Appendix A

Extracts from the Gold Coast Water (GCW) Water Quality Management System

In addition to the cases studies that have run alongside individual chapters, this appendix contains extracts from the Water Quality Management System HACCP (Hazard Analysis Critical Control Point) plan of Gold Coast Water (GCW), adapted slightly to reflect the water safety plan terminology. GCW operates several thousand kilometres of water mains with 74 storage tanks and two water treatment plants (Molendinar and Mudgeeraba) in Australia.

A1 INTRODUCTION

The HACCP plan (Hazard Analysis Critical Control Point) from which this example water safety plan extract has been derived is scoped to cover the entire water system from catchment to tap and is a dynamic document continually evolving as increased knowledge and experience present opportunities for

improvement. There is very little detail on monitoring, corrective action, reporting, records and verification within the body of the plan, as such information is contained in written procedures, which are referenced in the plan. In the day-to-day activities of operational staff, the plan document has little relevance. The operational procedures that implement the plan, however, are well-known. Staff understand that product quality failures are detected and reported in this system. They also realise that adherence to procedures is a defence whereas ignorance of procedure places individuals in a compromised situation. Almost all procedures received staff approval before being signed by management.

Management themselves are constantly presented with the opportunity to interpret trends in operational failure reports and instigate planning or strategic responses if necessary.

A2 TEAM

To construct the initial system GCW gave the initiative formal project status and allocated funding accordingly. Because of the size of the system, it was appropriate to have a dedicated water quality officer to administer the project. A team was assembled to obtain the necessary detailed information about the water supply chain.

Team expertise includes:

Quality systems – chemistry and biology;
Water treatment – process design and control;
Senior water treatment plant operator;
Microbiologist – with extensive water experience;
Co-ordinator of catchment management;
Water storage and distribution management;
Electronic control systems;
Senior Ranger (Hinze dam); and
Customer liaison.

A3 WATER SUPPLY DESCRIPTION AND HAZARD ANALYSIS

GCW strives to produce potable water that reaches its customers complying with those parameters of the Australian Drinking Water Guidelines relevant to the nature of its harvesting, treatment and distribution operations.

The distribution for Gold Coast has been divided into discrete reservoir zones. The zones are delineated by pressure differences or other supply considerations. Each zone has a number of test points that are either reservoirs or sites unambiguously linked to reservoirs.

The team leader, in conjunction with the various team members, identified all the process steps involved in the harvesting, treatment and distribution activities. From this identification, process flow diagrams were created (See A8 for examples of flow charts of the Molendinar water purification plant and the reticulation system) and then returned to appropriate staff for on-site verification. The next stage was to conduct the hazard analysis. This was done by holding workshops and carrying out numerous on-site discussions with facilitators and as many operational staff as practicable. It was valuable to engage a variety of operational staff as important additional 'fragments' of knowledge were obtained in this way.

A4 MONITORING, CONTROL AND CORRECTIVE ACTION

Control measures were identified. For most control measures the matter of corrective action was dealt with by incorporating into monitoring and control procedures. For other issues it was more suitable to state the corrective action in the plan. Development of monitoring, critical limits and corrective actions was achieved through a series of workshops, meetings, impromptu discussions (usually on-site), literature searches and experimentation.

A5 INCIDENT RESPONSE

GCW uses an Incident Management Plan that describes how incidents and emergency situations will be managed. This plan refers to the Incident Management Procedure. The advantage of the Incident Management Procedure is that it is activated by certain critical limits (among other things) and that corrective action is then specifically tailored to the conditions of the particular incident. For example when cyanobacteria levels in the storage exceed a critical limit, declaration of an incident is mandatory.

A6 VERIFICATION AND INTERNAL AUDIT

The water quality management system has been designed to avoid reliance of 'end product testing' as system verification. This has certainly been the case with respect to the water plants. End product testing, however, is required by

the guidelines and still has an important role to play in the verification of distribution system activities. The plan treats each of the activities and process steps as 'barriers' to product degradation and each barrier has a role to play, standards expected of it and specific mechanisms to achieve these standards. System verification has been built into key procedures by creating an auditable accountability trial that encourages continuous improvement.

GCW has structured its internal audit system to have maximum effectiveness by using trained internal auditors having no direct involvement with auditees and by rotating auditor tasks. Appropriately qualified persons carry out audits requiring technical understanding. Further, many key operational procedures are written so as to prompt the internal auditors to matters requiring close attention.

A7 SUPPORTING PROGRAMMES

Many hazards may be related to the condition and suitability of equipment, the management of assets and the competency of staff. These are dealt with through supporting programmes. These include:

Service Level Agreements;
Process Audits;
Asset Management; and
Staff Training

A8 FLOW DIAGRAMS

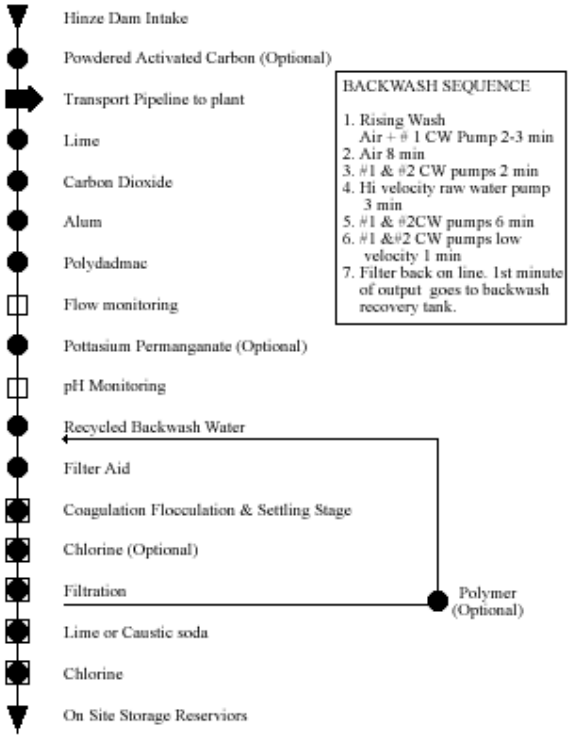

Figure A1: Molendinar water purification plant – HACCP process diagram

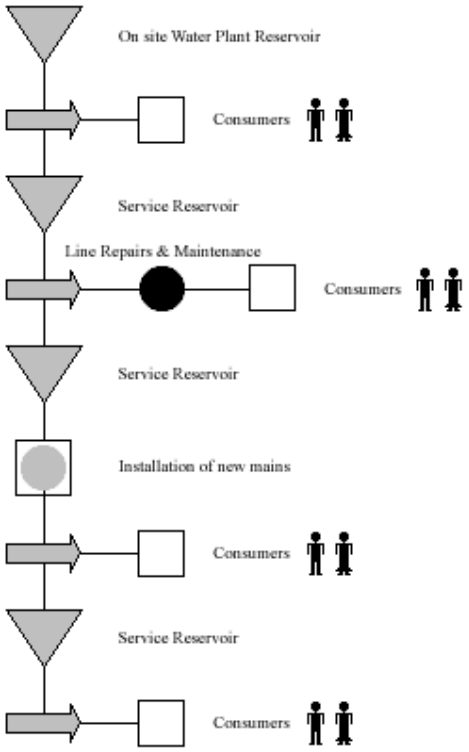

Figure A2: Reticulation system – HACCP process flow diagram

A9 EXTRACTS FROM THE WATER QUALITY MANAGEMENT PLAN

Table A1: Catchments and dams

Activity or process step	Potential hazards	Control issues	Critical limits	Monitoring and/or control measures	Corrective actions
Water Harvesting & Storage					
Agriculture activities	Faecal contamination of waterways	Grazing activities	Site specific limits for colour, turbidity, bacteria, pH, salinity and nutrients, to be advised	Regular stream Monitoring by Community Services directorate of 13 catchment sites. Program to be revised and procedure for critical limits and corrective action to be created. Refer also to existing Catchment Management Plan to control current activity. Town plan prohibits further such development in catchment.	Detection of significant pollutant levels initiates investigation by GCW staff. Community awareness and support fostered. Landcare groups consulted. Complaints can be made to relevant Government agencies (eg EPA) Government agencies can be approached to alter or introduce regulation.
	Algal blooms from nutrient run off	Dairying activities	Refer procedure	Refer to the Algal Management procedure for detail.	See Algal Management Procedure.
	Pesticide & herbicide run off	Crop growing			
	Erosion	Land management			
Urban and industrial activity	Seepage from un sewered properties	Monitoring of un sewered domestic and commercial sites.		PE&T directorate to monitor sewage discharges and regular stream monitoring is carried out.	Improvement notices to be issued to owners found discharging substandard effluent.

