



A Risk Assessment and Structural Survey of The Non-Traditional Housing Stock

For



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Housing Management
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by

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1.0 Executive Summary

Curtins Consulting Engineers plc were appointed by Salisbury District Council to undertake a desk top review followed by a stock condition survey of their Non-Traditional Housing. This was carried out between December 2005 and June 2006.

A summary of the anticipated structural repair costs in order for the properties to achieve at least a further 30 years life is outlined below. We have indicated costs for the minimum amount of works required to achieve a further 30 years, those for an Enhanced option and costs for our recommended works profile.

Non-Traditional Type	Accommodation	No. of units		Minimum Recommended Works to Achieve 30 years (£)	Enhanced 30 years (£)	Recommended (£)
		Rented	Leasehold			
Airey	House	26		52,000	312,000	52,000
Cornish	House	43		0	0	0
Reema	Flat	17	1	42,500	42,500	42,500
	Bungalow	64		160,000	160,000	160,000
	House	680		3,400,000	3,400,000	3,400,000
	Monitoring inspections			47,000	47,000	47,000
Unity	House	79		0	0	0
Wates	House	4		0	0	0
Total		913	1	3,701,500	3,961,500	3,701,500

Costs are inclusive of preliminaries but exclude VAT, fees, decanting costs (where applicable), management charges, leaseholder costs, asbestos disposal costs etc.

1.0 Executive Summary (continued)

Salisbury District Council has non-traditional properties of five construction types as per the property address list provided to us (see Appendix A).

These property types – Airey, Cornish, Reema, Unity and Wates, are designated as being ‘Defective’ in terms of the Housing Defects Act 1985. Having been declared ‘Defective’ they would normally be deemed to be not mortgageable – however, from our previous work with Salisbury District Council we can confirm that some of the properties (all of the Cornish and Wates houses and all except two of the Unity houses) have been refurbished in accordance with the requirements of a PRC Homes Ltd repair scheme and, consequently, they are fully mortgageable. The remaining dwellings would require refurbishment to a recognised standard i.e. a PRC Homes Ltd licenced repair scheme in order to make them fully mortgageable. It should be noted, however, that even if repaired to a mortgageable standard, flats would still not generally be considered mortgageable as the repair schemes were developed specifically for houses. Building Societies are, in general, very reluctant to provide loans on repaired flats.

All the Airey houses have had the external walls replaced but still retain the original PRC loadbearing components in the internal spine and party walls. The minimum recommendations for these partially refurbished houses would be for minor structural repairs to the internal PRC walls over the next 30 years whilst enhanced recommendations for the full repair of these internal walls would provide a further life of more than 30 years in addition to rendering the properties generally mortgageable.

The Reema properties have all benefited from a proprietary insulated render overcladding system. Our previous investigations on the PRC floor beams found high levels of chloride ion content although additional tests measuring corrosion rates of the reinforcement in these beams revealed generally very low readings. Further investigations undertaken on these properties during 2006 have revealed that the original external wall panels and insitu columns, underlying the overcladding system, are in sound condition with generally low levels of chloride ion content recorded. In addition, tests carried out on the PRC floor beams confirmed our previous inspections in that, whilst a few instances of high levels of chloride ion content were noted, the beams appeared to be in good condition with minimal surface corrosion only found on the reinforcement. Therefore, the recommendations for these dwellings, in order to achieve a further 30 years, would be for patch repairs only to the over render system in order to maintain it in a weathertight fashion. In addition, our report on the floor beams (reference 20694/January 2003) recommended that a group of properties be surveyed on a five yearly basis to monitor the corrosion rates and we have included the relevant costs in our overall figures.

The Cornish, Unity and Wates properties already repaired in accordance with PRC Homes Ltd repair schemes can now be considered to be of traditional construction and no costs have been allowed for these dwellings due to non-traditionality. The two remaining Unity properties are either to be repaired to a PRC Homes Ltd licence standard or redeveloped during 2006.

2.0 Introduction

Curtins Consulting Engineers plc were appointed by Salisbury District Council to undertake a stock condition survey of their non-traditional housing.

Following an initial appraisal of the non-traditional housing stock, based upon a desk top review and our own experience of the condition and behaviour of these dwellings in terms of their anticipated long-term structural performance over the next 30 years, an interim (desk top review) report was produced.

