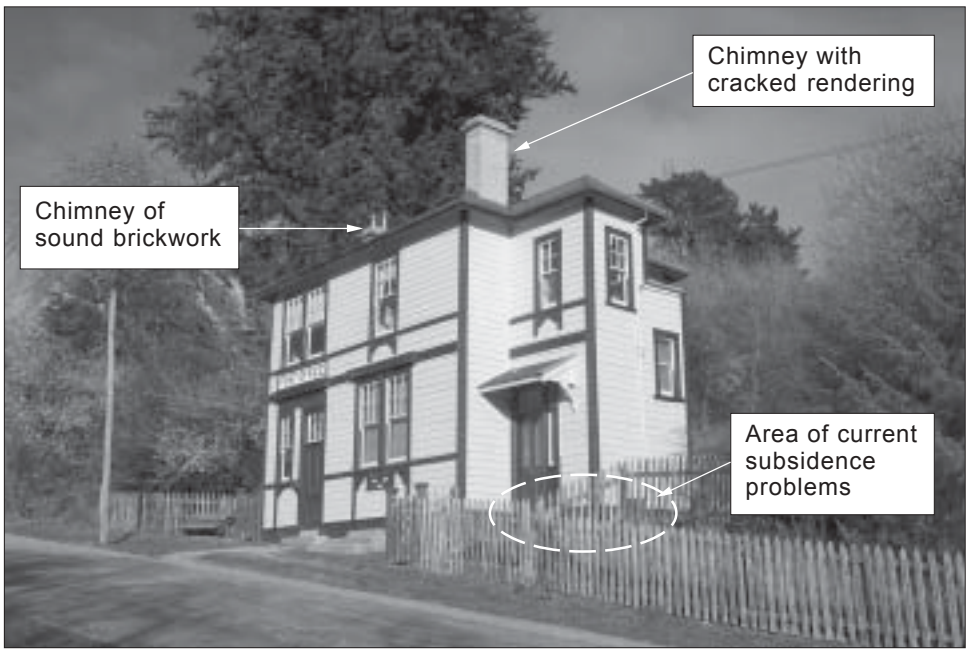

Figure 15. St Bathans Post Office.

5.3 ENGINEERING COMMENTS

The Post Office is a solid-looking timber structure founded on an array of timber piles. The 1984 and 2000 piling works involved packing up old piles, and installing and packing new piles with jacking to level the floor.

The contract documents for the 2000 piling works (Otago Conservancy, date unknown) note the following:

'The St Bathans Post Office (particularly the entrance at the western end) has slumped from rotted or failed replacement piles and / or ground settling from a septic tank installed at the western boundary.'

The front of the Post Office faces north-east so presumably the 'western end' is the right-hand front door (as viewed from the road). It is understood that the septic tank is in the section to the right (north and downhill) of the Post Office. The area occupied by the septic tank has dense ground-cover. No evidence of ground movement was observed during the recent walkover survey.

The Post Office has two chimneys. The left-hand chimney (as viewed from the road) has sound brickwork and stands the full height of the building. The external face can be inspected from the southern side of the building. The right-hand chimney runs up inside the building and only the stack can be seen. The stack appears to have a concrete render that has random cracking. Although the render is cracked, the stack does not display any signs of instability, but this would need to be confirmed by closer examination.

One of the replaced piles retrieved from the 2000 levelling works is shown in Figs 16 and 17. It is presumed that this is a pile installed during the original 1909 construction works and not one of the replacements installed in 1984. No records were available to confirm this.

It is clear that severe rot has set in over the years since the building was constructed, and this has seriously reduced the pile's bearing capacity. Similar deterioration of other foundation members will certainly have been a major

Figure 16. Example of timber pile replaced during 2000 levelling works.

Figure 17. Timber pile shown in Fig. 16 above. Note severe rot at contact with ground.

contributing cause of the building subsidence that led to the need for remedial works.

The contractor who carried out the re-piling work in 2000 noted that the ground under the Post Office was 'bone dry hard clay' and that the piles are either set directly on the soil surface, locally levelled to seat the timber, or sit on timber footings. The ground in the yard area behind the Post Office was wet. A trench drain across the back of the building has been installed to improve surface drainage[4].

At the time of our inspection, floor subsidence was confined to the front right-hand corner of the building. It is understood that the contractor who carried out the 2000 piling works intends to rectify the floor levels and door closing problems (pers. comm. Sharon Hinds and John Symons, 2003).

