# ANNEXURE A

## Acronyms used in Annexure B

| | |
|---|---|
| BHN | Basic Human Needs |
| EIS | Ecological Importance and Sensitivity |
| EWR | Ecological Water Requirement |
| IUA | Integrated Unit of Analysis |
| NMAR | Natural Mean Annual Runoff |
| MCM | Million Cubic Metres |
| PES | Present Ecological Status |
| REC | Recommended Ecological Category |
| TEC | Target Ecological Category |

## SURFACE-WATER - QUANTITY COMPONENT FOR RIVERS

The results for the Reserve determination and ecological categorisation for F60 and G30 catchments, where the Reserve amounts are expressed as a percentage of the NMAR for the respective catchments (cumulative) in terms of section (16)(1).

# ANNEXURE B

**Table 1.1:** Reserve determination for the quantity component for the rivers which include the EWR & BHN for the priority sites.

| Quaternary Catchment | Water Resource (Node/ EWR site) | PES | EIS | REC | NMAR (MCM)[1] | Ecological Reserve[3] (MCM) | BHN Reserve[4] (MCM) | Total Reserve[2] (% NMAR) |
|---|---|---|---|---|---|---|---|---|
| F60A | Lower Brak River – **EWR 1** | B | Moderate | B | 0.07 | 0.019 | 0.001 | 28.59 |
| F60B | Klein Goerap River at the confluence with the Sout River – Node 1 | C | Moderate | B | 0.07 | 0.019 | 0.009 | 43.28 |
| F60C | Sout River at the confluence with the Klein Goerap River – Node 2 | C | Moderate | C | 0.255 | 0.046 | 0.004 | 39.36 |
| F60D | Lower Groot River – **EWR 3** | C | Moderate | C | 0.11 | 0.020 | 0.008 | 25.45 |
| G30A | Lower Papkuils River – **EWR 15** | C/D | High | C | 1.378 | 0.407 | 0.129 | 43.2 |
| G30B | Bergvallei River at the confluence with the Kruismans River – Node 3 | D/E | High | C | 16.353 | 7.039 | 0.038 | 39.19 |
| G30C | Upper Kruismans River at the confluence with the Bergvallei River – Node 4 | D | High | C | 11.457 | 4.510 | 0.004 | 19.67 |
| G30D | Lower Kruimans River – **EWR 10** | D | High | C | 27.813 | 11.279 | 0.004 | 42.2 |
| G30D | Lower Krom Antonies River – **EWR 11** | C/D | High | C | 7.318 | 2.730 | 0.001 | 39.1 |
| G30E | Lower Verlorenvlei River – **EWR 12** | D | High | C | 47.502 | 17.617 | 0.021 | 39.2 |
| G30F | Lower Langvlei River – **EWR 8** | E | High | D | 8.955 | 1.718 | 0.025 | 19.5 |
| G30G | Lower Jakkals River – **EWR 7** | C/D | Moderate | D | 2.315 | 0.685 | 0.131 | 37.4 |
| G30H | Lower Sandlaagte River – **EWR 6** | C/D | Low | C | 2.80 | 0.330 | 0.059 | 13.89 |

1) NMAR is the Natural Mean Annual Runoff.
2) The total Reserve amount accounts for both the Ecological Reserve and the Basic Human Needs Reserve (BHN).
3) This amount represents the long-term mean based on the NMAR. If the NMAR changes, this volume will also change.
4) Represents the Basic Human Needs (BHN).

# SURFACE-WATER - QUALITY COMPONENT FOR RIVERS

## Reserve determination for the Quality component at EWR sites

**Table 2.1:** Water quality Reserve Requirements for the Papkuils River (**G30A**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chloride (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.015 - 0.025 |
| | Total Inorganic Nitrogen (mg/l)[3] | <0.5 | <0.9 | <0.7 – 1 |
| Physical water quality | pH (pH units) | 7.6 | 6 - 9 | 5th percentile 5.6 – 5.9 / 95th percentile 8.8 – 9.2 |
| | Electrical conductivity (mS/m) | 129 | <70 | ≤129[5] |
| | Total Dissolve Solid (mg/l) | 868 | <450 | ≤868[5] |
| | Turbidity (NTU) | 3.8 | 1 - 5 | 1 – 5 |
| | Dissolve Oxygen (mg/l) | 12.4 | | 6 – 7 |
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |
| Microbiological Water Quality[3] | Faecal Coliforms (count per 100ml) | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**Table 2.2:** Water quality Reserve Requirements for the Kruismans River (**G30D**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chlorine (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.015 - 0.025 |
| | Total Inorganic Nitrogen (mg/l)[3] | <0.5 | <0.9 | <0.7 – 1 |

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| Physical water quality | pH (pH units) | 7.19 – 7.35 | 6 - 9 | 5th percentile 5.6 – 5.9/ 95th percentile 8.8 – 9.2 |
| | Electrical conductivity (mS/m) | 650 - 990 | <70 | ≤650 (wet season) ≤990 (dry season)[5] |
| | Total Dissolve Solid (mg/l) | 4400 - 6800 | <450 | ≤4400 (wet season) ≤6800 (dry season)[5] |
| | Turbidity (NTU) | 1.8 – 19.2 | 1 - 5 | 1 – 5 |
| | Dissolve Oxygen (mg/l) | 13 | | 6 – 7 |
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |
| Microbiological Water Quality[3] | Faecal Coliforms (count per | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**Table 2.3:** Water quality Reserve Requirements for the Krom Antonies River (**G30D**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chlorine (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.015 - 0.025 |
| | Total Inorganic Nitrogen (mg/l)[3] | <0.5 | <0.9 | <0.7 – 1 |
| Physical water quality | pH (pH units) | 7.65 – 7.78 | 6 - 9 | 5th percentile 5.6 – 5.9/ 95th percentile 8.8 – 9.2 |
| | Electrical conductivity (mS/m) | 29 - 157 | <70 | ≤29 (wet season) ≤157 (dry season)[5] |
| | Total Dissolve Solid (mg/l) | 202 - 1044 | <450 | ≤202 (wet season) ≤1044 (dry season)[5] |
| | Turbidity (NTU) | 1.4 – 18.2 | 1 - 5 | 1 – 5 |
| | Dissolve Oxygen (mg/l) | 10.8 | | 6 – 7 |
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| Microbiological Water Quality[3] | Faecal Coliforms (count per 100ml) | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**Table 2.4:** Water quality Reserve Requirements for the Verlorenvlei River (**G30E**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chlorine (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.015 - 0.025 |
| | Total Inorganic Nitrogen (mg/l)[3] | <0.5 | <0.9 | <0.7 - 1 |
| Physical water quality | pH (pH units) | 7.62 | 6 - 9 | 5th percentile 5.6 – 5.9/ 95th percentile 8.8 – 9.2 |
| | Electrical conductivity (mS/m) | 194 | <70 | <194[5] |
| | Total Dissolve Solid (mg/l) | 1300 | <450 | <1300[5] |
| | Turbidity (NTU) | 4.4 | 1 - 5 | 1 - 5 |
| | Dissolve Oxygen (mg/l) | 8.9 | | 6 - 7 |
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |
| Microbiological Water Quality[3] | Faecal Coliforms (count per 100ml) | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**Table 2.5:** Water quality Reserve Requirements for the Langvlei River (**G30F**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chlorine (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.025 – 0.125 |
| | Total Inorganic Nitrogen (mg/l)[3] | 1.98 | <0.9 | <1 - 4 |
| Physical water quality | pH (pH units) | 6.9 | 6 - 9 | 5th percentile 5.0 – 5.6/95th percentile 9.2 – 10.0 |
| | Electrical conductivity (mS/m) | 1214 | <70 | ≤1214[5] |
| | Total Dissolve Solid (mg/l) | 7998 | <450 | ≤7998[5] |
| | Turbidity (NTU) | 37 | 1 - 5 | 1 – 5 |
| | Dissolve Oxygen (mg/l) | 14 | | 6 – 7 |
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |
| Microbiological Water Quality[3] | Faecal Coliforms (count per 100ml) | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**Table 2.6:** Water quality Reserve Requirements for the Jakkals River (**G30G**)