Further detailed and intrusive investigations were then undertaken on a selected sample of the Reema properties in order to verify, or otherwise, our initial opinions.

In brief, the purpose of this report following detailed investigations is to provide a robust appraisal of the non-traditional housing stock with a view to establishing whether it will last for at least a further 30 years and, if so, what structural, remedial or improvement works will be needed, and when, during this term. This report also indicates the costs of each of these repairs/improvements. The base date for all costs is at first quarter 2006 and the costs indicated are inclusive of preliminaries but exclude VAT, fees, decanting costs (where applicable), management charges, leaseholder costs, asbestos disposal costs etc.

The appraisal is in relation to the structural elements only of the dwellings and does not consider items of fabric which have been taken into account by the main stock condition survey undertaken by Savills.

3.0 Composition of the Non-Traditional Housing Stock

The non-traditional housing stock has been identified as containing concrete built dwellings from bungalows and houses to flats.

The stock may be summarised as follows:

Non-Traditional Type	Accommodation	No. of units	
		Rented	Leasehold
Airey	House	26	
Cornish	House	43	
Reema	Flat	17	1
	Bungalow	64	
	House	680	
Unity	House	79	
Wates	House	4	
Total		913	1

The above summary has been prepared from the details and address list issued by the Council.

4.0 Review of Existing Data

4.1 A limited amount of archive material was made available by the Council, which related mainly to previous inspections undertaken on the various property types. In addition, documentation held by Curtins relating to the non-traditional housing stock was reviewed as part of this exercise. This information is summarised as follows;

4.1.1 Airey

- Documentation for the refurbishment of Airey PRC properties
Curtins project reference 20293/DRB/HT, 20422

4.1.2 Cornish Type 1

- Documentation for the refurbishment of Cornish PRC properties
Curtins project reference 20293/H, 20422

4.1.3 Reema

- PRC Housing Condition Survey – 1994; Part 5 – Reema Houses undertaken by Michael Dyson Associates
- PRC Housing Condition Survey – 1994; Part 5 (Phase II) – Survey of Reema Houses, Older Type undertaken by Michael Dyson Associates
- PRC Housing Condition Survey – 1994; Part 5 (Phase II) – Survey of Reema Houses, Passageway Lintols undertaken by Michael Dyson Associates
- Report on Ongoing Monitoring of Reema PRC Houses undertaken by Curtins Consulting Engineers; reference 20694/January 2003

4.1.4 Unity

- Documentation for the refurbishment of Unity PRC properties
Curtins project reference 20673/20673A

4.1.5 Wates

- Documentation for the refurbishment of Wates PRC properties
Curtins project reference 20673A

5.0 Investigation Strategy

The purpose of our investigation was to establish the structural condition of the non-traditional properties and advise on the extent and cost of structural refurbishment to ensure a minimum future life of thirty years.

A reasonable amount of “desk top” information was available concerning the history, maintenance or details of the particular variants of the property types (see Section 4.0).

Initially, Curtins undertook a general assessment and desk top review of the housing stock to establish the most appropriate sampling and inspection regime, the details of which can be found in Section 7.0. Based upon this information an initial assessment of the likelihood of each construction type achieving a further minimum 30 year life was made.

The purpose of the detailed survey on the Reema properties was to verify and augment the findings of the initial assessment and our previous investigation by undertaking visual and intrusive investigations and associated laboratory analysis.

Scope of the Investigations

The extent of the investigation has been particularly influenced by the general desk top review and Curtins’ experience and knowledge of the potential defects that can occur in these types of buildings. It is arranged into the following sections:-

- External visual inspections
- Exploratory (intrusive) investigations
- Laboratory testing

Information obtained during the desk top review has been used to determine the scope of the investigation, namely:-

- Extent and location of inspections
- Number and type of site tests
- Number and type of samples for laboratory analysis, where required

Whilst property addresses were chosen partly at random, the units selected where detailed testing occurred (see Appendix A and Section 8.0 for specific addresses) were considered to be representative of the overall stock.

