Appendix 18

RETURN TO APPENDICES LIST

Condition Evaluation of Water Supply & Associated Assets Stage 1A Report

(Alf Grigg & Associates Pty Ltd)

GLADSTONE AREA WATER BOARD

CONDITION EVALUATION OF WATER SUPPLY & ASSOCIATED ASSETS

STAGE 1A REPORT

ALF GRIGG
ALF GRIGG & ASSOCIATES
22nd DECEMBER, 2006

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Stage 1 Report
Executive Summary

The water supply pipeline and associated infrastructure condition assessment project consists of a two stage process, with Stage 1 being a preliminary overview evaluation stage that is intended to identify the strategic condition evaluation issues.

The field inspections and evaluation of known service failures, discarded and failed pipes, and exposed pipeline sections at over twenty field sites confirmed that, with one exception, all known recent pipeline failures can be attributed to corrosion-weakened pipe sections that then fail. The dominant corrosion process is external corrosion with the most advanced corrosion found on the bottom and underside of ducile iron pipelines. Cast iron pipeline corrosion was more uniform over greater sections of the pipe wall. No examples of internal corrosion or failures of the internal pipeline lining were observed.

Sections of three significant pipelines, the 300 DI Boyne smelter raw water, the 300 DI East End treated water, and the 300 CI treated water pipelines have reached, or are close to being life-expired. The GAWB risk rating is severe, and the SMEC risk rating is on these key assets is zero to one.

Immediate actions have been recommended to minimize the probability and consequences of failures in some weakened pipelines.

Stage 2 will be the comprehensive condition evaluation that will confirm the current condition of key pipeline assets considered at greatest risk, together with a range of initiatives intended to optimize the service life of the water supply system and to continue to fulfill the approved project brief.

The Phase 1 condition evaluation plan of Stage 2 will include training of GAWB staff to undertake field soil tests and to evaluate and interpret the data to determine the most likely corrosion process. The plan is quantified, cost-effective, definitive, upskills GAWB staff, and is likely to eliminate further evaluation of some of the critical pipelines.

The Phase 2 survey plan, following Phase 1, may include advanced, cost-effective techniques that can be quantified and costed. The results of such surveys, if justified and approved, should assist in establishing accurate predictions of residual service life spans for the most critical sections of the three pipelines considered at greatest risk. In limited circumstances such as the 600 MS QAL raw water pipeline, advanced non-destructive testing techniques may be recommended be deployed to detect any internal or hidden corrosion processes in the pipeline joints.

The Stage 2 program can commence within four weeks of approval to proceed.

Alf Grigg
Alf Grigg & Associates

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

22nd December, 2006

TABLE OF CONTENTS

Attachments

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

1.0 Report Objectives

This report presents the outputs from Stage 1 of the condition evaluation of GAWB pipelines known to have failed and considered critical to service provision.

The report presents the first two phases of the implementation of Stage 2 of the approved project brief, including the sequential phase tasks and provisional costing implementation.

2.0 Project Implementation Plan

The consultancy is being implemented in two stages:

- Stage 1 consisted of an initial system and field review of the GAWB pipeline system to establish the factual functional and service history situation, from which this initial project report presents the strategic system assessment and proposes a detailed implementation plan for Stage 2 of the project.

  This report concludes Stage 1 of the project, and is limited to evaluating the pipeline and associated assets known to be at risk or have previously failed. Many other assets such as pipelines, valves, pump stations, reservoirs, pipeline markers and easement management were observed within this stage but, with two exceptions (the 50 Ml raw water storage and the pipeline easement adjacent to the water treatment plant) , not subjected to detailed evaluation.

  These latter assets will be progressively evaluated as Stage 2 is implemented and the priority is progressively shifted to less critical assets.

  This report includes proposals for the engagement of specialist sub-consultants to undertake specific condition assessment tasks such as corrosion and coatings evaluation, leak detection and pressure monitoring, NDT pipe wall thickness and structure measurement assessment, and advanced condition assessment on composite pipelines such as AC.

- Stage 2 will include the evaluation of GAWB pipelines in a number of ways including physical inspection, invasive and non-invasive pipe evaluation and location techniques, and pot holing of pipes to determine their exact location in field.

  All assessments and condition-based evaluations are to be carried out using GAWB's own risk assessment and criticality matrix. This will be used in conjunction with the Board's SMEC 1 to 5 scale for rating the condition of assets.

  The scope of the Stage 2 evaluation works is detailed in Attachment No. 1. Stage 2 will be subject to the approval of an overall implementation and detailed sub-stage plans that will include design, costing, and formal approval prior to any

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

assessment work proceeding. The first two phases of Stage 2 are detailed in this report for consideration and approval to proceed.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

3.0 Stage 1 Implementation

3.1 Field Inspection Activities

Board staff forwarded a compact disc of pipeline system information in the week prior to the field inspection visit, and had previously forwarded failure event histories and photographs.

