JG AFRIKA
EXPERIENCE QUALITY INTEGRITY

# LICHTENBURG LAFARGE CEMENT PLANT

# ALTERNATIVE WATER SOURCES STUDY

**October 2022**

**REVISION 00**

LAFARGE


Prepared by:

**JG AFRIKA (PTY) LTD**

Pietermaritzburg
6 Pin Oak Avenue
3201
Tel: 033 343 6700
Email: Hullp@jgafrika.co.za
Project leader: Phillip Hull

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| **JG AFRIKA (PTY) LTD**<br>**Pietermaritzburg**<br><br>PO Box 794<br>Hilton<br>3245<br><br>Tel.: +27 33 343 6700<br>Email: hullp@jgafrika.com | **Lafarge Industries South Africa (PTY) LTD**<br>**Lichtenburg**<br><br>1 Manana Road<br>Industrial Site<br>2740<br><br>Tel: +27 21 633 3011<br>Email: uneysa.taljard@lafargeholcim.com |
| **AUTHOR** | **CLIENT CONTACT PERSON** |
| Phillip Hull | Uneysa Taljard |

**SYNOPSIS**

Specialist alternative water sources study as part of the Water Use Licence Application.

**KEY WORDS:**

Lafarge Lichtenburg Cement Plant, National Water Act 36 of 1998, Water Balance Study



**QUALITY VERIFICATION**

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO9001: 2008 which has been independently certified by DEKRA Certification under certificate number 90906882

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# LICHTENBURG LAFARGE CEMENT PLANT
# ALTERNATIVE WATER SUPPLY STUDY

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# 1 INTRODUCTION

JG Afrika (Pty) Ltd were appointed by Lafarge Industries South Africa (Pty) Ltd to undertake a study to identify potential alternative water sources for the Lichtenburg Lafarge Cement Plant, located in the North West Province. The cement plant is located on Portion 61 of Lichtenburg Town Farm No 27. This specialist study is required as part of a Water Use Licence Application (WULA) for the cement plant, based on the requirements of the National Water Act (Act 36 of 1998). The objectives of this alternative water sources study are to determine:

- The long-term water resource potential of water stored in the Townlands Pit (without augmentation from the boreholes),
- The water resource potential of water stored in the Tswana Lime Pits and limits associated with using this water (such as the transfer of water from Tswana to Lichtenburg),
- The potential for recycling water within the Cement Plant (particularly water used in the Kilns and for cooling purposes),
- The potential for using wastewater from the Wastewater Treatment Plant to augment supply, and
- The potential and complexities associated with sourcing water from the local municipality. This will include:
    - Whether the municipality has the capacity to supply the required demand from Lafarge,
    - Cost implications of using water from the municipality,

## 1.1 Declaration of Independence

JG Afrika were appointed to conduct an independent water balance study for the Lafarge cement plant. JG Afrika have undertaken this study in an objective manner, even if this results in views and findings that are not favourable to the Applicant or Client. JG Afrika have the expertise required to undertake the necessary studies and the following report presents the results in an objective manner. The main author of the report, Mr. Phillip Hull, is an Executive Associate and Senior Hydrologist at JG Afrika, has an MSc. in Hydrology, is professionally registered and has 15 years of relevant project experience.

# 2 SITE DESCRIPTION

## 2.1 Locality

The location of the Lafarge cement plant is presented in **Figure 2-1**. As depicted in this map, the cement plant is located 2 km northeast of Lichtenburg town, within the Ditsobotla Local Municipality of the North West Province. A site plan of the project site, presenting a layout plan of the main infrastructure associated with the cement plant is provided in **Figure 2-2**.

## 2.2 Lafarge Cement Plant Operations Description

A process of grinding and burning takes place at the cement plant. Fine grinding produces a fine powder (known as raw meal) which is preheated and then sent to a Kiln. The material is heated to approximately 1 500°C before being rapidly cooled. This produces clinker, the basic material required for the production of all cements. The final manufacturing process involves cement grinding and shipping. A small amount of gypsum (3-5%) is added to the clinker to regulate how the cement will set. The mixture is then very finely ground to obtain “pure cement”. During this phase, different mineral materials, called “cement additives”, may be added alongside the gypsum. Used in varying proportions, these additives, which are of natural or industrial origin, give the cement specific properties such as reduced permeability, greater resistance to sulphates and aggressive environments, improved workability, or higher-quality finishes. Finally, the cement is stored in silos before being shipped in bulk or in bags to the sites where it will be used.