5.0 Investigation Strategy (continued)

The following table indicates the sampling regime undertaken;

Non-Traditional Type	Accommodation	No. of Units		Sample
		Rented	Leasehold	
Airey	House	26		Desk top review only
Cornish	House	43		Desk top review only
Reema	Flat	17	1	4
	Bungalow	64		3
	House	680		36
Unity	House	79		Desk top review only
Wates	House	4		Desk top review only
Total		913		43

5.0 Investigation Strategy (continued)

This report is based upon visual inspections, discussions with Council employees and detailed intrusive investigations, undertaken in accordance with BRE guidance. It is not feasible when undertaking this type of survey to inspect every property. Therefore, a sampling regime has been adopted that is considered to be representative of the stock as a whole.

The sampling regime adopted is such that where components were visible, a representative sample of those elements either noticeably suffering from or most likely to suffer from degradation were tested. Where the components were not visible, testing has been undertaken in areas considered to be most vulnerable to degradation. The results obtained are used as the basis of the recommendations and are given as being representative of the stock as a whole. However, as the entire structural fabric of every building cannot be inspected, there is no guarantee that the worst or most aggressive areas of degradation have been identified.

The present structural risk assessment is confined to consideration of the principal structural elements of each of the construction types. The condition of doors, windows, guttering, rainwater goods, canopies, outbuildings and external fixtures and fittings, together with gas, water and electrical services, central heating, flues, bathroom and kitchen fittings and internal decorations are all excluded from consideration and are the subject of a separate stock condition survey carried out by Savills as part of the overall appraisal of the Council's housing stock.

Subsoil investigations were excluded from the survey although evidence of structural movement associated with foundation instability was recorded during the visual inspections, if present. Whilst many of the foundation solutions adopted at the time of construction would not comply with current standards, it is most likely that any settlement due to inadequate foundation size or depth would have already occurred. However, this does not exclude the potential risk of future movement, for example, as a result of flooding or drainage failure.

The structural risk assessments exclude items of a geotechnical and environmental nature. The assessment of potential foundation problems is confined to a review of information provided on historic problems and observations made on site.

Information provided for review has not been substantiated or validated by independent research or inspection or investigation. Curtins Consulting cannot be held responsible for any errors, discrepancies or inaccuracies in the information provided by the Council or its representatives.

No testing for asbestos has been carried out during the preparation of this report.

6.0 Assessment Of Potential Defects

The investigations sought to determine the presence of the following defects, all of which have a direct influence on the long-term durability and performance of the structural elements.

Reinforced Concrete

Deterioration of the reinforced concrete elements is caused by corrosion of the steel reinforcement and degradation of the concrete matrix, either independently or as a result of steel corrosion. Concrete is inherently alkaline and this alkalinity protects the encased steel reinforcement from corrosion. However, the protection can be reduced by the action of acidic gases present in the air (such as carbon dioxide and sulphur dioxide). This process is called carbonation. If the depth of carbonation is greater than the concrete cover surrounding the reinforcement steel, the risk of reinforcement corrosion increases, reducing the integrity of the concrete and leading to a reduction in structural capacity.

Corrosion can increase or be more severe in the presence of high levels of chloride ion within the concrete; this can be common if chloride based admixtures were used in the concrete during the construction process (normal practice up to the late 1960's). Therefore, the following characteristics need to be assessed in order to determine the structural condition and future durability of the concrete.

- Chloride ion content
- Carbonation depth
- Cover to reinforcement
- Quality of workmanship during construction

Chloride Ion Content

Chloride attack on reinforcement is aggressive and can occur despite the alkalinity of the surrounding concrete. It sets up an electrolytic cell, which encourages the migration of chloride ions from surrounding areas to the site of the attack. This results in localised deep pits in the reinforcement, which decreases its cross sectional areas significantly before sufficient rust has formed to crack the concrete to the surface. As this form of reinforcement attack is hidden from view, it is potentially a serious cause of weakness to reinforced concrete and it can progress undetected.

Consequently, it is important that the level of chloride in the concrete is established. Concrete samples are taken, by collecting the debris from drilled holes or by chipping pieces of concrete from the corners of components.

6.0 Assessment Of Potential Defects (continued)

Carbonation Depth

There are four basic factors that contribute towards the resistance of concrete to carbonation, as follows: -

- The type and proportions of the materials used in the concrete mix
- The compaction achieved during casting
- The curing regime to which the concrete has been subjected
- The environment in which the concrete is located

The depth of carbonation is a good indicator of the quality of the concrete, the degree to which the concrete has suffered from weathering and the approximate time scale before the reinforcement is affected by the environment.

