–.138	–14.182	.000
PROPTYPE_3	–.109	.014	–.096	–8.059	.000
PROPTYPE_5	–.186	.025	–.093	–7.310	.000
PROPTYPE_6	–.257	.027	–.154	–9.378	.000
GRADE_A	.398	.106	.026	3.749	.000
GRADE_B	.208	.023	.069	9.135	.000
GRADE_D	–.095	.023	–.072	–4.151	.000
GRADE_E	–.213	.120	–.014	–1.778	.076
SUBERA_D1	–.074	.018	–.037	–4.038	.000
SUBERA_T1	–.203	.018	–.124	–11.317	.000
SUBERA_D2	.099	.021	.036	4.683	.000
SUBERA_S2	.036	.019	.015	1.942	.052
SUBERA_T2	–.149	.026	–.047	–5.753	.000
AGE30	–.002	.000	–.046	–4.218	.000
STOREYS_1	.066	.008	.076	8.337	.000
STOREYS_3.5_4_5	–.094	.070	–.010	–1.342	.180
HEATING_None	–.045	.016	–.022	–2.877	.004
HEATING_Partial	–.043	.015	–.021	–2.961	.003
SEWERAGE_NS	–.169	.117	–.014	–1.443	.149
POWER_NP	–.261	.104	–.024	–2.508	.012
REPAIR_PR	–.203	.042	–.038	–4.825	.000
GARAGE_MHS	.049	.007	.058	6.726	.000
GARAGE_MHD	.109	.011	.082	9.924	.000
SITEPOSITIVE_1	.808	.087	.065	9.278	.000
SITEPOSITIVE_2	.429	.023	.149	18.864	.000
SITEPOSITIVE_3	.233	.026	.066	9.105	.000
SITEPOSITIVE_4_5_6	.161	.040	.028	4.003	.000
SITEPOSITIVE_7	.107	.047	.016	2.297	.022
SITENEGATIVE_3	–.091	.031	–.021	–2.977	.003
SITENEGATIVE_5	–.104	.051	–.014	–2.055	.040
LN_OUTBUILDINGS	.424	.068	.051	6.271	.000
NBHD_1	–.251	.023	–.099	–10.994	.000
NBHD_2	–.249	.022	–.112	–11.460	.000
NBHD_5	–.090	.019	–.034	–4.661	.000
—	—	—	—	—	—
NBHD_34	–.336	.032	–.085	–10.430	.000
NBHD_35	–.195	.056	–.024	–3.454	.001
NBHD_36	–.133	.068	–.014	–1.956	.051
NBHD_39	–.143	.057	–.017	–2.498	.013
LOCATION_RD	.169	.016	.156	10.716	.000
LOCATION_RV	.147	.019	.179	7.728	.000

sales algorithms is determining weights to assign to each property characteristic (living area, neighborhood, grade, garages, and so on). The spatialest software assigns these weights optimally based on a consideration of beta values for each property characteristic. Essentially, the spatialest software linearizes values for a categorical variable such as grade or neighborhood into weights based on their respective coefficients and runs a "shadow" model to determine the beta weights for the consolidated variables (one per characteristic). These beta weights determine the relative weight of each characteristic in comparables selection.

Comparables Selection

For each subject property, spatialest software also determines the geographically closest sales within a specified radius. The user has the option of determining how much weight to assign to physical similarity and geographic proximity (e.g., 50 percent to each or 75 percent to one and 25 percent to the other). Selected comparables are adjusted for differences from the subject property based on MRA coefficients. Since sales have been time-adjusted, sale date is already accounted for.