The field inspection was undertaken on Tuesday, Wednesday, and Thursday, 17th – 19th October. Pipelines and associated assets visited included:

- The 50 Ml raw water storage reservoir;
- The water treatment plant, including low and high lift pump stations;
- The pipeline easement housing the pipelines between the plant and the general road network;
- The QAL 600 and 375 mm diameter raw water pipelines from the 16 Ml storage to the facility boundary;
- The water treatment plant, low and high lift pump stations;
- The pipelines between the water treatment plant, the GCC reticulation system, the 9.1 Ml South Gladstone treated water storage, and beyond the decommissioned Glen Eden pump station;
- The 450/375 mm diameter raw pipeline to the Orica, Cement Australia, the oil shale plant, Comalco, and the Yarwun water treatment plant;
- The 150 mm diameter galvanised pipeline crossing of Boat creek north of the Boat Creek pump station;
- A limited part of the 300 mm diameter DI pipeline from Boat Creek pump station to East End Reservoir;
- A general route tour of the 900/700 raw water pipeline from the area around Yarwun back to the urban area;
- The 300 mm diameter part DI/part MS raw water pipeline to Boyne aluminium smelter;
- Limited sections of the 300 CI pipeline that originally linked the urban system to the Awoonga dam, and is now utilised as the treated water pipeline at various remaining sections of the pipeline;
- Limited viewing of the 700 MS above-ground raw water pipeline, and a preliminary inspection and discussion of mortar shards considered to be parts of the internal lining from the pipeline.

While not all pipelines and associated assets were not fully toured and inspected, field inspections concentrated on assets ether known to have suffered service failures or defects, or are at an advanced age. The field inspections enabled the primary objectives of Stage 1 to be achieved.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

3.2 General Observations and Initial Findings

With one exception, the failed pipes available for inspection were displaying evidence of gross external corrosion that caused the consequent failure of the weakened pipe section.

The most extreme progression of the corrosion appeared to be on the bottom of the pipeline suggesting that aggressive groundwaters were concentrating on and flowing in the original construction trench with consequent constant moist, corrosive conditions in the trench floor.

The external corrosion process varied from aggressive and rapid with ferrous oxides visible within 25 mm of the pipe wall, to relatively slow yet progressive corrosion processes that had converted the ferrous material to non-structural oxides and possibly graphite in the case of the 300 mm diameter cast iron pipe.

Aggressive removal of the corrosion/non-structural material revealed the true extent of corrosion and how little actual competent pipe wall material was remaining.

All internal linings observed were in good condition with no evidence of internal corrosion.

The failures of the 300DI Boyne Island smelter, 300 CI, and 300 DI East End pipelines are most probably caused by aggressive soils and/or groundwater. The specific mechanism in each site and pipeline probably varies due to local natural and man-made environmental factors.

The 300 DI Boyne Island raw water pipeline failure site may feature alkali groundwater from adjacent tailings dams, or may be the consequence of highly sodic soils of the coastal tidewater flats. A further factor may be stray DC current leakage from the smelter pot line, though this is considered a lower risk due to the rubber ring jointed construction of the pipeline making the pipeline electrically non-continuous and therefore less attractive to a stray current corrosion attack.

An interesting circumstance is the example of the 300 DI Boyne Island treated water pipeline that runs parallel to the 300 DI raw water pipeline. The pipeline is bedded in the same soils as the raw water pipeline, yet no service failures are known even on the sites of the failure of the raw water pipeline. Why two pipelines would perform so differently in such a site remains to be revealed.

The 300 DI East End treated water pipeline failure sites appear to predate the adjacent Comalco tailings dam operations and are more likely to be associated with naturally occurring aggressive groundwater.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

The 300 CI treated water pipeline displays evidence of full circumferential corrosion at a range of geographically distributed sites, suggesting long-term progressive corrosive processes.

Only one failure at the air valve on the 300 CI pipeline at the ridgeline in Mann's paddock was considered a structural failure of the pipe section. This failure appeared to be a longitudinal structural failure of a visibly competent pipe with no evidence of corrosion or metal conversion processes.

By comparison, the dump of failed 300 CI pipes in the Mann's flats paddock featured pipe sections that were in an advanced state of corrosion, and were consequently weakened. Some form of hydraulic impact then caused an inevitable longitudinal cracking structural failure in the reduced pipe wall section.

Individual pipeline condition assessments and risk ratings are presented in Attachment No. 2.

3.3 Other Assets

Storage reservoirs, pump stations, valve pits, pipe support bridges and pipeline easements inspected were generally in good condition.

Some valve pits and pipeline fittings were located in flooded access pits and displaying progressive corrosion processes.

One exception was the 50 Ml raw water reservoir where some post-tension bolts in the walls have failed by seemingly snapping in tension, and in one case has ejected itself through the roof cladding. These failures and remediation options should be assessed by a specialist structural engineering firm.

The second observation was the variability of pipeline and easement marking to warn landowners and others of the location of pipeline assets.

The most critical easement situation is that of the 450 and 600 diameter high lift pipelines that exit the water treatment plant and pass over a ridgeline. One side of the easement is potentially structurally compromised by a landowner who has excavated his property down to a level at least 4 metres lower than the natural surface on the easement.