The depth of carbonation in concrete is determined by spraying the surface of the drilled hole with liquid Phenolphthalein indicator. This clear liquid turns uncarbonated concrete purple. The colourless zone can be measured as the carbonation depth.

Cover to Reinforcement

Measurement of depth of cover is necessary to establish the potential vulnerability of corrosion occurring in the reinforcement. It is of importance that reinforcement is afforded adequate protection from the carbonation process in order for it to remain effective within the concrete section; too little cover can lead to premature corrosion resulting in cracking and spalling of the concrete face and, ultimately, failure of the component.

Reinforcement cover was established through opening up of the units and drilling holes together with the use of a cover meter.

Quality of Concrete Construction

Poor quality can arise as a result of deficiencies in the original mix specification or bad workmanship on site during the compaction and curing of the concrete. It often leads to one or more of the following problems:-

- Weathering and frost attack of the concrete surface leading to cracking, spalling and loose concrete, often due to low cement content reducing durability, or poor compaction.
- Porous concrete which allows deeper penetration of moisture and corrosion of the reinforcement.
- Where the concrete components are cast in thin sections, resulting in little or no cover.
- Lack of fit between components at joints due to poorly formed connections.

7.0 Details Of The Investigations

7.1 External Visual Inspections

Visual inspections were undertaken primarily to assess the extent of the potential problems.

The inspections focused on the following :-

- Signs of cracking, spalling, loose bricks, loose render and similar defects requiring short term repairs
- Signs of frost damage, soluble salts, lichen growth, porous bricks
- Signs of misalignments, out of plumb, bowing or bulging
- Eroded mortar joints, cracking due to sulphate attack, or cavity tie corrosion
- Condition of the roofs
- Signs of defects in exposed reinforced concrete, cracking, spalling, corrosion staining, dampness, porous concrete and cover to reinforcement

7.2 Exploratory (Intrusive) Investigations

These investigations comprised the localised opening up of the external building envelope to confirm the form of construction, assess any visual defects to the structural elements and obtain concrete samples for chloride ion analysis, undertake reinforcement cover and concrete carbonation depth measurements.

7.3 Test Programme

Following our desk top review the following test programme was proposed and adopted;

7.3.1 Airey

- Desk top review of archive information only.

7.3.2 Cornish

- Desk top review of archive information only.

7.0 Details Of The Investigations (continued)

7.3 Test Programme (continued)

7.3.3 Reema

Carry out the following investigations on three bungalows, thirty six houses and four flats;

- Take concrete dust samples for chloride ion analysis from wall panels, insitu columns (core through existing overcladding), floor beams in houses and floors of flats. Determine the depth of carbonation and cover to the steel and inspect its condition.
- Assess the condition of the insitu columns.
- Visually inspect the internal aspect of the dwellings and examine structure in roof space.
- Take key dimensions.
- Note the general condition of the external fabric, particularly those parts of the external envelope likely to deteriorate to the point of requiring repair/replacement during the next 30 years.

7.3.4 Unity

- Desk top review of archive information only.

7.3.5 Wates

- Desk top review of archive information only.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations

Background

Non-traditional forms of construction were encouraged when craftsmen skilled in traditional building materials were in short supply, particularly after the Second World War. They generally consist of prefabricated frames and infill panels, mainly in reinforced concrete, but steelwork and other metals together with timber were also used.

The decay mechanism of reinforced concrete was poorly understood until the 1970's and no assessment of the likely life of non-traditional dwellings was ever made at the time of design and construction.

The foundations to most properties are trench fill or strip footings in the vast majority of cases, and investigation of the footings would, therefore, usually only be undertaken where signs of settlement cracking were noted.

The typical structural arrangement of the various dwelling types contained within the housing stock are listed as follows. More detailed information is available in the appropriate BRE publications (see Appendix C).

A brief description of the generic systems is given below; where the investigations of the stock have identified variations to the descriptions given, these have been noted.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.1 Airey

Classified as defective by the Secretary of State under Part XVI of the Housing Act 1985

Published information describes the construction as follows:

External walls are formed by precast concrete storey height columns at 450mm centres reinforced with a 30mm diameter steel tube. The posts are clad with concrete panels tied to the outer face of the columns with hardened copper tie wires. The concrete cladding panels are ship lapped and have an exposed aggregate face. The internal face of the wall is clad with plasterboard (or fibre board in some cases).

