

ALPINE RESORTS LAND STABILITY

3.5.175 Victoria has 6 alpine resorts, which are located on approximately 10 815 hectares of land owned by the State. These resorts provide a wide variety of recreational and leisure activities, attracting in excess of 600 000 visitors a year.

3.5.176 Since 30 April 1998, the resorts have been managed by individual Alpine Resort Management Boards. These boards were established under the *Alpine Resorts (Management) Act* 1997, replacing the former Alpine Resorts Commission. The Act also created the Alpine Resorts Co-ordinating Council with responsibility for:

- making recommendations to the Minister on matters related to the provision and improvement of services and facilities in alpine resorts;
- co-ordinating, in conjunction with Tourism Victoria, the promotion of the alpine resorts;
- and attracting investment for the improvement of the alpine resorts.

3.5.177 Over the past 200 years, since European occupation of Australia, there have been hundreds of reported landslides that have been responsible for the deaths of at least 74 people and the damage or destruction of over 200 buildings. In addition, damage estimated at hundreds of millions of dollars has been caused to infrastructure and privately-owned assets including roads, railway lines, pipelines and crops.

3.5.178 Australia's worst landslide occurred in 1997 above the New South Wales alpine resort of Thredbo, and resulted in the collapse of 2 large ski lodges and the loss of 18 lives. A coronial inquest investigating the incident found that the landslide was caused by a leaking water main located in the embankment of a road above the lodges. This road was originally constructed for short-term use in connection with the Snowy Mountains Hydro-Electric Scheme and not for the purpose for which it had been used by the resort.

Review of alpine resorts land stability in Victoria

3.5.179 Following the Thredbo landslide, the State Government, through the Department of Natural Resources and Environment, initiated a comprehensive review (the Review) of land stability at all 6 of Victoria's alpine resorts. Mt Buffalo was not included in the Review as it is classified as a national park and is managed by Parks Victoria.

3.5.180 The Review consisted of 3 stages:

- a preliminary geotechnical risk assessment of roads and car at the alpine resorts;
- mapping (geographical and aerial) of the alpine resorts to provide information on specific site features and to assist in the development of a basis for classifying land stability risk; and
- using the information gathered on each site to assess the stability of developed areas, proposed development areas and access roads within the alpine resorts.

3.5.181 A preliminary assessment of roads and car parks was carried out by the Roads Corporation (VicRoads), on behalf of the former Alpine Resorts Commission, during the period from November 1997 to January 1998. The objectives of that assessment were to:

- identify areas requiring detailed site investigation;
- disclose sites where remedial action may be required; and
- provide preliminary information prior to undertaking a more detailed appraisal of these areas.

3.5.182 The assessment, which concentrated on the higher risk areas, was based on visual inspection only by VicRoads geotechnical engineers. Problem sites were categorised into 3 levels of risk:

- Priority 1 - potential high risk/high impact;
- Priority 2 - potential high risk/low impact or low risk/high impact; and
- Priority 3 - potential low risk/low impact.

3.5.183 The assessment process identified 43 existing Priority 1 sites, the majority of which were located at Falls Creek (21 sites) and Mt Buller (14 sites).

3.5.184 Following receipt of the preliminary assessment undertaken by VicRoads, the Department assigned responsibility for undertaking further investigations and any associated remedial works to the Alpine Resort Management Boards. These works were incorporated into a remedial works program developed by each Board, with urgent works scheduled and completed prior to the commencement of the 1998 ski season.

3.5.185 In late 1998, the Department appointed a firm of engineering consultants to undertake stages 2 and 3 of the Review, with the purpose of identifying and reporting on areas within the resorts that were at risk of landslip. Particular emphasis was placed on:

- the existing land developments and roads located in the resort village areas;
- potential development sites;
- utility and service corridors; and
- ski fields and slopes.

3.5.186 The Review included the production of hazard assessments for approximately 660 developed and potential development sites at the resorts. The landslip hazards were classified into 4 types of instability, namely, natural shallow landslides, rockfall, failure of cut slopes, and failure of fill slopes.

3.5.187 Two of these instability types (natural shallow landslides and rockfall) relate to naturally occurring landslips. The likelihood of these instability types occurring is influenced by natural features including the angle of the slope, the shape of the slope, site geology, the thickness and strength of foundation material, the concentration of surface and ground water, and the incidence of previous instability.