The selection process can also be controlled though comparable rules in which the user limits the search to properties with specified characteristics; for example, consider only detached homes when finding comparables for detached homes and consider only era 2, 3, and 4 homes when valuing era 3 homes. Of course, such filters can result in failure to obtain the specified number of comparables for many subjects, in which case the user must relax the criteria and perform another search for subjects that failed to obtain the required number of

Table 3. Variables excluded from the final model*

				Partial	Collinearity
NBHD_37	.011	1.384	.167	.026	.816
ERA_03	.007	.656	.512	.012	.456
ACCESSTYP_DIF	–.003	–.391	.696	–.007	.922
NBHD_6	–.001	–.054	.957	–.001	.401
STOREYS_1.5	–.004	–.524	.601	–.010	.891
PROPTYPE_4	–.005	–.687	.492	–.013	.837
WATER_WW	–.005	–.731	.465	–.014	.843
SITEPOSITIVE_11_12	.005	.743	.458	.014	.982
SUBERA_S1	.007	.917	.359	.017	.798
NBHD_3	.007	.836	.403	.016	.632
SITEPOSITIVE_10	.006	.920	.358	.017	.974
STOREYS_2.5	–.010	–1.305	.192	–.025	.850
NBHD_38	–.005	–.737	.461	–.014	.922
NBHD_4	.007	–.889	.374	–.017	.860
NBHD_13	–.008	–.860	.390	–.016	.545
STOREYS_3	.010	1.209	.227	.023	.702
ERA_04	–.014	–1.439	.150	–.027	.509
NBHD_27	–.012	–1.617	.106	–.031	.842

** Dependent variable LN_ADJ_PRICE*

Table 4. Ratio Statistics for ESP/ADJ_PRICE in final model

			Weighted				
Sales	2559	1.004	.987	.561	1.696	1.023	.107
Beacons	299	.990	.988	.599	1.577	1.024	.132
Overall	2858	1.003	.987	.561	1.696	1.024	.110

comparables on the prior iteration.

In this case, 10–12 iterations were typically required for each market areas, and the process produced considerably better and more defensible comparables than if properties were not stratified. This process is further aided by the implementation of valuer-created "estate codes," whereby neighboring contiguous groups of streets containing properties with a high degree of physical similarity are assigned a common estate code value. The spatialest selection process is therefore bolstered still further by insertion of an even more micro-location factor than neighborhood.

Figure 3 shows the criteria used in the first iteration of a model that required

Figure 3. Example of spatialest® output

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MODEL NAME:                          MODEL_10_03_06

Note: The report only contains information on TARGETS and SALES

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----------------------------------------------------------------------
ITERATION:                                  1
----------------------------------------------------------------------
TARGETS VALUED IN ITERATION:                16848 (55.81%)
TOTAL TARGETS VALUED:                       16848 OUT OF 30190 (55.81%)
SALES VALUED IN ITERATION (EXCL BEACONS):   2030 (74.99%)
TOTAL SALES VALUED (EXCL BEACONS):          2030 OUT OF 2707 (74.99%)
COD:                                        6.6688
ITERATION COD:                              6.6688
----------------------------------------------------------------------
BUFFER DISTANCE:                            4000
No. COMPS:                                  3
SIMILARITY WEIGHTING:                       75
ADJUST BY MRA:                              YES
ADJUST BY:                                  PERCENT
GENERATE VALUES BY:                         MOVING AVERAGE
----------------------------------------------------------------------
                              COMP RULES
----------------------------------------------------------------------
HABITABLESPACE: + or - 50%
PROPTYPE:                          1: can also match 4
                                   4: can also match 1
                                   2: can also match 3
                                   3: can also match 2
                                   5: can also match 6
                                   6: can also match 5

SUBERA:                           D1: can also match D2
                                  D2: can also match D1,D3
                                  D3: can also match D4,D2
                                  D4: can also match D3,D5
                                  D5: can also match D4
                                  S1: can also match S2
                                  S2: can also match S1,S3
                                  S3: can also match S2,S4,T3
                                  S4: can also match S3,S5,T3,T4
                                  S5: can also match S4,T5
                                  T1: can also match T2
                                  T2: can also match T1,T3
                                  T3: can also match T2,S3,S4,T4
                                  T4: can also match T3,S3,S4,T5
                                  T5: can also match T4,S5

