# SEISMIC SURVEILLANCE OF AWOONGA HIGH DAM

# OPERATIONAL REPORT TO JUNE 1994

PRESENTED TO GLADSTONE AREA WATER BOARD

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25 OCTOBER 1994

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# 1 - INTRODUCTION

## 1.1 - CONTENT

This report summarises the operational aspects of the Awoonga High Dam seismic monitoring project for the 13 year period from 1981 to 1994. Only operational aspects of the project will be presented; a report detailing the results of analyses of the seismological data will be presented to Gladstone Area Water Board (GAWB) later in 1994.

This report details the instrumentation (Section 2), operating procedures (Section 3) and summarises costs associated with the project (Section 4).

## 1.2 - HISTORY

The project commenced with the installation, in 1981, of a seismograph by the Geological Survey of Queensland (GSQ), Department of Minerals and Energy[1]. GSQ were also involved with monitoring projects at the Burdekin Falls, Wivenhoe and Boondooma dams.

In 1990 the Department of Applied Physics, University of Central Queensland (UCQ), installed several seismographs in the Rockhampton area and organised that records from the Awoonga High Dam seismograph be sent to UCQ to aid in the operation of their network.

In 1993 the Department of Minerals and Energy deemed that seismic monitoring by the GSQ did not fit into the Departmental mission and decided to discontinue the service. Following approaches from users of the service, the Department of the Premier, Economic and Trade Development organised for the Department of Earth Sciences at the University of Queensland (UQ) to supply the service under contract. UQ became responsible for the project in August 1993. The project will be the responsibilty of QUAKES (Queensland University Advanced Centre for Earthquake Studies), a research centre currently being established at UQ.

## 1.3 - STAFF

UQ staff involved with the project are: Mr Russell Cuthbertson, routine operations and analysis; Mr Col Lynam, analysis of data for international collaboration and Mr Nick Sibbald, equipment maintenance and repairs. Several part-time students are employed for the routine analysis of the data. The entire project comes under the directorship of Dr Peter Mora as the director of the Queensland University Advanced Centre for Earthquake Studies.

## 1.4 - RELATED PUBLICATIONS

A summary of many aspects of the data analysis process and results of seismic monitoring in southeastern Queensland was presented in Cuthbertson (1990). Discussions of the seismicity and seismo-tectonics of southeastern Queensland were given in Cuthbertson (1990), Cuthbertson and Murray (1990) and McKavanagh and others (1993). Cooper and others (1992) discussed the central Queensland network operated by UCQ.

Results of the reservoir-induced seismicity aspect of the project were published in Cuthbertson (1989).

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[1] Then Department of Mines and later Department of Resource Industries.

## 2- SEISMOGRAPH INSTALLATION

The seismograph installation consists of a sensor and recorder. The sensor (seismometer) is installed in the ground while the recorder and ancillary equipment (batteries and radio) are housed in a hut.

### 2.1 - LOCATION

The seismograph was originally installed beside the water tank on Golegumma Mt. (AWG). This site was chosen because it was remote from the seismic noise generated by the construction work and because it was secure. Modifications to the inlet pipe to the tank resulted in extremely large noise levels when the tank was being filled. Large portions of the records from the early part of 1987 were obliterated due to this noise.

In April 1987 the seismograph was moved to the GAWB compound near the dam (AWA). The construction work had finished and it was hoped this site would prove satisfactory. Unfortunately, high noise levels originating from traffic on the adjacent road and from the Callide pipeline, were recorded. The noise from the pipeline most likely came from the surge-tank approximately 500 m away.

In June 1987 the system was again moved, this time to a location on the east side of the river (AWD), remote from traffic and all noise associated with the dam. The only problem with this site is the high noise level during periods of high winds.

The location and operating dates of the various sites are given in Table 1.

TABLE 1 - SEISMOGRAPHS AT AWOONGA HIGH DAM

| Code | Longitude | Latitude | Height | Start | Finish | Name |
|---|---|---|---|---|---|---|
| AWG | 151.3157 | 24.0462 | 0.125 | 81-09-22 | 87-04-14 | Golegumma Mt. |
| AWA | 151.3017 | 24.0681 | 0.06 | 87-04-14 | 87-06-30 | GAWB compound |
| AWD | 151.3157 | 24.780 | 0.11 | 87-07-01 | ---- | East side of dam |

Note that longitudes are degrees east, latitude are degrees south and heights are kilometres. Dates are in YY-MM-DD format.