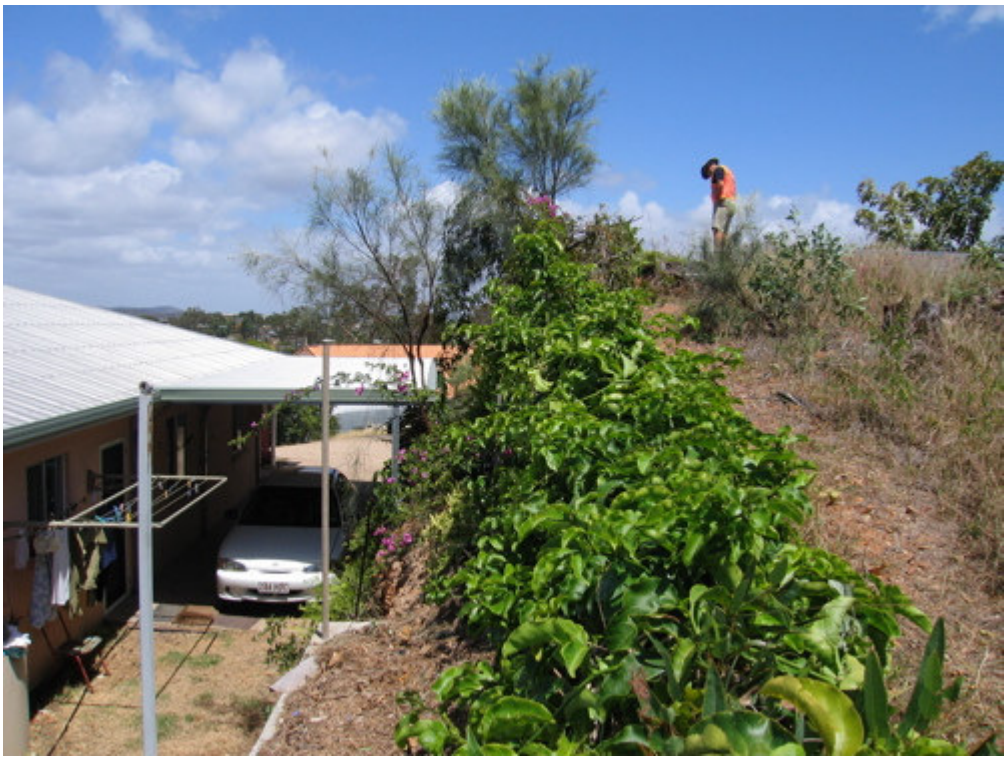
The landowner has installed a nominal, treated pine retaining wall to support the exposed bank and buried pipeline. The structural competency of the existing retaining wall is doubted, and the situation should be assessed by a competent geo-technical/structural engineering consultancy to ensure that the situation is safe for both the occupants of the property and for the integrity of the pipeline.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Pipeline markers of new and recent pipeline assets appeared to be adequate. Markers for older assets were generally non-existent.

Finally, the mortar shard reputed to have been lost from the 700 MS raw water pipeline and deposited in the reservoir is interesting from an asset management viewpoint, but probably of limited consequences in the immediate future. The pipeline will be the subject of detailed condition evaluation within Stage 2

Section View of the Embankment Rear of Water Treatment Plant



162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

3.4 Evaluation of Pipelines by GAWB Matrix and SMEC Valuation

The summary of risk assessment of the inspected pipelines by both the GAWB and SMEC assessment systems provides the following provisional assessment:

Pipeline	GWAB Risk Rating	SMEC Rating
300 DI Boyne smelter raw water pipeline	Severe	0
300 CI treated water pipeline, South Gladstone to Golegumma.	Severe	0
300 DI treated water pipeline to East End Reservoir	Severe	1
150 Galv. Iron treated water pipeline to CA	Severe	1
675 MS QAL raw water pipeline	Significant	3
375 AC raw water pipeline to QAL	Low	3
450/375 AC raw water pipeline to Yarwun WTP	Low	3

In short, only four pipelines inspected during the Stage 1 visit require condition assessment as a first order priority to confirm the risk ratings.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

4.0 Proposed Stage 2 Condition Evaluation

4.1 General Evaluation Approach

There are a range of approaches to condition evaluation.

One extreme approach is to undertake an advanced condition assessment utilising best practice technology.

While the circumstances and justification for such an approach are understood, the recommended initial approach is a low-cost, low technology approach that can be substantially implemented by Board operational teams and supervisory staff. The proposed approach would consist of the following initiatives:

- Further exploration of historical events with sources such as Gladstone City Council and Calliope Shire employees to confirm locations and types of failures on pipelines such as the East End 300 DI treated water pipeline;

- Only one pipeline, the 300 CI treated water pipeline, justifies accurate, high-speed pressure logging to establish whether this aged pipeline is failing prematurely due to high water hammer effects or from pipe wall section loss due to corrosion/conversion processes.

  The Board has the necessary pressure logging equipment to undertake short - duration pressure logging that may reveal short-duration high transient pressures that are beyond the capacity of the corrosion-weakened sections of the pipeline.

  The pressure survey should commence as soon as possible on the section from the South Gladstone reservoir to the end of supply. The pressure survey should proceed regardless of whether the pipeline modification works have or have not been completed. The pressure survey will enable the maximum hydraulic grade line and any spikes to be logged and the residual pipeline strength checked against the probably competent pipeline wall thickness.

  The results can be logged into the hydraulic software system to establish the frequency and extremes of pressure.

  The costs are confined to the field deployment and data analysis.

- It is important to establish the dominant corrosion process that has impacted on the 300 DI Boyne smelter, 300 CI East End, 300 CI, and possibly the 600 MSCL QAL pipelines.

  This task has been discussed at length with Bill McEwan, an experienced materials engineer and metallurgist of CTI Consultants. He has suggested that, rather than undertake metallurgical evaluation and analysis of old discarded

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

failed pipe sections, followed by extensive outsourced soil corrosivity mapping using systems such as the Earthtech LPR soil testing system, as proposed in the 6th December Stage 1 report, a different approach be proposed to GAWB.