EstateCode:                       Must Match Exactly
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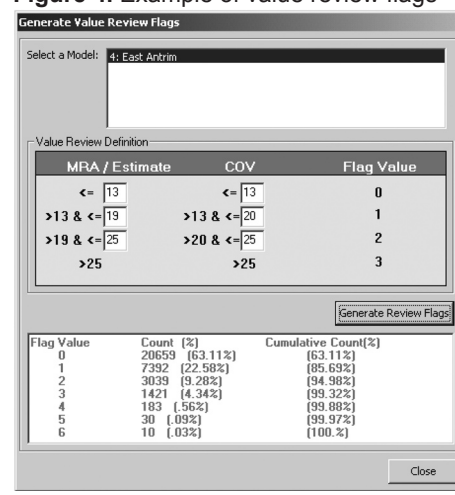
a total of 10 iterations to complete. Iteration 1 allowed property to be valued using only comparable sales with the same estate code. Additional comparable rules specified that property types 1 and 4 (private- and public-built detached homes) could use sales of either of these types as comparables, and similarly for property types 2 and 3 (private-built semidetached and terrace homes) and property types 5 and 6 (public-built semidetached and terrace homes). Comparable rules of the same ilk were also in place for the subera variable where D, S, and T represent detached, semidetached, and terrace property and 1–5 represent age bands, with 1 denoting oldest properties (built pre-1919) and 5 denoting youngest properties (built post-1990). With the specified comparability criteria there were 16,848 out of 30,190 "target" properties valued in the population (55.81 percent). For these properties spatialest software could find the required number of comparables (3) within the given radius (4,000 m). By the termination of iteration 10, all but 44 of the target properties in the market area considered by the model had been valued. These 44 properties were those for which spatialest software could not find at least three comparable sales (or beacons) given any of the user-specified comparability criteria. VLA valuers subsequently handled these individually.

The final model estimates produced by spatialest software were then subject to a smoothing algorithm developed within the VLA modeling team. This was necessary to ensure that, for example, all physically identical properties within the same small street were given the same appraisal value. This was not always the case with the unsmoothed spatialest model estimates. The value of a particular property based on, say, three comparable sales may have been different from the value of an identical property at the other end of the street because its value was based on a different set of three comparables. The smoothing algorithm proved very effective in overcoming this difficulty, helping to maximize the defensibility of the list value produced.

Valuation Review, Results, and Maintenance

VLA staff field reviewed spatialest values for problems and inconsistencies. This work was expedited through the use of value review flags (0–6) calculated for each property. As shown in figure 4, a value review flag of 0 indicated close agreement between MRA and spatialest values, as well as close agreement among adjusted comparables. The higher the review flag, the less consistency between MRA and spatialest values and the more dispersion in values indicated by the selected comparables.