### 2.2 - SEISMOMETER

The sensor used is a short-period (1 Hz), vertical component seismometer (Mark-Products L4C). To reduce the effects of wind generated noise the seismometer is housed in a steel container that is buried in the ground . To prevent groundwater entering the container, the top is left slightly above ground level. Rocks or bricks are stacked on the top of and around the container to further to isolate the sensor from the wind.

### 2.3 - HUT

The recorder is housed in a small (approximately 100 cm wide x 50 cm deep) wooden hut that stands on a galvanised iron frame. GAWB staff have erected a canopy over the hut to enable the site to be serviced in the rain. Some of the lids of similar huts at other sites throughout eastern Queensland have had to be replaced due to weathering but at Awoonga High Dam the canopy has protected the hut. The hut was repainted in 1992.

## 2.4 - RECORDER

The recorder is a Sprengnether MEQ-800 drum recorder. A record is produced with a stylus scratching diesel soot off a sheet of gloss paper. Subsequent fixing of the record in a bath of synthetic shellac allows it to be handled. This method of recording may be antiquated but the final seismograms provide excellent definition and detail.

Electronic filters are used to decrease noise from traffic, thunderstorms and aircraft. The site has generally operated at an overall magnification of 84 db. Translation rates are 60 mm/min with second marks being recorded on the records.

## 2.5 - POWER

The recorder requires two batteries to provide a split 12 V DC supply; ie. -12 V, 0 V and +12 V. Two pairs of small motorcycle batteries are used; each pair mounted in a wooden carry box. While one set is being used on the seismograph the other set is being charged at the GAWB dam site office.

The original three-pin plugs used in the power system were modified to four-pin plugs. These provided better power continuity when batteries were being changed. The internal power connection of the recorder has been modified to prevent the external batteries being accidentally short-circuited.

## 2.6 - TIMING

Accurate absolute timing is essential in obtaining accurate earthquake locations. The recorder has a built-in clock but this slowly drifts and an absolute time reference is required.

A short-wave Labtronics radio was used to receive the Telecom VNG broadcast from Lyndhurst, Victoria on 4.500, 7.500 and 12.000 MHz. Transmission of this signal ceased in October 1987. The Navy provided an interim time service with broadcasts on 6.449 and 12.984 MHz. The WWVH transmissions from Hawaii, on 5.000, 10.000 and 15.000 MHz, were received using a Labtronics radio on loan from UQ but the reception was very poor.

The new VNG transmission (from Llandilo in Sydney on 2.500, 5.000, 8.638, 12.984 and 16.000 MHz) provided a stronger signal and in 1991 a Sony short-wave receiver was purchased. This receiver has the advantage over the original Labtronics radios in that it can be tuned to any short-wave frequency.

# 3 - OPERATION

## 3.1 - SEISMOGRAPH MAINTENANCE

Basic maintenance of the recorders and ancillary gear is performed by GAWB staff. Staff from Brisbane (formerly from GSQ, now from UQ) visit the site at least once per year for preventative maintenance, adjustments and repairs. The equipment has at times been returned to Brisbane for more complicated repairs. UCQ have also performed some servicing of the equipment.

The repairs to the equipment can generally be classified as mechanical or electrical. Mechanical repairs include motors, belts and bearings. Simple electrical repairs include repairs to cables or the replacement of faulty batteries. More involved electrical repairs usually require the assistance of the UQ electrical technician. These repairs often involve the components of the digital clock.

Lightning struck the site in 1982, damaging the radio and also the input circuitry of the recorder.

Water penetrated the seismometer container in 1987 and found its way into the sensor itself. The seismometer was replaced in December 1987.

A cyclone in 1992 severely damaged the canopy.

In 1992, it was noticed that the rotation motor slowed whenever a large amplitude event was recorded. The problem was eventually traced by UCQ staff to a poor connection on the battery pack and repaired. The symptom reappeared in 1994 and was traced to the same cause. There are two alternatives to provide a more permanent solution to this problem. The first would be to use a DC/DC converter to provide the ±12 V from the one battery pack. This would do away with the need for multi-pin plugs; these being replaced with heavy duty dual-pin plugs.