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| General chemistry – Major Ions[1,2,3] | Sodium (mg/l) | N/A | <200 | <200[4] |
| | Magnesium (mg/l) | N/A | <70 | <70[4] |
| | Chloride (mg/l) | N/A | <200 | <200[4] |
| | Calcium (mg/l) | N/A | <80 | <80[4] |
| | Sulphate (mg/l) | N/A | <200 | <200[4] |
| | Chlorine (mg/l) | N/A | N/A | <0.35[4] |
| | Fluoride (mg/l) | N/A | < 1.5 | <1.5[4] |
| | Manganese (µg/l) | N/A | <0.15 | <0.15[4] |
| | Potassium (mg/l) | N/A | <50 | <50[4] |
| Nutrients [1,2,3] | Phosphate ($PO_4$)(mg/l) | <0.2 | N/A | <0.015 - 0.025 |
| | Total Inorganic Nitrogen (mg/l)[3] | <0.5 | <0.9 | <0.7 - 1 |
| Physical water quality | pH (pH units) | 7.12 – 7.39 | 6 - 9 | 5th percentile 5.6 – 5.9/ 95th percentile 8.8 – 9.2 |
| | Electrical conductivity (mS/m) | 2200 - 10100 | <70 | ≤2200 (wet season) ≤10100 (dry season)[5] |
| | Total Dissolve Solid (mg/l) | 14606 - 61200 | <450 | ≤14606 (wet season) ≤61200 (dry season)[5] |
| | Turbidity (NTU) | 0.88 - 14 | 1 - 5 | 1 - 5 |
| | Dissolve Oxygen (mg/l) | N/A | | 6 - 7 |

| Quality Constituent | Parameter | Ecological Reserve Requirements (PES) | Basic Human Needs Requirement | Reserve Requirement: water quality |
|---|---|---|---|---|
| Toxics and complex mixtures[1] | Toxics (as listed in DWAF, 1996) | ≤ TWQR | ≤ TWQR | ≤ TWQR |
| Microbiological Water Quality[3] | Faecal Coliforms (count per 100ml) | - | - | - |
| | Total Coliforms (count per 100ml) | - | <10 | <10[4] |

**NOTE**: *Where a difference in the water quality values for the Ecological Reserve and Basic Human Needs Reserve was found, the stricter or more protective value was selected for the water quality component of the Reserve.*

[1] ***ref:*** *South African Water Quality Guidelines, Volume 1: Domestic Water Use, 2nd Ed. 1996. Department of Water Affairs and Forestry. Pretoria, South Africa.*

[2] ***ref:*** *South African Water Quality Guidelines, Volume 7: Aquatic Ecosystems, 2nd Ed. 1996. Department of Water Affairs and Forestry. Pretoria, South Africa.*

[3] ***ref:*** *South African National Standard 241:2011 Water Quality Standards*

[4] ***note:*** *Based on Basic Human Needs requirements. Water for domestic use should be treated to SANS 241: 2011 Water Quality Standards.*

[5] ***note:*** *The Reserve Requirement does not meet the Basic Human Needs requirements as it is a naturally high salinity system and would never meet the BHN requirements. Water for domestic use should be treated to SANS 241: 2011 Water Quality Standards*

# SURFACE-WATER - ESTUARIES COMPONENT

# QUANTITY

**Table 3.1.** Geographical boundaries of Estuaries

| Estuaries | Quat | Estuary Type | Location of Estuary Head | Location of Estuary Mouth | Lateral boundaries |
|---|---|---|---|---|---|
| Verlorenvlei Estuary | G30E | Estuarine Lake | 32°25’55.82”S; 18°29'57.78”E | 32°18'58.34"S; 18°20'5.96"E | 5 m contour above Mean Sea Level (MSL) along each bank |
| Wadrift Estuary | G30F | Predominantly Closed estuary | 32°12’49.87”S; 18°22'37.15”E | 32°12'15.54"S; 18°19'32.43"E | 5 m contour above Mean Sea Level (MSL) along each bank |
| Jakkals Estuary | G30G | Temporarily Closed estuary | 32°5’26.89”S; 18°20'1.32”E | 32°5'5.39"S; 18°18'48.25"E | 5 m contour above Mean Sea Level (MSL) along each bank |
| Sout (Noord) Estuary | F60D | Predominantly Closed estuary | 30°28'17.92"S 17°22'32.83"E | 30°28'20.54"S 17°21'34.07"E | 5 m contour above Mean Sea Level (MSL) along each bank |

**Table 3.2.** The ecological water requirements of Estuaries.

| Quaternary catchment | Water Resource | PES | EIS | REC | Ecological Reserve* (MCM) | Ecological Reserve (% NMAR) | Natural MAR (MCM) | Present MAR (MCM) |
|---|---|---|---|---|---|---|---|---|
| **G30E** | Verlorenvlei Estuary | D[1] | Important | B[2] | 27.505 | 82.6 | 33.3 | 17.93 |
| **G30F** | Wadrift Estuary | D | Important | C | 3.658 | 77 | 4.75 | 3.2 |
| **G30G** | Jakkals Estuary | D | Low to Average | D | 0.804 | 57 | 1.41 | 0.96 |
| **F60D** | Sout (Noord) Estuary | E | Average | D | -[3] | -[3] | 0.46 | 0.46 |

*[1] The observed Present (2022) was estimated to be E Category due to the extended drought, which together with the abstraction of water, caused persistent long-term exposure of the lake margins and bed (very low water levels). Assuming that recovery is possible after lake levels increase again, an evaluation of the 101-year Present simulation scenario indicated a PES = Category D.*

*[2] The Verlorenvlei Estuary was categorised as an “important estuary”. It is a Ramsar site and a desired protected area in the Biodiversity Plan for the National Biodiversity Assessment. Therefore, according to the guidelines for assigning a REC, the condition of the estuary should be elevated to the Best Attainable State (BAS). The Best Attainable State for the estuary is B.*

[3] *The Sout Estuary assessment was undertaken at a desktop level with hydrology that was of a very low confidence. It is recommended that the system should be restored from an unstable E category to a D category. As most of the impacts are non-flow related the present-day flows should be maintained as the recommended flow.*

## ECOLOGICAL SPECIFICATIONS

**Thresholds of potential concern** (TPC) are defined as measurable end points related to specific abiotic or biotic indicators that if reached (or when modelling predicts that such points will be reached) prompt management action. In essence, TPCs should provide early warning signals of potential non-compliance to ecological specification (i.e. not the point of 'no return'). This implies that the indicators (or monitoring activities) selected as part of a long-term monitoring programme need to include biotic and abiotic components that are particularly sensitive to changes in river inflow. The TPCs associated with each of the ecological specifications are also provided in Table 3.3 to Table 3.6.

**Table 3.3:** Ecological Specifications and TPC associated with an **Ecological Category B** in the Verlorenvlei River Estuary

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Water quality | Salinity structure and the occurrence of different abiotic states should correspond as closely as possible with the Reference condition; State 5 (Closed, Low water level hypersaline) should not occur at all. | • Salinity in Zone A > 45 (for 3 years)<br>• Salinity in Zone B > 3<br>• Salinity in Zone C > 1.5 |
| | Water quality in **river inflow** does not detrimentally affect water quality conditions in estuary, specifically relating to inorganic nutrient enrichment and toxic substances | River inflow:<br>• pH of river inflow exceeds 8.5 or is less than 5.5<br>• Dissolved oxygen (DO) less than 4 mg/ℓ<br>• Turbidity persistently exceeds 10 NTU<br>• Dissolved Inorganic Nitrogen (DIN) persistently greater than 200 µg/ℓ<br>• Dissolved Inorganic Nitrogen (DIN) persistently greater than 50 µg/ℓ<br>• Toxic substance concentrations (e.g. heavy metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine) |
| | Water quality **in estuary** does not detrimentally impact biotic health, specifically relating to nutrient enrichment and diurnal fluctuation in pH and (e.g. decreasing at night and increasing during day time), or acidification and potential hypoxia developing during algal decay. | Estuary:<br>• pH drop below 6, or persistently above 9<br>• DO less than 4 mg/ℓ<br>• Turbidity persistently exceeds 20 NTU (e.g. as a result of persistent algal blooms) |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| | | • Resultant DIN exceeds 100 µg/ℓ (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Resultant DIP exceeds 20 µg/ℓ ) (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine) |
| Hydrodynamic | Estuary should be allowed to function as naturally as possible with minimal human intervention | • The mouth is breached artificially<br>• No connectivity between Zone A, B and C |
| Sediment dynamics | Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota | • As for hydrodynamics above |
| Microalgae | Phytoplankton communities should reflect a diverse community, with moderate to low biomass (measured as chlorophyll-a concentration), and reduced occurrence of HABs. Benthic microalgal communities should reflect moderate biomass and medium- (closed phase) to high (open phase) benthic diatom diversity. | • Phytoplankton biomass greater than 20 µg Chl-*a* $l^{-1}$.<br>• High-biomass HABs (> 60 µg Chl-*a* $l^{-1}$ dominated by a single taxa, e.g., cyanophytes) in spring/summer.<br>• Subtidal benthic microalgal biomass greater than 100 mg Chl-*a* $m^{-2}$.<br>• Benthic diatom diversity (*H'*) less than 2. |
| Macrophytes | Monitor the distribution of plant community types i.e. reeds and sedges, submerged macrophytes, salt marsh during water level fluctuations. Maintain reeds and sedges and open water habitat which supports associated biota. Reeds and sedges are dependant on groundwater discharge (See methods decribed in Verlorenvlei EWR report). Increases in upper reaches are in response to sediment and nutrient input. Monitor acidic soils as long-term effects on the recovery of macrophytes are unknown. Important risk factors are pH and salinity, particularly in the groundwater and sediment. Water column turbidity is important for submerged macrophyte . | • Greater than 20% change in the area covered by different macrophyte habitats.<br>• Open water area below 1.2 ha (Zone A), 405 ha (Zone B) and 14.3 ha (Zone C) results in exposure to acidic soils.<br>• Groundwater salinity above 10 to 5 reduces the growth of reeds and sedges.<br>• Sediment salinity > 75 results in no significant growth. Seed germination hampered below 15. |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Invertebrates | The estuary should contain a diverse invertebrate community that includes representatives of all functional groups listed in this report, particularly the freshwater and brackish species including the macroinvertebrates. | A decline in the abundance and diversity of crustacea and insect lavae in zooplankton (baseline to be determined). |
| Fish | Retain the following fish assemblages in the estuary (based on abundance): estuarine-resident species (20-30%), estuarine associated marine species (60-70%) and indigenous freshwater species (<1%).<br>All numerically dominant indigenous species are represented by 0+ juveniles within 12 months of the system being open. | • Level of estuary-associated marine species drops below 50% of total abundance.<br>• Occurrence of alien freshwater species in the estuary.<br>• Absence of 0+ juveniles of any of the dominant fish species within 12 months of the system being open. |
| Birds | The estuary should contain a diverse avifaunal community that includes representatives of all functional guilds listed in this report, particularly the migratory waders and waterfowl.<br>The estuary should support thousands of birds in summer and hundreds in winter. | • Reduced abundance of piscivores (< 3 species; or <100 birds).<br>• Numbers of waterfowl drop below 600 or waders below 100 in summer.<br>• Overall numbers of waterbirds drop below 2000 for 3 consecutive counts in summer. |

