Fortescue
The New Force in Iron Ore

Christmas Creek Water Management Scheme Detailed Infrastructure Description

---

26 October 2010

CC-RP-HY-0009

Document Title:	**Christmas Creek Water Management Scheme Detailed Infrastructure Description**
Document No:	**CC-RP-HY-0009**
Document Type:	**Report**
First Issue Date:	**26/10/2010**

Rev	Issue Date	Description of Revisions Made	Signatures		
			Originator	Checked	Approved
0	26/10/2010	Initial Report	Ian Brandes De Roos	Jed Youngs	Doug Brown

TABLE OF CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

This report describes the proposed infrastructure for the Christmas Creek Water Management Scheme. It outlines the major infrastructure components and applicable design standards. The background to the water management system objectives, rationale and operating conditions is given in "Hydrogeological Assessment for the Christmas Creek Water Management Scheme" (Fortescue, 2010).

1.2 SYSTEM OVERVIEW

The proposed Christmas Creek water infrastructure system is as follows:

- Dewatering system – consists of up to three water streams; brackish bore dewatering stream, saline bore dewatering stream and sump dewatering stream. Includes associated pumping equipment, bores and interconnected pipelines that deliver water to other parts of the system (transfer pond, settlement pond or direct to conveyance pipeline).
- Transfer ponds and settlement ponds – water storage facilities for the purpose of facilitating bulk flow transfer and/or settlement of suspended material (typically for treating sump dewatering), for handling both brackish and saline water. Facilities include pumping station and associated power sources.
- Conveyance pipelines – pipelines that connect transfer ponds, settlement ponds and in some cases dewatering systems directly to points of water use or disposal, for handling both brackish and saline water.
- Injection systems – networks of injection bores and interconnected pipelines, includes both brackish and saline injection systems.
- Process water pond – located adjacent to the process plant. This pond receives raw water from the brackish conveyance system.
- System instrumentation – includes both manual and automated systems of monitoring and control.
- Groundwater monitoring network – in addition to the water handling system a network of purpose built groundwater monitoring bores have been constructed for the purpose of monitoring groundwater impacts.

1.3 GROUNDWATER MANAGEMENT SYSTEM

An approved groundwater operating strategy is currently in place (FMGL, 2010a). Elements of the management system outlined in this document include:

- Mine site water balance forecast including dewatering, injection (brackish and saline) and mine site water demand
- Details of groundwater monitoring bore network, monitoring and sampling programs;
- Groundwater management framework that delineates zones for management according to hydrogeological conditions, operational activities and beneficial use.
- Trigger level system with trigger level values aligned with predicted water level change and potential ecological impacts;
- Trigger level breach response strategies including implementation of contingency plans; and
- Reporting requirements

2. PROPOSED WATER MANAGEMENT INFRASTRUCTURE

2.1 DESIGN PARAMETERS

2.1.1 Dewatering System

Dewatering bores and interconnecting pipelines are located along mine pit perimeters and in some cases within mine pits. Ongoing bore- commissioning and decommissioning process will occur as pits are completed and other pits are commenced. A 100 m wide disturbance corridor bounding the southern perimeter of the mine pits has been designated for dewatering infrastructure.

Bores are typically constructed up to 80 m deep and spaced approximately 100 m apart. Bores are constructed of steel or PVC with screened/slotted sections across the aquifer(s) to be dewatered. Brackish and saline aquifer zones are targeted discretely.

Abstraction is facilitated using submersible electrical bore pumps powered by diesel generators. All generators are fitted with self-bunded fuel tanks; however, in addition an earthen and lined bund or prefabricated plastic tub is provided for containment of potential spills.

Currently one generator is required for each pump (bore), however use of a single generator to supply power to multiple bores is being investigated, as is reticulated power from the central mine power station.

Dewatering sumps are developed in pits as required and typically consist of excavated trenches to approximately 4 m below the pit floor level along strip perimeters where groundwater inflow is encountered. Diesel-powered centrifugal pumps are employed to abstract groundwater from the sump. All centrifugal pumps are fitted with self-bunding fuel tanks.