It appears that the building takes time to respond to re-piling, jacking and re-packing works, requiring a re-visit from the contractor to complete the levelling exercise by further repacking. Given the hard, dry composition of the foundation soil noted above and that piles in the effected area have been replaced, it seems unlikely that the current subsidence is due to foundation bearing capacity failure.

However, if subsidence continues after the proposed re-levelling, there are a number of possible causes that will require investigation. These include:

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[4] Comments by John Symons, contractor, John Symons Ltd, May 2003.

- Timbers may have rotted, requiring complete replacement.
- The re-piling, jacking and re-packing works have been ineffective or are incomplete.
- The bearing strength of the soil beneath the subsiding part of the building has been exceeded. It is possible that the clay soil is soft and wet beneath a hard, dry near-surface crust.
- Subsidence may be partly or wholly associated with the septic tank, and could be continuing (as noted by Department of Conservation 2000).

The first two items can be readily assessed by inspection under the building. If ground failure / subsidence is suspected, ground investigation works by hand or mechanical pitting would be required to determine foundation requirements to provide long-term solutions to the last two items.

5.4 MAINTENANCE ISSUES

- The front right-hand corner of the building should be re-levelled. If the further work described above has been properly carried out, this should provide a long-term remedy to the current subsidence problems.
- All timber pile and foundation members in contact with the ground should be H5 treated.
- At least 100 mm clearance should be maintained between the ground surface and any painted and / or untreated timber.
- Detailed records of all future work, including photographs, notes, sketches and reports should be maintained at a central archive (e.g. at DOC's Central Otago Area Office.

6. Gold Office (Bank of New South Wales)

6.1 CURRENT CONCERNS

DOC has no concerns for any specific structural or ground stability problems at the Gold Office.

6.2 BRIEF HISTORY

c. 1860s	Gold Office built. It was originally located opposite the Public Hall.
Late 1940s(?)	Building relocated to Oturehua.

1983	Draft Reserves Management Plan (Department of Lands & Survey 1983) notes that the building is in good order. At this time it was still in Oturehua.
1985	By the time of the publication of St Bathans—an Historic Town (Department of Lands & Survey 1985), the Gold Office had been relocated back to St Bathans but was now located between the Stone Cottage and Post Office.
May 2003	External inspection of the Gold Office during the walkover survey showed it to be in very good condition (Fig. 18).

Figure 18. Gold Office as viewed from the main street.

6.3 ENGINEERING COMMENT

The Gold Office is a sound wooden structure with a good paint finish. The only observation regarding upkeep relates to the need to maintain clearance between the ground soil surface and the building's woodwork.

The May 2003 inspection showed a build-up of soil at the rear left-hand corner of the building (as viewed from the road). This is allowing moisture to migrate up the grain of the timber, causing localised peeling of the paintwork. The building appears to be well secured to its timber-post pile foundations that are set in concrete footings.

6.4 MAINTENANCE ISSUES

- At least 100 mm clearance must be maintained between the ground surface and any painted and / or untreated timber.

7. Stone Cottage

7.1 CURRENT CONCERNS

The Stone Cottage exhibits severe cracking of its walls. The left-hand or up-hill wall (as viewed from the road) has a pronounced inward bulge.

7.2 BRIEF HISTORY

c. 1880s	Stone Cottage built in St Bathans—Department of Lands & Survey (1985) notes that the building is 'one of the town's earlier residences'.
1983	The Draft Reserves Management Plan (Department of Lands & Survey 1983) notes the following: 'Exterior stone walls and roof remain, but no windows, doors or internal fittings. The building is in poor condition'.
1990	Cottage restored by DOC. Details of this work could not be confirmed.
c. 2000	Soil and vegetation built-up against left-hand wall removed.
May 2003	External and internal inspection of the cottage during the walkover survey showed it to be in fair condition[5]. It has windows and doors, a tin roof and a relatively new-looking wooden ceiling. The floor has a rough flagstone surface. Figs 19–22 show details of the cottage.

Figure 19. The stone cottage.

[5] This is a relative descriptor, placing the condition of the cottage between that of the Post Office and Gold Office, which are in very good condition, and the Public Hall, which is in poor condition.

Figure 20. Trench alongside left-hand (as viewed from the road) wall. This view is from the rear of the cottage.

