

The Palmiet Pumped Storage Scheme - Summary description of civil works

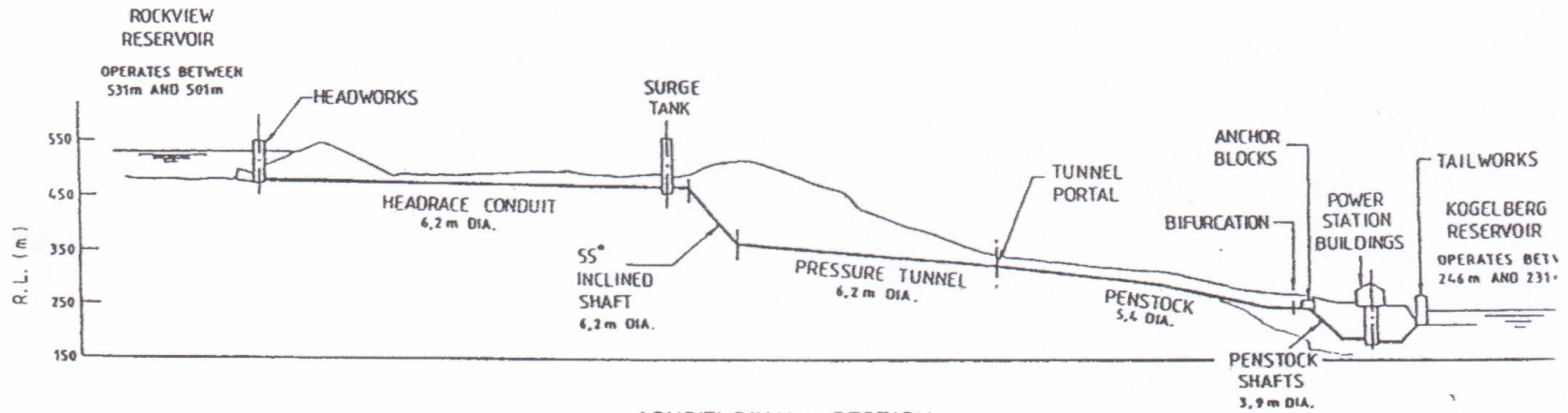
Section of works	Brief description	Principal dimensions or quantities	Methods of construction
<p>Headworks</p> <p>- Tower</p> <p>- Access bridge</p>	<p>Control and access tower in upper Rockview reservoir with emergency stoplogs and maintenance gate to the inlet/outlet bellmouth at bottom, leading to headrace</p> <p>Vehicular access from Rockview Dam crest to permit gate loads</p>	<ul style="list-style-type: none"> - Excavation 6 000m³ - 70m high prestressed tower - 11m x 14m elliptical section comprising wet and dry wells - 50m bellmouth tapering from 2 x 14m x 7m rectangular to 6,2m dia - 4 x 20m deck spans - Piers up to 50m high 	<p>Excavation: As for headrace (below)</p> <p>Tower: Climbing shutter</p> <p>Bellmouth: Conventional RC construction</p> <p>Deck: Precast beams and launch girder</p> <p>Piers: Conventional climb</p>
Headrace	Trapezoidal section cut-and-cover trench to accept welded in situ steel liner later encased in concrete	<ul style="list-style-type: none"> - 500m long - Depth variable 8m to 22m - Excavation 35 000m³ - Steel liner dia 6,2m - Gradient 1:225 	<p>Conventional surface drill and blast and rock support techniques</p> <p>Conventional RC encasement followed by void grouting</p>
Surge tank	Circular tank in open excavation off-line but connected to the end of the headrace by a 60° Y-piece	<ul style="list-style-type: none"> - Excavation 32m wide, depth 22m - Tank 21m ID, 78m high, prestressed 	<p>Excavation: As for headrace (above)</p> <p>Conventional climbing shutter to prestressed structure</p>
Inclined shaft	Underground circular inclined shaft and bends connecting headrace/surge tank to pressure tunnel steel liner as headrace	<ul style="list-style-type: none"> - 125m long inclined - Excavation dia 7,8m - Steel liner dia 6,2m - Gradient 1:0,7 (55°) 	<p>Raise-bore to pressure tunnel, D&B widen, muck out through pressure tunnel</p> <p>Mass concrete type backfill with three-stage grouting of rock and voids</p>

Pressure tunnel	Underground horseshoe section tunnel with steel liner as headrace	<ul style="list-style-type: none"> - 500m long - Excavation dia 7,8m - Steel liner dia 6,2m - Gradient 1:10 	<p>Conventional drill, blast and support:</p> <ol style="list-style-type: none"> 1. Pantafort – drilling (two-boom jumbo) 2. Heading and bench (hardness of rock and short length precluded TBM excavation) <p>Concrete and grouting as for inclined shaft</p>
Penstock and bifurcation	Similar to headrace, with bifurcation at lower end	<ul style="list-style-type: none"> - 560m long - Depth variable 8m to 18m - Excavation 45 000m³ including bifurcation - Steel liner dia 5,4m - Gradient 1:15 	As for headrace (above)
Penstock shafts	Twin circular inclined shafts and bends connecting bifurcation to base of machine shafts, via a horizontal section in each	<ul style="list-style-type: none"> - About 92m long inclined - Gradient 1:1 - 4,7m dia excavation for liner 3,9m dia - 37m long horizontal excavation tapering to 3,4m dia for liner tapering to 2,6m dia 	As for inclined shaft, except raise-bores and mucking were done to the horizontal drives from machine shafts