The second solution would be to convert the site to solar panel charging. This would eliminate the need for battery packs altogether, thereby significantly reducing the problems associated with the maintenance of batteries and leads and thus decreasing down-time. The second solution is preferred and will hopefully be implemented next year.

Solar panels installed at similar sites in eastern Queensland are mounted directly onto the lid of the hut but at Awoonga this is prevented by the canopy. A solution would be to construct a simple mounting frame on a pole. The pole could be erected in a cleared area up to 10 m from the recorder. The construction of the frame and support would best be carried out on-site by GAWB.

## 3.2 - SEISMOGRAPH SERVICING

Day-to-day operation of the seismograph consists of GAWB personnel servicing the instrument (ie changing the record) twice per week. The records are sent to UCQ in Rockhampton where they are analysed. The records are subsequently sent to UQ in Brisbane where the UCQ readings are checked and any important events read in more detail. Events that are studied in more detail include obvious earthquakes, possible earthquakes and unidentified quarry blasts.

The log sheets that are filled out at the site are sent with the records to Brisbane where the relevant information is entered into a computer file. This file is used to obtain magnitude estimates.

## 3.3 - DATA ANALYSIS

The majority of the data processing, including earthquake location and earthquake database maintenance, is performed on a Webster minicomputer purchased in 1984 by the Queensland Water Resources Commission for the Burdekin Falls Dam seismic monitoring project. Information relating to each earthquake, including arrival times, location data and magnitude information, is stored on computer file for subsequent output or further analysis. The file also includes earthquakes that occurred prior to the installation of the Wivenhoe Dam network, such as those listed in Jones (1958) and Rynn (1987). All earthquakes in the database are assigned a location accuracy code. This code is a subjective estimate of the accuracy of the earthquake location.

The analysis programs are currently being adapted to run on a Macintosh computer.

UQ exchanges data with other Australian seismological agencies, including the Australian Geological Survey Organisation in Canberra, the Seismology Research Centre in Melbourne and the University of Central Queensland in Rockhampton.

## 4 - COSTS

A summary of the costs recouped from GAWB since 1989 by GSQ and UQ is presented in Table 2. GSQ did not recoup any expenses during the period from 1981 to 1988.

The figures for 1990/91 and 1991/92 include the salary of a contractor hired to analyse data from all the seismic networks operated by GSQ. Cost recovery of the analyst's salary was shared amongst all the GSQ clients. Specific costs associated with a particular client's project (eg. travel allowance, consumables) were recouped from that client.

Full cost recovery of all GSQ expenses was initiated late in 1992 following the decision by the Department of Minerals and Energy to discontinue the service. Salaries, with 30% on-costs, of all the staff associated with the monitoring projects were recouped. This lead to a dramatic increase in charges.

Additional cost recovery of GSQ expenses was initiated in December 1992 following the decision by the Department of Minerals and Energy to discontinue the service. Salaries, with 30% on-costs, of all the staff associated with the monitoring projects were recouped leading to a dramatic increase in charges. If the additional cost recovery had have been in action for the entire year the figure would have exceeded $6,000.

With the transfer of operations to UQ in 1993 and the consequent funding by Premier's Department, the clients are now being asked to pay a fixed fee rather than recoupment of expenses. The agreement between Premier's Department and UQ proposed the 1993/94 annual fee for GAWB be set at $7,500.

TABLE 2 - COSTS RECOUPED FROM GAWB.

| PERIOD | AMOUNT |
|---|---|
| 1989/90 | $300 |
| 1990/91 | $3,952 |
| 1991/92 | $3,081 |
| 1992/93 | $4,181 |
| 1993/94 | $7,500 |

## 5 - SUMMARY

The monitoring of the Awoonga High Dam has proceeded satisfactorily since 1981. The recorder has been relocated twice to decrease noise interference.

GAWB personnel at the dam site are operating the equipment and UQ staff perform routine maintenance trips from Brisbane.

Consideration is being given to converting the equipment power supply to solar panel charging.

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