This proposal involves designing and planning a program of equipping and training GAWB staff to undertake a suite of field and laboratory tests to identify soil corrosion processes that can be reasonably anticipated to occur within the Gladstone area environment.

Training will involve implementing a field inspection program in which Bill will train selected GAWB staff to plan and implement a field evaluation of pipeline failure sites. He will then train GAWB staff to interpret the results and establish the dominant corrosion process, and take action to plan an appropriate response for maintenance of essential water supply purposes.

Bill will conduct materials sampling to obtain sufficient corrosion material samples from relevant field sites. These samples will then form the basis of laboratory analysis and assessment as deemed essential to validate field and laboratory testing of soil corrosivity issues.

The proposed training and inspection program will focus on field inspections and exposures of the critical pipelines in selected locations to determine the extent of the pipelines that are severely externally corroded. These should include:

- The 300 DI Boyne Island smelter raw water and 300 DI treated water pipelines;
- The 300 CI treated water pipeline at various sections and field conditions along its route;
- The 300 DI East End treated water pipeline from Boat Creek pump station at various locations to the East End reservoir.
- The 600 MSCL QAL raw water pipeline on the tidal flats.

The sampling and analysis might reveal how much of a particular pipeline is in acceptable service condition with confined corrosion-weakened lengths limited to specific sites and certain field conditions.

For example, the 300 DI raw water Boyne smelter pipeline in elevated sections through the low rises might be in good condition, with the corrosion-weakened sections confined to the low flats where the pipeline is buried.

The same investigation approach might apply to the 300 DI treated water East End pipeline, particularly when combined with more detailed evaluation of the pipeline failures that are reputed to have occurred during the period of high-pressure service.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

The survey outcome might provide definitive evaluation of the three critical pipelines such that one or more can be confirmed as life-expired with no value to be gained from additional condition evaluation activities.

This approach ensures that GAWB staff will be trained to be capable of undertaking a range of soil corrosivity testing and interpretation of results

This training and skills transfer process will enable the field teams to better understand failure modes and be prepared to probe beyond a pipeline failure to better understand the primary pipeline failure mechanism to establish the extent and probability of a similar failure at an adjacent location.

The second phase may utilise advanced techniques where the first phase assessment activities provide the justification for such evaluation. These advanced techniques of non-destructive condition evaluation of critical pipelines could include both the Earthtech BBEM and the Rock Solid BEM NDT systems.

Both systems may have application to the evaluation of the 600 MS QAL pipe joints. Both techniques are capable of revealing both external and internal corrosion processes. Establishing which corrosion system is dominant will enable the future serviceability and predicted service lifetime of the total pipeline to be established.

Rock Solid has expressed doubts and limitations about the ability of BEM to evaluate both the internal and external corrosion processes, due in part to the double layer of metal at the pipeline spigot and socket joint.

Field exposures, soil corrosivity testing and corrosion evaluation of the three critical pipelines are most likely to reveal the status and future of each pipeline without the need for further, expensive condition evaluation.

4.2 Stage 2 Condition Evaluation Project Costings

The first phase of Stage 2, as detailed in Attachment 2, is provisionally estimated to cost approximately $26,726 plus GAWB internal and support costs. The scheduled costs for CTI Consultants are the direct consulting cost, and do not involve any overhead component or profit for Alf Grigg & Associates. The intention is to encourage the establishment of a relationship between GAWB and CTI for future specialist projects.

Phase 2 costs remain as unconfirmed at this time.

4.3 Stage 2 Project Implementation Timings

Stage 2, phase 1 can commence within four weeks.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

The Stage 1, Phase 1 corrosion evaluation condition assessment stage can be completed within two months depending substantially on how quickly the Board can order a limited list of testing and analysis equipment, prepare for training of staff in soil testing, and prepare to undertake field exposures.

Advanced NDT condition assessments such as the BBEM/BEM system on the 600 MS QAL pipeline can be undertaken in parallel with the soil corrosivity tasks, and should be completed within three-four months.

5.0 Conclusions and Recommendations

5.1 Conclusions

Stage 1 focused on selected pipeline and other assets known to have histories of failure or problems. Some of the pipelines are in an advanced state of deterioration, and do require detailed condition assessment to confirm the residual life span of each.

The majority of assets inspected during the Stage 1 visit were operating satisfactorily, and present few life span limiting issues.

The first phase of Stage 2 will complete the detailed assessment of those assets considered at the most extreme risk, will provide for the balance of the system to be initially assessed to determine asset condition, and to fulfil the approved project brief.

5.2 Immediate Recommended Actions

The following recommendations are offered for immediate consideration and implementation regardless of when Stage 2 proceeds:

- Undertake short time interval hydraulic pressure logging along those sections of the 300 CI pipeline remaining in service, analyse, graph, and report the data;
- Implement the proposed modifications to the 300 cast iron treated water pipeline to reduce hydraulic impact effects. As of this date, the modification work is understood to be approaching completion;
- Engage a specialist structural engineering consultant to evaluate the failed post-tension bolts in the 50 Ml reservoir to determine the cause, possible consequences, and remedial actions to ensure the safety and service durability of the structure;
- Seek discussions with QAL technical management to encourage the identification, formalisation, and if necessary, improvement to the interconnectivity between the 375 and 675 mm diameter pipelines within the plant property to better provide for leaks/bursts in the 675 mm diameter MS pipeline. As of this date, the information and plans on the internal QAL system are virtually complete;

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

- Engage a competent geo-technical/structural consulting engineer to assess and ensure that the situation is safe in both the short and long term for both the occupants of the property and for the integrity of the pipeline.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

The final recommendation is that the Board approve the implementation of phase 1 of the specified Stage 2 project.