Figure 21. Severe cracking in left-hand wall.

Figure 22. Recent soil removal on left-hand (uphill) side has relieved earth pressure on the wall, but undermined the footing to the chimney.

7.3 ENGINEERING COMMENT

The Stone Cottage is a simple sturdy structure with four stone walls constructed from partially dressed stone. The walls are probably formed of an inner and outer skin of stone with rubble infill.

There is clear evidence that the building has been subject to numerous phases of re-pointing, with patches of lime mortar, cement mortar and mud infill randomly distributed throughout the stonework.

Despite areas of severe cracking, the building is in no immediate danger of collapse. However, undermining of the chimney during soil removal works to relieve earth pressure on the left-hand (southern, uphill) wall has seriously compromised the long-term stability of this feature.

During our inspections in May 2003, a small pit was excavated at the rear right-hand corner (as viewed from the road) to determine foundation conditions. The pit encountered dense gravel / cobbles at c. 100 mm depth and excavation was terminated. It is envisaged that the building is seated on shallow strip footings.

Cracking of the rubble fill walls is most likely attributable to aging and weathering of the weak lime mortar and earth infill. These materials are susceptible to softening and erosion by wind and rain.

Cracking may have been exacerbated by minor settlement and / or root systems of (recently removed) vegetation. There do not appear to be signs of significant settlement-induced distress that would require underpinning.

7.4 MAINTENANCE ISSUES

- If cracks are to be re-pointed or in-filled, this work should be done with a properly specified lime mortar only, and using gravel- or cobble-sized aggregate infill where crack widths permit. Cement mortar is unsuitable for maintenance work at the cottage and, where it has been used, it should be removed and replaced with lime mortar.
- Soil built-up against external walls should be removed to prevent moisture migration into the mortar. For example, there are still patches of soil on the uphill side of the building that should be cleared.
- The chimney is in quite a precarious state because of the exposed foundation soil under its footing. Ideally, the footing should be underpinned, under a carefully controlled procedure to remove the soil fill and replace it with stonework and / or concrete infill. An investigatory pit should be excavated to determine the depth to a suitable founding layer prior to commencement of underpinning work.
- The building and its surrounds should be regularly inspected to ensure that no vegetation that could damage mortar-work becomes established.
- Site inspection records should be maintained. These should provide a summary of observations so that future inspections can determine, for example, whether any further movement is occurring.

8. Public Hall

8.1 CURRENT CONCERNS

Of the four subject buildings, the Public Hall (Fig. 23) exhibits the most advanced structural distress. DOC's principal concerns relating to the Public Hall are:

- There is acute deformation of the left-hand wall (as viewed from the road).
- There is subsidence and severe cracking of the rear wall, and associated cracking towards the rear of both sidewalls.

Detailed structural assessments and a remedial strategy for the Hall have been prepared by Hadley & Robinson Ltd (2003a, b, c)

8.2 BRIEF HISTORY

1880s	Public Hall built.
1956	Hall acquired by former Department of Lands & Survey.
1983	The Draft Reserves Management Plan (Department of Lands & Survey 1983) notes: 'It was in a dilapidated condition for many years but has been substantially restored'.
Pre-1993	Retaining wall constructed parallel to left-hand wall (as viewed from the road) and c. 1.2 m up-hill from it (Fig. 24). Trench excavated, longitudinal drain installed 500 mm above base of wall footing and trench backfilled (Petherick 1993).