Figure 4. Example of value review flags

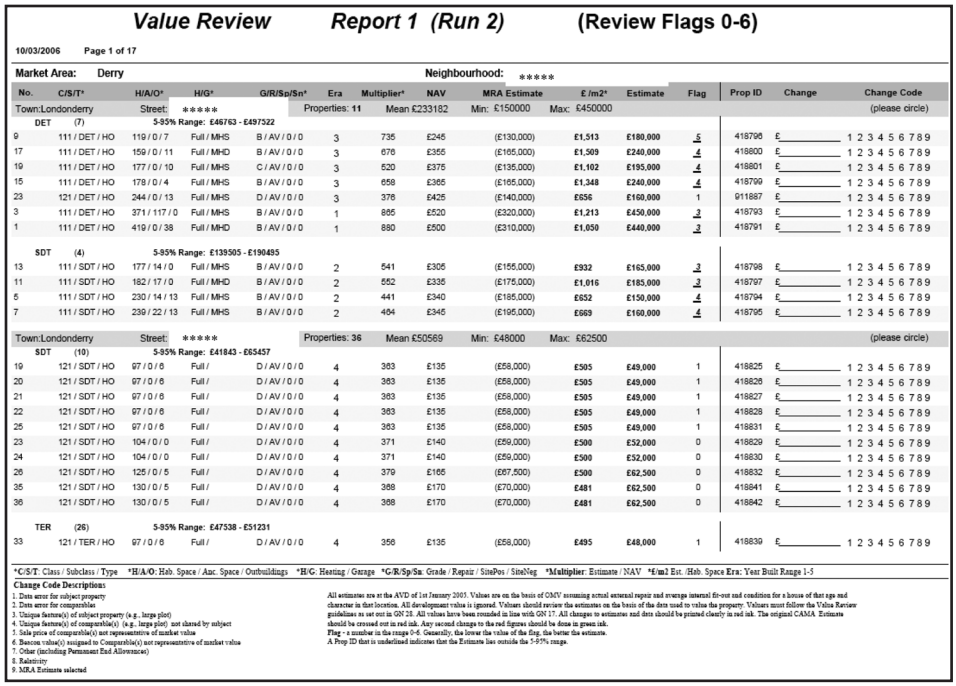


Consolidated one-liner value review reports (see figure 5) were initially utilized for all properties regardless of value review flag score, although most properties displayed values of 0–2. Value reviewers could enter an override value, if warranted, and circle an appropriate reason code.

A more extensive format, including pictures of the subject property and comparable sales, was used for review flags 3–6 (see figure 6).

Final sales ratio analyses indicated that all 25 market areas exceeded IAAO ratio study standards in terms of both level

Figure 5. Example of field review report (value review flags 0–2)



Value Review ***Report 1 (Run 2)*** **(Review Flags 0-6)**

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Market Area: Derry **Neighbourhood:** *****

No.	C/S/T*	H/A/O*	H/G*	G/R/Sp/Sn*	Era	Multiplier*	NAV	MRA Estimate	£ /m2*	Estimate	Flag	Prop ID	Change	Change Code
Town:Londonderry		Street: *****			Properties: 11		Mean £233182	Min: £150000		Max: £450000				(please circle)
DET	(7)	5-95% Range: £46763 - £497522												
9	111 / DET / HO	119 / 0 / 7	Full / MHS	B / AV / 0 / 0	3	735	£245	(£130,000)	£1,513	£180,000	5	418796	£	1 2 3 4 5 6 7 8 9
17	111 / DET / HO	159 / 0 / 11	Full / MHD	B / AV / 0 / 0	3	676	£355	(£165,000)	£1,509	£240,000	4	418800	£	1 2 3 4 5 6 7 8 9
19	111 / DET / HO	177 / 0 / 10	Full / MHS	C / AV / 0 / 0	3	520	£375	(£135,000)	£1,102	£195,000	4	418801	£	1 2 3 4 5 6 7 8 9
15	111 / DET / HO	178 / 0 / 4	Full / MHS	B / AV / 0 / 0	3	658	£365	(£165,000)	£1,348	£240,000	4	418799	£	1 2 3 4 5 6 7 8 9
23	121 / DET / HO	244 / 0 / 13	Full / MHS	D / AV / 0 / 0	3	376	£425	(£140,000)	£656	£160,000	1	911887	£	1 2 3 4 5 6 7 8 9
3	111 / DET / HO	371 / 117 / 0	Full / MHS	B / AV / 0 / 0	1	865	£520	(£320,000)	£1,213	£450,000	3	418793	£	1 2 3 4 5 6 7 8 9
1	111 / DET / HO	419 / 0 / 38	Full / MHD	B / AV / 0 / 0	1	880	£500	(£310,000)	£1,050	£440,000	3	418791	£	1 2 3 4 5 6 7 8 9
SDT	(4)	5-95% Range: £139505 - £190495												
13	111 / SDT / HO	177 / 14 / 0	Full / MHS	B / AV / 0 / 0	2	541	£305	(£155,000)	£932	£165,000	3	418798	£	1 2 3 4 5 6 7 8 9
11	111 / SDT / HO	182 / 17 / 0	Full / MHD	B / AV / 0 / 0	2	552	£335	(£175,000)	£1,016	£185,000	3	418797	£	1 2 3 4 5 6 7 8 9
5	111 / SDT / HO	230 / 14 / 13	Full / MHS	B / AV / 0 / 0	2	441	£340	(£185,000)	£652	£150,000	4	418794	£	1 2 3 4 5 6 7 8 9
7	111 / SDT / HO	239 / 22 / 13	Full / MHS	B / AV / 0 / 0	2	464	£345	(£195,000)	£669	£160,000	4	418795	£	1 2 3 4 5 6 7 8 9
Town:Londonderry		Street: *****			Properties: 36		Mean £50569	Min: £48000		Max: £62500				(please circle)
SDT	(10)	5-95% Range: £41843 - £65457												
19	121 / SDT / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	363	£135	(£58,000)	£505	£49,000	1	418825	£	1 2 3 4 5 6 7 8 9
20	121 / SDT / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	363	£135	(£58,000)	£505	£49,000	1	418826	£	1 2 3 4 5 6 7 8 9
21	121 / SDT / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	363	£135	(£58,000)	£505	£49,000	1	418827	£	1 2 3 4 5 6 7 8 9
22	121 / SDT / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	363	£135	(£58,000)	£505	£49,000	1	418828	£	1 2 3 4 5 6 7 8 9
25	121 / SDT / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	363	£135	(£58,000)	£505	£49,000	1	418831	£	1 2 3 4 5 6 7 8 9
23	121 / SDT / HO	104 / 0 / 0	Full /	D / AV / 0 / 0	4	371	£140	(£59,000)	£500	£52,000	0	418829	£	1 2 3 4 5 6 7 8 9
24	121 / SDT / HO	104 / 0 / 0	Full /	D / AV / 0 / 0	4	371	£140	(£59,000)	£500	£52,000	0	418830	£	1 2 3 4 5 6 7 8 9
26	121 / SDT / HO	125 / 0 / 5	Full /	D / AV / 0 / 0	4	379	£165	(£67,500)	£500	£62,500	0	418832	£	1 2 3 4 5 6 7 8 9
35	121 / SDT / HO	130 / 0 / 5	Full /	D / AV / 0 / 0	4	388	£170	(£70,000)	£481	£62,500	0	418841	£	1 2 3 4 5 6 7 8 9
36	121 / SDT / HO	130 / 0 / 5	Full /	D / AV / 0 / 0	4	388	£170	(£70,000)	£481	£62,500	0	418842	£	1 2 3 4 5 6 7 8 9
TER	(26)	5-95% Range: £47538 - £51231												
33	121 / TER / HO	97 / 0 / 6	Full /	D / AV / 0 / 0	4	356	£135	(£58,000)	£495	£48,000	1	418839	£	1 2 3 4 5 6 7 8 9