Alf Grigg
Alf Grigg & Associates
22nd December, 2006

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Attachment No. 1
Stage Two Approved Project Scope

The scope of the Stage 2 evaluation works are to include but not exclusive to those portions of work nominated below:

- Detailed condition assessment of all GAWB's pipelines. This will include an evaluation of the pipeline materials by both destructive, non-destructive methods and soil corrosivity testing.
- Inspection, assessment & data collection of all associated pipeline infrastructure including air, scour, isolation valves, and booster pump stations and surge vessels.
- Pressure monitoring and leak detection suggestions for the most appropriate systems to achieve a high degree of confidence in the integrity of GAWB's pipelines.
- In-field identification of pipelines physical location within the easement and review of easement documentation to identify problematic areas where pipeline is outside or no easement exists.
- Digital photo's and summery with the attached condition rating and other relevant documentation for that asset.
- The final report is to include a list of the most critical pipelines that place GAWB at the most risk on a customer basis. The development of a program of works starting with the most critical condition assessed and working toward the least. This information will need the ability to make capital suggestions for coming budgets with approximate cost estimates for rehabilitation.
- In addition to the final report, we will provide an "Operation & maintenance" manual for each pipeline system, with these manuals being developed in conjunction with GAWB staff.
- The "Operation & Maintenance" manual is to include:
    - Customer database with key contact personnel, names and numbers for all customers on the raw and treated water reticulation networks.
    - Nature and frequency that maintenance should be carried out. This will include but not be exclusive to the exercising of valves, scouring of pipelines, cleaning air valves, replacing bolt sets in flanges and painting of above ground infrastructure.
    - Normal operating procedures
    - Emergency operating procedures
    - Physical location of all pipelines and related infrastructure, to include GPS coordinates.
    - Map of pipelines
    - Map of pipelines including correct location of Easement
    - Table of criticality & risk of each asset on that system.

Stage 2 will be subject to the approval of an overall implementation and detailed sub-stage plans that will include design, costing, and formal approval prior to any assessment work proceeding.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Attachment No. 2
Stage 2 Condition Evaluation Project Tasks and Costings

Please note that the following schedule of tasks and costs, with the exception of the pressure testing of the 300 CI treated water pipeline, does not include the immediate action tasks as recommended.

The schedule does not, and cannot, attempt to quantify the internal costs of GAWB participation and task completion.

The following schedule details the external costs for Phase 1 of the Stage 2 condition evaluation project:

Phase 1 Activity	**By**	**Unit**	**Rate**	**Item Total**	**Prog. Total**
Research pipeline histories of 300 CI and 300 DI East End treated water pipelines and any other available service history from GCC and CSC	GAWB staff.	?	?	?	?
Pressure log the 300 CI treated water pipeline.	GAWB staff.	?	?	?	?
Provision of a Phase 1 project plan and list of testing and analytical equipment for purchase by GAWB.	AAG & B.McE				
Purchase of soil sampling and analytical equipment by GAWB.	GAWB				Approx. $4,000
Visit to site by AAG and Bill McEwan to undertake the staff training and field inspection program of 300 CI, 300 DICL East End, 300 DICL Boyne Island Raw Water and 600 MSCL QAL raw water pipeline. Inspections of 900 and 700 pipelines plus other pipelines and associated assets not inspected during first visit. Review of field exposure and pipeline inspection results and metallurgical report outcomes. Preparation of a progress report and preparation of the detailed plan for the next phase of the condition evaluation. See Attachment 4 for costing breakdown.					22,726
Phase project cost estimate:					**$26,726**

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Attachment No. 3
Individual Pipeline Reports

The following individual pipeline condition assessments and risk rating are based on a limited visual inspection of discarded pipe sections and limited pipeline exposures. The assessments are provisional and require implementation of detailed condition evaluation tasks in order to confirm the risk assessments.

The assessments are reported to ensure that condition evaluation activities in the first period of Stage 2 are concentrated on those pipeline assets posing the greatest risk to continued water supply activities.

600 mm diameter QAL Raw Water Pipeline

The QAL bauxite processing plant is serviced by a 600, coal tar-wrapped, rubber ring jointed, mortar-lined mild steel pipeline with the external joint surfaces field wrapped with Denso tape and product.

The pipeline has a limited history of leak failures in the joint region, with a ring failure due to an operational procedure.

While the pipeline is partially duplicated by the original 375 mm diameter AC pipeline, the capacity of the latter is considered insufficient for an extended period. There is uncertainty as to whether the two pipelines are effectively interconnected within the QAL plant to best optimise supply in the event that the 600 mm diameter pipeline is decommissioned for repairs.

An internal report on the causes of the reported pipeline failures was inconclusive.

An inspection of the pipeline route revealed salt flat conditions and evidence of aggressive corrosion of unprotected ferrous materials. Failures such as those previously reported are likely to continue unless the corrosion process can be reduced or halted. Such protection initiatives are limited in a pipeline that, by virtue of the rubber ring construction, is not electrically continuous.