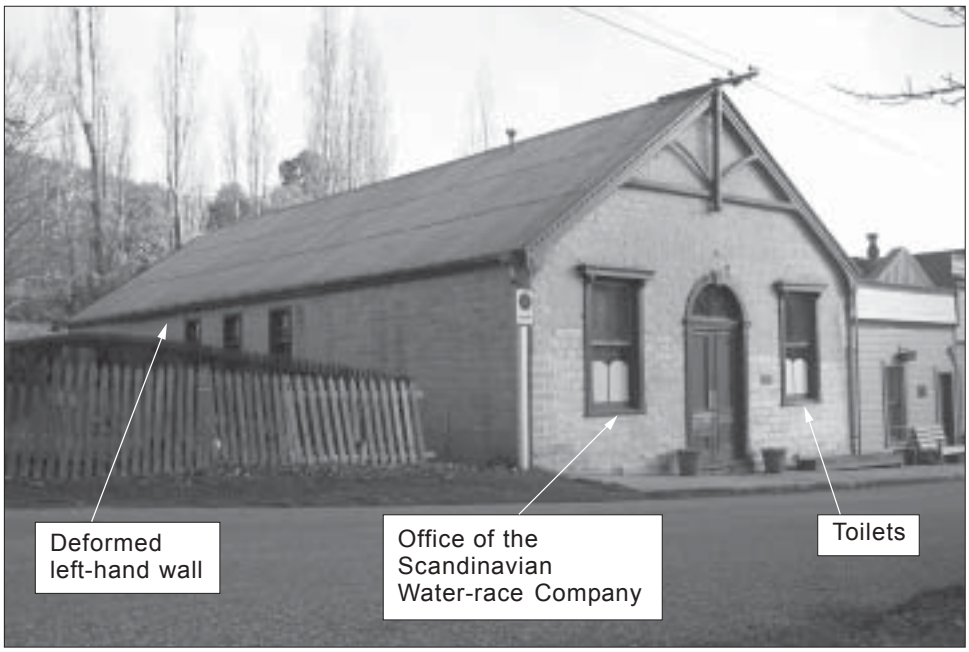

Figure 23. The Public Hall.

Figure 24. Tie-rod system along left-hand side wall. Before the retaining wall was installed, the ground had built-up against the foundation wall, exerting earth pressure for c. 100 years.

Note: It is evident that deformation and instability of the left-hand wall were on-going concerns prior to 1993.

1993 Structural assessment report produced for sidewall (Petherick 1993). Recommendations for current restoration measures made (i.e. excavation of wall backfill and installation of tie rod system, see Fig. 24).

Note: A recommendation to install a new sub-soil drain (Petherick 1993) below the wall footing base was not followed through. Petherick (1993) also notes that minor settlement of the rear wall of a room that has been added to the rear right-hand corner of the main hall is also evident (Fig. 25). Also noted is that movement of the east sidewall (left-hand wall as viewed from the road, Fig. 23) 'has in turn induced some stresses in other parts of the building, notably in the roof structure and in the stage surrounds, and some movement is evident in these areas'. It is apparent that in 1993 there was little indication of any significant settlement or cracking of the rear wall.

1993–1995 Areas of brickwork and mortar replaced (exact location or works unconfirmed) (Petherick 1995).

1995 Remedial works inspection report produced (Petherick 1995). Report notes that the tie-rod system 'has apparently stabilised the wall'. Continuation of sidewall deformation monitoring recommended.

Figure 25. Rear right-hand storeroom. Failure of 'recent' concrete foundations cast at ground surface.

Note: The implication is that wall deformation monitoring was on-going pre-1995, although this was not apparent from earlier reporting. There is no mention of distress to the rear wall. It could be assumed that there were no visible signs of deterioration at the time, or perhaps that the inspecting engineer did not venture to the rear of the building (exact reason not known).

1998	Left-hand wall deformation monitoring array established (Paterson Pitts Partners (Cromwell) Ltd 1998).
1998–2002	Wall deformation monitored (Paterson Pitts Partners (Cromwell) Ltd 1998).
1999	Left-hand wall stability report produced (Hadley & Robinson 2003c).
March 2003	Structural assessment report produced for rear wall (Hadley & Robinson 2003b). Recommendations for recently completed remedial measures made i.e. underpinning of rear wall and drainage installation.
April 2003	Rear wall underpinned and cut-off drainage installed (see Fig. 26).
May 2003	External and internal inspection of the hall during the walkover survey showed it to be generally in poor condition. (Figs 27 & 28). The rear of the building, in particular, displays severe cracking.
	Consolidated report on previous hall studies and work produced (Hadley & Robinson 2003a).

Other significant events with no confirmed dates include:

- Removal of trees at front left corner and in adjoining (up-hill) section (Fig. 29).
- Tie-system installed in the office of the Scandinavian Water-race Company (SWC). See Figs 30 and 31.

Figure 26. Rear wall of the Public Hall. 'X' marks plate referred to in Fig. 31. 'A': location of recent concrete sleeper underpinning (April 2003); 'B': new surface water cut-off drainage trench (April 2003).

