BLOEMWATER HYDROPOWER PLANT: BRANDKOP – ONE OF SOUTH AFRICA'S LARGEST CONDUIT HYDROPOWER INSTALLATION

WRC WATER RESEARCH, DEVELOPMENT AND INNOVATION SYMPOSIUM, 16 – 18 SEPTEMBER 2015 TO BE HELD AT THE BIRCHWOOD HOTEL & OR TAMBO, CONFERENCE CENTRE, BOKSBURG, SOUTH AFRICA

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WATER RESEARCH COMMISSION

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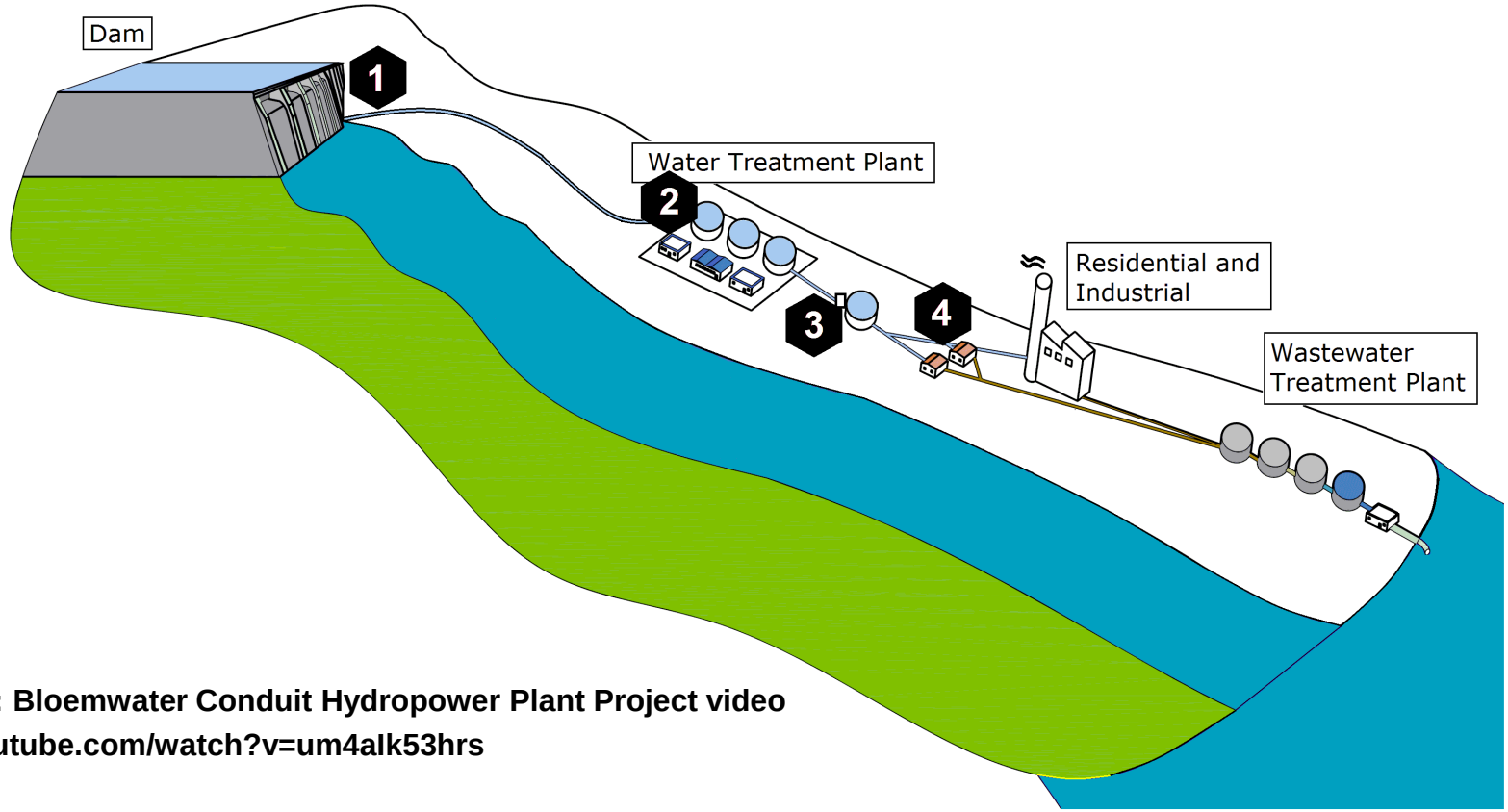
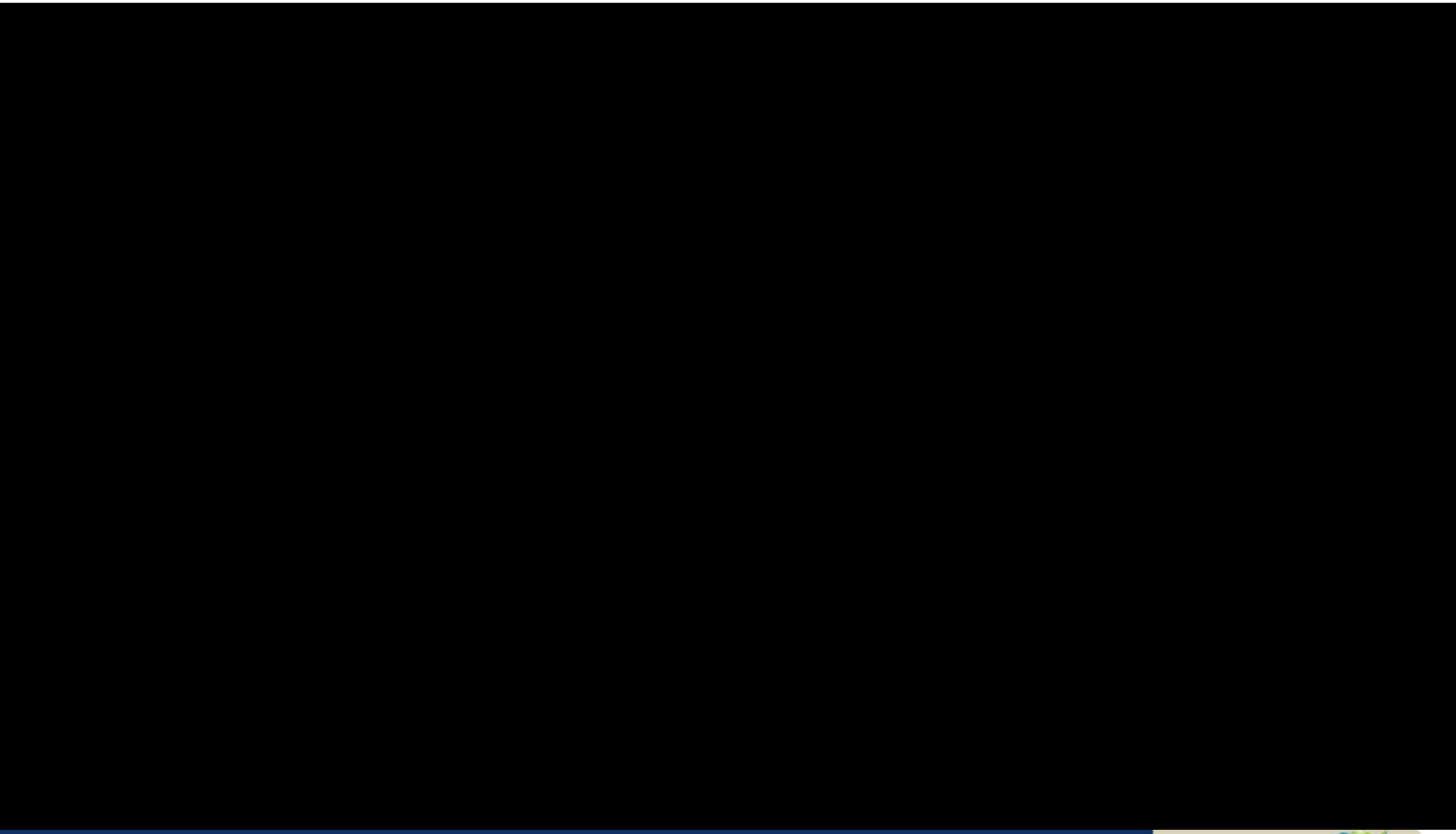
What is Conduit Hydropower?