*C/S/T: Class / Subclass / Type *H/A/O: Heb. Space / Anc. Space / Outbuildings *H/G: Heating / Garage *G/R/Sp/Sn: Grade / Repair / SitePos / SiteNeg *Multiplier: Estimate / NAV *£/m2 Est. /Heb. Space Era: Year Built Range 1-5

Change Code Descriptions
1. Data error for subject property
2. Data error for comparables
3. Unique feature(s) of subject property (e.g., large plot)
4. Unique feature(s) of comparable(s) (e.g., large plot) not shared by subject
5. Sale price of comparable(s) not representative of market value
6. Bescon value(s) assigned to Comparable(s) not representative of market value
7. Other (including Permanent Bad Allowance)
8. Relativity
9. MRA Estimate selected

All estimates are at the AVD of 1st January 2005. Values are on the basis of OMV assuming actual external repair and average internal fit-out and condition for a house of that age and character in that location. All development value is ignored. Valuers should review the estimates on the basis of the data used to value the property. Valuers must follow the Value Review guidelines as set out in GN 28. All values have been rounded in line with GN 17. All changes to estimates and data should be printed clearly in red ink. The original CAMA Estimate should be crossed out in red ink. Any second change to the red figures should be done in green ink.
Flag - a number in the range 0-6. Generally, the lower the value of the flag, the better the estimate.
A Prop ID that is underlined indicates that the Estimate lies outside the 5-95% range.

