## Australian Water Well Technology

Australia is the most arid continent on earth. About two-thirds of Australia receives less than 500 mms of rain a year, and only 10 percent of the continent receives more than 1000 mms. In parts of Australia, rainfall may total less than 125 mms per year. Many of the drier inland regions are underlain by vast ground water aquifers such as the Great Artesian Basin which, covering an area of 1.7 million square kilometres, is one of the World's largest underground water basins. So, it's not surprising that much of Australia relies on groundwater to fulfil its water needs.

It is generally recognised that, in fulfilling the need to develop this water resource, Australia has also developed some of the world's best practices in water well drilling, completion and management. In recent years, this has included many well completion techniques that rely on inflatable packers – a product with a long and reliable history in oil and gas applications, but formerly not much used in water wells.

The use of such products and general completion practices used in many areas of Australia today is probably best illustrated by looking at a typical deep, gravel packed, water well completion. This well will have a design lifetime of 50 – 100 years with the expectation of minimal maintenance downtime.

Depending on water quality, the casing will be either carbon steel or fibreglass and will be placed in a borehole with sufficient annular clearance to ensure a complete and efficient cement grout seal around the casing. This also necessitates the use of centralizers spaced along the length of the casing to ensure it has an even cement covering around its circumference. Australia has pioneered the use of special plastic centralizers for this application which offer many advantages in water wells over the traditional oilfield type centralizers.

A float-shoe is typically connected to the bottom of the casing to allow pressure cementing from the bottom up in order to prevent voids in the sealing cement. They incorporate a check valve to prevent back flow of cement into the casing and were originally developed for oilfield cementing. All valve components are necessarily drillable and, without the heavy weights and high capacity of an oilfield rig, the traditional oilfield float-shoes are difficult to drill out using water well rigs. This shortcoming has been addressed by the use of specially developed, rubber filled cement for fast efficient drilling out after cementing. Such float shoes are specially designed for water well applications and are available to suit all water well casing sizes and materials, including fibreglass.

In the event of using fibreglass or similar casing that may be subject to potential collapse owing to the external pressure created by the cement, the casing is typically sealed at surface via a flanged connection, water filled and pressurised during cementing. Being water filled and slightly pressurized, the casing has no possibility of collapse and, since only a low pressure is maintained, there is no detriment to the cementing, for example, due to slight casing expansion.

After cementing, the float shoe is drilled out and drilling continues to TD below the target aquifer. A stainless steel, wedge wire wrapped screen is then installed telescoping back up into the casing. Many methods are available for screen installation but the preferred system for deep, long screens is via use of a "grab-packer". This consists of a heavy duty inflatable packer with external, high tensile, carborundum coated, steel strips running the full length of the packer. When the packer is inflated in a screen (or pipe) the coated strips provide very high frictional anchoring capacity. The screen itself is fitted with a riser pipe, typically 6 meters long, that is rigidly centralized inside the casing.

A grab-packer is thus run into the top of the screen on surface and inflated to form a strong yet gentle friction anchor to the top of the screen. Drill pipe connection to the grab-packer then allows the screen to be lowered into the required position.

The grab-packer includes a cone shaped deflector type cross-over which sits in the top of the screen and prevents gravel from entering. This allows gravel packing while the screen is suspended in location avoiding any possibility of screen damage by standing it in the bottom of the borehole. The grab-packer also has a central through pipe that allows pumping or reverse circulation through the rods to assist with gravel placement.

At the completion of gravel packing, the screen is simply and safely released but deflating the grab-packer. This is in contrast to other techniques, such as left hand threads or J-latches, which require drill pipe manipulation and thus lead to potential damage to the screen at the connection location or elsewhere.

Prior to development, the top of the screen must be sealed into the casing to prevent displacement and potential pumping of the gravel pack materials. This is achieved using a Slip-over Packer which seals externally on the centralized riser pipe previously mentioned and internally within the casing.

Several varieties of such packers are available, with an Inflatable, Mechanical, Retrievable (IMR) version being the most popular. This provides a long, inverted K-rubber shaped seal on the top of the screen and an inflatable packer to seal inside the casing. The internal seal is actually referred to as an M-rubber seal because of its length, typically 0.3 – 0.5 metres, and the fact that it is fully vulcanised to its outer steel casing preventing any possibility of it coming loose. Another variety of the Slip-on Packer, referred to as a Mechanical, Mechanical, Retrievable (MMR) packer uses such a seal both on the top of the screen and inside the casing.