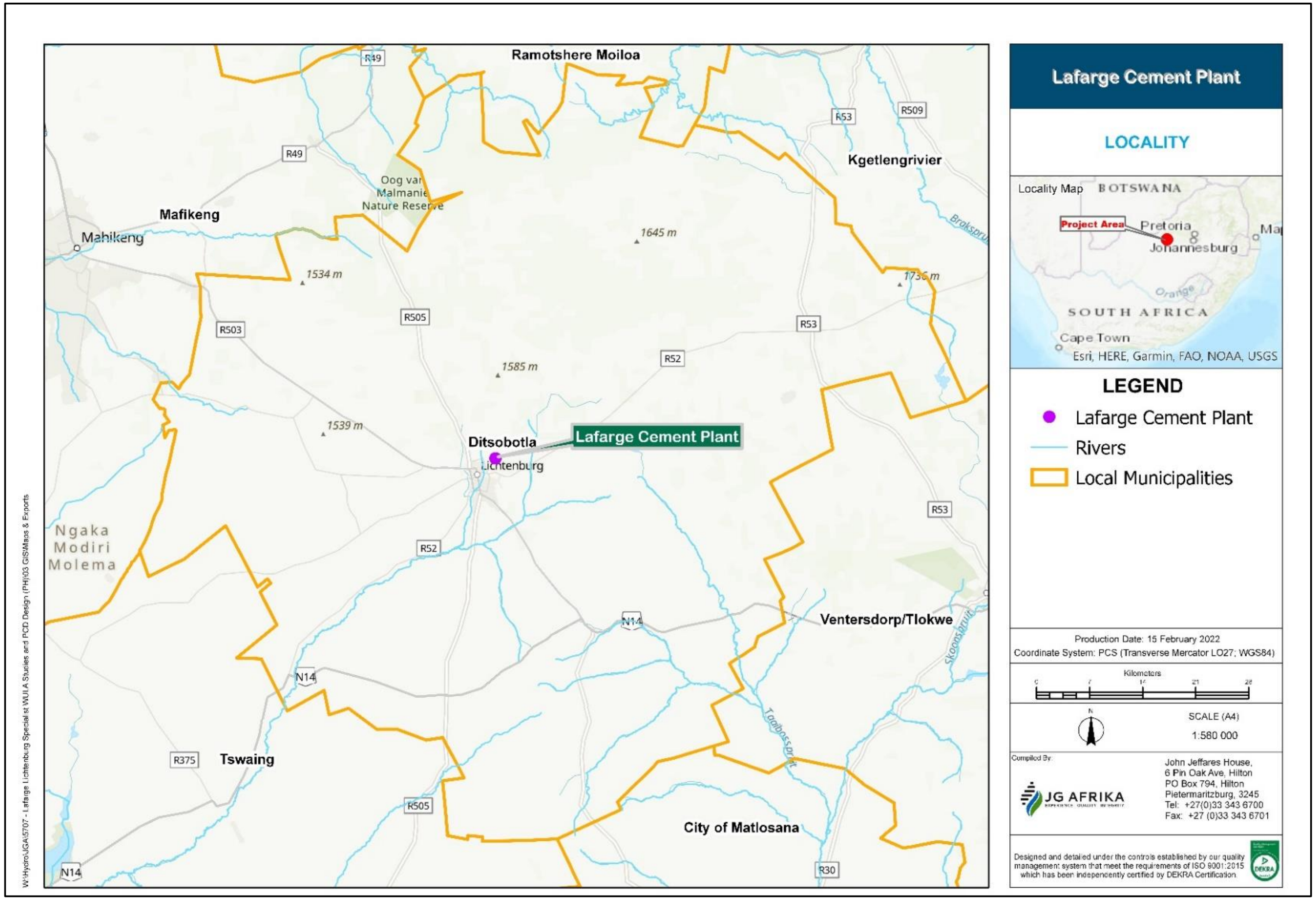


*Figure 2-1 Lafarge Cement Plant Locality Map*

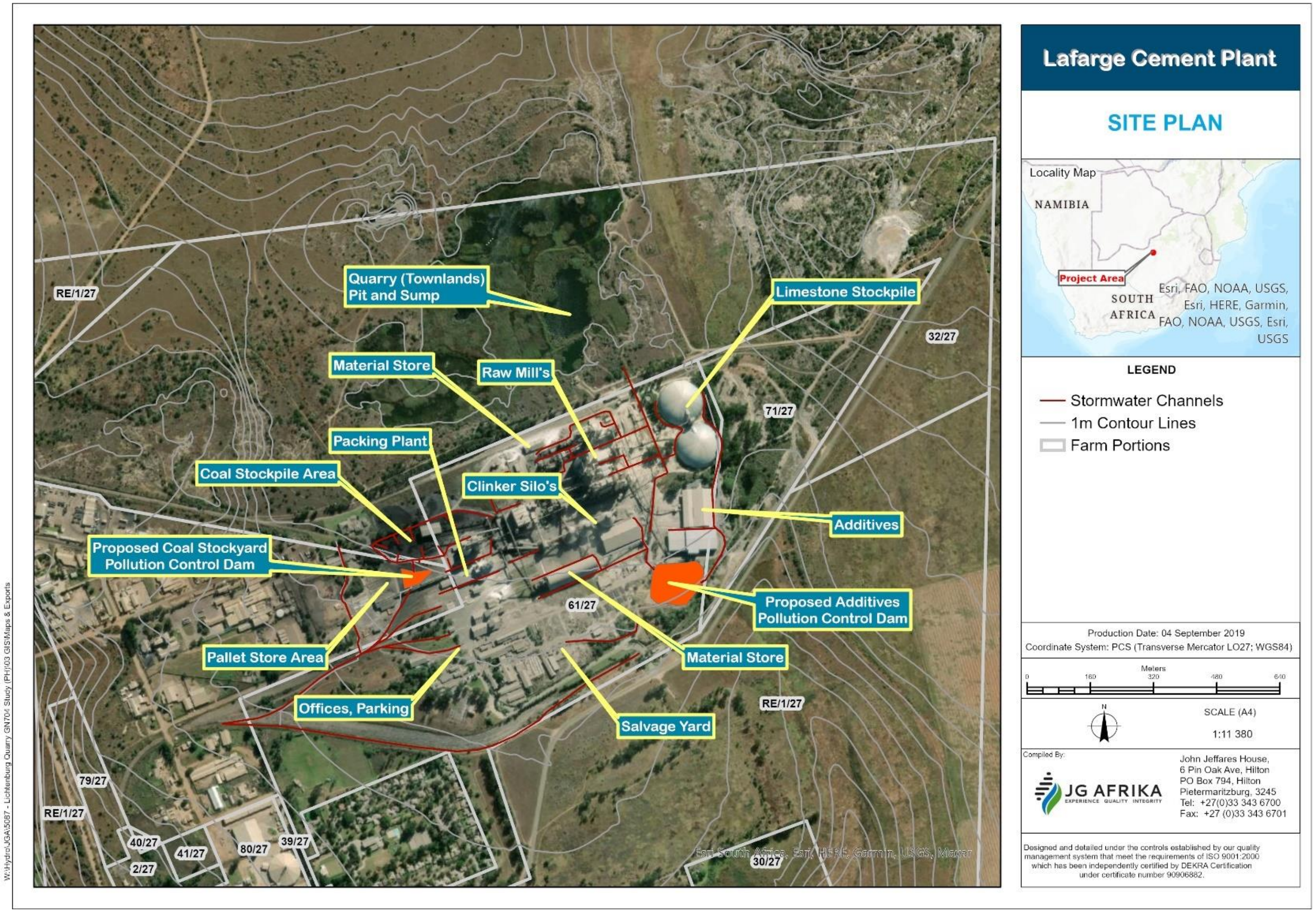


*Figure 2-2 Lafarge Cement Plant Site Plan*

### 2.3 Climate Description

The cement plant lies within an arid to temperate climatic region (Köppen-Geiger Climate Classification Maps, 2018). Rainfall occurs mostly during the summer months and the climate category can be described as hot during the summer months and dry and cold during the winter months.

Temperature data for the project area was obtained from the South African Weather Services (SAWS) meteorological station 0472280 A, as presented in **Table 2-1**. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures range from 18.9°C in June to 28.7°C in January. The region is the coldest during June when the temperature drops to -0.4°C on average during the night.

*Table 2-1 Temperature Recorded for Years 1950 – 1999 at SAWS 0472280 A*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 22.2 | 21.6 | 20.0 | 16.7 | 12.8 | 9.3 | 9.4 | 12.2 | 16.7 | 19.3 | 21.0 | 21.8 |
| Min. Temperature (°C) | 15.7 | 15.1 | 13.2 | 8.7 | 3.7 | -0.4 | -0.3 | 2.5 | 7.6 | 11.4 | 13.6 | 15.1 |
| Max. Temperature (°C) | 28.7 | 28.0 | 26.8 | 24.6 | 22.0 | 18.9 | 19.2 | 21.9 | 25.7 | 27.3 | 28.4 | 28.4 |

#### 2.3.1 Rainfall and Evaporation

Rainfall data for the project area was obtained from the SAWS rainfall station 0472455 W. This rainfall station is located approximately 3.2 km northeast from the project site and was selected based on its record period and the reliability of the historical rainfall data. The details of this rainfall station are presented in **Table 2-2**. The mean monthly rainfall amounts over the period 1950 to 1999 are presented in **Table 2-3**. From **Table 2-3**, it is evident that most of the rainfall falls over the summer period (November to March), with a total rainfall depth over these six months of 457.1 mm. It is also noted that low rainfall values are recorded over the winter months (May to September), with a total rainfall depth of 51.0 mm over these five months.