Activity or process step	Potential hazards	Control issues	Critical limits	Monitoring and/or control measures	Corrective actions
	Chemical and microbial pollution from stormwater, poor industrial practices and spillages	Stormwater control. Industrial practices eg. usage, storage and transport of fuels and chemicals		No control over run off or spillage from existing activities. Regular scientific tests are carried out on catchment waters. Town plan requires run off control for future approvals.	Detection of significant pollutant levels initiates investigation by GCW staff. Overt pollution events with clear evidence can be reported to EPA and fines issued by delegated council officers.
	Physical pollution from erosion and rubbish dumping	Development activities eg. Building, roadworks clearing, tourism expansion etc.		Rangers inspect catchment areas and maintain good awareness of local activity. (Rangers reside in the catchment).	Illegally dumped rubbish is removed.
Recreational activities	Nutrient release, erosion and ecological damage	Control of fishing, camping, picnics, social & sporting events, horse riding etc.		Catchment Recreational Management Plan and Procedure OM-06-03 (Recreation Management). Regular scientific tests are carried out on catchment waters. Refer procedure OM-06-08 Fish release into Hinze & Little Nerang Dams and OM-06-03 Dam Recreation.	Regular Range patrols (power to issue. Fines under Local Law 13) Detection of significant pollutant levels initiates investigation by GCW staff. Loads containing foreign or diseased species are rejected.
	Rubbish dumping	Availability of receptacles Monitoring of tracks		Refer Hinze & Little Nerang Dams Recreational Management Policy. Rangers carry out daily patrols of tourist locales.	Illegally dumped rubbish is removed. Many existing tracks have been closed by rangers.

Activity or process step	Potential hazards	Control issues	Critical limits	Monitoring and/or control measures	Corrective actions
	Sabotage	Security		Regular Ranger patrols are carried out and an after hours security firm employed. Completed security coverage is not feasible.	QP-19 (Incident Management Plan) details organisational response to unpredicted events.
Natural Events	Dam turnover	Monitoring of temperature stratum		Both dams are monitored weekly at multiple depths for Fe Mn nutrients, turbidity and colour.	Manipulation strategies such as oxygenation are being investigated.
	Erosion	Land use practices Bank inspections Drainage control		Feeder streams are regularly monitored. Rangers have extensive erosion control within GCW area.	For serious erosion events outside GCW control consult EPA, Landcare groups or State Rangers.
	Disturbance of the natural ecological balance in catchment from all activities	Ecological monitoring.		Insufficient ecological baseline data at present. No current biodiversity monitoring undertaken.	Plans are being developed to increase this field of monitoring and develop both interpretive procedures and corrective action.
	Damage from feral animals			Rangers use various removal techniques.	
	Fire	Risk reduction & control		Refer to the Hinze Dam and Little Nerang dam Bushfire Management Plan	Refer emergency response section of plan
Dam walls	Threat to supply from wall failure	Monitoring of wall condition	Maintain pressure monitoring	Refer procedure OM-06-06 Dam Surveillance Multiple pressure monitors in dam walls.	Manager Infrastructure Services to arrange stabilisation. Refer procedure OM-06-103 “Dam Structural Failure”. Refer GCCC Counter Disaster Plan.
Water transport intake towers	Interruption to supply optimisation of “draw-off” level	Structural integrity of installation		Regular inspection by Rangers.	Refer procedure OM-06-107

Activity or process step	Potential hazards	Control issues	Critical limits	Monitoring and/or control measures	Corrective actions
		Efficiency & reliability of equipment Power supply		Telementry maintenance schedule carried out by Operations & Maintenance. Valves can be operated manually at intakes.	Parts criticality analysis to be developed. Mudgeeraba can switch to LND supply.
		Telemetry		Maintenance schedule carried out by O & M.	
		Staff knowledge & competence		Refer procedure OM-01-200 "Optimising Raw Water"	Refer procedures OM-01-200.
Break in head tanks	Interruption to supply	Structural integrity of installation		Regular inspections by Rangers.	Mngr. Infrastructure Serv. To arrange stabilisation.
		Telemetry Control System		Maintenance schedule carried out by O & M.	Parts criticality analysis to be developed
		Mechanical & electrical maintenance		Maintenance schedule carried out by O&M	Parts criticality analysis to be developed
		Vandalism		Regular inspections by Rangers.	Fencing required
Raw water pump station	Interruption to supply	Staff knowledge & competence	Adhere to procedure OM-06-04.	Refer procedure OM-06-04 (Dam Pump Station Operation)	Refer procedure OM-06-04 (Dam Pump Station Operation)
		Telemetry		Maintenance schedule carried out by O & M	Equipment can be controlled manually
Raw water pipelines	Interruption to supply Bacterial contamination from biofilm growth	Efficiency & reliability of equipment		Maintenance scheduled carried out by O & M	Parts criticality analysis to be developed.

Activity or process step	Potential hazards	Control issues	Critical limits	Monitoring and/or control measures	Corrective actions
		Maintenance & repair of pipelines from Hinze & LND to water plants	Regularly inspect & maintain lines.	Maintenance schedule carried out by O & M as per S.L.A. schedule.	No alternative pipeline, repairs must be carried out immediately.
	Compromising the health of Consumers connected to the raw water pipelines	Control and protection of the consumers using the raw water pipelines		Signage posted and separate plumbing systems in place. Users advised water not potable. List of connections located in QEMS.	Refer Procedure OM-20 (Water Algal Management Plan)
Dam capacity	Poor water quality during low level periods	Water plant treatment capabilities		Plants to be certified to HACCP standard.	Refer Molendinar & Mudgeeraba HACCP plans.
	Supply inadequate to meet needs	Dam capacity		Dam capacity under question. Ability to withstand drought requires attention Planning is reviewed periodically.	Allowance has been made for increasing capacity. Brisbane water can be accessed to supplement supply.