The pipeline was not available for inspection on the tidal flats, though spare pipeline lengths stored at the water reservoir were inspected.

This pipeline is recommended for statistically-valid, non-destructive assessment of selected pipeline joints, together with a survey of soil corrosivity for that length of the pipeline located on the former tidal flats.

The GWAB risk assessment score, given known asset information, is as follows:

Likelihood of failure	Likely, given the known service history.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Consequences	Low, given the limited duplication provided by the original 375 mm diameter AC pipeline
Rating	Significant

Under the SMEC asset valuation system, and given known asset information, the pipeline has a **service potential rating of three**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, and risks are tolerable.

Expected wear and tear: "..but some risks for some asset types may be approaching.."

Age: Estimated remaining service life is 75% of total life.

Immediate recommendations are:

- Seek discussions with QAL technical management to encourage the identification, formalisation, and if necessary, improvement to the interconnectivity between the 375 and 600 mm diameter pipelines within the plant property to better provide for leaks/bursts in the 600 mm diameter MS pipeline;
- Investigate and, if not readily available, have a local fabrication firm fabricate at least one longitudinally-split repair coupling that can fully envelope the joint assembly of this pipeline. This short-term emergency repair fitting will ensure a prompt response to leaks or bursts, and enable a longer shutdown to be deferred and planned in association with QAL management.

375 mm diameter AC QAL Raw Water Pipeline

The 375 AC pipeline is the original raw water supply pipeline to the QAL Plant, and is now a secondary, part-capacity duplication of the 600 MS pipeline.

The AC pipeline across the tidal flats probably constitutes the best pipeline medium for corrosion resistance after PE and uPVC pipelines. Structural competency evaluation of the state of the AC pipeline by non-destructive testing methods will be recommended as a third priority condition assessment.

There was no reported history of failures or defects on this pipeline. The provisional condition rating under the GAWB risk management matrix is:

Likelihood of failure	Unlikely, given the potentially neutral-high pH soil conditions.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Consequences	Low, given the duplication provided by the primary supply 600 mm diameter MS pipeline
Rating	Low

Under the SMEC asset valuation system, and given known asset information, the pipeline has a **service potential rating of three**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, and risks are tolerable.

Expected wear and tear: "..but some risks for some asset types may be approaching.."

Age: Estimated remaining service life is 75% of total life.

450 and 375 mm Diameter Raw Water Pipeline (Hanson Road Main) to Northeast End and Yarwun Water Treatment Plant

This pipeline was visible on the Calliope River and anabranch bridge crossings, and at the cooling water channel.

The pipeline consists primarily of AC pipe with painted mild steel pipe confined to the cooling water channel bridge crossing. The AC pipe and joining collars appeared to be in good condition with no obvious external defects. Operational issues were:

- Air valves located at the mid-span points on the Calliope River and anabranch crossings, locations that eliminate safe access to and maintenance of the fittings. The result is that the fittings are not serviced, and have probably never been serviced. Non-functioning valves can lead to operational problems;
- Dissimilar metals in branch fitting assemblies, resulting in visible corrosion processes;
- Some corrosion in flanged mild steel pipe sections at the upstream end of the Calliope River bridge crossing.

The AC pipeline across the tidal flats probably constitutes the best pipeline medium for corrosion resistance after PE and uPVC pipelines.

Structural competency evaluation of the state of the AC pipeline by non-destructive testing methods will be recommended as a third priority condition assessment.

The mild steel pipeline at the cooling water channel pipe bridge appeared to be in good condition with no obvious defects.

There was no reported history of failures or defects on this pipeline. The provisional condition rating under the GAWB risk management matrix is:

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Likelihood of failure	Unlikely, given the potentially neutral-high pH soil conditions.
Consequences	Low, given the duplication provided by the 900 mm diameter
Rating	Low

Under the SMEC asset valuation system, and given known asset information, the pipeline has a **service potential rating of three**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, and risks are tolerable.

Expected wear and tear: "..but some risks for some asset types may be approaching.."

Age: Estimated remaining service life is 75% of total life.

300 mm Diameter DI Raw Water Pipeline to Boyne Smelter

This pipeline was visible on a tidal channel bridge crossing and as an elevated pipeline at different points along the pipeline route.

The pipeline consists primarily of buried 300 DI pipe, with sections of painted mild steel pipe confined to the channel bridge crossing and low sections of the mud flats. The above-ground MS pipe appeared to be in good condition with no obvious external defects.

The buried 300 DI pipeline has burst at low points within 300-400 metres from the smelter boundary. The burst pipe sections remaining on site displayed extensive external corrosion with the most extreme corrosion around the bottom of the pipe. The internal pipe mortar liner was generally intact and displayed no signs of failure.

Subsequent information regarding smelter redevelopment proposes complete diversion of the 300 DI raw water and 300 DI treated water pipelines. If this proposal actually proceeds within the next 12 – 18 months, it would economically negate the need to conduct an advanced condition assessment of the existing pipeline or partial replacement of the raw water pipeline.

The only variation to this approach is if both the company and Board consider the risk of failure in the interim to be unacceptable, and a decision is taken to replace the most extremely corroded sections of the 300 DI raw water pipeline.