*Table 2-2 Rainfall Station Details*

| Station Number | Station Name | MAP (mm) | Years Assessed | Reliability (%) | Longitude | Latitude |
|---|---|---|---|---|---|---|
| 0472455 W | Manana | 614 | 1950 - 1999 | 91 | $26^0$ 13’ E | $26^0$ 6’ 1” S |

*Table 2-3 Average Rainfall Depths Recorded for Years 1950 – 1999 at Rainfall Station 0472455 W*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | MAP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rainfall Depth (mm)** | 108.9 | 89.8 | 89.1 | 58.4 | 17.8 | 5.9 | 4.0 | 6.7 | 16.6 | 47.2 | 74.4 | 94.9 | 614 |

A high degree of variation in the annual rainfall data obtained from rainfall station 0472455 W has been noted. The lowest recorded annual rainfall value over the assessed period is 254.7 mm, recorded in the year 1965. **Table 2-4,** which presents the 10 wettest years over the 1950 to 1999 period, indicates the wettest recorded year over this period was 1 017.3 mm in 1967.

*Table 2-4 Ten Wettest Years Recorded for Period 1950 – 1999*

| Ranking | Year | MAP (mm) |
|---|---|---|
| 1 | 1967 | 1 017.3 |
| 2 | 1957 | 894.5 |
| 3 | 1975 | 885.2 |
| 4 | 1976 | 831.9 |
| 5 | 1997 | 814.7 |
| 6 | 1989 | 773.3 |
| 7 | 1991 | 749.0 |
| 8 | 1995 | 747.4 |
| 9 | 1979 | 717.6 |
| 10 | 1977 | 700.0 |

While rainfall is generally variable on a month-to-month and year-to-year basis, this is not the case with evaporation. Monthly evaporative demands do not vary significantly from one year to next (i.e. evaporation in one October-month, for example, is similar to evaporation in the next October-month). Therefore, it is generally considered to be acceptable to apply 12 average monthly evaporation values over the year. The evaporation data used for the cement plant was obtained from Evaporation Zone 8A (Middleton and Bailey, 2008). Catchment evapotranspiration is calculated by applying 12 monthly evapotranspiration conversion factors, as presented in **Table 2-5**. Similarly, evaporation losses from an exposed water body are calculated by applying 12 monthly lake evaporation conversion factors, as presented in **Table 2-5**. The annual potential evaporation rate for the area is 1 860 mm (WR, 2012).

From **Table 2-5**, the highest evaporation rates occur during the hotter summer months of November to March.

*Table 2-5 Cement Plant Potential Evaporation*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean Evaporation Rate (mm) | 214 | 167 | 151 | 118 | 98 | 78 | 91 | 130 | 173 | 207 | 213 | 221 | 1 860 |
| Lake Evaporation Factor | 0.84 | 0.88 | 0.88 | 0.88 | 0.87 | 0.85 | 0.83 | 0.81 | 0.81 | 0.81 | 0.82 | 0.83 | |
| Evapotranspiration Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.80 | 0.80 | 0.80 | 0.80 | 1.00 | 1.00 | |

## 2.4 Site General Hydrology

The project site is located in the Harts River Catchment within the Quaternary Catchment C31A of the Lower Vaal Water Management Area (WMA No. 10). Based on Department of Water and Sanitation (DWS) river coverages and 5 m contours, a drainage line (unnamed drainage line) alongside the eastern boundary of the cement plant drains into an unnamed tributary and eventually into the Harts River. The Harts River is located approximately 15 km downstream of the project site.

## 3 WATER DEMANDS

As part of the alternative water sources study, there is first a need to understand the water demands of the cement plant. In line with this, a water balance has been configured for the plant. The water balance is limited to the water reticulation associated with the cement plant. This includes water abstracted from the three supply boreholes, water used for cooling purposes, potable and wastewater generated at the cement plant and water associated with the Pollution Control Dams (PCD's).

There is an inherent difficulty in representing a complicated dynamic water reticulation system in a simplified water balance model. In order to determine the water demands for the plant, the water balance was simplified into ten circulation areas, as presented in **Figure 3-1**. This schematic is based on information provided by Lafarge. As per the information provided, the following water reticulations were included in the water balance schematic:

- **Main Tank.** The majority of water that is pumped from the well field is pumped to the Main Tank. As presented in **Figure 3-1**, water is then circulated from the Main Tank to water used at the Cement Mill Toilets, the Quality Lab, irrigation at the Old Packaging Plant gardens, water used for fire protection (Fire Tanks) and then water that is distributed to Softening Plants A and B.
- **Softening Plant A.** Water treated at the Softening Plant A is distributed to the Safety Offices, Stores, Offices and Boiler Shop, Plumber Stores, Clinic, Main Offices and to the Village, which is the greatest user of water from the Softening Plant A. A portion of the water used at the Village is lost to the environment. This water is assumed to be used for irrigation of gardens and for washing cars for example. As presented in **Figure 3-1**, potable water is assumed to be returned to the circuit as wastewater, which is either removed by honey suckers (as it currently is) or reports to the WWTW (once the WWTW has been refurbished/commissioned).
- **Softening Plant B.** Water from Softening Plant B is predominantly used for process water at the Kiln 3 and Cement/Raw Mills. In addition to this, water is also used from Softening Plant B to supply the Packaging Plant Ablutions.
- **Quarry (Townlands) Pit and Sump.** Water from the Townlands Sump is used both for cooling product at the Cement Mills (which is then lost to evaporation) and for water to Kiln 4, for cooling purposes. Based on information provided by Lafarge, it is noted that the cooling water does not come into direct contact with Trunnion Bearings but is rather piped through the Kilns to cool the mechanical processes. This water is, therefore, understood to be of the same

chemical makeup as water that is pumped from the dam (only the temperature of the water is changed). This water is then discharged, via stormwater channels, back into the Townlands Quarry Sump.