**Table 3.4:** Ecological Specifications and TPC associated with an **Ecological Category C** in the Wadrift River Estuary

| Abiotic/biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Water quality | Salinity structure and the occurrence of different abiotic states should correspond as closely as possible with the Reference condition; State 5 (Closed, Low water level hypersaline) should not occur at all. | • Salinity in any part of the estuary exceeds 65 |
| | Water quality in **river inflow** does not detrimentally affects water quality conditions in estuary, specifically relating to inorganic nutrient enrichment and toxic substances | River inflow:<br>• pH of river inflow exceeds 8.5 or decrease below 5.5<br>• Dissolved oxygen (DO) less than 4 mg/ℓ<br>• Turbidity persistently exceeds 10 NTU<br>• Dissolved Inorganic Nitrogen (DIN) persistently greater than 200 µg/ℓ |

| Abiotic/biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| | | • Dissolved Inorganic Nitrogen (DIN) persistently greater than 50 µg/ℓ<br>• Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine). A comprehensive baseline sampling will have to be conducted to determine the substances to be incorporated in long term monitoring programme. |
| | Water quality **in estuary** does not detrimentally impact biotic health, specifically relating to nutrient enrichment and diurnal fluctuation in pH and (e.g. decreasing at night and increasing during day time), or acidification and potential hypoxia developing during algal decay. | Estuary:<br>• pH drop below 6, or persistently above 9<br>• DO less than 4 mg/ℓ<br>• Turbidity persistently exceeds 20 NTU (e.g. as a result of persistent algal blooms)<br>• Resultant DIN exceeds 100 µg/ℓ (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Resultant DIP exceeds 20 µg/ℓ ) (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine) |
| Hydrodynamics | Estuary should be allowed to function as naturally as possible with minimal human intervention | • No connectivity between Zone A and B (culvert levels in bridges raised above the floor ground) |
| Sediment dynamics | Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota | • As for hydrodynamics above |
| Microalgae | Phytoplankton communities should be maintained to reflect a diverse community, with moderate biomass (measured as chlorophyll-*a* concentration), and limited occurrence of HABs. Benthic microalgal communities should reflect moderate levels of biomass and diversity during the closed phase, and improve during periods of increased river inflow. | • Phytoplankton biomass greater than 20 µg Chl-*a* $l^{-1}$.<br>• Frequent and monospecific (>90% relative abundance) high-biomass HABs (>60 µg Chl-*a* $l^{-1}$)<br>• Subtidal benthic microalgal biomass greater than 100 mg Chl-*a* $m^{-2}$.<br>• Benthic diatom diversity (*H'*) less than 2. |

| Abiotic/biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Macrophytes | Maintain the distribution, extent and diversity of plant community types, salt marsh and any remaining reed and sedges. Although peat swamps in the upper reaches will not return, increased freshwater inflow will increase habitat diversity and reduce terrestrial species that have now replaced lost habitat. | • Greater than 20% change in the area covered by different macrophyte habitats for baseline open and closed mouth conditions. |
| Benthic Invertebrates Zooplankton | Retain the present invertebrate assemblages | • Baseline to be determined |
| Fish | Retain the present fish assemblages. | • No fish present<br>• Occurrence of alien freshwater species in the estuary. |
| Birds | The estuary should contain a rich avifaunal community that includes representatives of all the original groups, significant numbers of migratory waders and terns, as well as a healthy breeding population of resident waders. The estuary should support thousands of birds in summer and hundreds in winter. | • Numbers of waterfowl drop below 600, waders below 100 in summer, and terns below 250<br>• Overall numbers of bird species drop below 1000 for 3 consecutive counts. |

**Table 3.5:** Ecological Specifications and TPC associated with an **Ecological Category D** in the Jakkals River Estuary

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Water quality | Salinity structure and the occurrence of different abiotic states should correspond as closely as possible with the Present State;<br>State 1 (Closed, Low water level hypersaline) should not occur more than at present. | • Salinity in any part of the estuary exceeds 35 |
| | Water quality in river inflow does not detrimentally affects water quality conditions in estuary, specifically relating to inorganic nutrient enrichment and toxic substances | River inflow:<br>• pH of river inflow exceeds 8.5<br>• Dissolved oxygen (DO) less than 4 mg/ℓ<br>• Turbidity persistently exceeds 10 NTU<br>• Dissolved Inorganic Phosphate (DIP) persistently greater than 200 µg/ℓ<br>• Dissolved Inorganic Nitrogen (DIN) persistently greater than 50 µg/ℓ |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| | | • Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine). Comprehensive baseline sampling will have to be conducted to determine the substances to be incorporated in long term monitoring programme. |
| | Water quality in estuary does not detrimentally impact biotic health, specifically relating to nutrient enrichment and diurnal fluctuation in pH and (e.g. decreasing at night and increasing during day time), or acidification and potential hypoxia developing during algal decay. | Estuary:<br>• pH drop below 6, or persistently above 9<br>• DO less than 4 mg/ℓ<br>• Turbidity persistently exceeds 20 NTU (e.g. as a result of persistent algal blooms)<br>• Resultant DIN exceeds 100 µg/ℓ (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Resultant DIP exceeds 20 µg/ℓ ) (in a closed system this would suggest excessive enrichment through remineralisation)<br>• Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine). Comprehensive baseline sampling will have to be conducted to determine the substances to be incorporated in long term monitoring programme. |
| Hydrodynamics | Estuary should be allowed to function as naturally as possible | • >11% occurrence in State 1:Closed marine/hypersaline, indicated by extensive exposure of Zone B and C.<br>• >72% occurrence in State 2:Closed marine<br>• <5% occurrence of open mouth conditions<br>• Overwash does not occur for 6 months |
| Sediment dynamics | Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota. | • As for hydrodynamics above |
| Microalgae | Phytoplankton communities should be maintained to reflect a diverse community, with moderate biomass (measured as chlorophyll-*a* concentration), and limited occurrence of HABs. Benthic microalgal communities should reflect moderate levels of biomass and diversity during the closed phase, and improve during periods of increased river inflow. | • Phytoplankton biomass greater than 20 µg Chl-*a* $l^{-1}$.<br>• Monospecific (>90% relative abundance) high-biomass HABs (>60 µg Chl-*a* $l^{-1}$)<br>• Subtidal benthic microalgal biomass greater than 100 mg Chl-*a* $m^{-2}$.<br>• Benthic diatom diversity (*H'*) less than 2. |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Macrophytes | Maintain the distribution, extent and diversity of plant community types, salt marsh and any remaining reed and sedges. Although peat swamps in the upper reaches will not return, increased freshwater inflow will increase habitat diversity and reduce terrestrial species that have now replaced lost habitat. | • Greater than 20% change in the area covered by different macrophyte habitats for baseline open and closed mouth conditions. |
| Benthic Invertebrates Zooplankton | Retain the present invertebrate assemblages | • Baseline to be determined |
| Fish | Retain the present fish assemblages. | • Less than 2 of the 5 expected species of fish observed<br>• Occurrence of alien freshwater species in the estuary.<br>• Absence of 0+ juveniles of any of the dominant fish species. |
| Birds | The estuary should contain a diverse although seasonally stochastic avifaunal community that includes representatives of functional guilds listed in this report, particularly the migratory waders and waterfowl. The estuary should support a few hundred waterbirds in summer in winter. | • Reduced abundance of piscivores (< 2 species; or <10 birds).<br>• Numbers of waterfowl or waders drop below 50 in summer.<br>• Overall numbers of waterbirds drop below 200 for 3 consecutive counts in summer, and less than 10 species are recorded in consecutive counts. |