3.5.188 The remaining 2 types of instability (failure of cut slopes and failure of fill slopes) result from development activities that are within the site under construction. Modification that may affect slope instability includes slope modification by cutting, slope modification by filling, removal of low strength material, installation of sub-surface drainage, poor management and disposal of run-off and snowmelt water, and poor disposal of sewerage.

3.5.189 The Review involved:

- mapping alpine land within each resort and determining the sites' stability hazards, based on a review of the respective landforms;
- visually inspecting leased sites at each resort to identify any areas of concern;
- identifying and prioritising remedial works and/or further geotechnical assessment (either monitoring or investigation); and
- preparing guidelines, focusing on planning, monitoring and maintenance, for the control of land instability.

3.5.190 For the purpose of the Review, each site was assessed by experienced geotechnical engineers and assigned a hazard rating for each of the 4 types of instability, based on the presence and type of the site features. The hazard ratings ranged from very high to very low, the implications of which are outlined in Table 3.5P below.

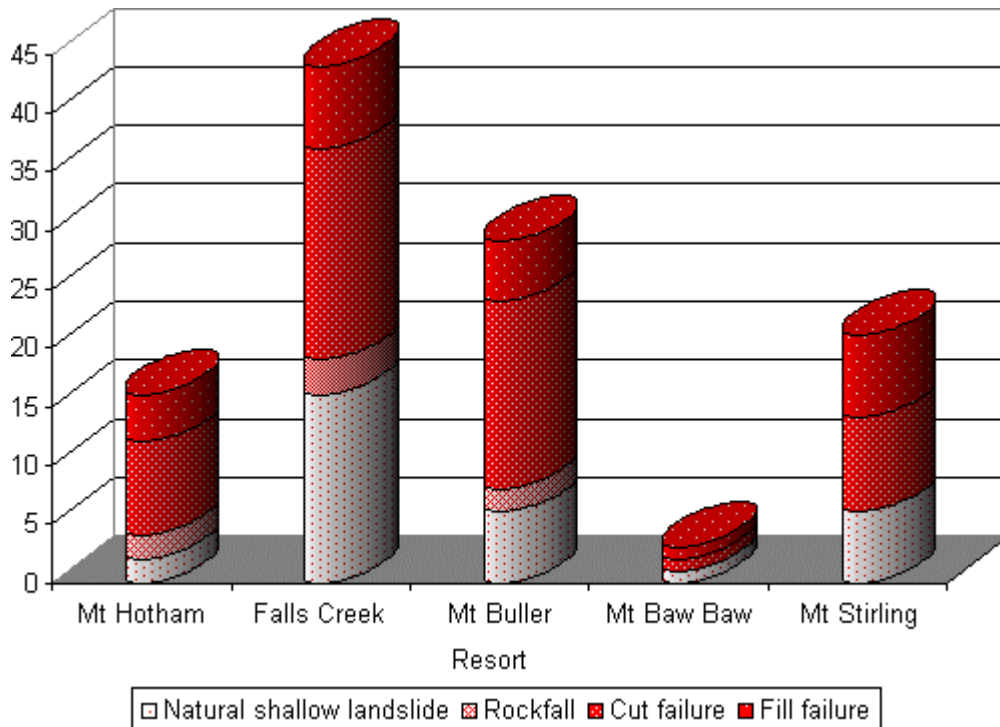
**TABLE 3.5P
HAZARD RATINGS AND ASSOCIATED IMPLICATIONS**

Hazard rating	Implications
Very high	Extensive investigation, planning and implementation of treatment options essential to reduce risk to acceptable levels.
High	Detailed investigation, planning and implementation of treatment options essential to reduce risk to acceptable levels.
Moderate	Acceptable provided a treatment plan, such as active monitoring, is implemented to maintain or reduce risk.
Low	Acceptable, however, treatment to maintain or reduce risks should be defined.
Very low	Acceptable, provided managed by routine procedures.

3.5.191 Of the 660 sites assessed, 76 were rated as either a high or very high hazard, with many sites at risk of more than one type of instability. Lake Mountain, which had very little development, was the only resort to have a low to very low hazard rating for all its sites.

3.5.192 Chart 3.5Q below discloses, for each type of instability, the instances of high or very high hazard at each resort.