- "Conduit hydropower" – energy generated from pressurized conduits"



The Power of Hydro: Bloemwater Conduit Hydropower Plant Project video
https://www.youtube.com/watch?v=um4alk53hrs



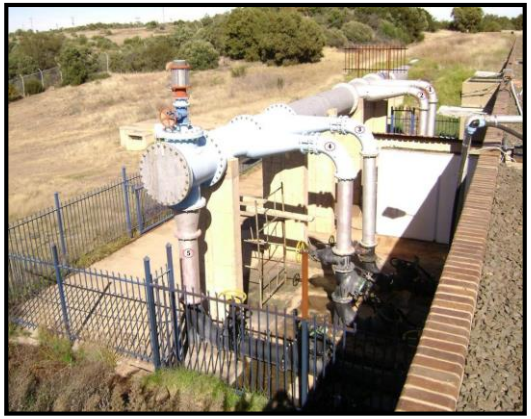
Background

- The Bloemwater pilot HPP was initiated in **July 2010**.
- Collaboration by Bloemwater, Water Research Commission and University of Pretoria,

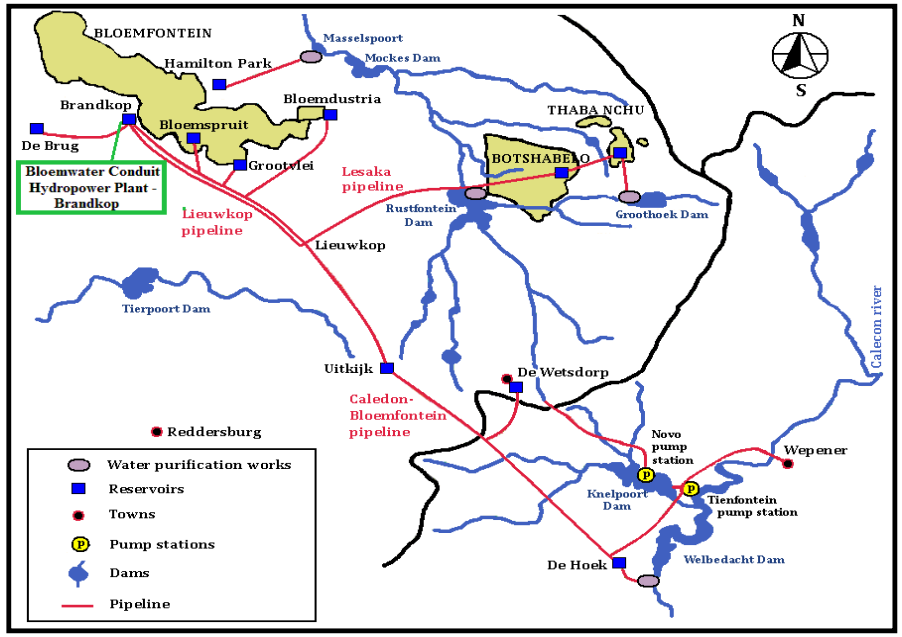
***"This is indeed an extraordinary collaborative effort and one that all South Africans should celebrate," noted Minister of Water and Sanitation, Nomvula Mokonyane at the launch**. "*

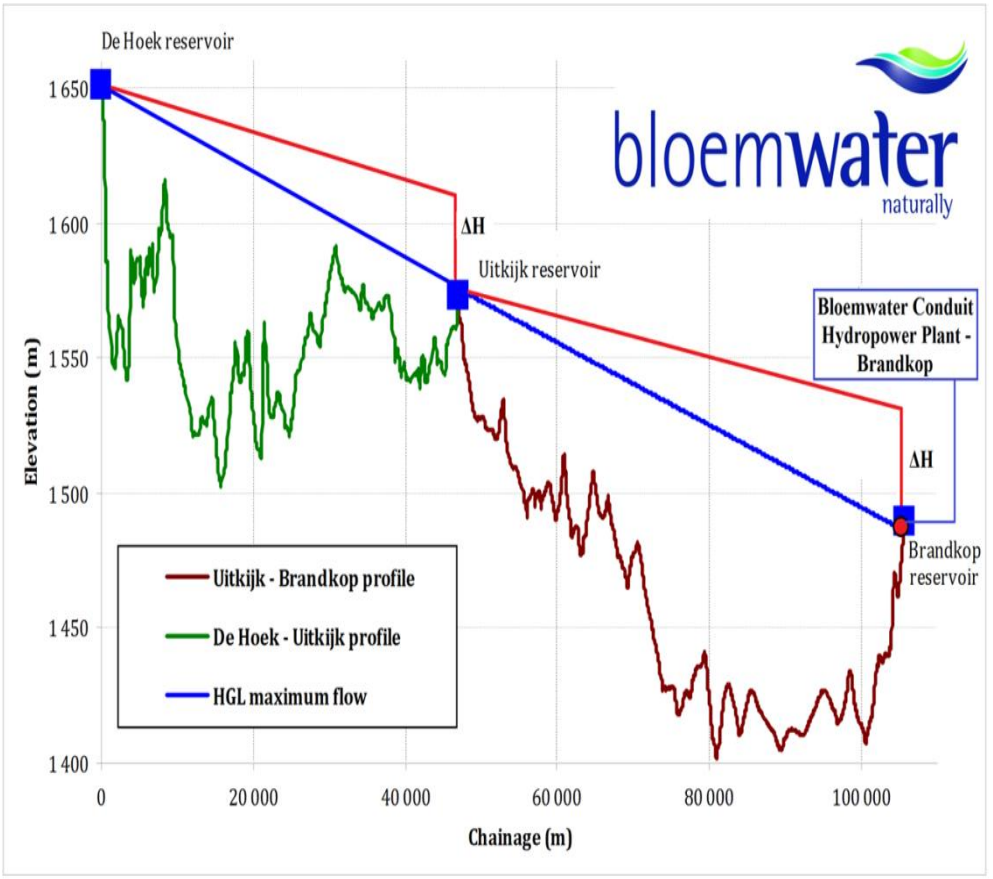
- **2010 – 2012:** Feasibility study to assess potential for energy generation by the system (**300 – 400 kW**)
- Power consumption data logging: **Nov 2012 – Jan 2013**
- Procurement and Construction: **July 2013 – Nov 2014**
  - Turbine
  - Civil
  - Mechanical
  - Electrical
- Launch: **31 March 2015**

