THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

24 JULY 2015: WINDHOEK

LCE – SCE JV & OTHERS

1. PROJECT BACKGROUND

1.1 PROJECT PRINCIPLES

- Separate consultancy teams:
  - Engineering Component
  - Environmental & Social Component
- Client liaison via the Project Steering Committee
- Long-term planning: Planning horizon: up to 2050
- 1st Part of the Project: Desk study, pre-feasibility investigation
- 3 Phases to the Project:
  - 1st Phase: Assessment of the water demands and water resources
  - 2nd Phase: Yield assessments, concept schemes, public participation
  - 3rd Phase: Evaluation of schemes, public participation

1.2 PROJECT OBJECTIVE

- Project objective:
  "To examine all nominally feasible options for securing the long term... water supply to the Central Area of Namibia and the Cuvelai area of Namibia where existing sources might become inadequate in the near future"
1. PROJECT BACKGROUND

1.3 PROJECT TEAMS

- Engineering Consultancy Team:
  - Lund Consulting Engineers CC & Seelenbinder Consulting Engineers CC (JV)
  - Environmental Engineering Services
  - Manfred Redecker Consulting Engineer
  - Pedro Maritz Civil Consultant
  - Professional Environmental Technologies
  - Dynamic Water Resources Management
  - The Maproom
  - AECOM

- Environmental & Social Consultancy Team:
  - Sustainable Solutions Trust & Others
  - Southern African Institute for Environmental Assessment

2. THE CUVELAI AREA OF NAMIBIA

2.1 WATER SUPPLY IN THE CUVELAI AREA

- 146 km of canals
- 5 Purification Plants,
- 37 Pump Stations (106 pump sets)
- 48 Reservoirs
- 1,359 km of Bulk (NamWater) Pipelines
- 4,873 km of Rural (DWSSC) Pipelines
2. THE CUVELAI AREA OF NAMIBIA

2.1 WATER SUPPLY IN THE CUVELAI AREA

2.2 WATER DEMANDS & SUPPLY

2.2.2 Abstraction Requirements at Calueque

CUVELAI

- Phase I (assessments of water resources & demands): complete
- The Kunene River should have sufficient supply capacity:
  - 2050 Required abstraction < 6 m³/s allowable
  - 95% Yield: 19.3 m³/s
  - → Need for storage provision (?)
- No redundancy of supply: Single point and source of supply
- Geopolitical concerns
- Future development unknown, water quality may deteriorate
2. THE CUVELAI AREA OF NAMIBIA

2.3 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area

2.3.1 Groundwater in the Cuvelai Area

2049/50:
- Zone 2: 229 BHs
- Zone 3: 621 BHs
- Zone 4: 276 BHs

1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse (20% of current supply)
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water
5. Ohangwena II Aquifer: Investigations underway
2.3 WATER SUPPLY OPTIONS

2.3.5 Ohangwena II Aquifer

Extents
BGR, 2014

Schematic Layout of the Ohangwena Aquifers (after BGR, 2013)

Transmissivity
(BGR, 2014)

Specific Capacity
(BGR, 2014)
2.3             WATER SUPPLY OPTIONS

2.3.5            Ohangwena II Aquifer

Water Quality for Human Consumption (BGR, 2014)

- Area: 5,170 km²
- Depth: 189 – 372 m below surface; average: 235 – 305 m
- Average thickness: 65 m
- Stored volume: 20.68 billion m³ (40 m thickness)
- Potential sustainable abstraction: 6 Mm³/a
- ± 30 Boreholes @ 30 m³/h each; N$ 30 million (BHs only)
- Potable water demand: 2013: ~ 36% of the potable demand
  2050: ~ 21% of the potable demand

2.8             WATER SUPPLY OPTIONS

2.8.5            Ohangwena II Aquifer Supply

Ohangwena II Aquifer supply: 6 Mm³/a
2. THE CUVELAI AREA OF NAMIBIA

2.8 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water: Investigations underway
5. Ohangwena II Aquifer: Investigations underway
6. Abstraction from the Kunene River at Ruacana: Investigations underway

2.8.6 Abstraction from Ruacana
2. THE CUVELAI AREA OF NAMIBIA

2.8 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water: Investigations underway
5. Ohangwena II Aquifer: Investigations underway
6. Abstraction from the Kunene River at Ruacana: Investigations underway
7. Possibly a combination of options
8. Abstraction from the Okavango River (possible abstraction for CAN)
   - Public participation
   - Infrastructure: New & upgrades required
   - Costing and other evaluations: Phase 3

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3. THE CENTRAL AREA OF NAMIBIA