Table A2: Molendinar Water Plant

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
Raw water optimisation	Increased probability of microbial contamination and process damage by drawing from low quality stratum.	Optimising draw off level Presence of chlorine resistant pathogens.	NA	Refer Procedure OM-01-200 "Raw Water Optimisation"(includes triggers for C&G testing) Weekly profiles and bacterial test are performed. Refer Catchment Management Plan for identification and control of potential protozoan sources.	Refer Procedure OM-01-200 "Raw Water Optimisation"
Carbon dosing	Offensive and toxic organics passing through to treated water.	Suitability of carbon type		Carbon currently in use is recommended by CRC tests.	Process Audit/Research section monitor new products and industry trends.
		Availability and quality of carbon supply		Supplier certified to ISO9002 and adequate supplies held.	Alternative carbon suppliers are available.
		Efficiency and reliability of process & equipment.		Service agreement exists with O & M. Maintenance schedule for facility exists. Unit and process are functional but require frequent monitoring.	Refer SLA document between O & M and Service Delivery
		Dosage determination & control	Dosing limits are event determined.	Refer Procedures OM-01-201&2 "Carbon Dosing Protocol & Procedure"	Refer procedures OM-01-2001 and 01-202

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Staff knowledge & competence		Senior operator trains day labour and verifies dosing.	Retrain operators.
		After hours control.		Failure alarms on key components linked to telemetry system. Duty operator to respond.	Backup response by 24hr. Call centre.
Recycling of backwash water	Reintroduction of concentrated chemical & microbial contaminants. Effect on chemical dosing strategy.	Control of manganese levels.	0.5mg/L soluble Mn (operations limit)	Refer Procedure OM-01-208 "Monitoring of Recycled Backwash Water". Backwash water is 1^{o} settled with solids to sewer.	Refer procedure OM-01-208 Monitoring of Recycled Backwash Water.
		Control of microbial hazards	50,000 cells/ml of "blue green algae". Faecal coliforms < 100 cfu per 100 ml	Refer Procedure OM-01-208 "Monitoring of Recycled Backwash Water"	Refer procedure OM-01-208 Monitoring of Recycled Backwash Water.
		Staff knowledge & competence		Refer competency testing regime (Molendinar)	Retrain operators.
CO_2 dosing	Detention in concrete lined mains causes increases in pH, which reduces efficacy of chlorine residual and promotes precipitation events.	Availability and quality of CO_2 supply.		Supplier certified to ISO 9000 series.	Alternative supply uncertain but plant can function without CO_2 at the expense of boosting alkalinity.
		Availability & quality of CO_2 supply			
		Efficacy and reliability of dosing unit	Alkalinity of 35-50 mg/L	Maintenance & Operation of unit are the responsibility of BOC gases.	Refer Procedure OM-01-204 (Carbon Dioxide Dosing)

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Dosage determination & control	Outside range for > 48 hours = report	Refer Procedure OM-01-204	Refer Procedure OM-01-204
		Staff knowledge & competence		Refer competency testing regime (Molendinar)	Retrain operators.
Coagulation flocculation & settling	Unacceptable levels of physical chemical and microbial impurities and/or toxins in treated water.	Maintenance of mechanical and electrical system.	Inspect daily.	Refer Procedure OM-01-210 “Daily Plant Inspection ”. No scheduled maintenance.	Contact O & M for reactive repairs. Spare butterfly valve can be obtained.
Inlet flow control		Maintaining a correct and known flow into the plant.	Calibrate monthly.	Refer to O & M Instrument Maintenance Schedule for Molendinar W.P.P.	Refer SLA document between O & M and Service Delivery
		Staff knowledge & competence		Refer competency assessment regime (Molendinar)	Retrain operators
Offline clarifier control	Concentrations of bacteria and algae in redundant clarifiers may become problematic when plant is in contact filtration mode for long periods	Control of Microbial growth. Changing from direct filtration		Refer to Procedure OM-01-216 “Clarifier Changeover Procedure”	Refer to Procedure OM-01-216 “Clarifier Changeover Procedure”

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
pH control of dosed water	Poor coagulation and flocculation could lead to pathogens breaching the filter barrier. Aesthetic colour problems could occur..	Controlling pH in the flocculation process.	6.5 to 7 (normal) 7-7.3 (Mn04 dosing ranges in brackets) 5.7-6.4 (6.9) for 4-8 hrs=report 5.7-6.4(6.9>8hrs=shutdown/report 7-7.5 for 4-8 hrs= report 7-7.5 for > 8hrs=shutdown/report <5.7 for 2hrs =shutdown/report >7.5 for 2 hours= shutdown /report	Refer Procedure OM-01-209 “Molendinar Dosed Water pH	Refer Procedure OM-01-209 “Molendinar Dosed Water pH”
		After hours pH control		pH probe has high & low alarms with variable time responses.	Auto dialler calls programmed numbers until human response achieved.
Pre Lime	If pre lime fails, CO_2 dosing is reduced and alkalinity falls.	Lime (Ca0)			