Site Location



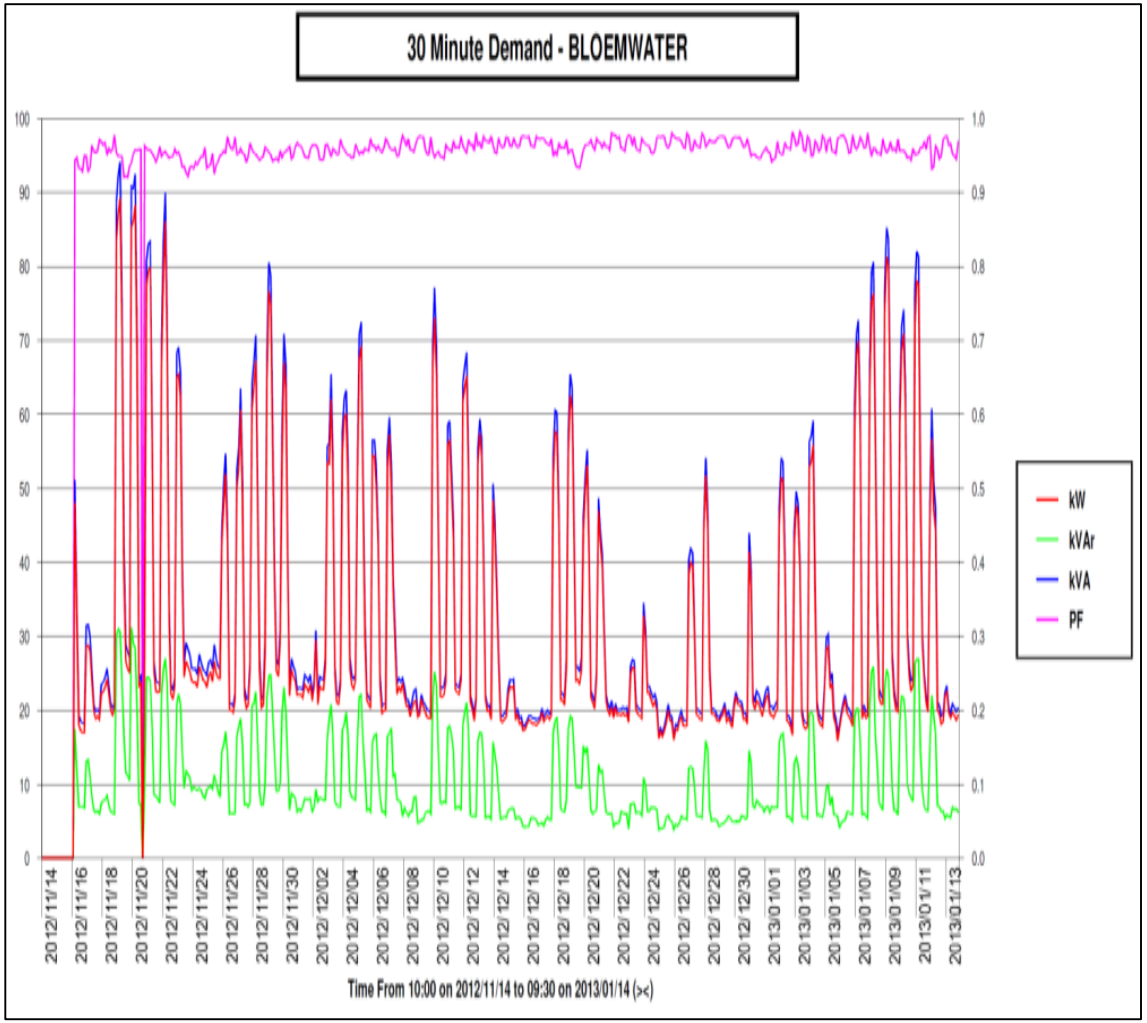
Caledon – Bloemfontein water supply system