**CHART 3.5Q
INSTANCES OF EACH TYPE OF INSTABILITY AT EACH RESORT,
RATED AS A HIGH OR VERY HIGH HAZARD**



3.5.193 The main causes of the hazards identified by the Review were:

- the steepness of the slopes;
- concentration of groundwater; and

- considerable excavation into the natural slope surface, which was supported by retaining walls that had deteriorated over time.

3.5.194 While the Review was in progress, in January 1999, a major warning was issued at Falls Creek in respect of an aqueduct site and the surrounding areas as a result of the consultant's inspection of the site. An immediate detailed site analysis was initiated and remedial works undertaken, which included sealing sections of the aqueduct, replacement of fill, construction of drainage and installation of piezometers to measure water tables. The works were predominantly funded by the lessee of the site.

3.5.195 Subsequent monitoring of piezometers at the site revealed dangerously high ground water levels, requiring drains to be bored into the hillside to prevent land saturation and slippage.

3.5.196 Furthermore, following evidence presented to the Thredbo Coronial Inquest in February 1999, which indicated that a faulty water main was responsible for that land slip, an investigation of the water mains at Falls Creek by the Resort Management Board identified a large quantity of plastic pipe found to be prone to cracking and leaking. As a result, the Board decided to immediately replace all plastic water mains at the resort, at a cost of \$177 000.

3.5.197 In September 1999, the Department referred the results of the Review to the individual Resort Management Boards for further investigation and resolution. Based on the Review's recommendations, the Boards appointed specialist geotechnical consultants to undertake detailed studies of high and very high hazard sites identified by the Review.

3.5.198 With the exception of Mt Buller, where many sites (initially rated as having a high or very high hazard) were downgraded to a moderate hazard following these detailed studies, the high to very high hazard ratings at the resorts were generally confirmed. These detailed studies also identified:

- an additional site at Mt Stirling, not assessed as part of the land stability review, with a very high risk of slope fill failure; and
- underlying geotechnical problems, requiring further detailed geotechnical assessment, at up to 25 sites at Mt Hotham that were initially rated as having a moderate hazard.

Remedial works program

3.5.199 Remedial works at the alpine resorts are being undertaken in 3 stages, with the majority of the works occurring during Stages 1 and 2 in 1999-2000 and 2000-2001, respectively. **High and very high hazard sites requiring urgent attention were managed at acceptable levels by the June 2000 snow season following the undertaking of remedial work and it is anticipated that the remaining remedial work will be completed by mid-2002.**

3.5.200 The remedial works are being directed at the following 3 main areas:

- reducing the slope angle;
- increasing the strength of construction material; and
- lowering the water table and improving drainage.

3.5.201 Each Resort Management Board has prioritised the remedial works according to factors such as the risk to human life, buildings and infrastructure, and the impact on service delivery, ski fields, roads, car parks, property values and insurance premiums.

3.5.202 Drainage was identified by the Review as a major issue at all resorts and the Review recommended that a comprehensive drainage scheme be developed as part of each resort's remedial works program. As a result of the Review,

significant resources have been devoted to assessing and improving drainage as part of Stage 2 of each resort's remedial works program. Specific problems related to drainage highlighted by the Review, which have been or are in the process of being addressed, include:

- the area around the chairlift base station and access road at Mt Baw Baw, which were of risk of collapse due to the discharge of stormwater drainage directly onto the ground and the deterioration of timber retaining walls;
- an unsealed road constructed at Mt Buller without appropriate drainage, which was channelling stormwater onto sites situated below the road and at risk of failure;
- a site at Mt Buller containing gas tanks and a storage shed, which was unstable as it was situated on a cut into the side of the slope with a dangerously high water table;
- a car park at Mt Buller showing evidence of slope failure, and erosion due to poor drainage and uncontrolled surface run off;
- poor drainage at Mt Stirling and Lake Mountain, which may have contributed to road failures and concern with the stability of the car park at these resorts, respectively; and
- inconsistent standards of drainage provided for site and roof water run-off at Mt Baw Baw, Mt Buller, Falls Creek and Mt Hotham.