The provisional condition rating for the final buried 300 DI pipeline section close to the smelter under the GAWB risk management matrix is:

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

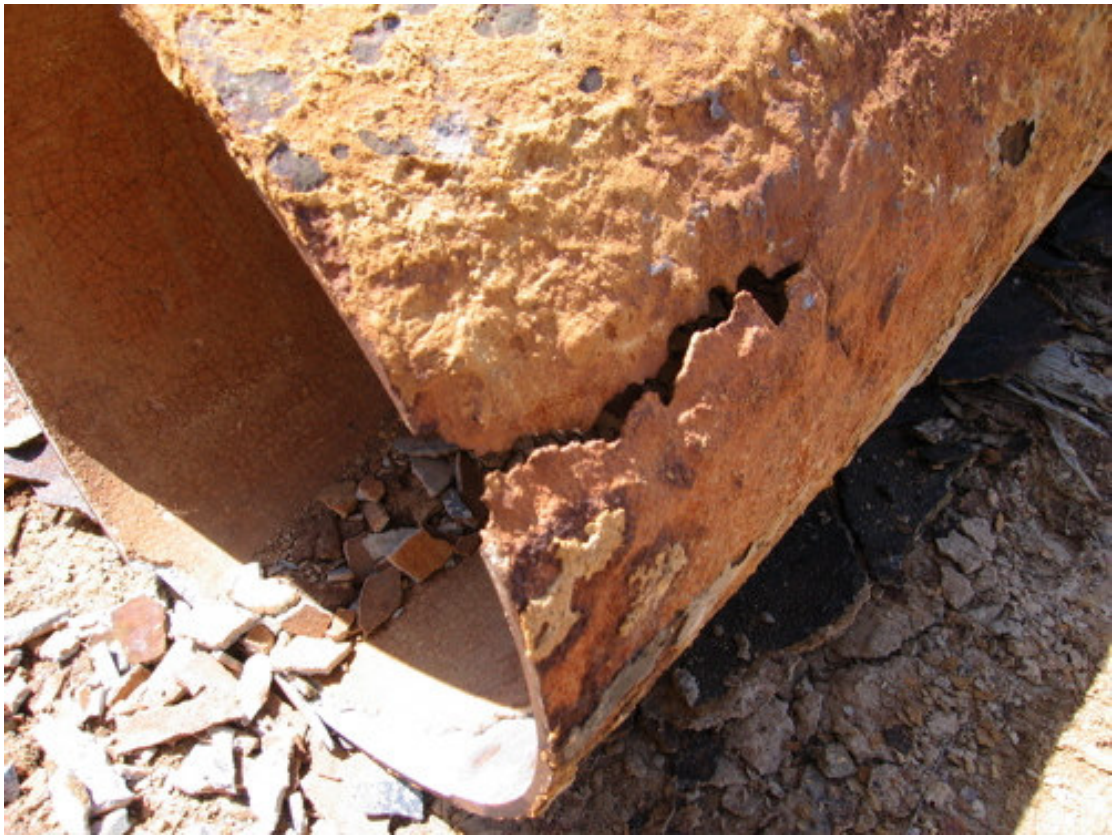
Likelihood of failure	Almost certain for some buried pipeline sections given the evidence of aggressive groundwater/soil conditions.
Consequences	High, given no duplication of the raw water supply.
Rating	Severe.

Under the SMEC asset valuation system, and given known asset information, the buried sections of the 300 DI pipeline has a **service potential rating of zero**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, but risks are intolerable.

Expected wear and tear: ".. risks are intolerable.."

Age: Estimated remaining service life is zero.



300 DI Raw Water Boyne Smelter Bottom Corrosion

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

300 mm Diameter DI Treated Raw Water Pipeline to East End Reservoir

This pipeline was visible as a bridge crossing on the east side of Boat Creek road bridge crossing, and at some points along the limited section of the pipeline route inspected.

The pipeline consists of buried 300 DI pipe, and has an anecdotal history of bursts at various points along the pipeline, with the most recent documented burst being located in the field just downstream of the Boat Creek pump station. The burst pipe sections remaining on the various sites displayed external corrosion with the most extreme corrosion around the bottom of the pipe. The internal pipe mortar liner was generally intact and displayed no signs of failure.

The known service history indicates that the pipeline suffered extensive failures when operating under high pressure, though this history could not be confirmed or quantified. Reports suggest that failures have been limited since the pipeline rate of flow and therefore operating service head was reduced.

This sequence of service history suggest that the pipeline may be approaching the end of its useful service life due to external corrosion reducing the pipe wall strength, but that the reduced operating head is masking the weakened state of the pipeline.

The provisional condition rating for this buried 300 DI pipeline sections under the GAWB risk management matrix is:

Likelihood of failure	Almost certain, given the evidence of corrosion due to aggressive groundwater/soil conditions.
Consequences	High, given no duplication of the treated water supply.
Rating	Severe.

Under the SMEC asset valuation system, and given known asset information, the buried sections of the 300 DI pipeline has a **service potential rating of one**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, but emergency management provisions may be required within five years.

Expected wear and tear: Asset is in poor condition.

Age: Estimated remaining service life is less than five years.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Bottom Corrosion of East End 300 DICL Treated Water

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

300 Cast Iron Treated Water Pipeline

This pipeline appears to have been constructed in at least two sections over an extended period. The pipeline was the original raw water supply pipeline to the urban area, and was converted to operating as a treated water pipeline after the construction of the 700 and 1440/1290 pipelines.

The pipeline has a number of sections that remain in service for GAWB, and seemingly for Gladstone City Council in its reticulation system.