The internal party wall consists of two leaves of the outer wall placed back to back. The internal spine wall (running parallel to the front elevation) is of concrete columns with plasterboard lining.

The first floor is constructed from lattice steel joists supported on the columns located in the front and rear external walls and in the central spine wall. The steel joists have timber fillets on the top and bottom to receive timber floorboards and plasterboard ceiling.

The roof is formed of timber primary trusses at third points supporting traditional purlin and rafter construction. Gable pikes are tile hung or timber clad.

The Airey house type is susceptible to column reinforcement corrosion, which can cause the columns to split in two.

From our previous involvement with Salisbury District Council and review of archive information we are aware that all the Airey houses in the stock have had the external walls replaced but still retain the original PRC loadbearing components in the internal spine and party walls. These components were repaired as required at the time of the main refurbishment. The minimum recommendations for these partially refurbished houses would be for minor structural repairs to the internal PRC walls over the next 30 years whilst enhanced recommendations for the full repair of these internal walls would provide a further life of more than 30 years in addition to rendering the properties generally mortgageable.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations. (continued)

8.2 Cornish

Classified as defective by the Secretary of State under Part XVI of the Housing Act 1985.

These properties comprise precast reinforced concrete plinths, ring beams and columns spaced at approximately 900mm centres with un-reinforced concrete panels stack bonded to form the external facades.

The traditional Cornish Unit house is a two storey construction, with only the ground floor construction of columns and panels as described above. The upper wall construction normally consists of a mansard roof with tiles hanging on timber studs.

The first floor is of timber construction although concrete beams can be located within the floor void generally under the first floor partition walls.

Cornish properties have the potential to suffer severe structural deterioration due to the presence of chloride ion mixed in with the cement during the original construction process.

The properties within the stock have been refurbished in accordance with a PRC Homes Ltd licence scheme and can now be considered to be of traditional construction. Consequently, no costs have been allowed for these dwellings due to non-traditionality.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.3 Reema

36 houses, 4 flats and 3 bungalows inspected:

Houses:	8 Spiders Island, Alderbury 67 Antrobus Road, Amesbury 35 Coltsfoot Close, Amesbury 29 Devereux Road, Amesbury 13 Finnis Road, Amesbury 60 Solstice Rise, Amesbury 39 St Martins Close, Barford St Martin 23 Maryland Close, Bemerton Heath 18 Olivier Close, Bemerton Heath 52 Pinewood Close, Bemerton Heath 67 Pinewood Way, Bemerton Heath Nos. 86 and 88 Rambridge Crescent, Bemerton Heath Nos. 19 and 69 The Valley, Bemerton Heath Nos. 61 and 63 Woodside Road, Bemerton Heath 10 Netton Close, Bishopstone 35 Meadow Road, Bulford 28 Coronation Drive, Donhead St Mary 35 Moot Close, Downton 18 Philip Road, Durrington 4 Spire View, Ford 20 Grovelly Cottages, Great Wishford 7 Sussex Road, Harnham 17 Wiltshire Road, Harnham 11 East Street, Hindon 2 Shepherds Close, Odstock 9 Coronation Square, Quidhampton 5 The Close, Redlynch 8 Trinity Road, Shrewton 13 St Andrews Road, South Newton 34 Churchill Estate, Tisbury 24 Olivier Road, Wilton 1 Hill Croft, Vale Road, Woodfalls 11 Orchard Cottages, Wyllye
Bungalows:	41 Norfolk Road, Harnham 3 Vale View Road, South Newton 3 Rawlence Road, Wilton
Flats:	18 East Street, Hindon 24 The Close, Redlynch 20 Eyres Way, Salisbury 65/67 Churchill Estate, Tisbury

Classified as defective by the Secretary of State under Part XVI of the Housing Act 1985

The Reema Hollow Panel system comprises storey height panels of lightly reinforced concrete with concrete “joists” at first floor. The panels are linked together with reinforced insitu columns and tied together at first floor and eaves level by reinforced insitu ring-beams.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.3 Reema (continued)

The reinforcement in the panels was of a light gauge steel and was used primarily to control shrinkage cracking and handling/erection stresses. Corrosion of this reinforcement is unlikely to have any effect on the overall structural integrity of the panels or dwellings.