The IMR version is run using a running tool that is a straddle packer assembly which is inflated inside the Sip-on at surface and run to location using drill pipe with an external inflation hose. The Slip-over packer has a series of valves built-in that allow inflation of the casing packer via pressurisation of the short straddle length between the packers of the running tool, which is accomplished via a second small bore hose run alongside the straddle packer inflation hose. After inflation of the IMR casing packer, the packers on the running tool are simply deflated to allow retrieval to the surface without applying any disconnection loads to the Slip-over packer.

The principal advantages of the IMR type Slip-over packer are that it is not subject to any possibility from casing joints while running in and, by virtue of the inflatable casing packer, is positively anchored in location. The later is an important feature in the event of high draw-down during pumping which generates a differential pressure across this seal which may be sufficient to pump an MMR type slip-over off location.

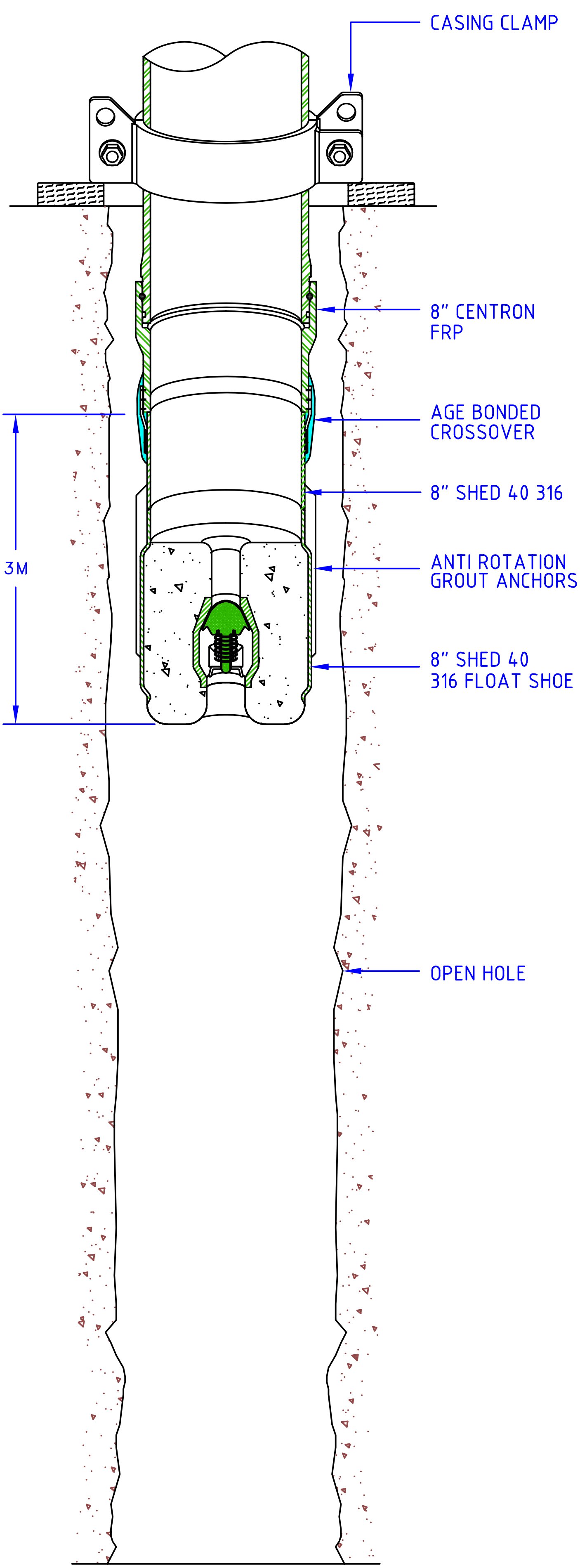
A feature of all slip-over sealing packers is that they are retrievable. This offers the option of topping up the gravel pack which may settle during development or subsequent operation. The same running tool used for installation is used for retrieval with, in the case of the IMR slip-over, a stop collar locating the tool slightly higher up inside the slip-over to straddle a shear type deflation valve. Pressurising the straddle zone of the tool in this case shears a deflation valve open, allowing the IMR packer to deflate and the complete slip-over to be removed. After re-dressing on surface and topping up the gravel pack, the IMR is re-run as previously.