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
	Pre lime is required if alum dosing is sufficient to force raw water pH too low.	Availability & quality of lime supply.		Supplier certified to ISO 9000 series.	Alternative suppliers available.
		Efficacy and reliability of dosing unit.		Refer to O & M maintenance schedule redundancy available on dosing equipment.	Refer SLA document between O & M and Service Delivery.
		Dosage determination & control.	Event determined	Refer Procedure OM-01-203 “Pre Lime Dosing”	Refer Procedure OM-01-203 “Pre Lime Dosing”
		Staff knowledge & competence.		Refer competency testing regime (Molendinar)	Retrain operators.
		After hours control		Key components are alarmed to dialling system.	Refer Procedure OM-01-203 “Pre Lime Dosing” and OM-01-209 (ph Control at Molendinar.
Alum dosing	Refer dosed water pH hazards.	Alum			
		Availability & quality of alum supply.		Supplier certified to ISO 9000 series.	Alternative supplier available.
		Efficacy and reliability of dosing unit.		Maintenance schedule, component redundancy.	Procedure OM-01-205 (Alum Dosing @ Mol.)
				Accessibility to spares and tech. Advice Procedure OM-01-205 (Alum Dosing @ Mol.)	24 hour service available.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Dosage determination & control	True Colour <5.0 CPU >5 for >24 hours = report >10 for >4 hrs = shutdown/report	Procedure OM-01-205 (Alum Dosing @ Mol.) and OM-01-209 "Molendinar Dosed Water pH"	"Molendinar Dosed Water pH" Procedure OM-01-205 (Alum Dosing @ Mol.) and OM-01-209
Polydadmac Dosing	At high flows dadmac control is important for optimal particle removal (turbidity)	Polydadmac (Cationic Polymer)			
		Availability & quality of supply		QA supplier (alternate supplier avail.)	Alternative supplier available.
		Efficacy and reliability of dosing unit.		Maintenance schedule, component redundancy.	24 hour service available.
		Dosage determination & control.	Event determined	Accessibility to spares & tech. Advice. Refer procedure OM-01-206.	Refer procedure OM-01-206 (Dosing of Polymer)
		Staff knowledge & competence		Refer Procedure OM-01-206 (Molendinar)	Retrain operators.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
Permanganate Dosing	First line response to high manganese in raw water. Failure places pressure on second mechanism. Dirty water complaints increase if Mn control fails.	Potassium permanganate (optional)			
		Availability & Quality of Supply.		QA supplier (alternate supplier avail.)	Alternative supplier available.
		Efficacy and reliability of Dosing Unit	Treated water soluble Mn levels of <0.02 mg/l	Maintenance schedule, component redundancy. Accessibility to spares and tech advice. Refer also Procedure OM-01-207 (Permanganate Dosing).	24 Hour service available.
		Dosing protocol, determination & control		Procedure OM-01-207 (Permanganate Dosing) Pre filter chlorination downstream removes criticality of this process step.	Procedure OM-01-207 (Permanganate Dsosing)
		Staff knowledge & competence.		Refer competency testing regime (Molendinar)	Retraing operators.
Filter Aid	Small amounts used to achieve high performance in peak demand situations.	Filter aid			
		Availability & Quality of Supply		ISO 9000 certified supplier.	Alternative supplier available.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Efficiency and reliability of Dosing Unit.		Temporary dosing unit in place due to main unit failure.	Service contract with Jetflo.
		Dosage determination & control.	Event determined	Procedure OM-01-212 (Use of Filter Aid)	Procedure OM-01-212 (use of filter Aid)
		Staff knowledge & competence.		Refer competency testing regime (Molendinar)	Refrain operators.
Solids Control		Solids Control			
	Excessive solids build up increases carryover and effects filter performance.	Effectiveness, reliability & structural integrity of raking system.		Clarifier rake systems are regularly maintained. Refer procedure OM-01-17.	Refer SLA document between Operations & Maintenance Branch Business Units
		Sludge blanket control.		Clarifiers are operated to run with no sludge blanket. Solids go to sewer. Clarifiers not used when plant in Contact Filtration mode.	Refer Procedure OM-01-17 “Clarifier Isolation and Draindown”.
Pre Filter Chlorination	High soluble Manganese in treated water causes dirty water complaints. Taste & odour (overdosing). Disinfection by Products.	Availabilty & Quality of CL2 Supply		QA supplier (alternate supplier avail.)	Alternative sources available.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Efficacy and reliability of Dosing Unit.		Maintenance schedule, component, redundancy accessibility to spares & tech. Advice.	24 hour Maintenance cover available. (refer S.L.A. with O & M.)
		Dosage determination & control.	Treated water soluble Mn levels of <0.02 mg/l. Report any AAS result >0.02 mg/L	Procedure OM-01-211 (Pre Filter Chlorination)	Procedure OM-01-211 (Pre-Filter Chlorination)
		Staff knowledge & competence.		Refer competency testing regime (Molendinar)	Refer T.S Training Plan.
		Simultaneous high algal counts and raw water manganese.		Procedure OM-01-211 (Pre Filter Chlorination)	Adjust dosing regime and dosing points. Avoid direct filtration.
Filtration	Release of a variety of physical, chemical and microbial impurities into treated water.	Choice and depth of media.		Choice and depth of media determined from extensive pilot plant work.	Resume pilot plant studies. Replace media if necessary. Maintain air and backwash systems.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Flow control. Performance management/ analysis. Backwashing procedure. Turbidity Control.	Filtered water turb. Of <0.2 NTU >0.2 for 2 hrs = report >0.2 for 5 hrs = shutdown >0.3 for 2 hrs = shutdown single filter>0.3 for 2hrs = take off line Acid sol. Al <0.15 mg/L: Report all failures.	Refer OM-01-213 Filtration & Turbidity Control at Molendinar*	Refer OM-01-213 “Filtration & Turb. Control”
		After hours turbidity control. Mechanical and electrical maintenance of backwashing system.		All filters have turbidity meters which are alarmed as is composite turbidity meter. Refer SLA with Operations & Maintenance Pump redundancies exist.	Upper limit alarm will activate auto dialer call out sequence. Refer SLA with Operations & Maintenance.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Accidental or deliberate contamination of filters.		No toxic materials are stored near the clarifiers of filter chambers. Facility is locked after hours with CCTV on the electronic gate entry. Standard perimeter barb wire fence in place. Malicious intent action is not controllable as plant is mostly unmanned without movement sensors.	Refer Procedure OM-01-107
pH Correction (lime or caustic)	Compromised disinfection. Failure to meet specification for Corrosive /Alkaline water.	Availability & quality of supply.	pH 6.9 – 7.5 pH > 7.5 or <6.9 for 5 hrs = report >8.5 or<6 for 5 hrs = shutdown & report	QA supplier (alternate supplier avail.)	Alternative sources available. Investigate use of Megapac or caustic.
		Efficacy and reliability of dosing unit.		Unit is effective.	"Contamination of the Clear Water Tank.
		Dosage determination & control.		Refer OM-01-214 Disinfection Control at Molendinar.	Refer OM-01-214 Disinfection Control at Molendinar.
		Staff knowledge & competence.		Refer competency testing regime (Molendinar)	Refer TS Training Plan.

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
Disinfection (Chlorination)	Failure to eliminate chlorine sensitive pathogens. Taste and odour problems. THM formation.	Availability & quality of Cl_2 supply Efficacy and reliability of dosing unit. (Chlorine delivery unit is not flow sensitive).		QA supplier (alternate supplier avail.) Maintenance schedule, component redundancy, accessibility to spares & tech. advice is available. Weekly bacterial testing is carried out on raw & potable water . Emphasis placed on strict filter turbidity performance (continuous) and chlorine control (continuous)	Alternative sources available. 24 hour maintenance cover available. (refer SLA). Dosing system upgrade budgeted for. Procedure OM-01-214 "Disinfection Control at Molendinar"
		Dosage determination & control.	Cl2 of 1-1.5mg/l with pH 7 to 7.5 Chlorine >1.5 or<1.0>8hrs=report >3 or <0.2 for 1 hr = contact manager for shutdown advice.	Procedure OM-01-214 "Disinfection Control at Molendinar"	Procedure OM-01-214 "Disinfection Control at Molendinar"
		After hours disinfection control.		On line chlorine analyser is alarmed	Back up unit in place. Auto dialler calls until human response.
		Staff knowledge & competence		Refer competency testing regime (Molendinar).	Refer Operations & Maintenance Training Plan.
		DBP monitoring	0.25 mg/l	Regular system monitoring by Scientific Services. Water is naturally low in DOC.	Alternative disinfectants eg. Chloramination
Computerised Control System	Product degradation due to loss of computer control.	Access to expert advice and service.	N.A.	System advice available on call from M.P.A.	System advice available on call from M.P.A..

Activity or process step	Potential hazards	Control issues	Critical or operational limits*	Monitoring and/or control measures	Corrective actions
		Knowledge of and competence in manual plant operation.		Refer procedure OM-01-32 “Changing from Kent to Level 2 Control”.	Refer Competency testing regime.
		Power failure.		UPS available for computer system.	Backup diesel generator can supply power to computer system (UPS in place)
		After hours failure.		System has back up hard drive and server.	Change to manual control.

* Procedure included in section A10

Table A3: Storage and reticulation system

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
Reservoir Storage	Physical, chemical & microbial contamination of treated water in reservoirs.	Security of reservoir sites. Structural integrity of reservoirs.	Carry out scheduled inspections.	Refer procedure OM-40-03 Reservoir Monitoring Programme*. All reservoirs are roofed.	Refer procedure OM-40-03 "Reservoir Monitoring Programme"
		Monitoring of internal conditions (physical, chemical & microbial)	True Colour <5c.p.u. Turbidity <1 n.t.u. Total & Faecal Coli's; 0 c.f.u./100ml Refer also procedure RS-39 "Reservoir Monitoring" for advice re:other parameters	Refer procedure OM-40-03 "Reservoir Monitoring Programme"	Refer Procedure OM-40-03 "Reservoir Monitoring Programme".
		Reliability of control system	NA	Refer Procedure OM-40-01 "operation of Service Reservoirs"	Refer Procedure OM-40-01 "Operation of Service Reservoirs". Refer also SLA with Field Services.