**Table 3.6:** Ecological Specifications and TPC associated with an **Ecological Category D** in the Sout River Estuary

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Water quality | Extreme hypersalinity should be prevented | • Upper reaches: >120 psu (hyper salinity)<br>• Middle Reaches: > 80 psu (hyper salinity)<br>• Lower reaches: > 60 psu (hyper salinity) |
| | Water quality in estuary does not detrimentally impact biotic health, specifically relating to nutrient enrichment and potential hypoxia developing during algal decay. | • DIN: Entire estuary, average >0.1 mg/ℓ<br>• DIP: Entire estuary, average >0.01 mg/ℓ<br>• DO: Entire estuary, average ≥6 mg/ℓ<br>• Turbidity: Entire estuary, average >10 NTU except during floods<br>• Toxic substance concentrations (e.g. metals and agrochemicals) exceed South African Water Quality guidelines (freshwater and coastal marine) Comprehensive baseline sampling will have to be conducted to determine the substances to be incorporated in long term monitoring programme. |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Hydrodynamics | Estuary should be allowed to function as naturally as possible | Improved connectivity with the different water bodies and restored connectivity with the catchment through removal/modification of weir at the head of the estuary. |
| Sediment dynamics | Flood and breaching regimes to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota | • The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat).The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).<br>• Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five-year average. |
| Microalgae | Phytoplankton communities should be maintained to reflect a diverse community, with moderate biomass (measured as chlorophyll-*a* concentration), and limited occurrence of HABs. Benthic microalgal communities should reflect moderate levels of biomass and diversity during the closed phase, and improve during periods of increased river inflow. | Maintain the distribution of different phytoplankton groups and low biomass in the lower reaches (< 10 µg $l^{-1}$ (Baseline to be determined). |
| Macrophytes | Maintain the distribution, extent and diversity of plant community types, salt marsh and any remaining reed and sedges. Although peat swamps in the upper reaches will not return, increased freshwater inflow will increase habitat diversity and reduce terrestrial species that have now replaced lost habitat. | • >20 % change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries).<br>• Water column salinity not greater than 50 in the lower reaches to limit salt accumulation and dieback of salt marsh (*Sarcocornia pillansii*).<br>• Prevent further disturbance and development in the salt marsh and floodplain habitat through salt works activities. |

| Abiotic/Biotic Component | Ecological Specification | Threshold of Potential Concern |
|---|---|---|
| Benthic Invertebrates Zooplankton | Retain the present invertebrate assemblages | • Unincysted Brine shrimp should be present in the system for < 75% of the time.<br>• Baseline to be determined |
| Fish | Not applicable. Hyper saline system. | • Not applicable. Hyper saline system. |
| Birds | The estuary should contain a diverse although seasonally stochastic avifaunal community that includes representatives of functional guilds listed in this report, particularly the migratory waders and waterfowl. The estuary should support a few hundred waterbirds in summer in winter. | • Including flamingos, more than 10 species of waders and water birds that feed on brine shrimp should be present < 75% of the time (During 40 – 150 and brine shrimp available).<br>• The occurrence and cause of bird mortalities needs to be verified. |

## SURFACE-WATER - QUANTITY COMPONENT FOR WETLAND

Proposed EWR sites were selected within each of the Wetland Resource Units during the reconnaissance field survey undertaken in March 2022. The EWR sites were selected together with the EWR sites/reaches for the River Resource Units to facilitate integration.

**Table 4.1** identifies the priority wetlands in the F60 and G30 catchments and summarises the PES, EIS, REC for the identified wetlands.

**Table 4.1:** Table showing results of the prioritised wetlands**.**

| Quat | EWR site/ Node | Water Resource | Geographic coordinates | | PES | EIS | REC |
|---|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | | | |
| F60A | EWR 2 | North West Fynbos depression | 30°57'15.89"S | 17°46'43.61"E | A/B | High | A/B |
| F60C | EWR 4 | Knersvlakte depression Wetland | 31° 7'12.48"S | 17°54'33.50"E | B | Moderate | B |
| F60E | EWR 5 | Sandveld depression Wetland | 31°24'10.86"S | 17°59'24.11"E | C | Moderate | C |
| G30F | EWR 9 | Wadrift Wetland | 32°12'52.21"S | 18°22'31.50"E | F | High | D |
| G30A | EWR13 | Isolated depression/ duneslack wetland | 32°22'39.14"S | 18°19'48.28"E | C | High | C |
| G30A | EWR14 | Rocherpan | 32°36'49.34"S | 18°17'55.89"E | D | High | C |
| G30A | EWR16 | Papkuilsvlei / Rietvlei | 32°38'1.26"S | 18°29'56.29"E | C | High | C |

## GROUNDWATER - QUANTITY COMPONENT

## WATER QUANTITY COMPONENT

Delineation of the groundwater system within the G30 catchment followed the existing quaternary boundaries (**Figure 2**) as they do tend to each incorporate a single valley that relates well with perceived groundwater flow and surface water contribution. The G30D quaternary catchment was split into a northern and southern GRU. This was based on a large difference in the rainfall received evidently increasing from north to south. The southern portion of the quaternary catchment experiences much higher rainfall in comparison to that of the north. Where the southern mountainous area comprises of sedimentary bedrock cross-cut by fault structures and fractured zones, linked to higher percentages of recharge. G30F has also been split into a northern and southern GRU as this quaternary catchment includes two valleys that each have a separate paleochannel type feature.

Taking into account the nature of the groundwater system within the F60 catchments, the existing quaternary boundaries (**Figure 3**) were also followed as they do tend to each incorporate a single surface water system and as the RQOs will be on that level and actual groundwater boundaries are not known, the quaternary boundaries will act as sufficient separation. Due to the presence of karst type aquifers in F60E`s coastal areas, it was attempted to divide the catchment. Due to a lack of data that could indicate exactly how far up the coast the karst aquifers stretch, it was decided to ultimately leave the boundaries of the GRU as is until sufficient data becomes available. Delineation areas in G30 catchments.

**Table 5.1:** Determination of the Groundwater Reserve

| Sub-catchments used to calculate recharge | River System | Area ($km^2$) | MAP (mm) | Estimated Recharge (% of total annual flow) | Calculated recharge ($Mm^3$) | Total abstracted for Town supply (million $m^3$) | Reserve (BHN + Springflow + Baseflow Contributions) | Total abstracted for irrigation (million $m^3$) | Groundwater Balance (million $m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| G30A1 | Papkuils | 131.1 | 292 | 3.5% | 1.34 | | | | |
| G30A2 | Papkuils Lower | 10.0 | 292 | 3.5% | 0.10 | | | | |
| G30A_Groundwater | | 604.3 | 260 | 3.5% | 5.50 | | | | |
| **G30A_Total** | | | | | **6.94** | **0** | **0.252981875** | **6.79956** | **-0.11070** |
| G30B1 | Upper Kruismans | 23.7 | 505 | 23.0% | 2.75 | | | | |
| G30B1 | Upper Kruismans | 92.4 | 300 | 5.0% | 1.39 | | | | |
| G30B2 | Soutkloof | 17.8 | 415 | 23.0% | 1.69 | | | | |
| G30B2 | Soutkloof | 194.5 | 300 | 5.0% | 2.92 | | | | |
| G30B3 | Huis tributary | 53.8 | 505 | 23.0% | 6.25 | | | | |
| G30B3 | Huis tributary | 288.5 | 300 | 5.0% | 4.33 | | | | |
| **G30B_Total** | | | | | **19.32** | **0.053676** | **3.5056685** | **2.1537** | **13.61017** |
| G30C1 | Kleinvlei | 64.3 | 404 | 23.0% | 5.98 | | | | |
| G30C2 | Jansekraal | 62.6 | 404 | 23.0% | 5.81 | | | | |
| G30C3 | Bergvallei | 218.2 | 383 | 3.5% | 2.92 | | | | |
| **G30C_Total** | | | | | **14.72** | **0.074207** | **1.541531375** | **6.33080** | **6.76926** |
| G30D1 | KA upper | 64.8 | 517 | 23.0% | 7.71 | | | | |
| G30D1 | KA lower | 55.1 | 366 | 5.0% | 1.01 | | | | |
| G30D2 | Hol upper | 51.7 | 517 | 23.0% | 6.15 | | | | |
| G30D2 | Hol lower | 102.6 | 366 | 5.0% | 1.88 | | | | |
| G30D3 | Matroosfontein | 128.2 | 347 | 3.5% | 1.56 | | | | |
| G30D4 | Verlorenvlei | 151.8 | 347 | 3.5% | 1.84 | | | | |
| **G30D_Total** | | | | | **20.14** | **0.03798867** | **3.286462** | **10.53787** | **6.27765** |
| G30E1 | Kruisfontein | 90.4 | 286 | 3.5% | 0.91 | | | | |
| G30E2 | Verlorenvlei | 44.9 | 286 | 3.5% | 0.45 | | | | |