Due to the variable water quality encountered during dewatering there will be up to four separate water streams as follows:

- Brackish bore abstraction, delivered into the brackish pipe network.
- Saline bore abstraction, delivered into the saline pipe network.
- Brackish sump abstraction, delivered into a brackish settlement pond, then pumped from the pond into the brackish distribution network.
- Saline sump abstraction, delivered into a saline settlement pond, then pumped from the pond into the saline distribution network.

2.1.2 Transfer and Settlement Ponds

Brackish water transfer ponds will be installed as an integral part of the water management system, as required, enabling bulk flow objectives.

A saline transfer pond is proposed for each pit zone as saline storage backup and an outlet point for pressure relief valves. Normal operation is for dewatering bores to feed directly into the injection network, bypassing the ST ponds.

A brackish settlement pond and a saline settlement pond will be constructed for each pit zone. In some instances only the saline settlement pond will be constructed to contend with both the brackish and saline condition when these flows are successive.

Saline ponds are engineered designs in accordance with the DMP document *Guidelines on the Safe Design and Operating Standards for Tailings Storage*. Brackish water transfer ponds have been designed to the same engineering standards as those used for saline transfer ponds, but they do not require the same emergency storage facilities. Brackish settlement ponds will generally not be lined.

Typically, transfer ponds will be of dimensions 175 m long, 175 m wide and 5 m deep, and will be lined with 1.5 mm high density polyethylene (HDPE) lining. A cut-and-fill design has been employed such that the ponds are excavated to approximately 2 m below ground level and the walls built to approximately 3 m above ground level. Pond walls will be battered to an approximate 30^{o} incline. These ponds will generally have a partially raised central spine, approximately 3 m high, dividing the pond in two. The purpose of the central spine is to enable utilisation of half the pond, at reduced level, when the other half is subject to maintenance.

Settlement ponds are anticipated to be slightly smaller in plan than transfer ponds. However, most pond dimensions are subject to the results of future calculations when more detailed information is available. For the purpose of disturbance calculations the same dimensions as transfer ponds have been assumed. These ponds will have similar vertical scale attributes to the transfer ponds. Their plan layout will differ in that cross-spines enforce an extended travel path, and hence settlement time, between inflow point and pumped abstraction.

Each pond will have a 600 mm freeboard from overflow facility elevation to pond crest. The overflow facility generally takes the form of an overflow weir or alternative overflow chamber. The weir will be typically 10 m wide and designed to operate at less than 100 mm in depth, enabling a minimum freeboard of 500 mm. Similar design objectives are addressed with the overflow chamber option. The freeboard height has been calculated to maintain this minimum of 500 mm during and following a 1 in 100 year, 72 hour storm event. Brackish overflow spills to drainage line. Saline overflow can either spill to a separate, lined emergency overflow storage or be effectively prevented by adopting the in-pond large emergency storage principle. The total saline storage structure also has a perimeter earth bund. The top of the brackish pond central spine will be below the height of the overflow structure and allows water to flow between pond halves during normal operation. Pond water levels will be monitored both visually and by telemetry depth sensors.

In the unlikely event of over topping, the shallow sheet-flow over the lined spillway will be no more than a 100 mm sub-critical flow at crest. The fall from the spillway is approximately 2.5 m, and as such, the embodied energy is expected to be low. Locally derived siliceous hardcap and/or iron ore material will be used in the spillway for the purpose of dissipating the energy and providing embankment toe protection.

Rock required for scour protection will be sourced from local waste stockpiles, with the material to be used selected on the basis of its high density, hardness, interlocking characteristics and geochemical inertness. The average size of material is estimated to be approximately 400 mm diameter, but subject to calculated scour velocities. Based on site metallurgical tests, the average density (specific gravity) ranges from 3.8 to 4.2, and hardness (Mohs hardness scale) will be approximately six. The rock scour protections chute will be lined and anchored under the rock, with other geofabric installation possible, if required.

There will be a disturbance area surrounding each pond of approximately 50 m in width on three sides of the pond and approximately 80 m on the other side, measured from the top of the pond wall. A pipe and pump lay down area will be contained within this disturbance area, as will the construction of fencing, additional bunding where required and a maintenance road. Surrounding the fencing will be a 10 m firebreak and cleared topsoil and vegetation stockpiles.