A further Australian innovation that is gaining increasingly wider acceptance (including oilfield application) is the so-called “Riserless Pump” system. This system allows the casing itself to be used as the riser for an electric submersible pump by sealing and supporting the pump in the casing with an inflatable packer. It eliminates the need for a separate riser column ensuring much lower frictional pumping losses and providing a broad range of contingent advantages, such as:

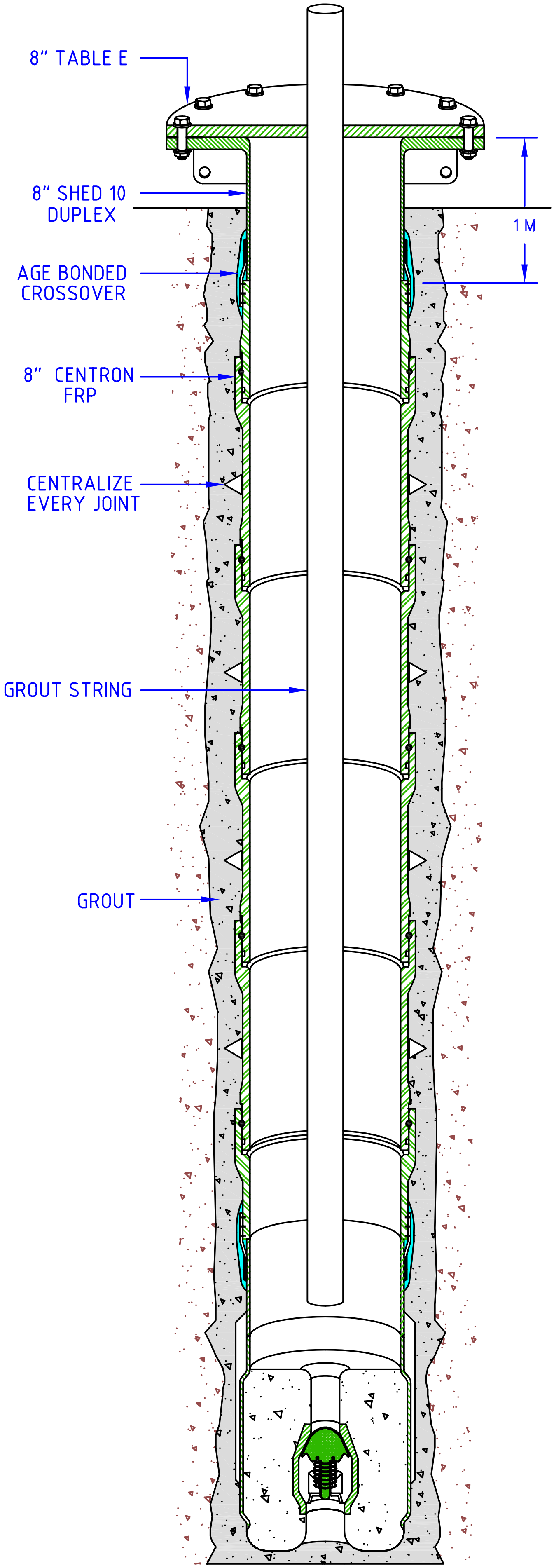
- Fast, efficient installation and removal
- Removal without dismantling piping
- Low frictional head loss
- Lower power consumption due to high electrical power efficiency and low frictional head loss
- Protects pump assembly
- Prevents chaffing of casing and pump
- Less corrosion due to elimination of “tide zone” in casing
- Reduced maintenance costs
- Improved well bore hydraulics
- Suitable for wells with severe dog-legs
- Ensures potentially polluted surface water and upper aquifers are excluded from produced water
- Reduced incidence of bio-fouling owing to removal of any air/water interface within the well

This system is ideally suited to large, deep bores and offers even more advantages in new wells where the original casing and drilled hole diameter can often be reduced without any reduction in bore production rates.