| Sub-catchments used to calculate recharge | River System | Area ($km^2$) | MAP (mm) | Estimated Recharge (% of total annual flow) | Calculated recharge ($Mm^3$) | Total abstracted for Town supply (million $m^3$) | Reserve (BHN + Springflow + Baseflow Contributions) | Total abstracted for irrigation (million $m^3$) | Groundwater Balance (million $m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| G30E3 | Verlorenvlei | 35.3 | 286 | 3.5% | 0.35 | | | | |
| G30E4 | Verlorenvlei | 190.5 | 286 | 5.0% | 2.72 | | | | |
| **G30E_Total** | | | | | **4.43** | **0.443172** | **0.791505375** | **2.9434064** | **0.25440** |
| G30F1 | Langvlei | 194.2 | 352 | 3.5% | 2.39 | | | | |
| G30F2 | Lambertshoek | 98.9 | 352 | 23.0% | 8.01 | | | | |
| G30F3 | | 397.8 | 236 | 3.5% | 3.29 | | | | |
| G30F4 | | 30.2 | 212 | 3.5% | 0.22 | | | | |
| G30F_Groundwater_North | | 20.2 | 175 | 3.5% | 0.12 | | | | |
| G30F_Groundwater_South | | 59.1 | 212 | 3.5% | 0.44 | | | | |
| **G30F_Total** | | | | | **14.47** | **0.98592** | **1.713247375** | **18.43323** | **-5.10282** |
| G30G1 | Jakkals | 134.4 | 268 | xx | 11.15 | | | | |
| G30G2 | Peddies | 49.4 | 268 | 23.0% | 3.05 | | | | |
| G30G3 | | 317.5 | 208 | 3.5% | 2.31 | | | | |
| G30G4 | | 21.7 | 138 | 3.5% | 0.10 | | | | |
| G30G_Groundwater_West | | 89.8 | 138 | 3.5% | 0.43 | | | | |
| G30G_Groundwater_East | | 44.2 | 208 | 3.5% | 0.32 | | | | |
| **G30G_Total** | | | | | **17.37** | **0.203213** | **0.670242125** | **3.616832** | **12.87576** |
| G30H1 | | 580.8 | 204 | 3.5% | 4.15 | | | | |
| G30H_Groundwater | | 495.4 | 138 | 3.5% | 2.39 | | | | |
| **G30H_Total** | | | | | **6.53** | **0** | **0.059102625** | **2.31426** | **4.16041** |
| F60A | Brak | 386 | 103 | 3.5% | **1.39** | **0** | **0.0010585** | | **1.39047** |
| F60B | Klein-Goerap | 320 | 129 | 3.5% | **1.44** | **0.183146** | **0.008513625** | | **1.25314** |
| F60C | Sout | 622 | 114 | 3.5% | **2.48** | **0** | **0.00406975** | | **2.47771** |
| F60D | Groot-Goerap | 481 | 120 | 3.5% | **2.02** | **0** | **0** | | **2.02020** |
| F60E | | 120 | 116 | 3.5% | **0.49** | **0** | **0.000556625** | | **0.48664** |

## WATER QUALITY COMPONENT

Groundwater Quality component of the Reserve Determined with the template that uses 10% above median as the Reserve. Please take note that groundwater quality naturally changes within a catchment, as well as seasonally. The groundwater quality should comply with the target water quality ranges as shown in **Table 6.1**. In preliminary determinations of the quality component the ambient groundwater quality is compared to the Class 1 potability value (SANS 241:1 2011). The lowest or more conservative value of the two is selected. In instances where the ambient value is selected, it is increased by 10 per cent. The overall water quality of the resource units is well within the drinking water quality guidelines.

**Table 6.1:** General Chemistry

| **Chemical Parameter** | **Target Water Quality Ranges**[1] | | | | |
|---|---|---|---|---|---|
| | **Units** | **Class 0** | **Class I** | **Class II** | **Class III** |
| pH (pH Units) | | 6 - 9 | 5 - 6 & 9 - 9.5 | 4 - 5& > 9.5 - 10 | < 4 or > 10 |
| Total Dissolved Solids | mg/l | 0 - 450 | 450 - 1000 | 1000 - 2450 | > 2450 |
| Electrical Conductivity | mS/m | 0 - 70 | 70 - 150 | 150 - 300 | > 370 |
| Calcium as Ca | mg/l | 0 - 80 | 80 - 150 | 150 - 300 | > 300 |
| Magnesium as Mg | mg/l | 0 - 30 | 30 - 70 | 70 - 100 | > 100 |
| Sodium as Na | mg/l | 0 - 100 | 100 - 200 | 200 - 400 | > 400 |
| Chloride as Cl | mg/l | 0 - 100 | 100 - 200 | 200 - 600 | > 600 |
| Sulphate as $SO_4$ | mg/l | 0 - 200 | 200 - 400 | 400 - 600 | > 600 |
| Nitrate as $NO_{x-}$ N | mg/l | 0 - 6 | 6 - 10 | 10 - 20 | > 20 |
| Flouride as F | mg/l | 0 - 1 | 1 - 1.5 | 1.5 - 3.5 | > 3.5 |
| Faecal coliforms | counts/100ml | 0 | 0 - 1 | 1 - 10 | > 10 |

1)Ref: South African Water Quality Guidelines, Volume 1: Domestic Water Use, 2nd Ed. 1996. Department of Water Affairs, Pretoria, South Africa.

**NOTE:**

**Class 0:** Water is classed as ideal drinking water, suitable for lifetime use. The values are essentially the same as the target water guideline in the South African Water Quality Guideline for Domestic Use.

**Class I:** Water is still safe for lifetime use; however, some mild health effects may, in very rare cases, occur. They may also be some aesthetic effects.

**Class II:** Water allowable for limited short term or emergency use. Health effects may be felt more commonly, as compared to Class I, especially by those who are long term users of the water. Therefore, it is not recommended that the water be used continuously for life. This is only class in the guideline which is not specific in terms of the exact duration that the water can be used

for. It states that it can be used for short term use; but does not define what length of time “short term” refers to.

**Class III:** Class III water will cause serious health effects, particular in infants and elderly people. Use of this water is not recommended for drinking purposes.