The potential for structural failure is more significant in the precast floor "joists", insitu ring-beams and insitu columns. The joists were often made with high concentrations of added chloride ion thus increasing their potential vulnerability to corrosion. The proximity of the reinforced insitu columns to driving rain at the panel joints also increases the risk of corrosion of steel if the concrete in the columns is not dense.

Floors within flats are either precast joists or panels.

These properties (flats, bungalows and houses) have all been overclad with a proprietary insulated render system.

The Reema properties owned by Salisbury District Council are flats, bungalows and terraced and semi detached houses. The external walls of the houses comprise four Reema PRC panels per elevation, which are fixed together with poured concrete inserted into the cavity between them, both horizontally and vertically, to form in-situ columns/beams.

The investigations indicated that, apart from the installation of a proprietary insulated render overcladding system, no major structural repair works have been undertaken to these properties. The underlying concrete components inspected were seen to be in good condition and generally display no evidence of corrosion of the reinforcement

Curtins detailed intrusive investigations revealed generally low to moderate levels of chloride ion content for the external panels ranging from 0.02% - 0.76% by weight of cement with an average level of only 0.19%. Carbonation depths were found to be variable, from surface only to full depth of the section tested.

Nevertheless, as the reinforcement in the panels was of a light gauge steel used primarily to control shrinkage cracking and handling/erection stresses, corrosion of this reinforcement is unlikely to have any effect on the overall structural integrity of the panels or dwellings.

Testing of the insitu columns between panels again determined low to moderate levels of chloride ion content, ranging from 0.02% - 0.81% by weight of cement with an average reading of 0.07%. Depth of carbonation was seen to vary from surface only to the depth of cover to the reinforcement, either 8mm or 10mm diameter bar. In addition, the concrete quality was noted to be good and generally dense with only minor segregation/honeycombing evident. These results would indicate at worst only a moderate risk of corrosion occurring in the future if the concrete was considered to be in a damp environment. As the properties have been overclad this risk is greatly reduced.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.3 Reema (continued)

The maximum chloride ion level found in the floor beams in the houses during these investigations was 1.06% by weight of cement which, with depths of carbonation exceeding the cover to the reinforcement, represents a very high risk of corrosion occurring in the future based on the guidelines produced by the BRE.

However, in order for corrosion to occur at a significant rate there must be sufficient moisture present to promote the corrosion reaction and to reduce the electrical resistance between anode and cathode to a level at which the ionic flow between anode and cathode is significant.

All the internal beams observed were very dry. There was no evidence of water leakage under the floorboards and in a warm, dry, internal environment, no corrosion would be expected.

In all observations of the concrete and the exposed steel the concrete was dry and the steel showed little or no signs of corrosion either in terms of rust staining or of loss of section.

As part of our previous investigation of the PRC floor beams (report reference 20694/January 2003), Linear Polarisation Corrosion Rate Measurements were undertaken. These results varied from 0.03 microns per year to a maximum of 1.06 microns per year. The highest rate of corrosion noted was encountered at No. 6 Angel Lane, Mere which is now not part of the Council housing stock; this amends the maximum reading to 0.19 microns per year.

Less than 1 micron per year section loss is considered to represent the background corrosion rate of the passive oxide layer that protects steel from significant corrosion, section loss and concrete cracking, in sound concrete. Therefore, with a maximum rate, previously recorded, of 0.19 microns per year, the corrosion rates can be considered to be 'background level'.

Generally, no corrosion is anticipated where corrosion rates are less than 1 micron per year (passive condition) and only a low to moderate risk of corrosion exists where corrosion rates are between 1 and 5 microns per year (damage in 10-15 years). In addition, it should be noted that even corrosion at the rate of 10 microns per year will take 100 years to lose 1mm of cross section of the steel reinforcement and that approximately 100 microns section loss is considered typical of the amount needed to crack and spall concrete in a normal reinforced concrete member. Consequently, it is considered that providing the concrete remains dry, the floor beams should perform adequately for the next 30 years.