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
Management of Transport Pipelines	Ongoing build up of chemo & biofilm. Microbial, chemical & physical contamination from water plant or reservoir failures.	Monitoring and control of organic and inorganic deposits in pipe system.	NA	Refer Procedure SD-17 "Distribution Analysis & Interpretation" Manganese and chlorine included in weekly testing regime of distribution system. Water plants configured for maximum Manganese removal.	Refer Procedure SD-17 "Distribution Analysis & Interpretation" Reactive flushing and swabbing carried out when sloughing occurs. Review distribution sampling results to identify areas requiring routine attention. Ongoing review of industry developments in chemo/biofilm control techniques.
		Monitoring and maintenance of pipe system integrity.	NA	O & M staff provide asset condition feedback on service request forms (OM-08-0001)	Recommendation for capex made.
				SD staff map all mains breaks to identify trends and instigate replacement projects.	Recommendation for capex made.
				Routine inspection of all trunk mains occurs.	Trouble spots placed in works programme.
		Knowledge and control of reservoir distribution areas.	NA	Refer Procedure OM-40-01 "Operation of Service Reservoirs" and procedure RS-04 "Network Manipulation of Trunk Mains"	Refer Procedure OM-40-01 "Operation of Service Reservoirs" and procedure RS-04 "Network Manipulation of Trunk Mains"

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
		Distribution System Monitoring	Plate count <100 cfu/ml. Turbidity < 1 n.t.u True colour <5 c.p.u. Faecal/total coli's 0 c.f.u./100 ml Refer also procedure RS-40.	Refer Procedure SD-17 "Distribution Analysis and Interpretation" and OM-40-03 "Reservoir Monitoring Procedure".	Refer Procedures SD-17 "Distribution Analysis and Interpretation", OM-40-03 "Reservoir Monitoring Procedure" and OM-40-04 "Network Manipulation of Trunk Mains"
	Inability to control pressure and flow to specification.	Monitoring and maintenance of devices to prevent pressure extremes.		Refer to procedures OM-07-22, 23, 27, 28 which deal with testing maintenance and repair of devices.	Refer to procedures OM-07-22, 23, 27, 28
	Physical, chemical & microbial contamination due to repairs, maintenance and development work.	Work Techniques	"Flush till Clear" Instruction applies to all line repair work.	Internal quality audits of Civil Works - Water procedures carried out in situ verify flushing regime is adhered to. Bacto testing has verified procedure is effective.	Refer to the OM-07 range of procedures which cover all maintenance and repair activities carried out by Operations & Maintenance.
		Contractor control	NA	Meter replacement contractors sign a formal agreement detailing flushing instructions. Infrastructure Services branch provide a team of experienced contract inspectors for new mains.	Enforce agreement penalty clauses. Sub-standard work can be rejected at any stage of contract.

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
		Staff knowledge and competence		New Field Staff are placed with experienced personnel for 3-6 months. Any changes in practices or equipment are demonstrated to involve staff & proceduralised.	All staff are subject to periodical performance appraisals. Field quality audits are carried out as part of ISO 9000.
		Response times		Breakage response times are detailed in SLA.	Refer Service Level Agreement with Operations & Maintenance
		New connections	Obtain bacterial & pressure certificates.	New mains must pass bacterial & pressure tests before connection to the live system.	Refer to Standard Specifications & Drawings (Water) 1999 edition
	Leaching of toxic substances from component linings.	Evaluation & approval of components.	Compliance with AS4020 required.	Refer procedure SD-01 "Approval of New Water & Sewage Products"	Refer procedure SD-01 "Approval of New Water & Sewage Products"
	Leaching of toxic substances into polyethylene pipes.	Selecting appropriate sites for installation of Polyethylene. Staff awareness of propensity of solvents to traverse PE.	Compliance with AS3500 required.	Refer procedure SD-01 "Approval of New Water & Sewage Products"	Replace pipe with resistant material or remove hydrocarbon source.
	Physical, chemical & microbial contamination of pipelines due to backflow.	Prevention of backflow from residences into mains.	All meters to have non return fitting.	All new domestic meters comply with AS3565.	

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
		Prevention of backflow from businesses into mains.		Water supply law requires that all properties with risk to water supply will have backflow prevention.	GCW has no control over these devices. Owners are responsible for maintenance.
		Failure of Fire fighting system check valves.		Owners required to comply with AS1851 series re: fire system maintenance.	GCW has no control over these devices. Owners are responsible for maintenance.
	Physical, chemical & microbial contamination of pipelines due to standpipe usage.	Control of standpipe distribution control, management and monitoring of usage practices.	NA	Procedure RS-01 "External Metered Standpipes" . Forms accompanying the procedure describe terms & conditions. Designated fill sites are inspected weekly.	Local laws give Reticulation officers to fine operators falling to adhere to terms and conditions in RS-01.
Cross connection of raw & treated water lines.	Physical, chemical & microbial contamination.	Control of areas where raw & treated water are separated only by valves.	Compliance with FS-09v	Potential cross connections are marked with red valves. Refer procedure OM-07-19 "Control of Red Valves"	Procedure OM-40-108 Contamination of Water Reticulation System.

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
Continuity of Supply	Failure to supply.	Control of Reservoir levels. Breakage response times Reservoir storage capacity and trunk delivery limitations Alternative supply methods	NA	Refer Procedure OM-40-01 "Operation of Service res." Prioritising system in place (refer SLA with Operations & Maintenance) Infrastructure Services monitor population trends to anticipate needs. Booster pumps available to overcome trunk inadequacy during extreme demand Refer Proc. OM-40-04 "Network Manipulation of Trunk Mains."	Refer Procedure OM-40-01 Operation of Service Reservoirs. Refer SLA with Operations & Maintenance. Forecasts can be revised through system failure feedback eg. QP-19 Incident Management Plan. Refer Procedure OM-40-04.
Importation of Brisbane Water via Logan Reticulation system.	Failure of Brisbane Water to provide water to specification.	Formal agreement with Brisbane Water (and Logan) specifying quality parameters. Monitoring incoming Brisbane water quality.	NA	Monthly bacteria monitoring of Logan City exit point. Beenleigh Rechlor facility has continuous pH. turb & chlorine readings. Weekly bact monitoring of water leaving rechlor facility.	Refer procedure OM-40-06 "Beenleigh Rechlorination" and Bulk Water Agreement with Brisbane Water & Logan City.

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
Rechlorination of Brisbane Water	Microbial contamination of product. Taste, odour & health problems associated with Chlorine. Taste & odour problems associated with Logan water.	Availability & quality of Cl_2 Supply efficiency and reliability of dosing unit. Dosage determination & control. Staff knowledge & competence. Disinfection by products.	pH 7 to 8 $C1_2$ 0.2 to 1.0 mg/L Turbidity <1 ntu (time limits apply for all failures)	Quality assured supplier. Back up supply not critical. Scheduled maintenance by Operations & Maintenance. Refer Procedure OM-40-06 "Beenleigh Rechlorination Facility" Contact Logan/Bris. Re T&O complaints or failure to meet agreed quality standards. Regular monitoring by Scientific Services.	N.A. Refer SLA between Service Delivery & Operations & Maintenance. Refer Procedure OM-40-06 "Beenleigh Rechlorination Facility" Logan city flow can be shut off by 24 Hour Centre. Adjust dosing or use alternative disinfectant.
Inherited Assets	Deterioration in product quality or service due to poor design and build of infrastructure by GCW. Deterioration in product quality or service due to poor design and build of infrastructure by developers.	Designing to suitable specification. Monitoring of construction activities. Approval of Design plans. Monitoring of construction activities.	NA	Design engineers observe standard specifications. GCW employs contract inspection team. GCW has no control over developers design approval. GCW does not carry out progress inspections on developer contributed assets.	Refer Procedure IS-06 Infrastructure Design" Refer Procedure IS-08 Contract Administration & procedure IS-09 Contributed Assets Audit. Refer Procedure SD-04 "Asset Familiarisation" SD-05 "Recording Substandard Contributed Assets" RS-14 "Asset Handover of Infrastructure"