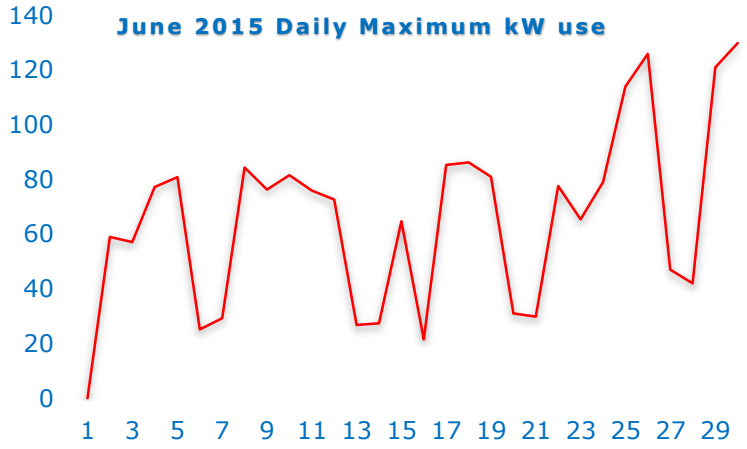


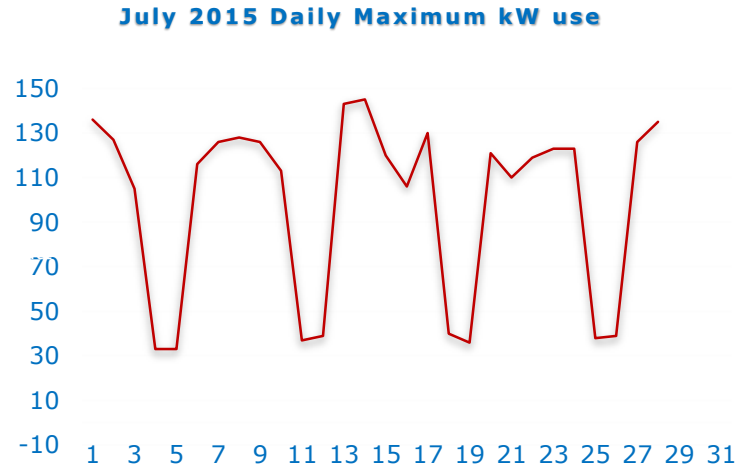


Pipeline Distance	**105 km**
Pipeline Diameter	**1170 mm**
Avg. Pressure Head	**46.5 m**
Avg. Flow rate	**1.05 m³/s**

HQ Power Consumption





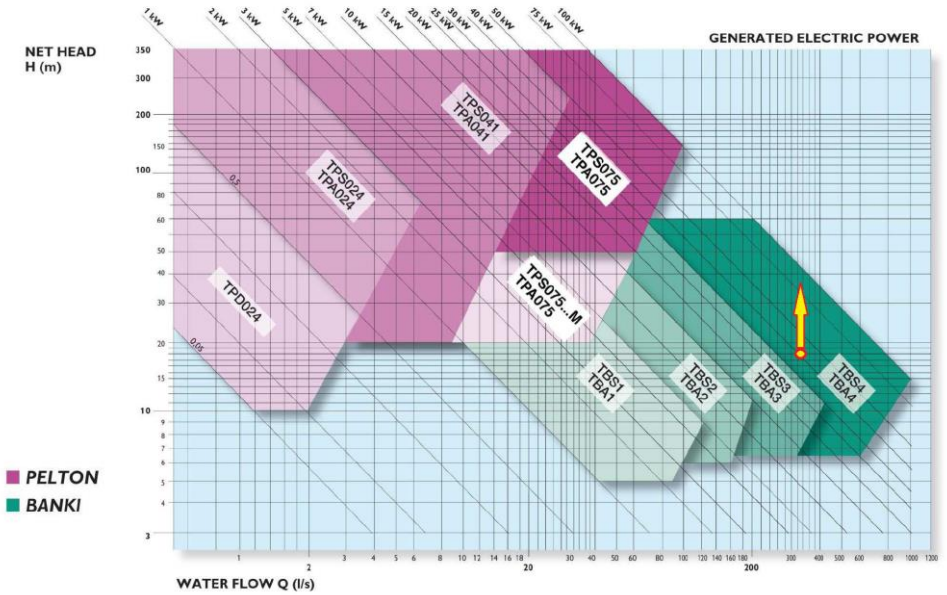


Turbine Details

IREM Banki Cross flow turbine from Italy

Turbine Data:

- Flow 350 l/s
- Output power 96 Kw
- Turbine speed 535 rpm
- Generator speed 1500 rpm



ECOWATT Micro hydroelectric power plant type TBS

- Cross Flow turbine in stainless steel type 4-0.5
- Synchronous generator type AZ 100
- Revolution multiplier by cogged driving belt
- Automatic flow regulation (with electric actuator 230Vac

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Bloemwater Brandkop Hydropower Plant