- **Additives and Coal Stockyard PCD's.** These PCD's are currently at a preliminary level of design, and are therefore not currently in place on site (proposed dams). The purpose of these dams is to capture contaminated stormwater runoff from the Additives and Coal Stockyard areas (in line with statutory requirements). In order to ensure that the dams do not spill more than once in fifty years, it is proposed that the water captured in the PCD's is circulated back into the process water system. This may require treatment to ensure that the quality of the water being re-introduced into the process water system is of an adequate standard for its intended uses.

**Figure 3-1** to **Figure 3-4** presents the resulting water balance for the cement plant for the annual average, annual daily average, dry season daily average (represented by average water use in the July months) and wet season daily average (represented by average water use in the January months) water usage. Water inputs into the various infrastructure are generally presented on the left of the diagram and outflows are presented on the right of the diagram. Values provided in **Figure 3-1** are in cubic meters per annum ($m^3$/annum), and values provided in **Figures 3-2** to **3-4** are in cubic meters per day ($m^3$/day).

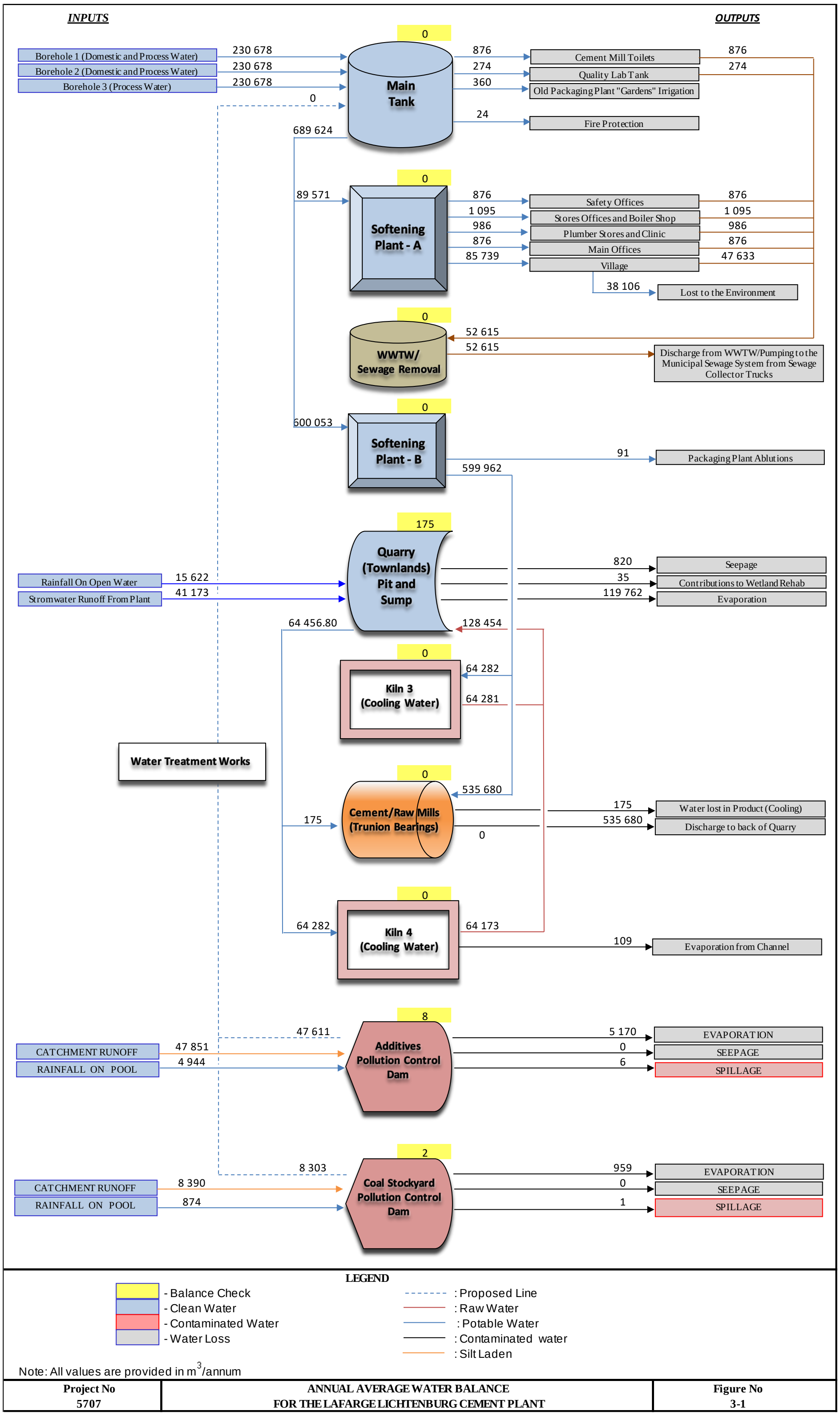


*Figure 3-1 Lafarge Lichtenburg Cement Plant Average Annual Water Balance*

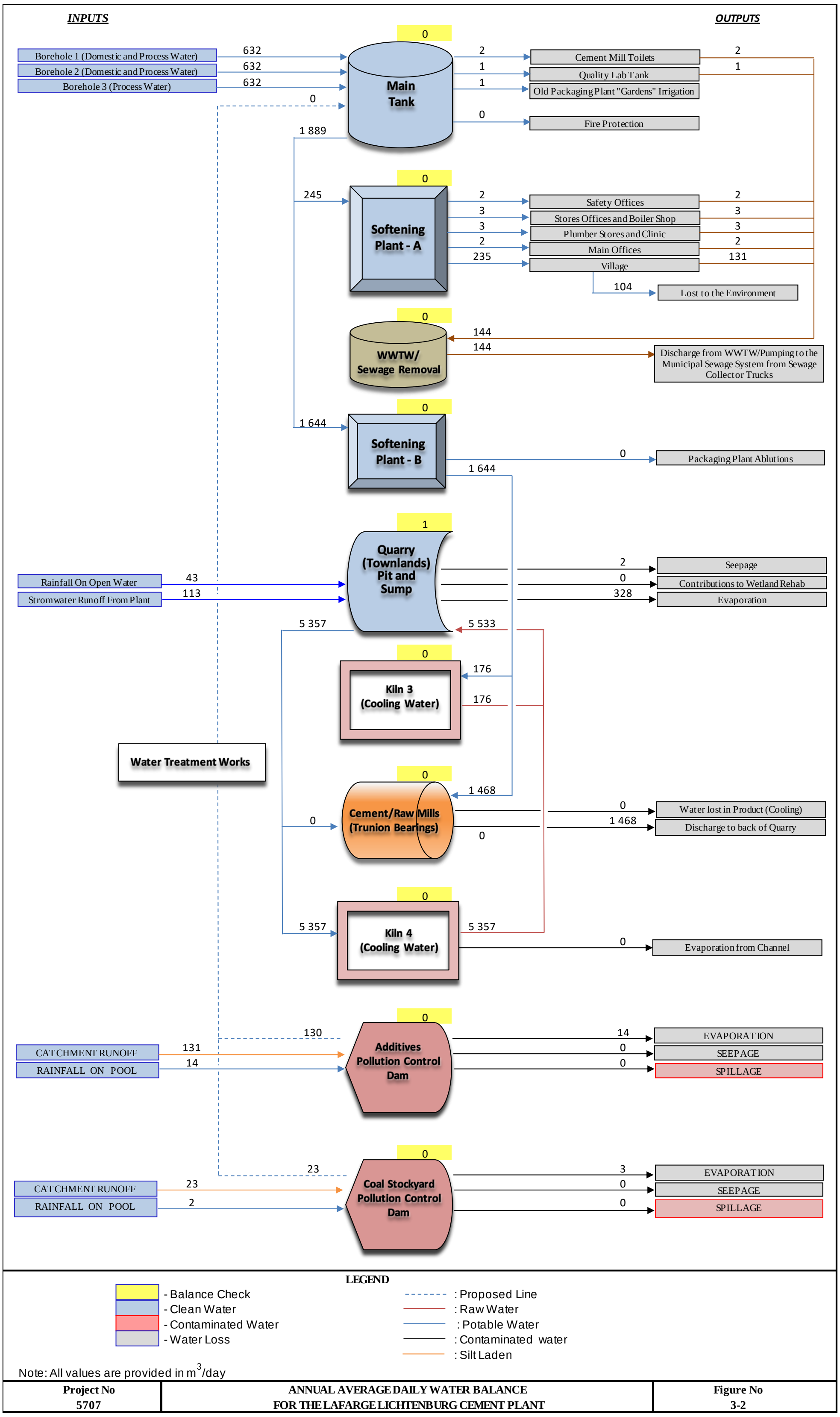


*Figure 3-2 Lafarge Lichtenburg Cement Plant Average Annual Daily Water Balance*

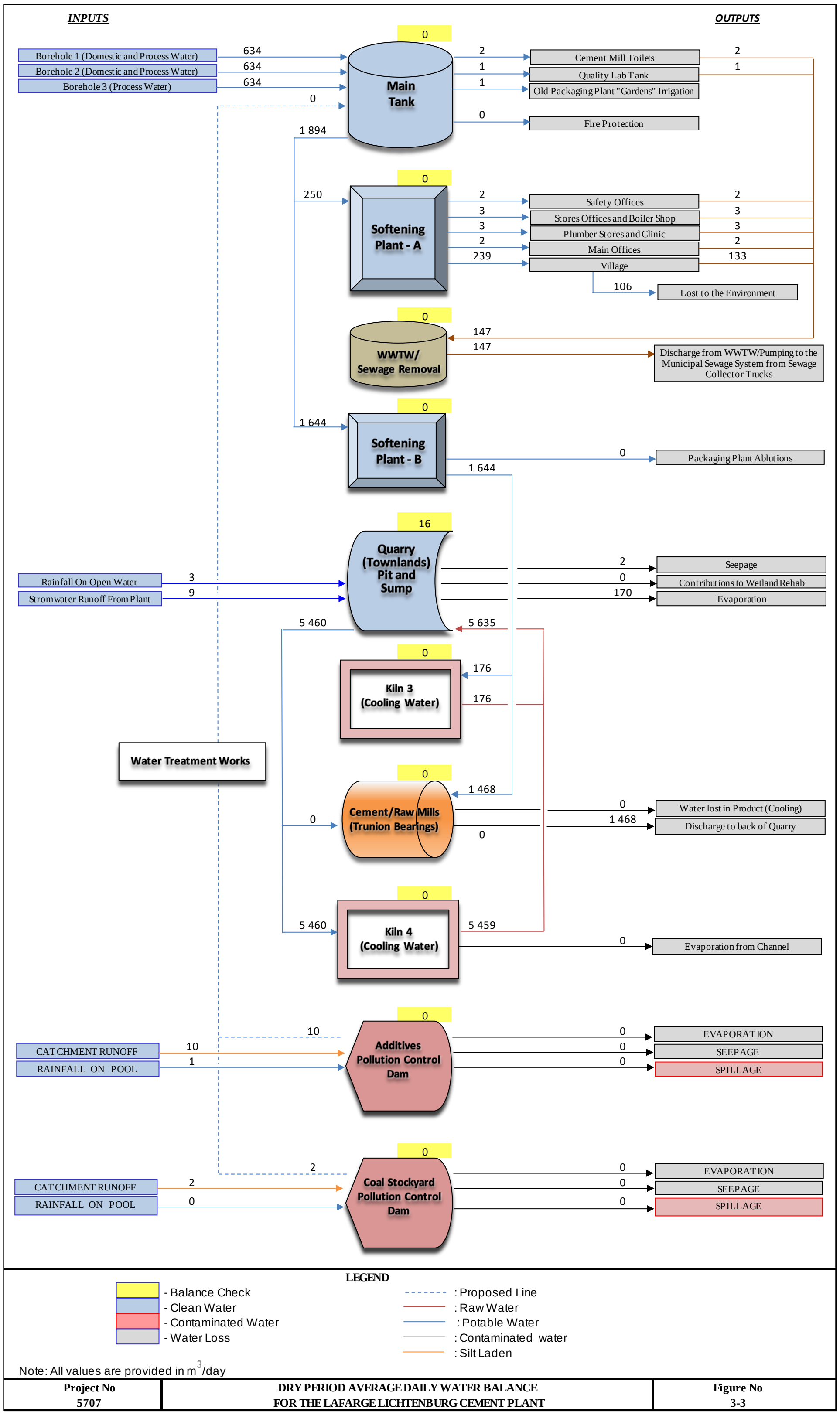


*Figure 3-3 Lafarge Lichtenburg Cement Plant Average Daily Dry Period (July) Water Balance*