3.5.203 In addition to the above, remedial works have been undertaken at the resorts to address:

- Inadequately supported cuts into the hill slope at 2 sites at Mt Hotham, which required emergency remedial works to be commenced in late 1999. These works included the replacement of a damaged crib retaining wall behind one of the lodges. Detailed geotechnical investigations also recommended the immediate decommissioning and replacement of a water main at the resort; and
- Unstable sections of the resort access road and circuit road embankment at Mt Stirling, which had been reconstructed following a major stability incident in 1998. Detailed investigations revealed that, due to unsatisfactory repairs to the embankment, the likelihood of slope failure was almost certain with over 50 per cent of the road formation at risk of collapse. The factors contributing to the instability included:
 - the use of poor quality materials and workmanship to carry out the reconstruction;
 - the inappropriate use of logs to temporarily support the embankment; and
 - uncontrolled water seepage flowing from the base of the embankment.



Remedial works being carried out at Higgi Drive, Mt Hotham, behind the Arlberg apartments.

(Photo courtesy of Mt Hotham Alpine Resort Management Board.)

Monitoring of sites

3.5.204 In addition to the identification of remedial works, the Review and subsequent detailed investigations recommended the implementation of a system to monitor all hazardous sites. The aim of the monitoring system was to ensure that the Resort Management Boards receive timely information regarding any changed conditions at these sites and that the Boards have confidence that remedial works undertaken are performing as intended. The Boards are currently developing, as part of their remedial works program, appropriate monitoring strategies for the control of slope instability in accordance with the guidelines prepared as part of the Review.

3.5.205 The guidelines required the:

- installation and measurement of piezometers at locations where site conditions indicate that the groundwater may be near the surface; and
- monitoring of land displacements by regularly reviewing the location and elevation of site markers in areas where landslide movement is suspected.

3.5.206 The importance of, and need for, ongoing monitoring of not only hazardous but also potentially hazardous sites is illustrated by the collapse, in January 2001, of a significant section of the fill supporting the resort access road at Mt Baw Baw. This problem had not previously been identified in any geotechnical investigations or reports. The Mt Baw Baw Resort Management Board was subsequently advised by the geotechnical consultants that a realignment of the road and substantial road works would be required to address the issue. Audit was advised that these remedial works have since been completed.

3.5.207 A comprehensive review of sections of the access road at Mt Baw Baw, not previously assessed, was also scheduled to be undertaken during Stage 2 of the remedial works program in order to identify and investigate other locations that may be prone to instability.



*Repaired pavement - Mt Baw Baw access road.
(Photo courtesy of the Department of Natural Resources and Environment.)
Asset maintenance*

3.5.208 Maintenance guidelines for the control of land instability, prepared as part of the Review, require:

- regular cleaning of all drains to remove material that may divert or restrict run off; and
- surface protection and slope support involving maintenance of grassed surfaces, repair of eroded areas and regular condition monitoring of the retaining walls.

3.5.209 The Review highlighted a number of deficient maintenance practices at the resorts, particularly in relation to roads, car parks and drainage. Specifically, the Review found:

- a road at Mt Buller with a failed stormwater drainage system where the run-off from the road was affecting lodge sites at the north-east side of the resort village;
- unstable retaining walls at Mt Buller, Mt Hotham, Mt Baw Baw and Falls Creek;
- evidence of soil erosion at most resorts, often resulting from a lack of vegetation and poor vegetation practices; and
- a blocked drain that had weakened a sealed car park at Lake Mountain.

Funding of remedial works

3.5.210 In April 2000, the Government approved the provision of funding of \$8.5 million to the alpine resorts over 3 years, concluding in the 2001-2002 financial year, for land stability risk mitigation programs.

3.5.211 Table 3.5R shows the allocation of the funding between the resorts.

TABLE 3.5R
FUNDING PROVIDED TO ALPINE RESORTS FOR REMEDIAL WORKS
(\$'000)

Resort	1999-00	2000-01	2001-02	Total
Mt Buller	650	560	240	1 450
Falls Creek	840	710	375	1 925
Mt Hotham	768	1 460	215	2 443
Mt Baw Baw	630	670	430	1 730
Lake Mountain	140	230	20	390
Mt Stirling	230	225	80	535
Total	3 258	3 855	1 360	8 473

3.5.212 Provision of the funding is administered by the Department of Natural and Resources and Environment through annual service agreements with the Resort Management Boards. In May 2000, the Department wrote to all Resort Management Boards and invited them to enter into the first of these service agreements, for works undertaken during the 1999–2000 financial year.