**Table 6.2.** Preliminary Groundwater Quality Component of the Reserve.

| Quaternary catchment | | Ca (mg/L) | Cl (mg/L) | EC (mS/m) | F (mg/L) | Mg (mg/L) | No3 + No2 (mg/L) | Na (mg/L) | SO4 (mg/L) | TAL | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F60A | No of Sample Sites | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | Median | 121.25 | 3386 | 1058.5 | 0.64 | 210.5 | 0.3125 | 1848.6 | 514.95 | 152.1 | 7.595 |
| | Average | 135.08 | 3405.97 | 980.8 | 0.924 | 218.11 | 0.7714 | 1896.43 | 466.39 | 153.24 | 7.519 |
| | 95 percentile | 315.03 | 8000.025 | 2088.25 | 2.3515 | 537.91 | 2.66535 | 4385.295 | 1067.57 | 229.75 | 8.2755 |
| | 5 percentile | 15.8 | 314.345 | 112.75 | 0.2 | 27.18 | 0.02 | 159.39 | 22.575 | 57.2 | 6.445 |
| | Groundwater Quality Reserve | 133.375 | 3724.6 | 1164.35 | 0.704 | 231.55 | 0.34375 | 2033.46 | 566.445 | 167.31 | 8.2709 |
| | | | | | | | | | | | |
| F60B | No of Sample Sites | 71 | 71 | 71 | 71 | 71 | 64 | 64 | 71 | 71 | 71 |
| | Median | 152.2 | 2005.3 | 656 | 1.415 | 187.1 | 1.535 | 1034.443 | 394 | 174.6 | 7.77 |
| | Average | 200.1151 | 2484.776 | 792.9345 | 1.47331 | 237.066 | 5.507414 | 1304.9 | 460.5053 | 166.7894 | 7.633296 |
| | 95 percentile | 507.85 | 4896.65 | 1415 | 2.5475 | 551 | 25.2245 | 1926.473 | 911.925 | 285.55 | 8.39 |
| | 5 percentile | 50.45 | 445 | 146 | 0.53 | 54.5 | 0.02 | 698.06 | 60 | 52.4 | 6.975 |
| | Groundwater Quality Reserve | 167.42 | 2205.83 | 721.6 | 1.5565 | 205.81 | 1.6885 | 1137.887 | 433.4 | 192.06 | 8.396625 |
| | | | | | | | | | | | |
| F60C | No of Sample Sites | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 | 32 |
| | Median | 142.3 | 2462.85 | 765 | 1.075 | 195.45 | 0.16 | 1280.5 | 361.9 | 103.4 | 7.175 |
| | Average | 184.0891 | 2705.688 | 838.1688 | 1.22375 | 220.4469 | 3.301219 | 1344.302 | 404.7125 | 101.1922 | 7.2025 |
| | 95 percentile | 385.545 | 5112.41 | 1543.6 | 2.3345 | 435.815 | 13.707 | 2453.865 | 670.39 | 202.935 | 7.8325 |
| | 5 percentile | 48.385 | 635.55 | 223.76 | 0.37775 | 53.96 | 0.02 | 336.215 | 109.305 | 11.15 | 6.5685 |
| | Groundwater Quality Reserve | 156.53 | 2709.135 | 841.5 | 1.1825 | 214.995 | 0.176 | 1408.55 | 398.09 | 113.74 | 7.92275 |
| | | | | | | | | | | | |

| Quaternary catchment | | Ca (mg/L) | Cl (mg/L) | EC (mS/m) | F (mg/L) | Mg (mg/L) | No3 + No2 (mg/L) | Na (mg/L) | SO4 (mg/L) | TAL | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F60D | No of Sample Sites | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | Median | 288.7 | 4249.6 | 1255 | 2 | 270.7 | 0.59 | 2136.5 | 592.2 | 180.4 | 7.83 |
| | Average | 254.56 | 3955.46 | 1189.6 | 1.99 | 284.48 | 3.9268 | 2079.22 | 606.46 | 161.6 | 7.804 |
| | 95 percentile | 372.24 | 4786.36 | 1432 | 2.528 | 429.14 | 12.9508 | 2609.34 | 763.1 | 204.5 | 8.042 |
| | 5 percentile | 116.84 | 2664.02 | 808 | 1.576 | 161.86 | 0.02 | 1454.82 | 407.3 | 97.66 | 7.556 |
| | Groundwater Quality Reserve | 317.57 | 4674.56 | 1380.5 | 2.2 | 297.77 | 0.649 | 2350.15 | 651.42 | 198.44 | 8.5844 |
| | | | | | | | | | | | |
| F60E | No of Sample Sites | 13 | 13 | 13 | 5 | 13 | 13 | 13 | 13 | 5 | 13 |
| | Median | 461 | 8812.8 | 2565 | 3.08 | 620 | 1.13 | 4289.9 | 1264.4 | 112.5 | 7.5 |
| | Average | 486.6308 | 9206.658 | 2595.846 | 2.736 | 724.1154 | 2.535077 | 4568.458 | 1340.038 | 123.2 | 7.685385 |
| | 95 percentile | 1047.8 | 17630.12 | 4686 | 3.638 | 1546.6 | 9.9626 | 8138.7 | 2409.52 | 190.78 | 8.74 |
| | 5 percentile | 40.8 | 2537.42 | 802.58 | 1.272 | 82.4 | 0.012 | 1328.22 | 333.98 | 50.2 | 7.02 |
| | Groundwater Quality Reserve | 507.1 | 9694.08 | 2821.5 | 3.388 | 682 | 1.243 | 4718.89 | 1390.84 | 123.75 | 8.453923 |
| | | | | | | | | | | | |
| G30A | No of Sample Sites | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 |
| | Median | 38.9 | 928.6 | 325.5 | 0.41 | 79.55 | 0.09 | 510.55 | 105 | 59.55 | 6.705 |
| | Average | 66.80552 | 1329.66 | 429.7391 | 0.698424 | 112.3196 | 5.865696 | 718.1763 | 215.989 | 83.26383 | 6.678076 |
| | 95 percentile | 186.325 | 3593.05 | 1119.075 | 1.685 | 288.35 | 5.2575 | 1981.125 | 794.6 | 269.8 | 7.5975 |
| | 5 percentile | 7.825 | 201.519 | 86.45 | 0.106 | 13.7735 | 0.02 | 118.3 | 17.075 | 2 | 4.825 |
| | Groundwater Quality Reserve | 42.79 | 1021.46 | 358.05 | 0.451 | 87.505 | 0.099 | 561.605 | 115.5 | 65.505 | 7.345884 |
| | | | | | | | | | | | |

| Quaternary catchment | | Ca (mg/L) | Cl (mg/L) | EC (mS/m) | F (mg/L) | Mg (mg/L) | No3 + No2 (mg/L) | Na (mg/L) | SO4 (mg/L) | TAL | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G30A | No of Sample Sites | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 |
| | Median | 26.5 | 460.4 | 191 | 0.29 | 37.6 | 1.617 | 273.4 | 41.6 | 73.4 | 7.49 |
| | Average | 40.59099 | 717.4127 | 259.1075 | 0.371592 | 62.67571 | 5.757516 | 380.602 | 82.58715 | 89.5521 | 7.377781 |
| | 95 percentile | 154.65 | 2602.6 | 817 | 0.895 | 237.55 | 20.1255 | 1279.85 | 253.45 | 204.35 | 7.915 |
| | 5 percentile | 3.949167 | 25.77848 | 22.2 | 0.115 | 3.856292 | 0.02 | 16.11025 | 5.85 | 10.5746 | 6.66 |
| | Groundwater Quality Reserve | 29.15 | 506.44 | 210.1 | 0.319 | 41.36 | 1.7787 | 300.74 | 45.76 | 80.74 | 8.115559 |
| | | | | | | | | | | | |
| G30C | No of Sample Sites | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| | Median | 5.6 | 102.6 | 45.6 | 0.1045 | 9.6 | 2.898 | 52.5 | 10.3 | 5.8 | 6.24 |
| | Average | 7.493304 | 126.4481 | 51.1913 | 0.118891 | 11.67498 | 3.403674 | 65.37291 | 15.65283 | 13.14391 | 6.124261 |
| | 95 percentile | 23.81 | 284.05 | 107.01 | 0.249 | 25.61 | 8.40435 | 145.83 | 31.95 | 52.89 | 7.439 |
| | 5 percentile | 1.51 | 32.22 | 17.8 | 0.05 | 3 | 0.3131 | 16.99 | 2 | 0 | 4.904 |
| | Groundwater Quality Reserve | 6.16 | 112.86 | 50.16 | 0.11495 | 10.56 | 3.1878 | 57.75 | 11.33 | 6.38 | 6.736687 |
| | | | | | | | | | | | |
| G30E | No of Sample Sites | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |
| | Median | 30.11667 | 327.375 | 131.225 | 0.28 | 24.55 | 3.0675 | 179.9172 | 45.15 | 47.9 | 7.25 |
| | Average | 88.55904 | 2385.89 | 588.3099 | 0.318939 | 168.7501 | 5.32966 | 1283.713 | 316.2033 | 89.15064 | 7.031156 |
| | 95 percentile | 395.7825 | 14167.74 | 3614.135 | 0.85875 | 1026.97 | 16.31963 | 7557.27 | 1947.528 | 277.875 | 8.284 |
| | 5 percentile | 5.7135 | 53.66765 | 30.915 | 0.063325 | 5.565 | 0.05325 | 32.225 | 4.655 | 2 | 4.361 |
| | Groundwater Quality Reserve | 33.12833 | 360.1125 | 144.3475 | 0.308 | 27.005 | 3.37425 | 197.9089 | 49.665 | 52.69 | 7.734272 |
| | | | | | | | | | | | |