Table 5. Final sales ratio statistics

Market Area	spatialest® COD	spatialest® PRD
ANTRIM	0.090	1.016
ARDS PENINSULA	0.118	1.022
ARMAGH	0.105	1.016
BALLYMENA & HINTERLAND	0.096	1.015
BALLYMONEY & HINTERLAND	0.091	1.009
BANBRIDGE	0.078	1.015
CASTLEREAGH	0.071	1.008
COLERAINE AND NORTH COAST	0.102	1.016
CRAIGAVON	0.084	1.012
DERRY	0.083	1.009
DOWN	0.085	1.014
DUNGANNON & CLOUGHER VALLEY	0.109	1.021
EAST ANTRIM	0.083	1.011
FERMANAGH	0.110	1.019
GLENS AND NORTH ANTRIM COAST	0.117	1.018
GREATER BELFAST	0.097	1.016
LIMAVADY	0.096	1.015
LISBURN	0.081	1.012
MID DOWN	0.076	1.011
MID ULSTER	0.106	1.016
NEWRY & MOURNES	0.108	1.012
NORTH DOWN	0.091	1.016
OMAGH	0.097	1.016
SOUTH ARMAGH	0.131	1.005
STRABANE	0.105	1.020

and uniformity, as shown in table 5.

During the value review phase, some 49 percent of modeled capital values were changed. However, the vast majority were small changes—over two-thirds of the changes required the modeled value to be adjusted by less than 10 percent.

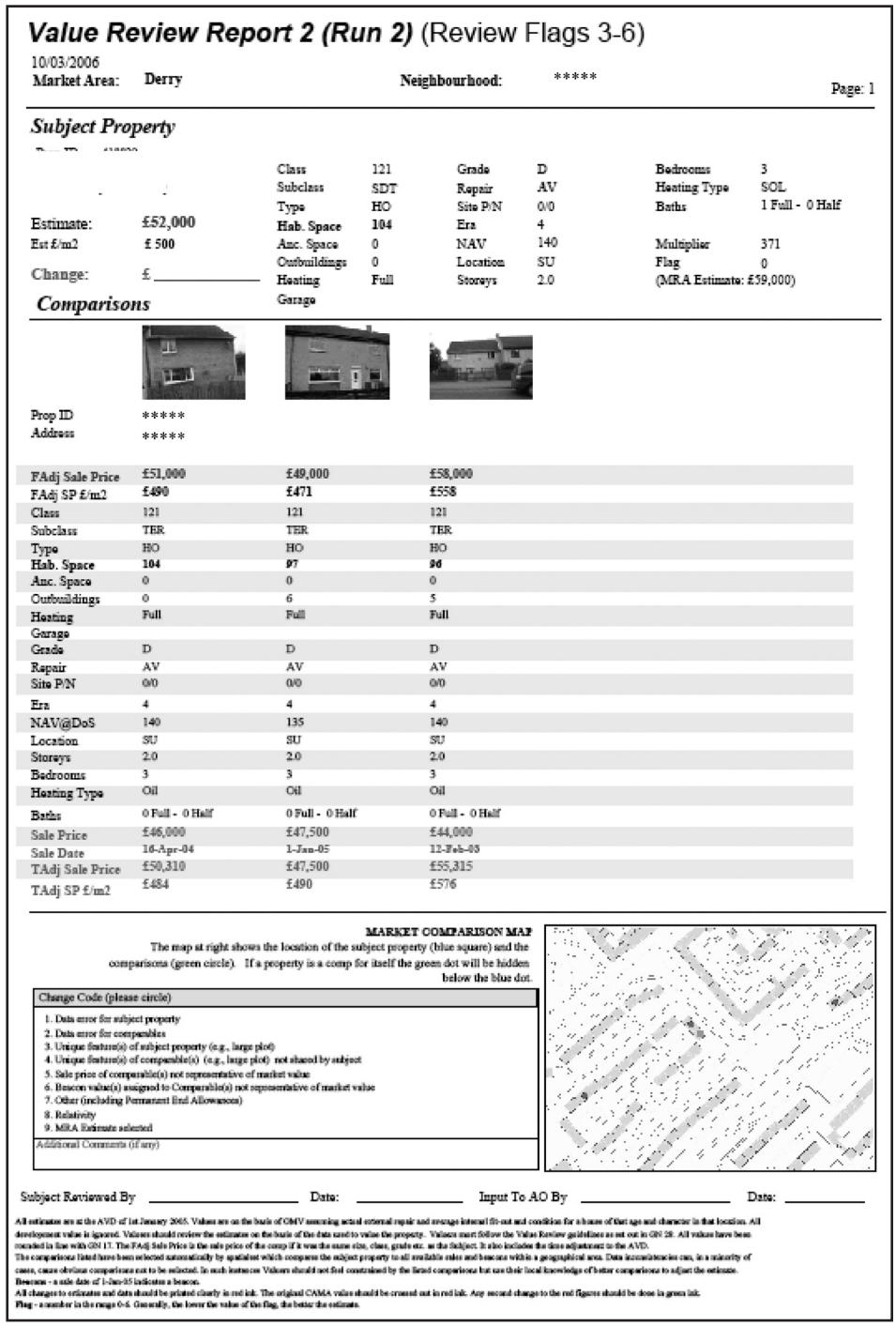
Values were published and ratepayers notified in the summer of 2006. Because the former values were greatly outdated and based on rental value rather than market value, new values were, on average, more than 500 times prior values. At the same time, property owners were largely well aware of contemporary real estate values and the revaluation, which had received considerable advance preparations and media attention.