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Financial Implication

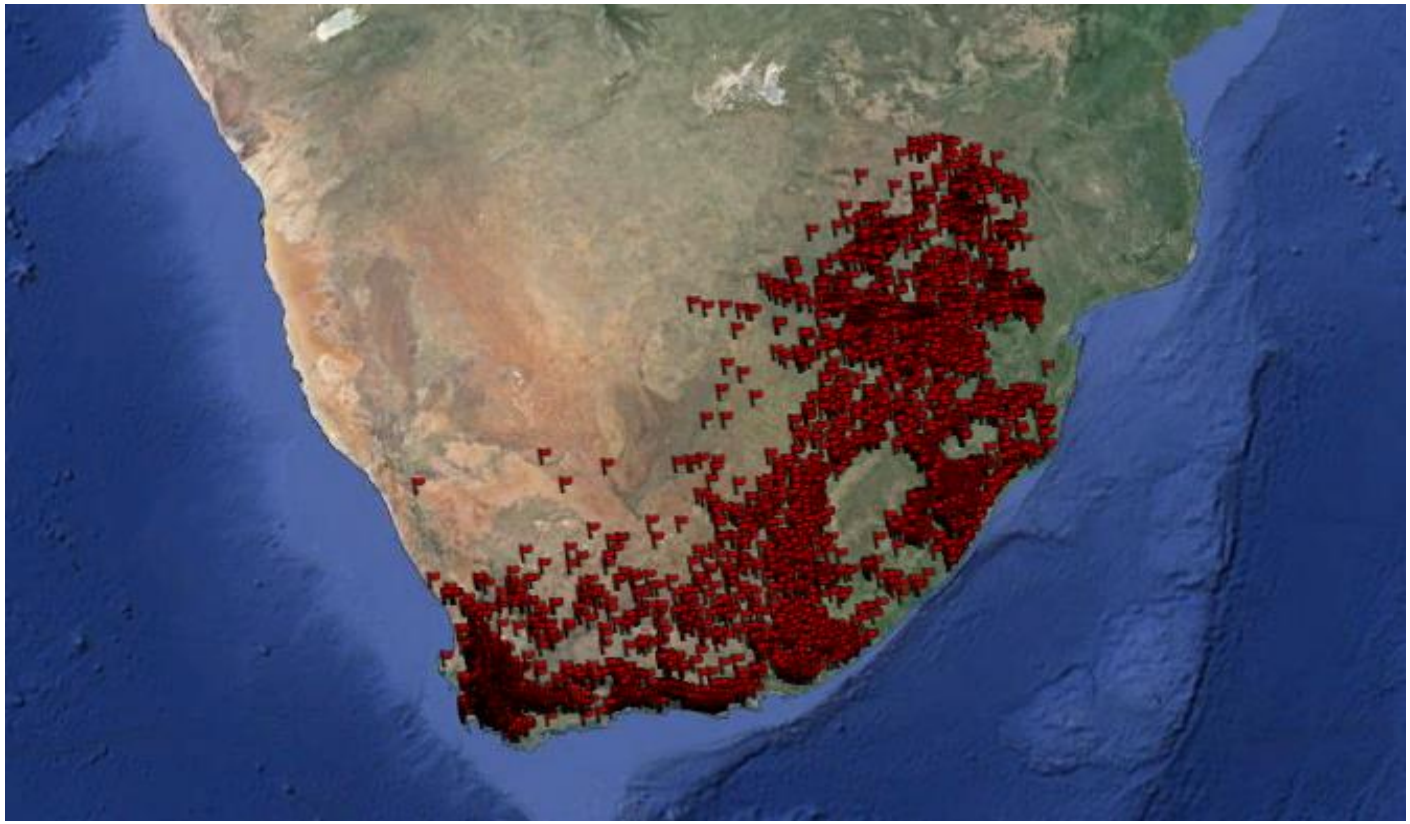
Item	Description	Cost
Pressure and flow measurements	The available head versus flow relationship is required to select a suitable turbine.	R25 000
Electricity consumption data	A monitoring system was installed measuring the electricity consumption of Bloemwater head office. Peak electricity consumption and daily pattern is required.	R20 000
Dynamic analysis	A dynamic analysis is required to ensure the safe operation of the hydropower plant.	R40 000
Valve chamber	Modifications to existing valve chamber providing off take and valve chamber.	R40 000
Pipe and valve work	Supply and installation of off-take pipeline (500 mm diameter) including bends, isolating valve, reducers and pressure control/regulating valve (400 mm control valve).	R445 000
Cross-flow turbine	Manufacture and supply of cross-flow turbine with bottom outlet, synchronous 3-phase generator, electronic regulator and control panel.	R1 350 000
Electrical connection to BW offices	Providing and installing electrical cable connecting to BW head office (distance ±200 m). Modifications to electrical panels, switching between municipal and hydroelectric power.	R762 690
Turbine room	The turbine, generator, electric control panel, monitoring equipment and regulator is housed in a brick walled lockable structure with safety signs, lighting, cameras etc.	R535 000
Monitoring system	Installing monitoring system of power output from generator, net power to the external load, system voltage, gross and net system current, status of all shutdown functions etc.	R30 000
Data logging and communication system	Logger with internal modem to capture data remotely installed in the Turbine room. Additional pressure transducers and monitoring equipment was also installed.	R60 000
Flow measurement & Pressure reducing and solenoid control	An ultrasonic flow meter was installed on the off-take to the turbine connected to the data logger.	R70 000
Design and implementation	Assistance with design, turbine selection and implementation	R225 000
Total		**R 3 602 690**