| Quaternary catchment | | Ca (mg/L) | Cl (mg/L) | EC (mS/m) | F (mg/L) | Mg (mg/L) | No3 + No2 (mg/L) | Na (mg/L) | SO4 (mg/L) | TAL | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G30G | No of Sample Sites | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | Median | 32.0305 | 512.9 | 183 | 0.2255 | 40.417 | 0.8905 | 251.5 | 69.736 | 35.209 | 6.2125 |
| | Average | 33.4133 | 730.7937 | 258.9 | 0.3231 | 59.5455 | 3.4445 | 387.1535 | 90.5404 | 56.2873 | 6.5516 |
| | 95 percentile | 57.1609 | 1359.691 | 444.6 | 0.778 | 107.8285 | 11.5959 | 704.3425 | 140.8546 | 134.2851 | 7.5442 |
| | 5 percentile | 11.78 | 284.6361 | 110.1 | 0.1 | 26.04 | 0.126 | 139.8467 | 48.664 | 17.48 | 6.008 |
| | Groundwater Quality Reserve | 35.23355 | 564.19 | 201.3 | 0.24805 | 44.4587 | 0.97955 | 276.65 | 76.7096 | 38.7299 | 7.20676 |
| | | | | | | | | | | | |
| G30H | No of Sample Sites | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Median | 42.6 | 853.35 | 268.5 | 0.265 | 66.15 | 2.199 | 424.7 | 95.65 | 44.65 | 7.135 |
| | Average | 64.71111 | 1187.418 | 362.7333 | 0.368833 | 98.79306 | 2.543806 | 580.0542 | 140.0961 | 48.27183 | 6.874111 |
| | 95 percentile | 203.575 | 3309.05 | 1013.55 | 0.8 | 306.875 | 6.615 | 1628.675 | 367.85 | 114.85 | 7.78 |
| | 5 percentile | 9.15 | 203.7 | 64.3 | 0.095 | 17.35 | 0.0515 | 128.25 | 24.925 | 2 | 4.09 |
| | Groundwater Quality Reserve | 46.86 | 938.685 | 295.35 | 0.2915 | 72.765 | 2.4189 | 467.17 | 105.215 | 49.115 | 7.561522 |
| | | | | | | | | | | | |
| Northern G30D | No of Sample Sites | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| | Median | 12.75 | 141.8 | 65.625 | 0.125 | 13.925 | 1.3535 | 78.65 | 21.4 | 19.7 | 6.83 |
| | Average | 13.45342 | 170.1839 | 71.14167 | 0.203167 | 14.91925 | 2.985611 | 91.82153 | 22.25411 | 34.35392 | 6.858528 |
| | 95 percentile | 34.295 | 329.31 | 129.585 | 0.4985 | 31.14 | 8.0653 | 174.11 | 46.1011 | 107.755 | 7.6645 |
| | 5 percentile | 4.615 | 81.855 | 38.88 | 0.05 | 4.27 | 0.02 | 44.64 | 2 | 7.185 | 6.241 |
| | Groundwater Quality Reserve | 14.025 | 155.98 | 72.1875 | 0.1375 | 15.3175 | 1.48885 | 86.515 | 23.54 | 21.67 | 7.544381 |
| | | | | | | | | | | | |

| Quaternary catchment | | Ca (mg/L) | Cl (mg/L) | EC (mS/m) | F (mg/L) | Mg (mg/L) | No3 + No2 (mg/L) | Na (mg/L) | SO4 (mg/L) | TAL | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern G30D | No of Sample Sites | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |
| | Median | 42.7 | 181.6 | 83.75 | 0.19 | 18.35 | 0.043 | 94.05 | 36.45 | 79.1 | 7.655 |
| | Average | 58.15952 | 322.6998 | 130.0214 | 0.18881 | 31.87619 | 1.21831 | 143.7095 | 59.50143 | 86.12857 | 7.553095 |
| | 95 percentile | 152.735 | 1027.355 | 333.3 | 0.4085 | 94.49 | 5.87915 | 459.58 | 231.98 | 189.52 | 8.355 |
| | 5 percentile | 4.345 | 48.93 | 33.145 | 0.05 | 5.15 | 0.02 | 31.405 | 8.403 | 2.1 | 6.6 |
| | Groundwater Quality Reserve | 46.97 | 199.76 | 92.125 | 0.209 | 20.185 | 0.0473 | 103.455 | 40.095 | 87.01 | 8.308405 |
| | | | | | | | | | | | |
| Northern G30F | No of Sample Sites | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 | 56 |
| | Median | 9.27925 | 223.45 | 85.825 | 0.12 | 18.65 | 2.2695 | 113.8 | 12.65 | 6.8 | 5.99 |
| | Average | 27.05899 | 602.7451 | 191.9863 | 0.140286 | 57.26182 | 3.307402 | 282.4382 | 52.72972 | 14.45998 | 5.967598 |
| | 95 percentile | 80.47775 | 3112.516 | 911.1 | 0.269625 | 247.9615 | 10.24425 | 1470.474 | 244.3508 | 54.42938 | 7.1725 |
| | 5 percentile | 2.13125 | 55.95 | 23.75 | 0.05 | 4.425 | 0.055 | 32.05 | 2 | 2 | 4.6475 |
| | Groundwater Quality Reserve | 10.20718 | 245.795 | 94.4075 | 0.132 | 20.515 | 2.49645 | 125.18 | 13.915 | 7.48 | 6.564358 |
| | | | | | | | | | | | |
| Southern G30F | No of Sample Sites | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 |
| | Median | 8.6445 | 183.7023 | 62.45 | 0.135 | 13.65 | 1.838 | 98.675 | 21.218 | 13.1 | 6.575 |
| | Average | 30.21916 | 444.8984 | 144.0739 | 0.218978 | 31.81539 | 2.471087 | 240.6488 | 64.96715 | 35.54945 | 6.50562 |
| | 95 percentile | 146.275 | 1464.35 | 514.3 | 0.485 | 95.8 | 5.6125 | 768.1 | 232.925 | 134.075 | 7.69 |
| | 5 percentile | 3.875 | 84.55 | 34.775 | 0.05 | 5.825 | 0.025 | 44.95 | 5.975 | 2.55 | 5 |
| | Groundwater Quality Reserve | 9.50895 | 202.0725 | 68.695 | 0.1485 | 15.015 | 2.0218 | 108.5425 | 23.3398 | 14.41 | 7.156182 |