VLA offices conducted an informal inquiry process, which was followed by a

Table 6. Volume of appeals after revaluation

	No. of Enquiries	No. of Informal Reviews
Estimated	135,000 (20%)	40,000–55,000 (6%-8%)
Actual	55,000 (8%)	28,000 (4%)

Figure 6. Example of field review report (value review flags 3–6)



Value Review Report 2 (Run 2) (Review Flags 3-6)

10/03/2006
Market Area: **Derry** **Neighbourhood:** *****

Page: 1

Subject Property

		Class	121	Grade	D	Bedrooms	3
		Subclass	SDT	Repair	AV	Heating Type	SOL
		Type	HO	Site P/N	0/0	Baths	1 Full - 0 Half
Estimate:	£52,000	**Hab. Space**	**104**	Era	4		
Est £/m2	£ 500	Anc. Space	0	NAV	140	Multiplier	371
		Outbuildings	0	Location	SU	Flag	0
Change:	£ _____	Heating	Full	Storeys	2.0	(MRA Estimate: £59,000)	
		Garage					

Comparisons

Prop ID	*****		
Address	*****		
FAdj Sale Price	£51,000	£49,000	£58,000
FAdj SP £/m2	£490	£471	£558
Class	121	121	121
Subclass	TER	TER	TER
Type	HO	HO	HO
Hab. Space	**104**	**97**	**96**
Anc. Space	0	0	0
Outbuildings	0	6	5
Heating	Full	Full	Full
Garage			
Grade	D	D	D
Repair	AV	AV	AV
Site P/N	0/0	0/0	0/0
Era	4	4	4
NAV@DoS	140	135	140
Location	SU	SU	SU
Storeys	2.0	2.0	2.0
Bedrooms	3	3	3
Heating Type	Oil	Oil	Oil
Baths	0 Full - 0 Half	0 Full - 0 Half	0 Full - 0 Half
Sale Price	£46,000	£47,500	£44,000
Sale Date	16-Apr-04	1-Jan-05	12-Feb-05
TAdj Sale Price	£50,310	£47,500	£55,315
TAdj SP £/m2	£484	£490	£576

MARKET COMPARISON MAP

The map at right shows the location of the subject property (blue square) and the comparisons (green circle). If a property is a comp for itself the green dot will be hidden below the blue dot.

Change Code (please circle)
1. Data error for subject property
2. Data error for comparables
3. Unique feature(s) of subject property (e.g., large plot)
4. Unique feature(s) of comparable(s) (e.g., large plot) not shared by subject
5. Sale price of comparable(s) not representative of market value
6. Beacon value(s) assigned to Comparable(s) not representative of market value
7. Other (including Permanent End Allowances)
8. Relativity
9. MRA Estimate selected
Additional Comments (if any)