Visual inspections revealed that these properties are currently in good condition.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.3 Reema (continued)

The overcladding to these properties appears to be in sound condition and is affording protection to the underlying loadbearing PRC wall components. Whilst some of the floor joists tested displayed high levels of chloride ion, corrosion rate measurements, previously undertaken, were low and, consequently, the joists should perform satisfactorily for a further 30 years.

Therefore, the recommendations for these dwellings, in order to achieve a further 30 years, would be for patch repairs only to the over render system in order to maintain it in a weathertight fashion. In addition, our previous report on the floor beams recommended that a group of properties be surveyed on a five yearly basis to monitor the corrosion rates and we have included the relevant costs in our overall figures.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.4 Unity

Classified as defective by the Secretary of State under Part XVI of the Housing Act 1985

Published information describes the system as follows:-

The structure comprises a framework of precast reinforced concrete columns spaced at 3 foot (1067mm) centres in external walls with pressed steel plate or lattice floor and eaves beams. Diagonal bracing is provided in the vertical plane between columns within the wall cavity. The steel beams at first floor support timber joists.

The external walls comprise two leaves of concrete slabs spanning between columns with a 150mm cavity between. The internal leaf of some properties can be constructed of lightweight concrete blocks. Party walls consist of two leaves of 62.5mm thick lightweight concrete blocks with a 62.5mm cavity between.

The ground floor is ground bearing and of solid construction. The first floor comprised timber joists spanning between steel beams.

The pitched roof construction consisted of timber trussed rafters at 3 foot (1067mm) centres connected to column heads.

Previous refurbishment of these properties was carried out in accordance with the details of a PRC Homes Ltd licence repair scheme. Therefore, these dwellings can now be considered to be of traditional construction and, consequently, no costs have been allowed for these properties due to non-traditionality.

We understand that the two remaining Unity properties still of original construction, Nos. 56 and 60 Winding Way, are to be either repaired to a PRC Homes Ltd licence standard or redeveloped during 2006.

8.0 Property Type Descriptions, Investigations, Findings, Discussions and Recommendations (continued)

8.5 Wates

Classified as defective by the Secretary of State under Part XVI of the Housing Act 1985

Published information describes the system as follows:

The structure consists of precast load bearing panel units of reinforced concrete backed with lightweight concrete and string bonding units at first floor and eaves level. The joints between the units are filled with fine concrete or cement mortar. Reinforcement is inserted in the joints at main intersections. The units are erected against a specially designed jig which ensures accuracy in positioning and is used for supporting scaffolding. The construction of floors follows normal practice viz, solid concrete ground floor slabs and timber joists for the first floors. A pitched roof consists of trusses and prefabricated timber units prepared to receive the roof covering.

The system is claimed to be applicable to almost any plan; the component parts are factory-produced and designed to reduce the amount of site and skilled labour to a minimum.

The external wall precast loadbearing panels are of storey height and of a number of standard widths. Each panel consists of a dense reinforced concrete shell approximately 32mm thick having flanges 150mm thick overall and a possible back filling of lightweight concrete projecting 22mm beyond the flanges. The vertical flanges of the units are grooved and form continuous spaces at the joints which are filled with in situ fine concrete. Reinforced concrete string bonding units are introduced at first floor and eaves levels, the joints between the strings and the panel units being tongued and grooved and bedded in cement mortar. Lengths of reinforcement bar are introduced vertically and horizontally into the joints as necessary.

Party walls consist of panel units similar in design to those for the external walls and filled with lightweight concrete. Internal walls can be of masonry, clinker block or timber stud with first floor timber joists supported internally by either steel joists or concrete beams.

All Wates properties owned by Salisbury District Council have undergone major refurbishment and have been repaired in accordance with the requirements of a PRC Homes Ltd licence scheme. These dwellings can now be considered to be of traditional construction and, therefore, no costs have been allowed for these properties due to non-traditionality.

9.0 Refurbishment Options and Mortgageability Issues

Curtins investigation works indicate that the non-traditional housing stock is in reasonable structural condition and will continue to perform satisfactorily for a further 30 years subject to the recommendations made in this report and routine maintenance.

The recommendations for the Reema properties allow for the maintenance of the existing insulated over-render system and this should ensure a future life well in excess of 30 years. In conjunction with overcladding it is of importance to provide adequate mechanical ventilation of the dwellings in order to maintain suitable humidity levels in the properties and to prevent excessive moisture build up in the retained external wall elements from within.