Conclusions

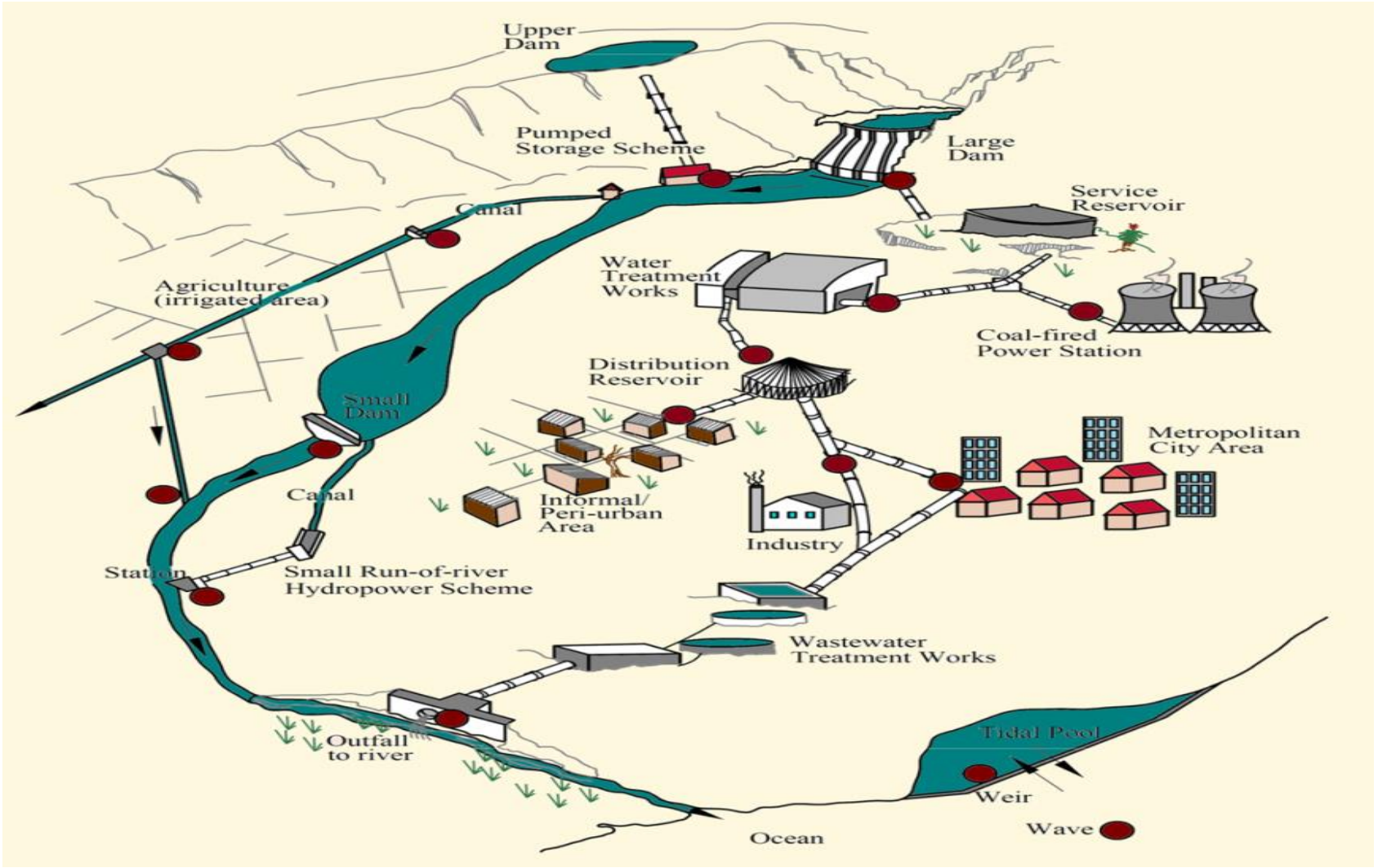
- Based on current spending of Bloemwater head office on monthly electricity bills will result in a payback period of **72 - 83 months** for this project i.e. approximately **6-7 years**.
- A PLC controlled change over panel integrated with the HPP PLC to ensure optimum power generation and supply to the office building. The automated change over panel will constantly monitor the demand required from the office building and should the demand exceed the 96 kW capacity of the Hydropower, the electrical source will automatically be changed to other (ESKOM/Generator) feed.