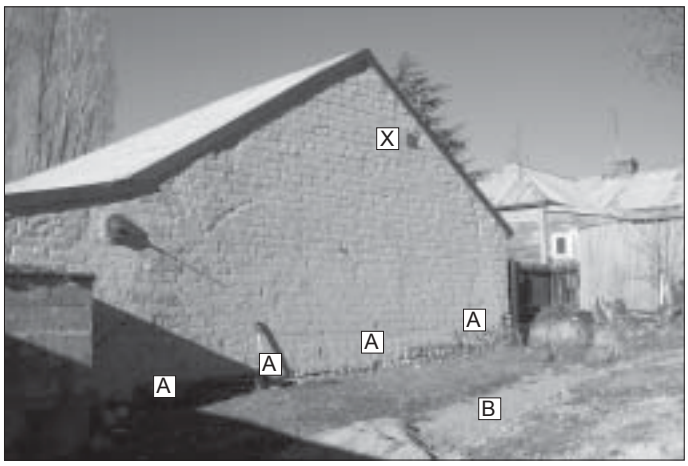

Figure 27. Rear right-hand corner of hall. Note severe cracking of concrete underpinning.

Figure 28. Severe erosion of brickwork and mortar from leaking spouting.

Figure 29. Front left-hand corner of Hall. Note drainage outfall adjoining side wall, and stump of large tree at left.

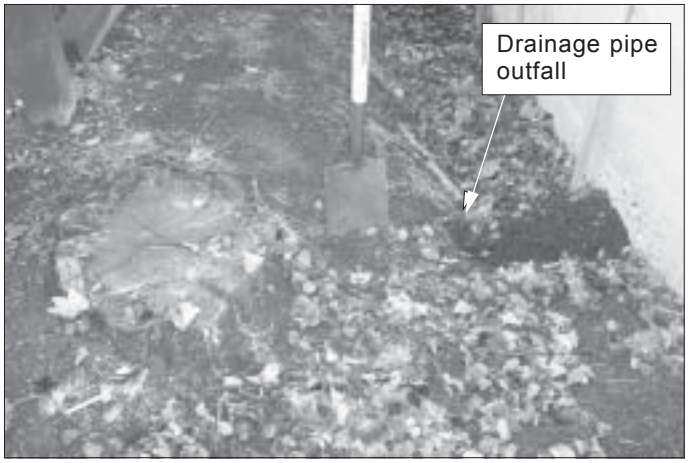

Figure 30. Tie-rod system inside the Scandinavian Water-race Company (SWC) office—view of front wall.

Figure 31. Tie-rod system inside SWC office—view towards rear wall. The upright passing through the ceiling may link into a tie-rod bonded to the plate marked 'X' on Fig. 26.

8.3 ENGINEERING COMMENT

The external walls of the Public Hall are constructed using a combination of shallow stone strip foundations and mud brick walls. The roof is timber-framed with steel tension ties and spans between the two side walls; the load from the roof being taken directly on top of the walls (Petherick 1993).

Although available records only date back to 1993, inspections reveal evidence that the building had been subject to movement and repair for many years before then. There are obvious areas of recent / modern remedial works including:

- Concrete underpinning at the front left corner and rear right corner (Fig. 25).
- Re-pointing and brick replacement along the left-hand wall.
- Re-pointed foundation stonework along the right-hand wall (Fig. 32).
- Re-pointing of the front wall.
- Modern rendering in the toilets.
- Re-plastering along the passageway and throughout the main hall room (Figs 33 and 34).

Excavations for remedial works at the rear wall and left-hand wall have shown that at these locations the building has shallow foundations of rounded cobbles bound in a low-strength mortar. It can be assumed with reasonable confidence that the entire building may originally have had a similar foundation form.

Figure 32. 'Modern' repointing (and possible rebuild) of cobble foundation midway along right-hand side wall.

Figure 33. Re-plastering work adjacent to door to SWC office.

Figure 34. View of re-plastered crack shown in Fig. 33 from inside SWC office.

Recent underpinning works (Fig. 26) encountered poor non-engineered fill and topsoil underlying at least 50% of the foundations of the rear wall (Hadley & Robinson 2003a). This soil profile will certainly have caused long-term settlement problems, probably commencing at the time of construction.

On-going settlement problems at the Hall may well have inspired the choice of piled foundations at the Post Office.

Figures 24 to 35 give an overview of some of the remedial works on the hall and other relevant features.