3.1 THE CENTRAL AREA OF NAMIBIA

Approximate extent of the Central Area of Namibia

3.2 WATER SUPPLY SUFFICIENCY

3.2.1 Supply: Water Resources in the CAN

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Yield Value</th>
<th>Yield (Mm³/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined 3 Dams</td>
<td>95% Safe Yield</td>
<td>20.00</td>
</tr>
<tr>
<td>Total Groundwater</td>
<td>Normal Period</td>
<td>4.84</td>
</tr>
<tr>
<td>Direct Reclamation (Whk)</td>
<td>Full capacity</td>
<td>5.00 (7.66)</td>
</tr>
<tr>
<td>Semi-purified Irrigation (Whk)</td>
<td></td>
<td>1.61</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>31.45 (34.11)</strong></td>
</tr>
</tbody>
</table>

31.45 Mm³/a until April 2017, 34.11 Mm³/a thereafter
3.2 WATER SUPPLY SUFFICIENCY

3.2.2 Historic Source Abstraction

- **Resource Capacity**: 31.45 Mm³/a
- **2013 Sales**: 32.85 Mm³/a
- **2013 Source Abstraction**: 36.68 Mm³/a

3.2.3 Demand: Water Demands in the CAN

- Water demands for the Central Area of Namibia:
  - In 2012/13: Sales: 32.85 (Abstraction: 36.68) Mm³/a
  - In 2049/50: 83.89 (Abstraction: 88.86) Mm³/a
  - 50 Mm³ increase: 2.5% per annum over 37 years
- Water demands d/s of Von Bach:
  - 89% (2013) to 95% (2050) of the total in the CAN
- Water demands in Windhoek only (incl. Eisesenheim & Brakwater):
  - 81% (2013) to 85% (2050) of the demand in the CAN

→ Windhoek is by far the largest water demand node in the Central Area of Namibia

3.2.4 Simplified Future Demand Scenario (1)

- **2013 Sales**: 32.85 Mm³/a
- **2013 Source Abstraction**: 36.68 Mm³/a

→ 2050 Shortfall: 55 Mm³/a

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Sales and Demand in Mm³/a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td></td>
</tr>
</tbody>
</table>

Resource Capacity: 31.45 – 34.11 Mm³/a

Simplified Comparison: No hydrological variation!
1. Brief Summary of Findings

5. Historic Water Consumption & Water Demand Projections

Legend:
- Local resources may become insufficient
- Areas not currently served

3.6 The Central Area of Namibia

3.3 Water Supply Options

1. Previous assessments:
   - Covering the ENWC, abstraction from the Kunene / Orange Rivers
2. Not considered:
   - Eiseb & Gobabis Aquifers, Zambezi River
3. Groundwater sources
4. Surface water sources

3.3.3 Groundwater Sources

Augmentation: Omaruru, Otjiwarongo & Otjinene

2050 Shortfall: 76 Mm³/a

Resource Capacity: 31.45 – 34.11 Mm³/a

Simplified Comparison: No hydrological variation!
3.3.4 Surface Sources

- Omatako Dam
- Von Bach Dam
- Swakoppoort Dam
- Friedenau Dam
- Oanob Dam
- Hardap Dam

Legend:
- Current supply to the CAN
- Dams with insufficient capacity

Combined 95% Yield: 20 Mm³/a

Friedenau Dam

Combined 95% Yield: 20 Mm³/a

Oanob Dam

±0.621 Mm³/a

Friedenau Dam

±0.461 Mm³/a

Combined 95% Yield: 20 Mm³/a

Hardap Dam

45.5 Mm³/a (95% Yield @ 70%)
3. THE CENTRAL AREA OF NAMIBIA

3.3 WATER SUPPLY OPTIONS

- Previous assessments:
  - Covering the ENWC, abstraction from the Kunene / Orange Rivers
  - Not considered:
    - Eiseb & Gobabib Aquifers, Zambezi River
- Groundwater sources:
  - Aquifers with insufficient information: Tsumeb & Kalahari Aquifers
  - Aquifers with insufficient capacity: Platveld, Otjiwarongo, Omaruru, Osona, Rehoboth, Nauspoort - Oamites
- Surface water sources:
  - Friedenau, Oanob & Hardap Dams have insufficient capacity
  - Okavango River, Desalination

3.4 SUPPLY / DEMAND MODELLING

3.4.1 Modelling and Basic Inputs

- Computer modelling: CA-Model, Revised to V5.3: November 2014
- 500 simulations: Statistical probability of supply
- Basic Inputs:
  - Likely scenario water demands (Phase 1)
  - Source capacities
  - Operating rules, transfer capacities, losses
  - Water supply scenarios
- Security of supply in terms of statistical probabilities

3.4.2 Scenario Overview

- Medium Term: up to 2023/24:
  - Improvements to existing supply sources
  - To “buy” time to implement the long-term strategy(ies)

3.4.3 Scenario Overview

- Long-term: up to 2050:
  - Augmentation
  - Additional supply requirements
3.4.4 Results: Baseline Scenario

- Computer modelling
- Statistical probability of supply
- Baseline scenario (do nothing)
- Assuming inflow into the dams!