3.5.213 Continuation of remedial works funding is, in accordance with the service agreements, conditional on the Boards submitting information to the Department including annual “post-completion” evaluation reports of the works undertaken and quarterly reports containing the objectives and a description of the proposed works, justification for undertaking the works, and timeframes for commencement and completion.

3.5.214 However, the Boards have experienced difficulties in complying with the reporting requirements outlined in the service agreements, with many of them submitting late reports. At the beginning of May 2001, the second quarter report, due on 1 February 2001, remained outstanding from all Resort Management Boards except Mt Stirling. Despite this, the Department indicated that it has received informal communication from the Boards as to the progress of the remedial works.

3.5.215 The Government’s decision to provide remedial works funding was subject to the *development of “... a State-wide strategy for alpine resorts (including an examination of the financial position of the Alpine Resort Management Boards to ensure their ongoing viability and long-term ability to undertake the required works and a strategy to mitigate risk in the long-term)”*.

3.5.216 In accordance with that direction, the Department has advised that it is currently undertaking a review of the financial management arrangements of the Boards and an assessment of each Board’s ability to continue to manage the alpine resorts geotechnical land stability program on an ongoing basis. It is expected that the review will be finalised in mid-2001.

Cost of works and adequacy of funding

3.5.217 The level of funding provided by the Department for remedial works at the resorts was based on advice from the Boards as to the estimated cost of implementing the planned works on a timely basis.

3.5.218 However, the criticality of the remedial works at many sites required the majority of the Boards to commence their works programs prior to the provision of funding, by utilising internal cash resources. This situation created significant cash flow difficulties for the Boards, requiring the Department, at the beginning of 2000, to provide advances of between \$250 000 and \$300 000 to each Board with the exception of Mt Stirling and Lake Mountain. Funding subsequently

provided under the service agreements was reduced by the amount of the advances provided.

3.5.219 Stage 1 of the remedial works program was fully funded by the Department at all resorts with the exception of the Mt Hotham, where the total cost of the works exceeded the funding provided by \$102 000. These additional costs were met by the Mt Hotham Resort Management Board's internal cash resources.

Safety of alpine resort access roads

3.5.220 The alpine access roads to the resorts are managed by agreement between the Department, the Alpine Resort Management Boards and VicRoads in accordance with section 12 of the *Alpine Resorts (Management) Act 1997*.

3.5.221 In April 1998, the then Minister for Roads and Ports and the then Minister for Conservation and Land Management agreed that:

- VicRoads would assume responsibility for the maintenance of all resort access roads, although the funding of remedial works on the Mt Stirling access road needed to be resolved; and
- snow clearing on resort access roads would be the responsibility of the Alpine Resort Management Boards, with the exception of snow clearing on the Mt Hotham access road, which would be the responsibility of VicRoads.

3.5.222 However, in the period since that exchange of Ministerial correspondence, the Department and VicRoads have been unable to reach agreement on the funding of road maintenance on the Mt Stirling access road. VicRoads has offered, in discussions with the Department, to maintain the road subject to the Department first upgrading the road to a minimum standard.

3.5.223 The Mt Stirling Alpine Resort Management Board has advised that without additional funding it will be very difficult for it to keep the access road properly maintained. This was confirmed by a risk assessment undertaken by geotechnical consultants in August 2000, which found that the alpine access road maintenance program at Mt Stirling has been deficient over several years and recommended that, as the roads at the resort are used as long-term public access roads (despite not being designed or built as such) they need to be managed in a manner that recognises that problems with road safety are likely to arise in the future.

3.5.224 The Board has estimated that an annual road maintenance budget of \$100 000 is required to ensure the safety of the resort's roads. This is \$90 000 more than the Board's current budget for this purpose and is equal to approximately 50 per cent of the total funding provided by the State Government to support the Board's operations.



Mt Stirling access road needing repair.

3.5.225 The funding of remedial works on the Mt Baw Baw access road has also created problems for the Mt Baw Baw Resort Management Board. In early 2000, the Board requested that VicRoads undertake remedial works on the resort's access road prior to the up-coming snow season. Audit was advised that these works were not undertaken by VicRoads, as the tight timeframe required by the Board did not provide sufficient time for VicRoads to assess the proposed works and incorporate the works into the Government's annual road program.