The significant curvature in the side wall shown in Fig. 24 is attributed to earth pressure, exacerbated by softening of the weak mortar from wet ground

conditions. A new retaining wall, underpinning and drainage works along the wall have been proposed (Hadley & Robinson 2003a)

Inspection reveals clear evidence that the Public Hall has been subject to movement for many years. There have been numerous phases of ad hoc patch-repair remedial works associated with significant building movements. It can be seen that some of the works provided important structural stability, but others (e.g. underpinning founded at or near to ground surface) (Fig. 25) have failed to perform.

8.4 MAINTENANCE ISSUES

- A key aspect of maintenance works will be to promote drainage at the foundations to prevent softening and deterioration of the weak mortar (Fig. 35). It is understood that drainage has been addressed at the rear wall and will be incorporated in the proposed works to the left-hand side wall. Drainage works at the left-hand side wall should be mindful of the following:
  - Spouting from the neighbouring property to the left (up-hill, as viewed from the road) apparently soaks directly into the ground behind the existing timber retaining wall.
  - Department of Conservation staff are concerned that effluent from the neighbour's septic tank may be infiltrating the sidewall trench. This will have a bearing on health and safety aspects of any future work in the trench
  - An earthenware drainage pipe has an outfall into the front of the trench. The source of this is unknown (see Fig. 29).
- The front and right-hand side walls do not appear to be vulnerable to poor drainage and no action is required here.
- Figure 28 clearly shows severe brickwork and mortar erosion resulting from leaking spouting. There are number of locations around the hall displaying similar erosion scars. If left unchecked, continued erosion could threaten the structural integrity of the walls and require costly repair work.
- Under-floor venting should be promoted throughout the building to prevent moisture damage and rot in the timber flooring.

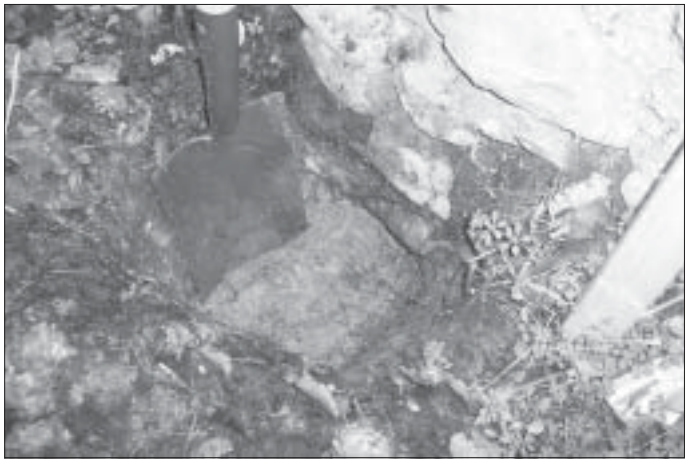

Figure 35. Pit excavated mid-way along foot of left-hand side wall. The ground is very wet.

9. Conclusions and recommendations

9.1 GENERAL

- The four buildings are in various states of disrepair, ranging from a renovated sound wooden structure (Gold Office) to an earth brick building subject to severe subsidence and cracking (Public Hall).
- The walkover survey has confirmed that there are no signs of global mass slope instability that may impact on the subject buildings. Any slope movement, manifest as leaning trees or power poles, for example, is primarily attributed to hillside creep, which is a natural imperceptible slope movement process.
- The foundation soil at the four buildings is inferred to be a highly variable mix of cohesive and non-cohesive granular deposits that have been weathered, mixed and transported by natural colluvial processes and locally modified by human activity (e.g. cutting / filling around buildings and road embankment construction). Recent underpinning works at the Public Hall encountered non-engineered fill and topsoil underlying its foundations.
- No running groundwater or springs were observed during the walkover survey (which was carried out following a relatively dry spell). There are, however, indications that the subsoil around the subject buildings generally has a low permeability, there may be pockets of perched groundwater, and recharge of the groundwater from the hillside may be occurring. Despite there being little rainfall in the weeks before the walkover survey, the ground along the access track to the rear of the hall was soft and wet under foot. The trench along the left-hand side of the hall was very damp with a high groundwater level observed in a shallow pit beside the exposed foundations.
- The minor nature of coal seams and the distance from the scorched ground to the main street indicates that there is little risk to the buildings of subsidence relating to the (historic) burning coal seams.
- Movement observed at the subject buildings and cracking of the road surface are independent phenomena.
- The Blue Lake Fault, an active fault, runs through the heart of St Bathans. However, the major seismic hazard for the South Island generally is the Alpine Fault. A sizeable event on either of these faults would probably cause severe damage to many of the buildings in St Bathans.