Activity or Process Step	Potential Hazards	Control Issues	Critical Operational Limits*	Monitoring and/or Control Measures	Corrective Actions
Consumer Feedback	Failure to recognise consumer needs. Failure to recognise system failures at an early stage. Failure to consider customer quality concerns in infrastructure design. Failure to recognise poor field work	Dirty water calls. Taste and odour calls. Illness complaints. Miscellaneous water quality concerns	Operational limits: 8 calls/24 hours 8 calls/24 hours 3 calls/24 hours	Refer procedure RS-08 “Processing Water Quality Enquiries”	

* Procedure included section A10

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Table A4: Validation of critical limits for Molendinar water treatment plant

Critical Control Point	Critical or Operational Limit	Validation	Comments
Carbon Dosing	Event determined.	Dosing is commenced based on a consideration of taste & odour complaints and algal trends. Dosing has to be sufficient to reduce complaints to, 6 per day in accordance with GCW targets.	Powdered activated carbon is added to water to remove unwanted organic compounds. These are usually associated with algal blooms in the supply dam. The amount of required carbon varies with the extent of the bloom and must be determined by experiment. Currently, due to the absence of baseline data, the dose is usually set at the moderate level of 15mg/l then adjusted as circumstances permit.(15mg/l with contact time >2hrs. has been effective in past incidents) Procedures TS-01-202/3 will allow greater precision of future dose determinations.
Recycle of Backwash Water	50,000cells/ml of potentially toxic blue green algae. Faecal coliforms of <100 cfu/100ml	Based on 5% recycle volume and taste threshold of 500 cells/ml blue green algae Faecal coliform limit based on 18 months of data and is designed to prompt investigation when unusual rather than unsafe levels of faecals are detected in the recycle stream.	Recycle can constitute 5% of daily flow. The source of faecals is the bird population that frequents the clarifiers and thickener tanks.
Coagulation, flocculation & settling	Raw water inlet flow		

Critical Control Point	Critical or Operational Limit	Validation	Comments
	Inspect Daily / Calibrate Monthly	Refer Comments	The inlet flow measuring device is important because the output from several dosing pumps is dependant upon its accuracy. Experience has shown that the instrument drifts only minimally over a one month period. However, it is easy for operators to do a visual check of the unit daily for mechanical failure and therefore, because of criticality, it is included in the daily plant check (proc. TS-01-210)
Coagulation, flocculation & settling	Alum Dosing		
	Treated water true colour of < 5 c.p.u.	ADWG (1996) for True Colour	ADWG specify <15 c.p.u. however, 5 C.P.U. has been selected as a Critical limit for corrective action because colour above 5 is noticeable in larger volumes and colour above this value would be indicative of non optimal dosing that would affect other water quality parameters
Coagulation, flocculation & settling	pH Control of Dosed Water		

Critical Control Point	Critical or Operational Limit	Validation	Comments
	6.5 to 7.0 (low manganese conditions). 7.0 to 7.3 (permanganate dosing conditions)	AWWA "Water Quality and Treatment" 4th Edition (chapter 6) See also 'Manganese & Iron Related Problems in Aust Drinking Water Supplies" at (www.clo2.com/reading/ drinking/iron.html)	Although a range of values is shown, set points will be in force at any given time and procedures dictate that significant deviations will be investigated. The range 6.5-7.0 is close to the solubility minimum for Alum. Set points in the range 6.7 or 6.8 are common to minimise the amount of pH correction in disinfection and this is arbitrary. The reaction of permanganate with manganese will yield increased Mn2+ if an acid environment persists. This is undesirable. Refer also procedure TS-01-209 'Molendinar dosed water pH'
Coagulation, flocculation & settling	Carbon Dioxide Dosing		
	Treated water alkalinity of 35 to 50 mg/L as CaCO3	Experimental value	GCW is attempting to overcome the phenomenon of "pH bounce" in concrete lined pipes. This occurrence results in some consumers receiving high pH water. The higher the alkalinity the greater the resistance to pH bounce. The figure of 35 to 50 (suggested by Hunter Water) is a considerable increase over the current figure of about 20. Distribution system pH monitoring of trouble spots indicates this level of alkalinity is probably adequate. Further data is required to optimise dosing.

Critical Control Point	Critical or Operational Limit	Validation	Comments
Coagulation, flocculation & settling	Pre Filter Chlorination		
	Treated Water soluble Mn levels of < 0.02 mg/L	Experimental work carried out for GCW by University of Qld. In 1986 Report entitled "Investigation into Biological Manganese Oxidation and Deposition in the Gold Coast Water Distribution System" by Dr. L. Sly	Report recommended that treated water should have less than 0.01 mg/l soluble Mn. Under normal operating conditions this is achieved. A figure of 0.02mg/L can be tolerated for short periods of time and this figure is chosen for corrective action instigation. Refer procedures TS-01-207 and 211 regarding manganese removal.
Filtration	Filtered Water Turbidity of < 0.2 N.T.U.	Water Industry 'Best Practice'. Refer AWWA publication "Self Assessment Guide for Surface Water Treatment Plant Optimisation" 1997 (chapter 1) by AWWA Research Foundation.	AWWA suggest a filtered water turbidity of < 0.1 should be routine in a modern well run plant. Molendinar plant is capable of <0.1 as a matter of routine and the limit of 0.2 is nominated as a trigger for corrective action. Refer procedure TS-01-213 "Filtration & Turbidity at Molendinar".

Critical Control Point	Critical or Operational Limit	Validation	Comments
Filtration	Acid soluble Aluminium of < 0.15 mg/L	ADWG (1996) for Aluminium	A figure lower than the 0.2 mg/L guideline figure has been chosen in order that corrective Action be commenced before the guideline value is reached.
pH Correction	Treated Water pH of 7.0 to 7.5	Australian Drinking Water Guidelines. See also "Chemistry" by Zumdahl 2nd edition page 625 for equilibrium constant of hypochlorous acid	To maximise germicidal efficiency in potable water, dosed chlorine should be in the form of hypochlorous acid. This species is pH dependant. It is at a maximum concentration below pH5 and is reduced to approx 10% above pH 8.5. In order to avoid corrosivity of water while still providing >50% chlorine as hypochlorous acid, the range of 7 to 7.5 is necessary. A set point within that range will be aimed for. Refer procedure TS-01-214 'Disinfection Control at Molendinar'
Disinfection	Residual chlorine value of 1.0 to 1.5 mg/L (as measured by D.P.D. method) with a pH of 7.0 to 7.5	Australian Drinking Water Guidelines(1996) for Chlorine. A chlorine residual of at 1.5mg/L has proven insufficient to provide all of the Molendinar service area with a >0.1 residual. However, above 1.5 mg/L (leaving the plant) there will be numerous complaints by consumers near the plant.	The chlorine residual will be aimed to a set point within the range 1 to 1.5 mg/L. Outside this range, corrective action will be initiated as per procedure TS-01-214 'Disinfection Control at Molendinar. The procedure also deals with the pH dependence of chlorine residuals. Chlorination levels will be reviewed as the effect of recent buffering capacity increases are assessed.

A10 EXAMPLE PROCEDURES

OM-40-03 Reservoir Quality Inspection Procedure

1 Aim

To provide instruction in carrying out Gold Coast Water's reservoir monitoring programme.

2 Introduction

Water leaving the Molendinar & Mudgeeraba Water Purification Plants is transported to approximately 75 reservoirs around the city. Water is stored in the reservoirs for varying amounts of time depending on demand. Storage reservoirs must be managed, constructed and maintained to preserve product safety and quality at all times. In order to help achieve this goal, the Reservoir Monitoring Procedure has been created.