3.4.5 Results: Medium-Term Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Cost (N$)</th>
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<tbody>
<tr>
<td>Scenario 2: Upgrade Von Bach Water Treatment Plant</td>
<td>N$ 40 million (40)</td>
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<tr>
<td>Scenario 3: Reduce losses at Von Bach Water Treatment Plant</td>
<td>N$ 26 million (7)</td>
</tr>
<tr>
<td>Scenario 4: Complete the WMARS</td>
<td>N$ 688 million (545)</td>
</tr>
<tr>
<td>Scenario 5: Supply from Abenab Mine</td>
<td>N$ 518 million (518)</td>
</tr>
<tr>
<td>Scenario 6: Upgrade Gammams &amp; add. reclamation plant</td>
<td>N$ 788 million (605)</td>
</tr>
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<td><strong>Total</strong></td>
<td><strong>N$ 1.5 billion (1.2)</strong></td>
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3.6.5 Results: Medium-Term Scenarios

- Scenario 2: Upgrade Von Bach Water Treatment Plant: N$ 40 million (40)
- Scenario 3: Reduce losses at Von Bach Water Treatment Plant: N$ 26 million (7)
- Scenario 4: Complete the WMARS: N$ 688 million (545)
- Scenario 5: Supply from Abenab Mine: N$ 518 million (518)
- Scenario 6: Upgrade Gammams & add. reclamation plant: N$ 788 million (605)
- **Total: N$ 1.5 billion (1.2)**
3.4.7 Results: Scenario 7 (Okavango)

Supply reaches CAN: 1 May 2022

99% Percentile (Design Values)
Okavango River Abstraction: 64.05 Mm³/a
2.44 m³/s (20 hrs)

50% Percentile (Median Values)
Okavango River Abstraction: 40.35 Mm³/a
1.54 m³/s (20 hrs)

3.4.8 Possible Abstraction from the Okavango

### Scenario 7 (Okavango)

<table>
<thead>
<tr>
<th>Source Supply (99%) and Scenario Explanation</th>
<th>Scenario 7</th>
<th>Scenario 9a</th>
<th>Scenario 9b</th>
<th>Scenario 9c</th>
<th>Scenario 8 (Desal)</th>
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<tr>
<td>Volume: 2049/50 (Mm³/a)</td>
<td>64.05</td>
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<td>72.98</td>
<td>81.18</td>
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<td>Rundu (MAR: 5,464 Mm³/a)</td>
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<tr>
<td>Flow Rate: 2049/50 (m³/s) (20 hrs)</td>
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### Scenario 7 – Okavango River

Supply reaches CAN: 1 May 2022

99% Percentile Values

- **Scenario 7**
  - Okavango River: 64.05 Mm³/a abstractions
  - Supply Scenario: 57.07 Mm³/a supply

- **Scenario 8**
  - Desalination: 57.07 Mm³/a supply

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**Possible Abstraction from the Okavango**

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3. **THE CENTRAL AREA OF NAMIBIA**

### 3.5 CONCLUSIONS

- **Phase I (assessments of water resources & demands):** complete
- **Supply / demand modelling has been conducted using the CA-Model**
- The CAN faces a major water supply problem:
  - No inflow in 2015/16: Run-dry date: Mid-2016 (?)
  - Even with normal rainfall / runoff: Crippling water shortages are to be expected in future
- **Medium-Term Strategy:**
  - Reducing the shortfalls up to 2022/23: N$ 1.5 billion
- **Long-Term Strategy:**
  - Plan, Design & Construct long-term augmentation scheme to have water reach the CAN by May 2022

### 3.6 CONSIDERATIONS & OPTIONS

- **Environmental and social analyses:**
  - Scenario 3: VBWTP supernatant recycling to reduce losses
  - Scenario 4: WMARS expansion
  - Scenario 6: Waste water treatment & advanced reclamation
  - Scenario 7: Okavango abstraction
  - Scenario 8: Desalination...?
- **Further considerations:**
  - Additional demands of Omaruru, Otjiwarongo & Otjinene?
  - Additional demand in Windhoek (+10% or +21%), NE areas?
  - Water demands along possible pipeline routes
  - Public participation
  - Infrastructure: New & upgrades required
  - Costing and other evaluations: Phase 3