Other opportunities

- Due to SA having a semi-arid climate, we have a vast network of large dams and water distribution infrastructure (according to SANCOLD > 4900 dams)



Other opportunities (Cont)



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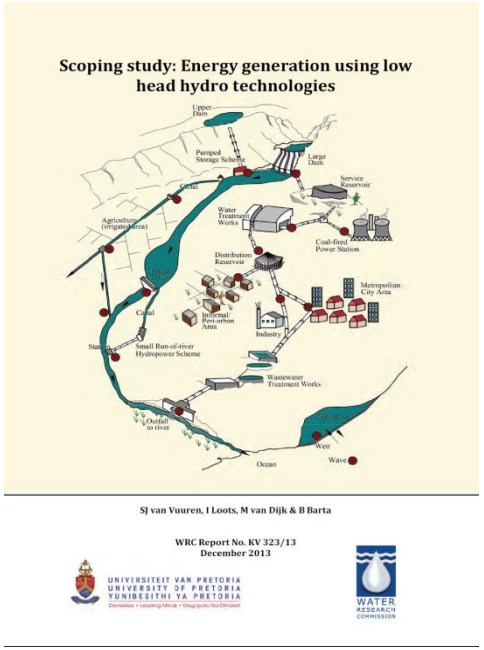
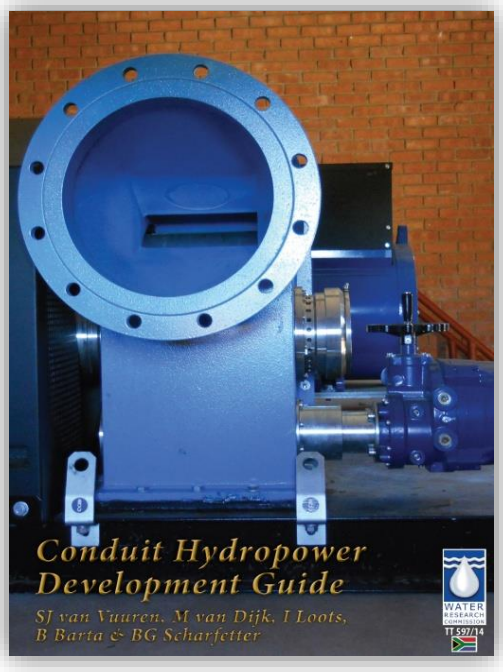
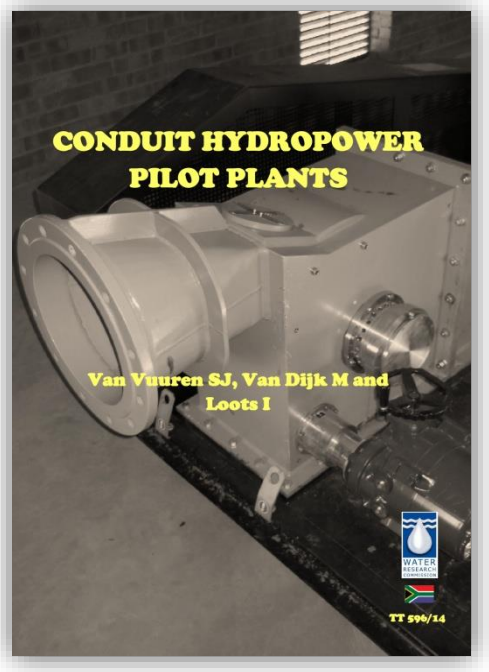
SA Literature/Reports

- KV 323/13 – *Scoping study: Energy generation using low head hydro technologies*
- TT597/14 – *Conduit hydropower development guide*
- TT596/14 – *Conduit hydropower pilot plants*







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Hydropower development opportunities

Prefeasibility study and site evaluation

- Pressure and flow measurements
- Conceptual design of system (pipework, turbine room, grid

Regulatory and permitting

- NERSA licence application
- Environmental Impact Assessment
- Water use licencing
- Land ownership

Detail system design

- Dynamic analysis of pipeline system
- Selection of turbine
- Design of turbine room
- Design of pipe and

Grid integration

- Design of electric control boards
- Design of regulator system
- Design of electric grid connection

Project finance and feasibility study

- Funding strategy and sustainability
- Detailed cost estimated
- Risk assessment
- Sensitivity analysis

Equipment procurement and construction

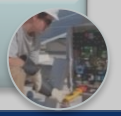
- Tender phase
- Tender evaluation
- Equipment procurement
- Construction of facilities

Project and construction management

- Overall project management
- Site supervision
- Commissioning and testing

Operation and maintenance

- Routine inspections
- Maintenance plan
- Training



Monitoring and evaluation

- Recording of flow, pressure, energy, efficiency, reservoir levels etc.
- Evaluation and optimizing of plant

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Acknowledgements

- Board of Bloemwater
- University of Pretoria
- Water Research Commission
- Mr. JN Bhagwan - Water Research Commission
- Mr. Marco van Dijk - University of Pretoria
- Bloemwater Project Team
  - Ms Colette Baatjies
  - Mr Jacques van Delft
  - Mr Mike Tuck

Thank You

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