3 Procedure

3.1 Inspections

Reservoirs will be inspected at least quarterly to determine the safety & integrity of the structure. The following tasks will be performed:

Any leaks, corrosion and cracking will be noted.

The roof structure will be inspected to ensure it has the condition to carry out its function. This will include the ability of the roof, hatches and any guttering to resist rain ingress.

Vents will be examined to ensure they are able to prevent the entry of birds or rodents and allow movement of air over the surface of the water.

The reservoir site will be assessed to ensure that the reservoir roof does not accumulate excessive leaf litter.

The reservoir and site should be assessed to determine its ability to resist vandalism. This will include a check of locks on ladders and determining if children or vandals may gain access to the roof by other means such as trees or embankments. Fencing and gates will also be checked. Signs of human activity will be noted.

At least every 5 years every reservoir will undergo physical examination of its internal structure. This will be performed by professional divers (using dedicated potable equipment) and will involve the recording of structural condition, safety, access, type of internal materials, mixing characteristics, sediment sampling and clean out (if required).

The details of inspections will be recorded in such a manner that the current and historical data of each reservoir is available.

3.2 Inspection assessments

Inspection findings will be reported on forms OM40-0301 and 0302.These forms contain prompts and a condition rating system for reservoir components. The reports will be forwarded to the Service Delivery Section. Service Delivery will determine the repair priorities for the various reservoirs based on cost and safety risks. Repairs amounting to less than $1000 can be organised by O&M staff without reference to Service Delivery.

Service Delivery will assess the risks outlined in the inspection reports and if necessary, increase the frequency of inspection. Reservoirs presenting serious risk will be brought to the attention of the Manager Service Delivery who has the authority to approve necessary expenditure.

4 Critical limits and correction action

The CRITICAL LIMIT for reservoir monitoring is that it be carried out quarterly. The corrective action is that Service Delivery section examines the reports and acts to reduce risk to an acceptable level. The reservoir condition reports will be used in the forward planning of asset renewals and upgrades.

In practice, the plan for the testing of the reticulation system provides strong support to the reservoir monitoring procedure. Failures for certain water quality parameters involve a physical inspection of the supply reservoir as part of corrective action. Major reservoirs have intruder alarms connected to the 24 hour control centre.

5 Reporting and verification

If O&M staff fails to carry out programmed inspections, Service Delivery will complete a HACCP excursion form (OM1101) and this will be forwarded to:

Director of Gold Coast Water
Managers of Service Delivery & O&M
Coordinator Civil Maintenance.

Service Delivery will keep records of reservoir reports for at least 5 years. Internal auditors of this procedure MUST select several reservoirs at random and ask to see the inspection reports. They will then determine if the inspection frequency is adequate and if required work has been carried out. Non-compliance with the procedure will be noted in the audit report and a Corrective Action Request raised.

6 References

OM-40-01 Operation of Service Reservoirs
OM-40-02 Reservoir Cleaning
OM-40-108 & 109 Accidental & Deliberate Contamination of the Reticulation System
OM-40-110 Reservoir/Water Tower Major Crack or Failure.
OM-32-113 Telemetry Failure
SD-17 Distribution Analysis & Interpretation.

OM-01-213 Filtration and Turbidity Control at Molendinar Water Treatment Plant

1 Aim

To provide direction on optimal filtration management and turbidity control at the Molendinar Water Plant.

2 Introductory information

It is the role of filtration to remove suspended materials from dosed water to a degree that will permit effective disinfection. To carry out the filtration process, the Molendinar plant has six dual media filters. The top layer of filter media consists of about 0.8 metres of crushed (filter) coal and the bottom layer consists of about 0.15 metres of sand above 0.25m of gravel which is graded in size with the larger particles at the bottom of the filter.

To put the capability of the filtration process into perspective, one must consider that a typical bacterium has a size of about 1micron, which is several thousand times smaller than the average filter sand particle. Clearly, this means that without an effective coagulation and flocculation process, filtration would be seriously limited in its ability to remove pathogens.

Filter performance is commonly measured in terms of turbidity or particle counts. Turbidity is a reasonably sensitive measure of the amount of particulate matter in water and is measured by turbidimeters. Turbidimeters however, cannot tell if the particles in water are gravel fragments, bacteria, algae or cryptosporidia. So, to err on the side of safety, an increase in turbidity is **always** assumed to mean a decrease in the safety of the product. An increase in turbidity of 0.1 to 0.2 can mean a ten-fold increase in particles. Therefore, whenever the turbidity of filtered water increases at a plant it should initiate a process of investigation by operating staff.

3 Monitoring procedure

Under normal conditions, the plant is capable of regularly producing filtered water with a turbidity of less than 0.1 NTU (according to the output from on line turbidity meters). As a matter of diligence therefore any deviation outside of the normal operating values will be treated as suspicious, investigated and rectified. It is not appropriate for operators to wait until critical limits are breached before commencing investigative action.

Each of the six filters at Molendinar is equipped with Great Lakes dual beam turbidimeters. These are sensitive instruments and must be inspected frequently for cleanliness and overall function. Each filter is also equipped with a flow meter and a head loss measuring device. In the first instance, the flow through all six filters is directed according to the output of two pressure sensors located in the clarifiers. The output signal from the six meters (plus a composite meter) is sent to the plant control system and the daily trends can be inspected at any time. Historical information for the past month is also easily accessible. Although the plant is not manned constantly, there is an alarm system designed to call the duty operator and there is back up to a security office if the operator fails to respond to the Critical Limit failure.

Proper management of the filtration process depends on the accuracy and reliability of **ALL** of the above devices and therefore, calibration and maintenance procedures must be carried out as required AND a record of calibrations must be available to the duty operator.

All operators must understand the filter backwash process. Filters will be put into backwash automatically (based on time elapsed, head loss or turbidity) or manually by the operator. The backwash sequence at Molendinar is as follows:

Rising wash (air plus 1 clear water pump for 2-3 minutes)
Air only for 8 minutes
Both clear water pumps for 2 minutes
High velocity raw water for 3 minutes
Both clear water pumps for 6 minutes
Both clear water pumps on reduced velocity for 1 minute
Filter goes back on line
First 3 minutes of filter output diverted to backwash recovery tank in order to avoid turbidity spike contaminating clear water storage.

3.1 Corrective action

3.1.1 Individual Filter Failure

On occasions, the turbidity of a particular filter will appear to drift above the normal operating level. When this occurs, the operator will carry out the following investigation.

On the SCADA system, check the head loss trend for the filter in question. If this shows rapid deterioration, check the previous trends for that filter. Place the filter into manual backwash and physically observe the backwash to determine of there are any signs or sounds that would indicate a problem with the

backwash sequence or equipment. O & M should be contacted if any equipment needs attention.

If the head loss trend has slowly increased since backwash and then appears to level off, and the filter displays a sudden rise in turbidity, this is a sign that breakthrough is occurring. In this instance the filter must be placed into manual backwash and subsequent performance closely monitored. If the filter repeats the breakthrough behavior then the filter will be taken off line and the individual system inspected.

If head loss of not excessive, and the pattern is normal, then the turbidimeter must be suspected of malfunction. The meter should be inspected, bled and cleaned. The last calibration record should be examined and if necessary, a new calibration performed. A manual laboratory test will be performed for comparison.

If the turbidimeter is in order and head loss in normal then the flow history (including UFRV's) of the filter should be considered. Sudden changes in flow will cause particle shear from filter media and this will of course increase turbidity. Also, clumping of filter media can contribute to breakthrough. In the first instance the history of the filter cell flow meter should be checked as well as the operation of the flow control valve.