Water will be extracted from the ponds either by piped outlet through the pond wall, or directly over pond wall by pump suction. Pumping platforms will be set up such as to abstract the water at a rate that controls the water level in the pond within defined high and low limits. Generally, the platforms will consist of three main pumps with one minor jockey pump. The pumps will operate on a rotating duty basis. Typically, two of the main pumps will be capable of delivering peak flow conditions with one pump remaining as standby. The jockey pump, where deployed, is to deal with minor flow conditions. The pumps will deliver into their respective brackish and saline bulk flow pipeline systems, onward to usage points or injection. The pumps will include a system of automated controls supported by a telemetry network.

Egress matting, buoyancy rings and external fencing will also be included in the pond construction where necessary to meet health and safety requirements and to avoid any unnecessary harm to wildlife.

2.1.3 Conveyance Pipelines

Bulk flow pipeline systems (brackish and saline) will traverse east-west across the mine site, hydraulically supplemented by transfer ponds when conditions require.

The brackish water bulk flow system generally runs adjacent or just south of the pits. It conveys freshwater from active pit areas through to injection at more distant, future pit areas. This pipe alignment will occasionally be moved locally when pit excavations are required beneath its incumbent position.

The saline bulk flow system consists of a saline collector main south of the pits. Saline dewatering feeds into this pipeline, which, in turn, connects at regular intervals to the saline injection main, running parallel further to the south. This promotes hydraulic efficiency and effectively creates a series of ring mains allowing redundancy for pipe shut down events.

Pipe material is predominantly white, co-extruded HDPE compliant with pipe work and valves specification 11098-07120-PI-SP-0001 (referencing Australian standards). Typical pressure ratings range from PN6.3 to PN12.5, dependent on application. Diameters range from DN110 to DN630.

2.1.4 Injection System

Proposed injection bores for brackish water injection east and west of the active mining area and typically target the mineralised Marra Mamba Formation. Injection bores are constructed of steel or PVC materials. Where formation stability permits, injection bores differ in construction from dewatering bores by leaving the drilled hole open (uncased) across the aquifer targeted for injection.

Saline injection bores are located between the southern limit of the resource area and the Fortescue Marsh. Saline injection bores target the Oakover Formation between 40 and 60 m below ground level (mbgl). As with injection bores in fresh to brackish groundwater areas, these bores may be uncased and unscreened across the target aquifer, where formation stability permits.

Groundwater is disposed of to the target aquifer by pumping water into the bore at a rate which allows the water to be transmitted into the aquifer without raising the operational head in the bore to the surface.

Fresh-saline blending stations will be provided as a contingency to lower the salinity of injected waters if adverse responses are seen in fresh or brackish aquifers as a result of injection.

2.1.5 System Instrumentation

Telemetry monitoring and controls are proposed for the system for the purpose of managing flows and potential environmental impacts. The telemetry system allows for remote monitoring of parameters such as flows, pressures, water levels, pumping plant status and water quality both in the infrastructure and groundwater system. Telemetry will also enable greater system control and understanding through remote operation and data collection.

Borefield telemetry has been trialled at Cloudbreak mine since late 2009 through installation on the saline trial system and also on 15 brackish dewatering bores. The saline trial was equipped with automated flow control valves and downhole pressure sensors on each bore, automated pump operation, a level sensor in the saline transfer pond, and in-line flow, pressure, turbidity and electrical conductivity sensors near the system pumps. Data for all valves and sensors reports to a central interface screen and a *Historian* database for logging. The saline trial system incorporates automated controls to prevent or minimise uncontrolled release of saline water. The key controls are a leak detection facility that notes flow imbalances, and automated closure of the flow valve to any bore in which water level approaches the surface.

The value of the leak detection facility is clear and future systems will include an automated leak detection capability on saline water pipelines. Systems to alert for possible leaks will also be located at defined points where pipes run under the railway. The system will alert the telemetry screen and operators (by SMS or email) of water imbalances. The alert will require investigation, response and logging by nominated operators within a specified time to ensure that leaks are managed rapidly.

Future instrumentation systems are currently being refined under the *Contract for Monitoring and Controls Engineering Services*.