<p>Machine shafts and services shaft, drainage and services galleries</p>	<p>Twin vertical shafts to accept pump turbines, motor generators and ancillaries. Services shaft and galleries located between two main shafts. Base of main shafts to accept draft-tubes to tailrace</p>	<ul style="list-style-type: none"> - Main shafts <ul style="list-style-type: none"> • Excavated dia 26m • Concrete lined dia 23m incorporating lift-shafts • Depth 70m • Concrete embedment and support framework to pump turbines and motor generators with access floors and galleries at shaft base, 30m high and 23m dia - Ancillaries <ul style="list-style-type: none"> • Services shaft 6m dia • Galleries about 6m dia horseshoe sections 34m long 	<p>Excavation</p> <ol style="list-style-type: none"> 1. Spiral D&B excavation by segments 2. Drilling by crawler rigs 3. Mucking by crane to surface loader and trucks 4. Rock support by bolts, anchors and mesh-reinforced shotcrete to designed parameters <p>Concrete machine-embedment with RC operation temperature controlled Concrete wall lining by climbing shutter</p>
<p>Tailrace shafts</p>	<p>Two asymmetrical inclined shafts and bends connecting draft-tubes to lower Kogelberg Dam and tailworks control structure, lined with reinforced concrete</p>	<ul style="list-style-type: none"> - 93m and 68m long - Gradient 1:1,9 and 1:0,9 - 6,0m dia excavated - 5,0m dia lined 	<p>As for inclined shaft, but no raise bore possible to 1:1,9 gradient where full-face D&B was used. Concreting to collapsible steel shutter specials to bends</p>
<p>Tail works - Tower - Access bridge</p>	<p>Twin control and access towers in lower Kogelberg reservoir surmounted by common control house for maintenance gates to twin intake/outlet bellmouths at bottom, leading to tailrace shafts</p> <p>Vehicular access from power station platform to permit gate loads</p>	<ul style="list-style-type: none"> - Excavation 36 000m³ - 7m square tower sections - 33m high towers - 28m x 7m x 12m high control house - 1 x 11,5m span - 1 x 20,0m span - Single pier 9m high 	<p>Excavation: As for headrace (above) but rock support as for machine shafts Bellmouth: Conventional RC construction</p> <p>Deck: Precast beams Pier: Climbing shutter</p>

LONGITUDINAL SECTION

Fig 2: Vertical alignment: SVE's review report



LONGITUDINAL SECTION

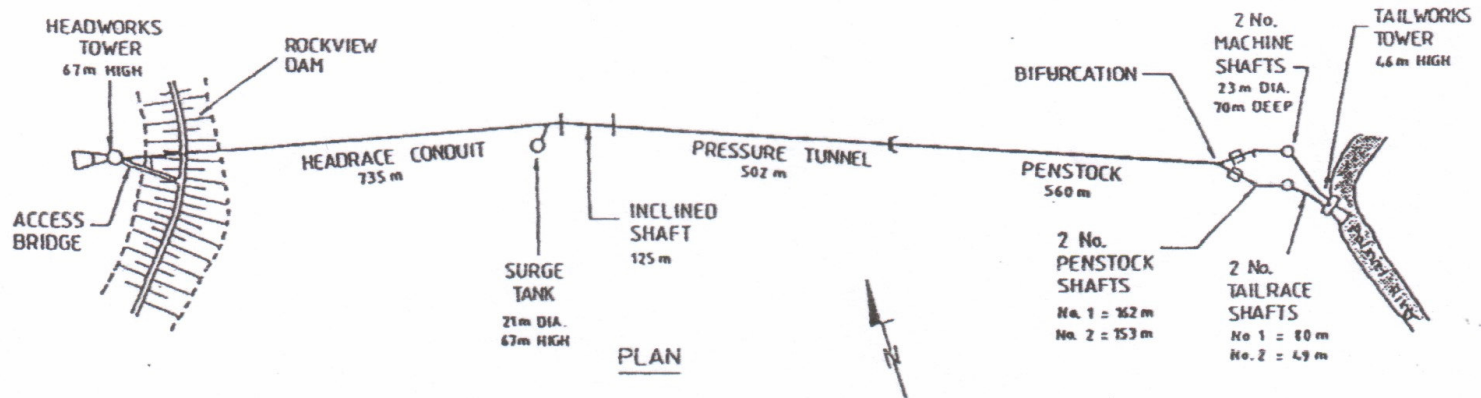


Fig 3: Final vertical and horizontal alignment