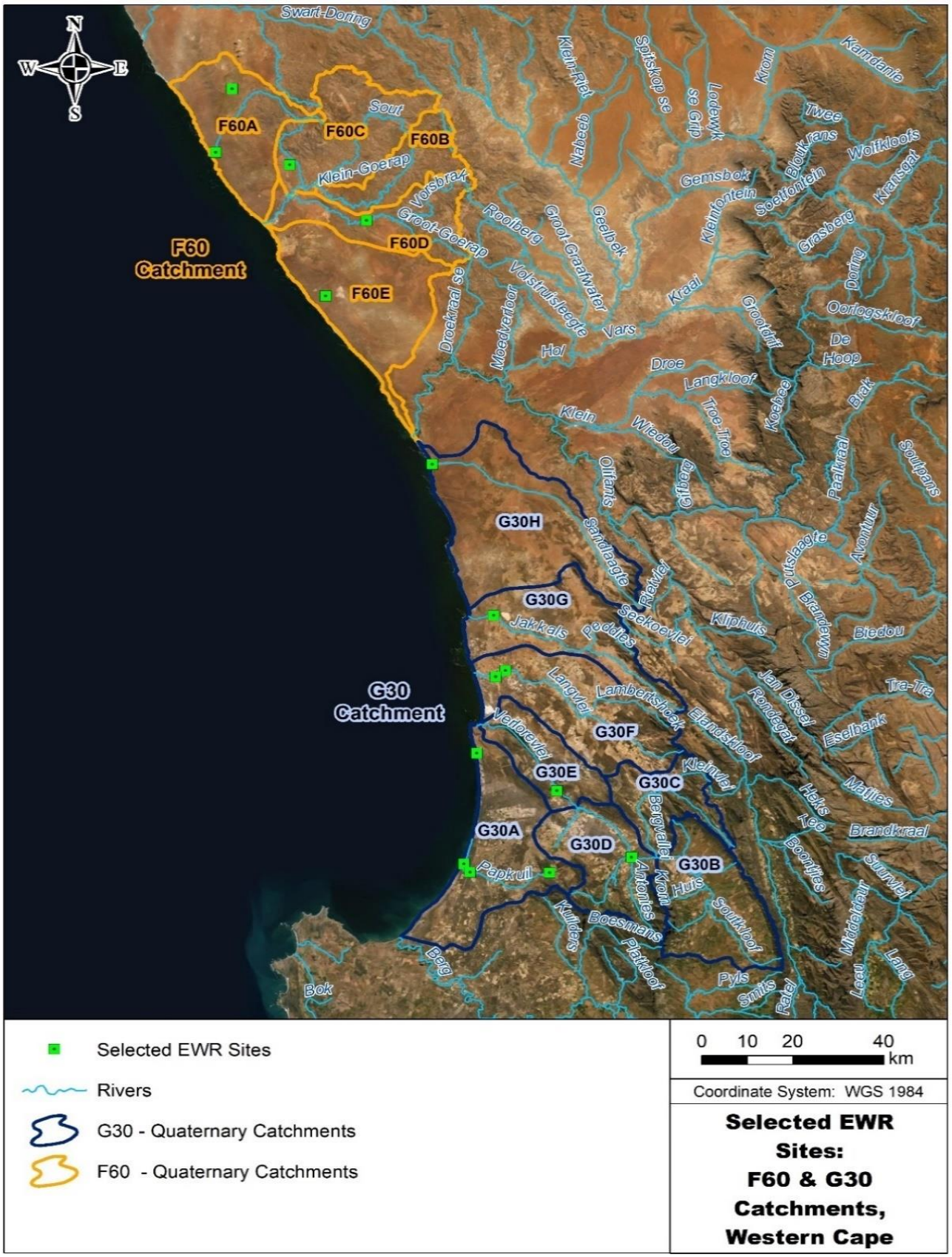


**Figure 1:** Locality map for the F60 and G30 catchments showing EWR sites and Quaternary Catchments.

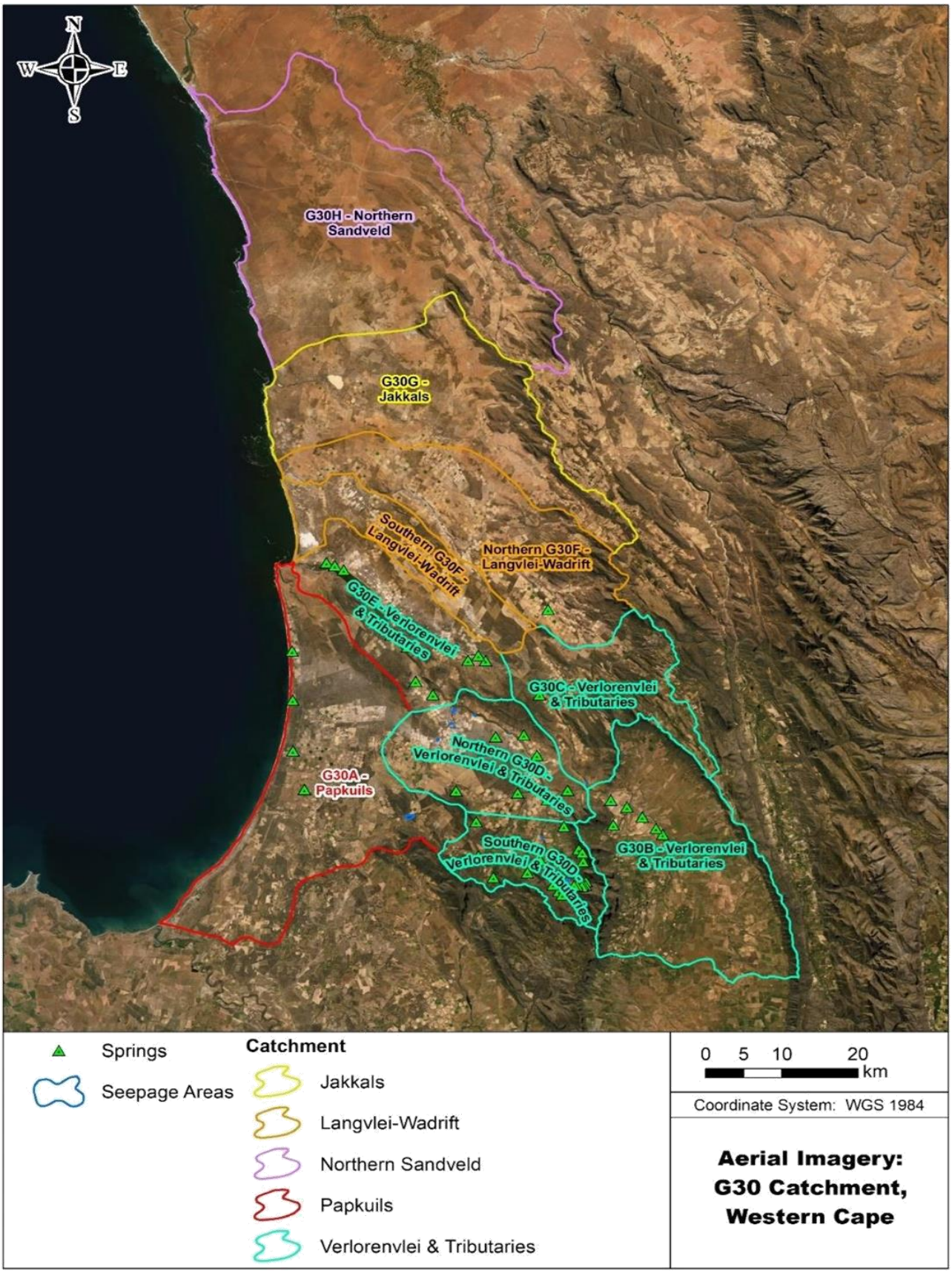


**Figure 2:** Combined map of delineated GRUs for the G30 catchment

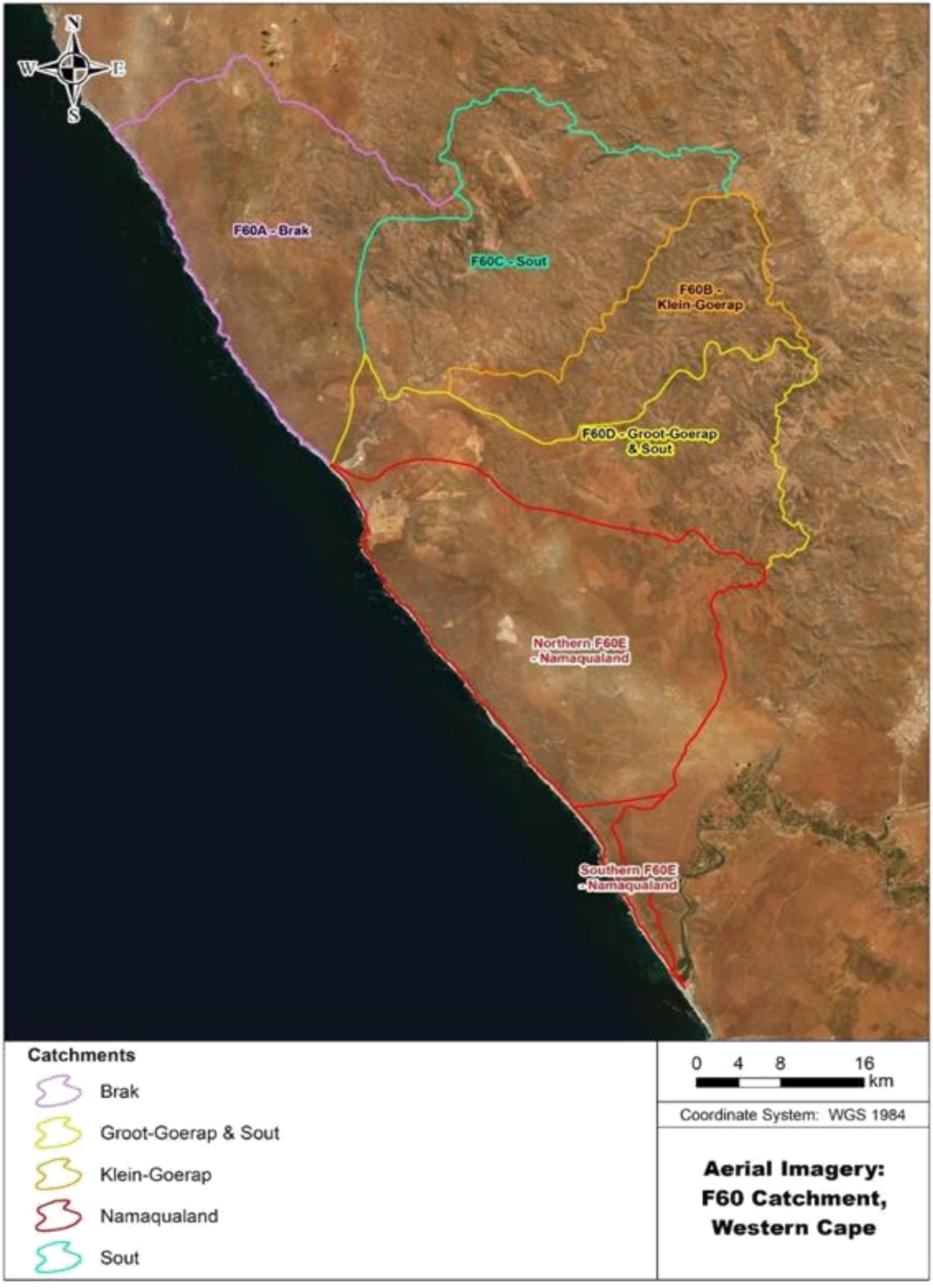


**Figure 3:** Combined map of delineated GRUs for the F60 catchment