2.2 CONSTRUCTION AND OPERATION REQUIREMENTS

2.2.1 Facilities

Facilities at the Christmas Creek mine site will be used for provision of fuel for the construction fleet and for first aid and emergency services. The construction and operation workforce will be accommodated at the Christmas Creek.

2.2.2 Workforce

The workforce for construction and operation of the proposed water management scheme will be represented by a diverse range of professions including hydrogeologists, hydrologists, civil, mechanical and electrical engineers, dewatering supervisors, dewatering operators and field technicians.

2.2.3 Transportation

Existing roads will be used for transportation of personnel and construction materials. Marble Bar Road, which is a public road, may be used for transport of construction materials. Access tracks will be required along pipe routes for construction purposes but will also serve as longer term access for routine inspection and maintenance.

2.2.4 Bore Drilling and Test Pumping

Drilling and construction of bores is undertaken by suitably qualified drilling contractors with established systems for health, safety and environmental management. Equipment used in the drilling operation typically consists of a truck mounted drill rig, trailer mounted air compressor, support vehicle with fuel and water storage and vehicle for transporting personnel. The drilling and construction of bores including specifications of materials and completion of the bore are specified in accordance with the Land and Water Biodiversity Committee publication *Minimum Construction Requirements for Water Bores in Australia, Edition 2.*

Materials used for construction of the bores are typically PVC or Steel. In the case of PVC, sections of PVC pipe are glued to form the complete bore. For steel construction, sections of steel pipe are welded by arc welding method. Discharge of groundwater during the drilling process and cleaning process (air lifting) is managed according to Fortescue Management Plan – 100-PL-EN-0001 – Discharge Management Plan. A drill pad is required to be cleared for the drilling operation. Where controlled discharge of groundwater is acceptable a 50m x 50m pad is required. Where containment of groundwater is required (when saline groundwater is expected to be encountered) a 100 m x 75 m drill pad is cleared, and a bunded area (turkey's nest) created for storage of discharge water.

Bores are individually test pumped to establish the bore yield and determine hydraulic parameters of the aquifer(s) that the bore intercepts. Test pumping is conducted by suitably qualified contractors with established systems for health, safety and environmental management. Equipment used in the test pumping operation typically includes a truck mounted submersible pump and power source (generator) and support vehicle.

The duration of tests may vary between several hours and several days depending on the objectives of the test and constraints such as suitable storage for saline discharge waters. Discharge of groundwater during the test pumping is managed according to Fortescue Management Plan *Discharge Management Plan* (Internal Ref. 100-PL-EN-0001).

2.2.5 Pipeline Construction

Pipeline infrastructure is almost entirely High Density Polyethylene (HDPE). This is constructed in accordance with Fortescue document *Specification for Pipe Work and Valves* (Internal Ref. 11098-07120-PI-SP-0001). This document references many relevant Australian standards including AS 2033 (*Installation of Polyethylene Pipe Systems*).

A clearing corridor of 15 m width is required for the pipeline route to allow access for pipe delivery and pipe handling during construction. Pipe is generally laid along the cleared pipe route prior to welding and connection of additional fittings. Pipe lengths (typically 20 m) are welded together using the thermal plate fusion welding technique and complying with the above standards. This work is undertaken in accordance with safe operating procedures. Fittings are generally connected by flange ends and bolts. All materials comply with pressure ratings specified during engineering design.

Standard commissioning of pipelines involves flushing to remove any debris from the pipeline and pressure testing to check for leaks in the pipeline or fittings. Flushing of pipelines is conducted with brackish water and discharge is to designated discharge points in accordance with Fortescue procedure *Dewatering Discharge Contingency* (Internal Ref. M-PR-EN-0001).

3. CONCLUSION

The infrastructure components for the proposed Christmas Creek Water Management Scheme include the dewatering system, transfer and settlement ponds, conveyance pipelines, injections systems, process water pond, instrumentation and a groundwater monitoring network. These components and their basis for design were outlined in the report.

4. REFERENCES

Fortescue, 2010, FMGL, Hydrogeological Assessment for the Christmas Creek Water Management Scheme, October 2010, CC-RP-HY-0004.