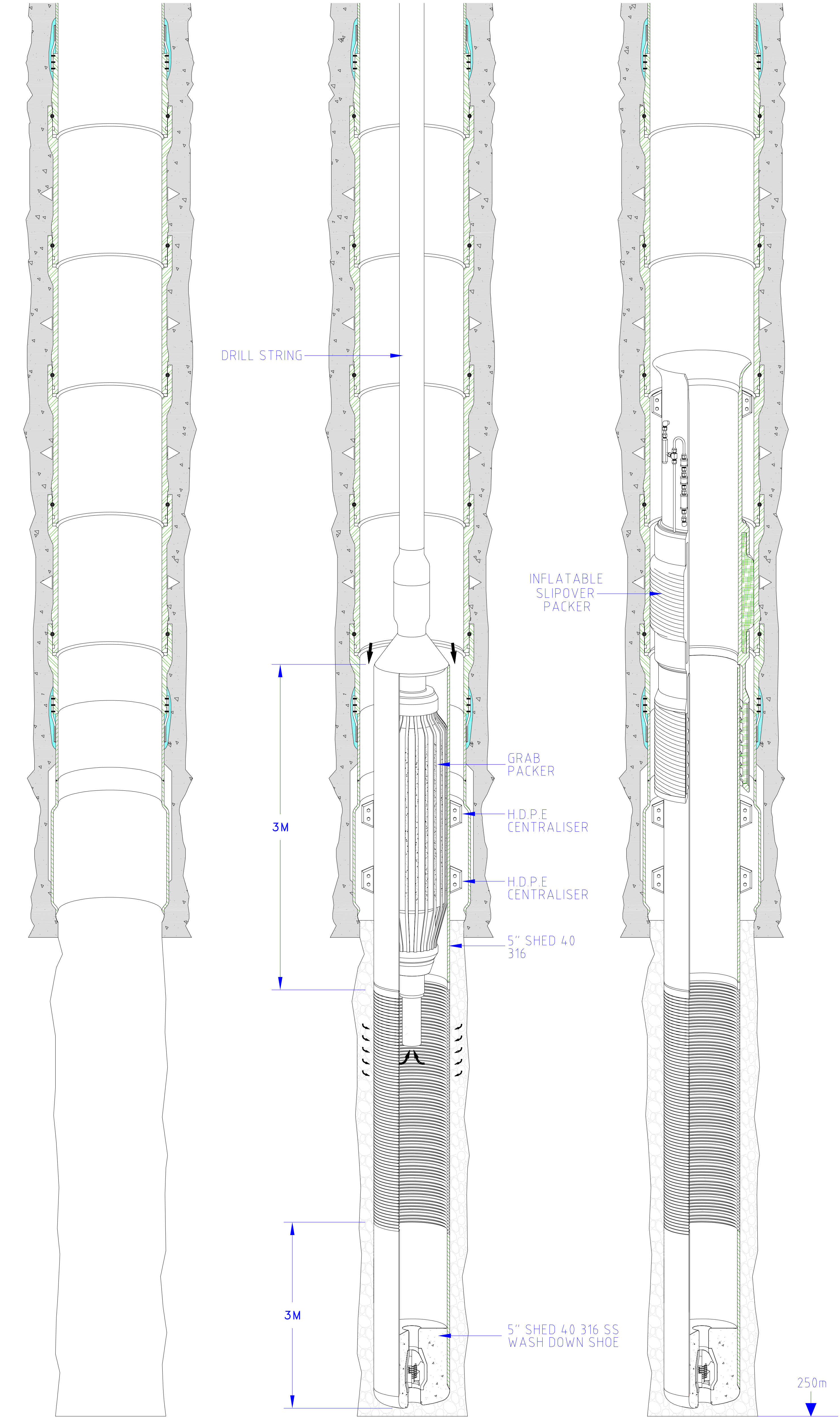
In conclusion, the above represents several new though now, well proven, technologies that have been developed in Australia but are applicable to deep, gravel packed, water wells worldwide. Their wider acceptance depends only on the recognition of the superior end product they lead to a well designed, efficient, low maintenance well with a minimum life of 50 – 100 years. Added to this, is the subsequent recognition that this may lead to a lower initial well cost for deep wells and definitely leads to a much lower “life of well cost” regardless.