As a last resort, the filter should be drained and the media inspected and cleaned if necessary. The nature of the particles providing the turbidity can be determined by microscopic examination. This task can be carried out by Scientific Services.

3.1.2 Collective Filter Failure

From time to time, all turbidimeters may indicate an upward trend from normal operation. When this occurs, the operator will carry out the following investigation.

Check the pH of the dosed water on the SCADA system and carry out a manual check also. Abnormal pH will indicate the dosing process has failed. Refer procedure OM-01-209 "Molendinar Dosed Water pH". In addition to the steps indicated there, a check of the polymer dosing and filter aid dosing systems should be made (if they are in use). The Operator MUST verify that dosing pumps in use are actually working and that the chemical is reaching it intended destination.

If the dosing process appears to be in order, inspect the display panels on all the turbidimeters for any message that indicates malfunction. Laboratory turbidity tests must be carried out to verify the readings from the on line instrument/s.

Check the raw water (including the recycled backwash water) for changes in pH, colour, turbidity, suspended solids and manganese. Significant alteration on the character of the raw water will involve re-optimization of the dosing regime, perhaps involving jar tests.

Check the raw water flow meter. Since dosing of most chemicals is flow paced, a significant drift in this meter can cause product deterioration. The meter should be bled as a first check and calibrated if necessary.

Check the quality of the recycled water. Deterioration in recycled water quality can mean the dosing regime is inadequate. Check also that sludge transfer from the bottom of the wash water recovery tanks to sewer is occurring during the settling phase.

Sudden flow increases can cause shearing of debris from filter media. If this is occurring, the operator will reduce flow to stabilize breakthrough and then slowly increase up to the desired level. It is preferable to choose lower output of high quality than higher output of compromised quality.

Carry out a laboratory pH and chlorine test on the filtered water if pre chlorination is in use. Excessive dosing of chlorine can drive the pH downwards possibly affecting the coagulation process.

When plant turbidity has increased beyond normal operating levels and the cause is either not obvious or will take considerable time to control then;

HELP WILL BE SOUGHT IMMEDIATELY. The help may involve phone advice or calling in of extra personnel. Remember, when turbidity increases, there are more particles in the water and in the absence of information to the contrary, these particles are assumed to present a health risk to the consumers.

3.1.3 Critical Limits

The Australian Drinking Water Guidelines recommend a turbidity of <1 N.T.U. in water that will undergo disinfection. The Molendinar Water Plant is capable of regularly producing filtered water that gives a reading of less than 0.1 NTU. This reading is not verified by laboratory tests that show a turbidity of 0.1 to 0.2 NTU due to the difference in sensitivity of the lab instruments. Nevertheless, the operator will be guided by the "on line" instruments, which operate around the 0.05 NTU level under ideal conditions. From the point of view of process control, it is the trend of this "on line" turbidity that is important, as much as its absolute value. Given that rising turbidity can be associated with increased health risk, every effort must be made to bring filtered water turbidity excursions under control as quickly as possible.

The Filtration process at Molendinar is a CRITICAL CONTROL POINT and therefore the following CRITICAL LIMITS apply.

If the turbidity of the filtered water As per the on line instruments reaches an average of 0.2 NTU (for all filters) for more than 5 hours the PLANT WILL BE SHUT DOWN until the problem has been rectified.

If the average turbidity of the plant filters exceeds 0.3 for more than 2 hours, the PLANT WILL BE SHUTDOWN until the problem has been rectified.

If the problem has been identified **and rectified,** a turbidity of greater than 0.3 will be tolerated as the plant regains normal function over the next few hours (provided the condition of the raw water is not deteriorating).

Any single filter that yields turbidity of greater than 0.3 for more than 2 hours will be taken off line until functional and a report completed.

ANY excursion above 0.2 NTU that lasts for more than 2 hours will require a report to the Senior Operator and a HACCP excursion form OM1101 will be forwarded.

Any decision to ignore shut down limits must be made by the Manager Operations & Maintenance. If the Manager is unavailable the Coordinator of Water and Wastewater or the Director of Gold Coast Water will make the decision.

In deciding whether to continue water production, the Manager will consider the following:

The condition of the raw water and the associated risk to consumers: Have recent bacterial counts been normal? Is the turbidity typical? (high turbidity from rain may mean increased protozoans in the raw water), what are the manganese levels in the raw water?, what is the colour of the filtered water? Are conditions stable.

The condition of the recycle stream. Have bacterial and algal counts been typical and stable? Does the recycle have a typical appearance (colour, turbidity)? Historically, Hinze dam has very low bacterial counts (avg of 3 cfu/100ml faecals) and the major source of faecals into the plant comes from the recycled water, which may be slightly contaminated by bird life. At Molendinar, faecal counts of 20 cfu/100ml are typical in the recycle stream. There will not be sufficient time to carry out bacterial tests in acute failure situations so the operator should physically inspect the clarifiers and recycle process for any unusual signs.

The manager may call for a microscopic examination of the filtered water to determine the nature of the turbidity (eg sand, clay, algae).

How far above the Critical Control Limit the water is and how long the plant will take to return to normal performance.

Uncertainty about risk should lead the manager to withhold supply as a precaution. Declaration of an incident (procedure QP-19) would then be a consideration. ANY staff member can declare an incident if they have

reason to believe the risk to public safety is or will soon be compromised. Incident teams will consist of various experts who will determine a response suitable for the features of the specific turbidity failure.

Shutting down the plant is an undesirable option therefore as a last resort, the Duty Operator may consider trying bringing turbidity under control by reducing flow from the filter/s. If this is successful in lowering the turbidity, then shutdown may be avoided (again, provided the risk level of the raw water has not increased). However, it is obvious that reduced flow may lead to customer water shortages and still does not address the underlying cause of the initial turbidity incident.

During a turbidity incident, the Operator will also check the turbidity of the water leaving the reservoirs. This water has a higher turbidity than filtered water due to the formation of insoluble inorganic material following post lime pH correction. A typical figure is around 0.3 NTU (using laboratory bench top unit) so it is possible a significant filter turbidity failure will not be easily detected at this point. Nevertheless, the turbidity of this water should be recorded and reported.

As a matter of routine, the Senior Operator will review the 24-hour turbidity trends each weekday and will ensure that any necessary excursions are written (OM-1101). The Coordinator of Water and Wastewater will make trend inspections on a random basis at least weekly. Internal quality auditors will also make a random check of turbidity trends during internal quality audits of this procedure. Any turbidity excursions that have not been properly reported will be drawn to the attention of the Manager Operations & Maintenance. Turbidity records for at least the previous 12 months will be held.

4 Reporting and Verification

All HACCP excursion reports (form 1101) will be forwarded within 24 hours to:

Director Gold Coast Water.
Manager Operations & Maintenance.
Manager Service Delivery
Coordinator Product Quality
Coordinator Water & Wastewater

Failing to report HACCP excursions is a serious matter. Operators, who fail to notify management of excursions, are exposed to the possibility of personal

liability in the event of public health consequences. Once excursions are reported, it is the responsibility of the Management team to consider if the excursion represents a need for a change in risk management measures.

The HACCP reporting system ensures that there is a paper trail for any event exceeding Critical Limits.

To verify that excursions are duly completed, internal HACCP auditors have access to the following information:

24 Hour Turbidity trend records
24 hour dosed water pH trends.
24-hour chlorine demand trends.
Daily manual checks by the Operators.
Routine checks by Scientific Services
Turbidity results from key locations in the distribution system.