Subject Reviewed By _____ Date: _____ Input To AO By _____ Date: _____

All estimates are at the AVD of 1st January 2005. Values are on the basis of OMV assuming actual external repair and average internal fit-out and condition for a house of that age and character in that location. All development value is ignored. Valuers should review the estimates on the basis of the data used to value the property. Valuers must follow the Value Review guidelines as set out in GN 28. All values have been rounded in line with GN 17. The FAdj Sale Price is the sale price of the comp if it was the same size, class, grade etc. as the Subject. It also includes the time adjustment to the AVD.
The comparisons listed have been selected automatically by spatialnet which compares the subject property to all available sales and houses within a geographical area. Data inconsistencies can, in a minority of cases, cause obvious comparisons not to be selected. In such instances Valuers should not feel constrained by the listed comparisons but use their local knowledge of better comparisons to adjust the estimate.
Beacons - a sale date of 1-Jan-05 indicates a beacon.
All changes to estimates and data should be printed clearly in red ink. The original CAMA value should be crossed out in red ink. Any second change to the red figures should be done in green ink.
Flag - a number in the range 0-6. Generally, the lower the value of the flag, the better the estimate.

formal appeal period. In all, the volume of appeals turned out to be considerably lighter than originally anticipated, as shown in table 6.

A final interesting note on the revaluation is the procedure being used to compute values for new or physically altered properties until the next revaluation. Staff has developed MRA models based on existing valuation list values

(rather than sales), which are applied to new residences and to existing properties that have had physical changes made to them and that require value recalculation. Because the models are developed from the population of properties and existing values themselves serve as the dependent variable, the models provide virtually complete coverage and ensure that newly valued properties fit perfectly into the "tone" of existing values. Models are incorporated into a user-friendly Microsoft Excel-based interface for use by valuation staff (non-modelers) which has been termed the Ready Reckoner and which will ultimately be integrated into the core CAMA production system.

Conclusions and Lessons Learned

The revaluation represented a watershed for Northern Ireland. In effect, a complete, new valuation system and supporting software, methodologies, training, and culture were required. Happily, despite some considerable struggles, the project was completed effectively, on schedule, and with excellent results in terms of accepted professional standards. Public acceptance was also positive. Appraisal and technical lessons learned were as follows:

- The need for good data is imperative, and the data must be in place before successful modeling is possible.
- If possible, a core system replacement should not be undertaken at the same time as a revaluation. Ideally, the system would be operated in test mode for at least one year prior to use in the revaluation.
- It is possible to build useful neighborhoods and market areas from existing census delineations, at least in urbanized areas. Ideally, however, the preference is for valuers to construct neighborhoods geospatially based on market knowledge and free from any constraints imposed by the census output areas.
- In rapidly changing markets, exploratory data analyses and outlier detection can be enhanced through preliminary time adjustments based on the value per unit method or the sales ratio trend method if applicable.
- Beacons (appraisals of benchmark properties by qualified valuers) can effectively supplement sale prices for property types with few sales (e.g., custom-built and waterfront homes). This of course requires the use of professional valuation staff who are well aware of their local area.
- MRA is a highly effective and efficient mass appraisal technique, particularly valuable for its rich diagnostics and consistency in values. It can, however, struggle with atypical properties. For example, site-negative or site-positive characteristics may not have uniform weight across a market area; all such properties may need to be flagged for value review.
- Although multiplicative MRA involves the use of logarithms, the technical advantages of the technique can make it a wise choice, particularly if the models must adapt to a broad range of housing types and range of values.
- The spatialest software provides a way of fine-tuning MRA models for the nearest and closest comparables. It also produces comparable sales that can be used in value review, explana-

tion, and support. Of course, additional modeling work is required and valuers need to ensure that consistency in values is preserved "down the street," because different subject properties can be valued using different comparables.

- In the end, potential spatialest users should weigh its strengths in terms of potential increases in accuracy and value support through comparable sales against the added work of incorporating the software and the increased difficulty in ensuring consistency in the "tone" of values.
- While a potential advantage of spatialest and other comparable sales algorithms is their roots in the traditional comparable sales approach, this also makes values calculated for each subject property dependent on a small set of sales (as few as three to six). Thus, good sales screening is even more vital.
- Value review flags can improve the efficiency of field reviews.
- Good public relations are essential, particularly when new valuation procedures are installed or values have changed markedly. An informal inquiry and review process can help facilitate public acceptance and reduce formal complaints.