RUN-IN CASING



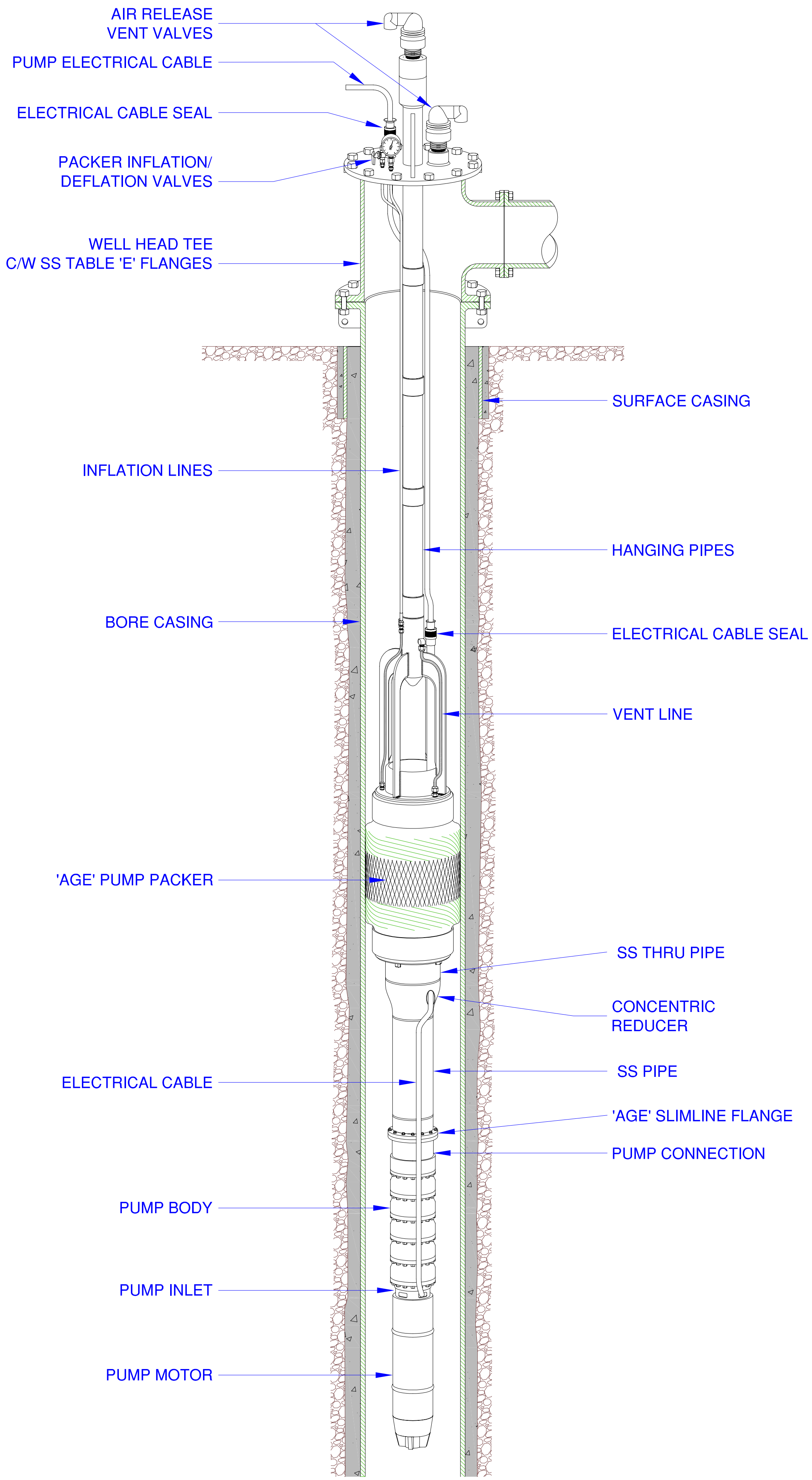

PUMP GROUT TO SURFACE




DRILL THRU FLOAT SHOE TO REQUIRED DEPTH

RUN-IN & GRAVEL PACK SCREENS

INSTALL SLIPOVER AND COMPLETE


AIR RELEASE
VENT VALVES
PUMP ELECTRICAL CABLE
ELECTRICAL CABLE SEAL
PACKER INFLATION/
DEFLATION VALVES
WELL HEAD TEE
C/W SS TABLE 'E' FLANGES
SURFACE CASING
INFLATION LINES
HANGING PIPES
BORE CASING
ELECTRICAL CABLE SEAL
VENT LINE
'AGE' PUMP PACKER
SS THRU PIPE
CONCENTRIC
REDUCER
ELECTRICAL CABLE
SS PIPE
'AGE' SLIMLINE FLANGE
PUMP CONNECTION
PUMP BODY
PUMP INLET
PUMP MOTOR