All the property types within the non-traditional stock – Airey, Cornish, Reema, Unity and Wates are designated 'Defective' under the terms of the Housing Act 1985. As a result they are not accepted as a sound investment for mortgage purposes unless radical improvements are made in accordance with approved methods e.g. PRC Homes Ltd licenced repair scheme.

However, we can confirm that some of the properties (all of the Cornish and Wates houses and all except two of the Unity houses) have been refurbished in accordance with the requirements of a PRC Homes Ltd repair scheme and, consequently, they are fully mortgageable. The remaining dwellings, Airey and Reema, would require refurbishment to a recognised standard i.e. a PRC Homes Ltd licenced repair scheme in order to make them fully mortgageable. It should be noted, however, that even if repaired to a mortgageable standard, flats would still not be considered mortgageable as the repair schemes were developed specifically for houses. Building Societies are, in general, very reluctant to provide loans on repaired flats.

10.0 Budget Costs

The estimated budget repair costs are set out in the following tables in the categories of Minimum recommended works to achieve 30 years, Enhanced 30 years and Recommended works.

A brief description of the works included under these headings for the various types of dwelling is as follows;

		(£)/unit	No.	Total Cost (£)
10.1 Airey (26 No.)				
Minimum 30 years	Concrete repair to internal spine and party walls	2,000	26	52,000
Enhanced 30 years	Refurbishment of internal spine and party walls	12,000	26	312,000
Recommended	Concrete repair to internal spine and party walls	2,000	26	52,000

10.2 Cornish (all repaired to PRC Homes Ltd licence scheme)

No structural works due to non-traditionality required.

2.0 Budget Costs (continued)		(£)/unit	No.	Total Cost (£)
10.3 Reema				
Flats (17 No.)				
Minimum 30 years	Patch repairs to existing overcladding system	2,500	17	42,500
Enhanced 30 years	We do not consider that an Enhanced option is applicable in this instance; costs as above	2,500	17	42,500
Recommended	Patch repairs to existing overcladding system	2,500	17	42,500
Bungalows (64 No.)				
Minimum 30 years	Patch repairs to existing overcladding system	2,500	64	160,000
Enhanced 30 years	We do not consider that an Enhanced option is applicable in this instance; costs as above	2,500	64	160,000
Recommended	Patch repairs to existing overcladding system	2,500	64	160,000
Houses (680 No.)				
Minimum 30 years	Patch repairs to existing overcladding system	5,000	680	3,400,000
Enhanced 30 years	We do not consider that an Enhanced option is applicable in this instance; costs as above	5,000	680	3,400,000
Recommended	Patch repairs to existing overcladding system	5,000	680	3,400,000

10.0 Budget Costs (continued) (£)/unit No. Total Cost (£)

10.3 Reema (continued)

Monitoring inspections at five yearly intervals;

- i) First inspection at end of 2007 – install permanent corrosion monitoring probes; inspection, monitoring and report £12,000
- ii) Subsequent monitoring inspections at five yearly intervals – inspection , monitoring and report £7,000 47,000

10.4 Unity (all except two repaired to PRC Homes Ltd licence scheme – outstanding two to be repaired/ redeveloped during 2006)

No structural repairs due to non-traditionality required.

10.5 Wates (all repaired to PRC Homes Ltd licence scheme)

No structural repairs due to non-traditionality required.

Non-Traditional Type	Accommodation	No. of units		Minimum Recommended Works to Achieve 30 years (£)	Enhanced 30 years (£)	Recommended (£)
		Rented	Leasehold			
Airey	House	26		52,000	312,000	52,000
Cornish	House	43		0	0	0
Reema	Flat	17	1	42,500	42,500	42,500
	Bungalow	64		160,000	160,000	160,000
	House	680		3,400,000	3,400,000	3,400,000
	Monitoring inspections			47,000	47,000	47,000
Unity	House	79		0	0	0
Wates	House	4		0	0	0
Total		913	1	3,701,500	3,961,500	3,701,500

APPENDIX A

**NON-TRADITIONAL PROPERTY ADDRESS LIST
(inspected properties highlighted)**

APPENDIX B
CHEMICAL ANALYSIS RESULTS AND CERTIFICATES

APPENDIX C
BIBLIOGRAPHY