With one exception, the failed pipes that were available for inspection and sampling displayed advanced, significant corrosion of the pipe wall that, once removed by aggressive hammering, revealed the limited actual competent cast iron pipeline wall thickness that remains.

Any pipe sections still in service and in equivalent condition should be considered life-expired and capable of failure at any time under any conditions that challenge and overcome the remaining pipe wall strength.

Only one failure at the air valve on the 300 CI pipeline at the ridgeline in Mann's paddock was considered a structural failure of the pipe section. This failure appeared to be a longitudinal structural failure of a visibly competent pipe with no evidence of corrosion or metal conversion processes.

By comparison, the dump of failed 300 CI pies in the Mann's paddock at the flats featured pipe sections that were in an advanced state of corrosion, and were consequently weakened. Some hydraulic impact then caused a longitudinal cracking structural failure.

Condition assessment of this pipeline is likely to reveal a pipeline that has extensive sections that are life-expired. These sections may yet be revealed to constitute much of the pipeline remaining in service.

There is a history of burst failures on this pipeline. The provisional condition rating under the GAWB risk management matrix is:

Likelihood of failure	Almost certain.
Consequences	High, depending on exactly which section fails.
Rating	Severe

Under the SMEC asset valuation system, and given known asset information, the pipeline has a **service potential rating of zero**, due mainly to its observed condition. Capacity is probably acceptable where it is the sole pipeline. The criteria are follows:

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Service output: The asset is performing/operating unreliably, and the risks are intolerable.

Expected wear and tear: The asset has excessive deterioration, and risks are significantly intolerable.

Age: Estimated remaining service life is close to zero.

The immediate recommendations are:

- Undertake short time interval hydraulic pressure logging along those sections of the 300 CI pipeline remaining in service, analyse, graph, and report the data;
- Implement the proposed pipeline modifications to the 300 cast iron treated water pipeline to reduce the potential for, and the severity of hydraulic impact effects to minimise bursts.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Longitudinal Failure of 300 CICL Treated Water Pipeline, Manns' Ridge

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

150 mm Diameter Galvanised Iron Treated Water Pipeline Bridge Crossing over Boat Creek to the Cement Australia Fisherman's Landing

The pipeline section under assessment is confined to the road bridge crossing over Boat Creek. There were no exposures of the balance of the pipeline.

The pipeline section appears to be a 150 galvanised iron pipe located in a bridge services duct/channel that has been filled with sand then a protective cement render placed over to protect the pipeline.

The visual consequence of this installation method is that the galvanised iron is displaying significant corrosion blisters/patches. No attempt was made to clean the corrosion to evaluate the extent of the corrosion given the risk of immediate leakage or burst.

The provisional condition rating for the bridge crossing section of this pipeline under the GAWB risk management matrix is:

Likelihood of failure	Likely, given the extent of the corrosion blisters.
Consequences	High, given no duplication of the treated water supply.
Rating	Severe.

Under the SMEC asset valuation system, and given known asset information, the buried sections of the 150 galvanised steel pipeline has a **service potential rating of one**, as follows:

Service output Asset is performing/operating to 100% capacity effectively, but emergency management provisions may be required within five years.

Expected wear and tear: Asset is in poor condition.

Age: Estimated remaining service life is less than five years.

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Attachment No. 4
Stage 2 First Phase Project Costs for A. Grigg & Associates Pty Ltd

Estimate of costs for the specialist project management of the first phase of Stage 2 of the condition evaluation of the pipeline and associated infrastructure as per the approved Stage 2 project brief (as detailed in Attachment 1 and the formal letter of approval):-

• One day off-site project planning	$1,200
• Three days on site @ $1200/day	$3,600
• Three days off-site for preparation of progress report @ $1200/day:	$3,600
• Return travel to Gladstone:	
o Air , at actual costs	$ 700
o Car travel to and from Melbourne & parking:	$ 350
o Local travel, Gladstone, assume taxi fares local	$ 50
o Accommodation and meals: three nights	$ 450
Sub-total:	$9,950
GST:	$ 995
Phase 1, Stage 2 Total, Grigg:	**$10,945**

Stage 2 First Phase Project Costs for Bill McEwan of CTI Consultants Pty Ltd

Estimate of costs for the specialist project management of the first phase of Stage 2 of the condition evaluation of the pipeline and associated infrastructure as per the approved Stage 2 project brief (as detailed in Attachment 1 and the formal letter of approval):-

• One day off-site to plan and schedule the equipment list, etc	$ 1,360
• Three days on site @ $1360/day	$ 4,080
• Two days off-site for preparation of specialist report @ $1360/day:	$ 2,720
• Metallurgical analysis of limited samples, estimate:	$ 1,000
• Return travel to Gladstone:	
o Air , at actual costs	$ 700
o Car travel to and from Melbourne & parking	$ 350
o Local travel, Gladstone, assume taxi fares local	$ 50
o Accommodation and meals: three nights	$ 450
Sub-total:	$10,710
GST:	$ 1,071
Phase 1, Stage 2 Total, McEwan/CTI:	**$11,781**

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890

Phase 1 Project total: **$22,726**

162 Wharparilla Drive Echuca 3564 Victoria. Phone: 03 54 801 955
E-mail: aagricon@bigpond.com
58 Bamfield Street, Sandringham. 9598 5538
Visit us on www.grigg-group.com.au
Mobile: 0428 164 890