The following sections provide a summary of maintenance issues discussed in the main text. For greater detail, refer to the main text.

9.2 POST OFFICE

- The Post Office is a solid-looking timber structure founded on an array of timber piles. Rot of timber foundation members will certainly have been a major contributing cause of the subsidence that has required and continues to require remedial work.

- On-going subsidence of the front right-hand corner of the building is likely to be due to a 'settling down' phase as the structure adjusts to the piling works carried out in 2000. Uneven floor levels should be remedied by the piling contractor.
- If subsidence continues following these works, then ground investigation work (test pitting) may be required to determine a long-term foundation solution.

9.3 GOLD OFFICE

- The Gold Office is a sound wooden structure. The only observation regarding upkeep relates to the need to maintain at least 100 mm clearance between the ground soil surface and the building's woodwork.

9.4 STONE COTTAGE

- The Stone Cottage is a simple sturdy structure with four stone walls. Despite areas of severe cracking the building is in no immediate danger of collapse.
- Cracks in the stone walls should be repaired to prevent wind and rain erosion.
- It is likely that the building is seated on shallow strip footings. Currently there are no signs of significant settlement-induced distress.
- All future repair works should use a properly specified lime mortar only, and use gravel- or cobble-sized aggregate infill where crack widths permit. Cement mortar is unsuited to maintenance work at the cottage and should be removed and replaced with lime mortar.
- The chimney is in quite a precarious state due to the exposed foundation soil under its footing. Underpinning of the chimney is required and this should be done as soon as possible. Underpinning works should be preceded by test pitting to determine foundation conditions.
- Built-up soil should be removed from the external walls to prevent moisture migration into the weak mortar.
- The Stone Cottage should be regularly inspected as part of its maintenance programme, to check, for example, for crack growth. Tell-tales[6] should be installed across areas of significant cracking once they have been fully repaired. There are patches of loose stone adjoining some of the cracks, so the installation of tell-tales prior to crack repair should be avoided.

9.5 PUBLIC HALL

- The Public Hall is a mud-brick structure. Of the four subject buildings it exhibits the most advanced structural distress, with some walls exhibiting acute deformation or severe subsidence.

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[6] Tell-tales are small mechanical devices attached to walls to provide a means of accurately measuring crack widths.

- The hall has been subject to a number of studies and assessments, and has recently undergone a programme of underpinning at the rear wall. A new retaining wall, underpinning and drainage works along the left-hand sidewall have been proposed.
- Hadley & Robinson (2003a, b, c) should be referred to for details of the building damage assessment and proposed remedial works.
- Recent underpinning works encountered poor non-engineered fill and topsoil underlying at least 50% of the foundations of the rear wall. This soil profile will almost certainly have caused long-term settlement problems, probably from the time of construction.
- On-going settlement problems at the hall may well have inspired the choice of piled foundations at the Post Office.
- Inspection reveals clear evidence that the Public Hall has been subject to movement for many years. There have been numerous phases of ad hoc patch-repair remedial works associated with significant building movements.
- A key aspect of on-going maintenance works will be to promote drainage at the foundations to prevent softening and deterioration of the weak mortar. Under-floor venting should be promoted throughout the building to prevent moisture damage and rot to the timber flooring.

9.6 EARTHQUAKE PROTECTION

- The historic buildings in St Bathans form an integral part of New Zealand's industrial history and gold-mining heritage. In accordance with the Otago Goldfields Park and Reserve Management Plans the buildings are to be preserved 'in perpetuity'.
- It is recommended that a programme of seismic risk assessment of the buildings be undertaken to determine how best to safeguard them from earthquake damage.

9.7 SITE AND BUILDING INSPECTIONS

- Records of all site and building inspections should be maintained at a central archive as part of a management plan for the historic buildings.
- The Stone Cottage, for example, should be regularly inspected as part of its maintenance programme to check for crack growth.
- Crack monitoring and simple site notes recording any salient observations, even if no crack development is evident, can build a powerful database for any future works that may be required.