3.5.226 As a consequence, the works required were incorporated into the Board's remedial works program and are expected to be completed in conjunction with the Board's other works to ensure that public safety and security of access to the resort is not compromised.

3.5.227 Additional funding has been provided by the Department for the works and the Board has advised the Department that it intends to seek to recover the costs from VicRoads in due course.

Planning policies

3.5.228 The use and development of land at the alpine resorts is regulated by the Alpine Resorts Planning Scheme, which was introduced by the Department of Infrastructure in November 1997 when it took over responsibility for resort development planning from the former Alpine Resorts Commission.

3.5.229 The Scheme encompasses statutory requirements and State and local government planning policies. It also outlines the information required to be submitted with planning applications and the matters to be considered when planning applications are decided. The Scheme currently specifies that planning applications for the development of ski fields and resort village areas are to be accompanied by details of soil, geotechnical and drainage conditions of the site. Applications for planning permits under the Scheme are made to the Department of Infrastructure and referred to the individual Resort Management Boards for comment. In applying the Scheme, the Department of Infrastructure is required to

consider the capability of the land to accommodate the proposed use or development.

3.5.230 In August 2000, the Minister for Environment and Conservation wrote to the Resort Management Boards requesting them to provide details of land stability issues to the Department of Infrastructure for land subject to planning applications. At the time the Review of Land Stability was undertaken in 1998, it was the Department of Infrastructure's intention to use the hazard mapping of sites at the alpine resorts and guidelines developed as part of the Review in planning for future developments within resorts.

3.5.231 In particular, consideration was to be given to amending the Scheme to:

- identify risk categories;
- modify the uses and development permissible on land in different risk categories; and
- include conditions that should attach to planning permits, such as the way in which a development is carried out or is subsequently maintained.

3.5.232 However, the Scheme has not been amended as concerns exist as to how to incorporate the findings of the Review into the Scheme without explicitly exposing the State to liability should any land stability issues arise. In addition, it was felt that by publicly disclosing the hazard ratings of individual sites, it was possible that the value of the developments on the high hazard sites may be negatively impacted.

Management of safety at alpine resorts

3.5.233 Resorts by their nature are built in areas characterised by steep unstable terrain. These resorts are also major tourist attractions where large numbers of people congregate in relatively small areas. In this environment a landslide, especially where it might impact on infrastructure or buildings, could result in the loss of life and significant damage to property and the environment.

3.5.234 As a consequence, the Resort Management Boards have an obligation to ensure that all resort land under their control is managed to minimise the risk to the public and property. Sound asset management involves:

- recording of sites and documenting site features;
- assessing the level of risk associated with each site;
- ongoing monitoring of site conditions and associated risk;
- adequately maintaining infrastructure such as drains, roads, car parks and utility distribution assets;
- undertaking remedial works to address the problems in risk areas; and
- administering a planning scheme which, when assessing planning applications, takes into consideration the site conditions and risk profile.

3.5.235 It is pleasing to report that the significant hazards identified by the Review have largely been addressed and the majority of the good infrastructure management processes identified above (with the exception of the amendments to the Planning Scheme) are, or will shortly be, in place.

3.5.236 It is quite clear that the Thredbo disaster was the catalyst for the action taken to identify the significant hazards at the Victorian alpine resorts and the subsequent actions taken to mitigate those risks.

RESPONSE provided by Secretary, Department of Natural Resources and Environment

In general terms, the Department is satisfied that the Report accurately reflects the scope of the Department's Alpine Resorts Land Stability Review and the programs that have been set in place by the Alpine Resort Management Boards

to properly manage this important public safety issue. It is pleasing that the Report acknowledges that land stability hazards identified through the Department's Review have been addressed by the Alpine Resort Management Boards who have also established sound infrastructure management processes which have proceeded in a timely fashion with the benefit of government funding for the program.

The Report identifies that there is a need for ongoing management of land stability in the alpine resorts. In particular, the Report notes the importance and need for continuation of monitoring systems on an ongoing basis.

The audit review has been carried out at around the halfway point of a 3 year funding program. Because of the nature of the program, investigations have been carried out (and continue to be carried out) and the scope of anticipated remedial works undertaken by the Boards has subsequently changed; it is possible that the scope of remaining remedial works may be subject to further change. It is, therefore, difficult to be conclusive at this time about the adequacy of funding for the remaining stages of the program.