9.8 ARCHIVING

- The process of gathering information for future studies and remedial works programmes would be greatly aided by the compilation and centralised storage of all records, reports and correspondence relating to the subject buildings and St Bathans.
- It is strongly recommended that all available information and all future documentation be carefully archived as part of a historic building management strategy.

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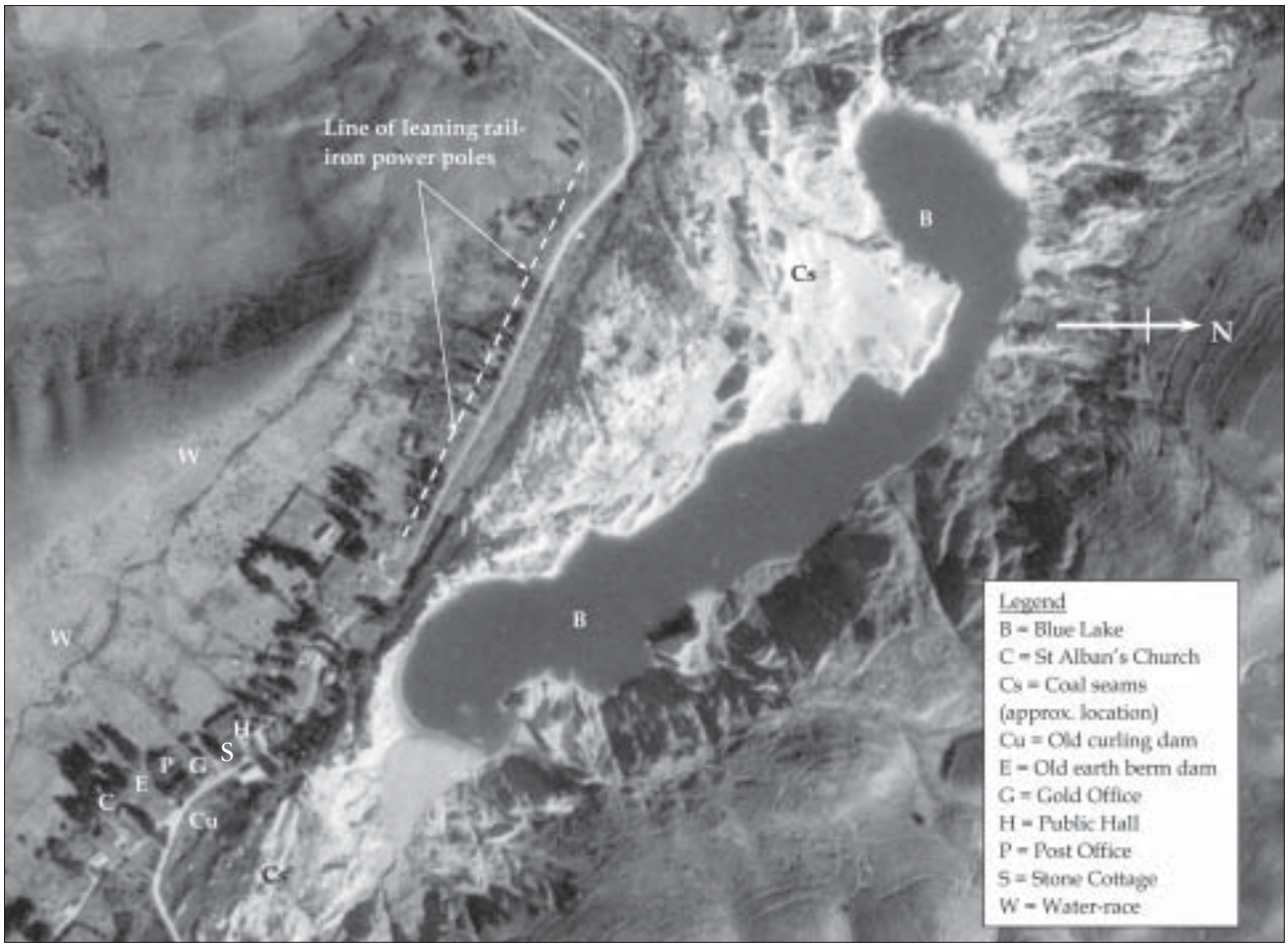
Appendix 1

LOCATION PLAN FOR ST BATHANS (AERIAL PHOTO DATED MARCH 1959)



Appendix 2

ROAD CRACK LOCATION PLAN FOR ST BATHANS