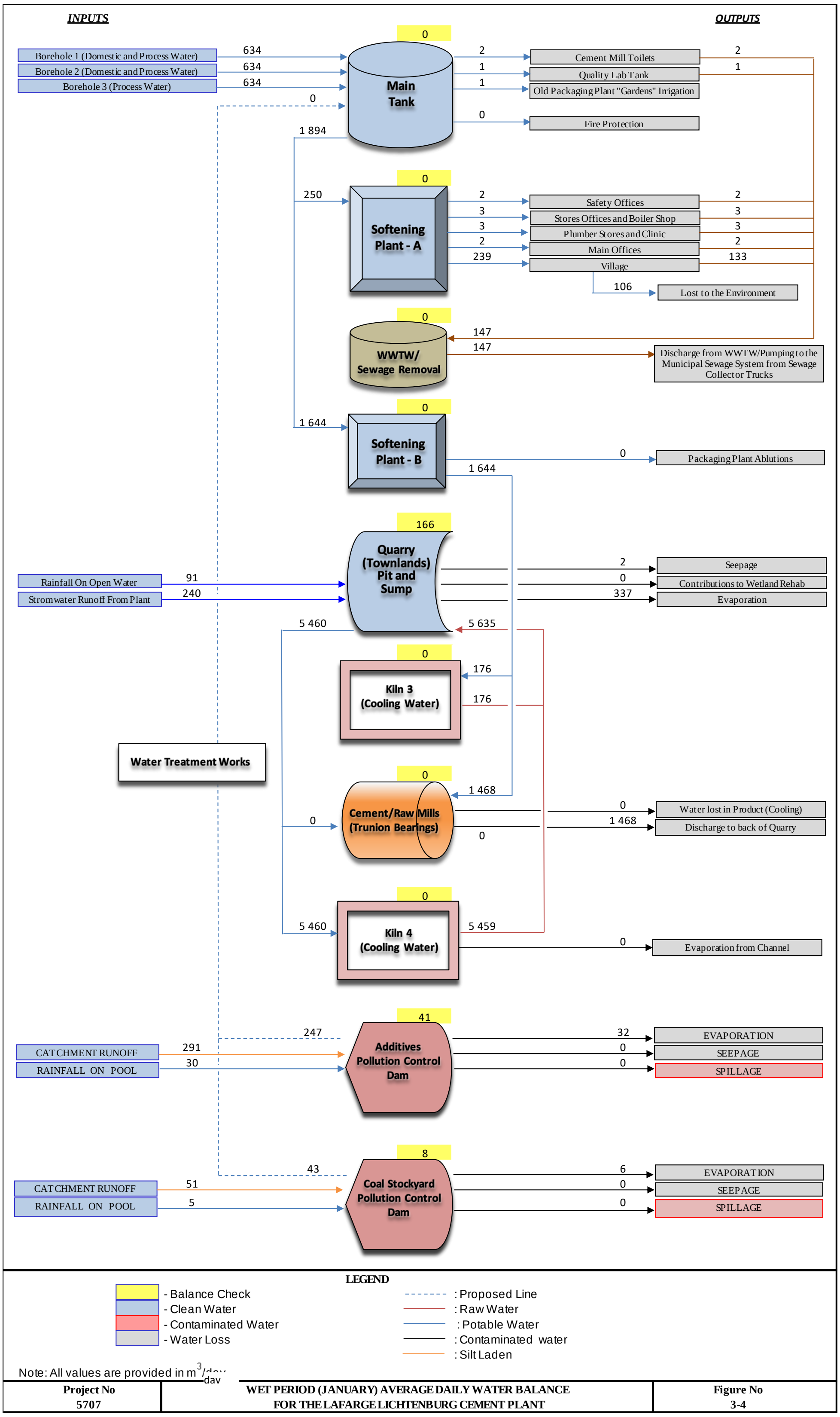


*Figure 3-4 Lafarge Lichtenburg Cement Plant Daily Wet Period (January) Water Balance*

It should be noted that the water balance was simulated over a period of 50 years (1950 to 2000). This was done so that the variability of climate, which affects the water balance results, is accounted for. The water balance results are summarised as follows:

- As presented in **Figure 3-1** and **3-2**, the annual average daily potable water requirement for the plant area equates to approximately 248 $m^3$/day (or 89 571 $m^3$/annum). The volume of water used for domestic purposes was estimated based on historical information provided by Lafarge, on the volume of wastewater collected by external service providers (i.e. honey suckers abstracting wastewater from the septic pits) who transfer this water by truck to the Lichtenburg sewage treatment works.
- The most significant user of potable water is the Lafarge staff village, which is estimated to use 130.5 $m^3$/day (47 633 $m^3$/annum) on average for domestic consumption and approximately 104.4 $m^3$/day (38 106 $m^3$/annum) for irrigation and washing purposes (i.e. water estimated to be lost to the environment). The majority of water used for domestic purposes is sourced from Softening Plant A (with the exception of water sent to the Packaging Plant Ablutions).
- The average volume of wastewater generated from the plant and village equates to 144.15 $m^3$/day (or 52 615 $m^3$/annum). Currently this water is collected by service providers and transferred to the municipal sewage treatment works, however, Lafarge are in the process of upgrading/refurbishing their WWTW, and so the wastewater generated in the future will report to the Lafarge WWTW.
- Water treated at the Softening Plant B is used predominantly for water supply to Kiln 3 and the Cement/Raw Mills for cooling water. The estimated water used from Softening Plant B equates to 1 643.98 $m^3$/day (approximately 600 053 $m^3$/annum). This water is used predominantly at the Cement/Raw Mills (1 467.6 $m^3$/day or 89% of the water treated at Softening Plant B).
- Water used at Kiln 3, which is sourced from the Softening Plant A (equating to 176.11 $m^3$/day), is returned to the Quarry (Townlands) Dam. A portion of this water (from the Townlands Dam) is then recycled for product cooling at the Cement Mill (0.48 $m^3$/day) and is also used at Kiln 4 for cooling purposes.
- A significant volume of water (1 467.6 $m^3$/day or 535 680 $m^3$/annum) is discharged from the Cement/Raw Mills to the wetland area located at the back of the cement plant. During consultations with Lafarge, it was noted that there are plans to construct a reservoir to capture this water so that it can be recycled back into cooling process at the Cement/Raw Mills, without being discharged to the environment. Based on the location of the discharge point, water discharged from the Cement/Raw Mills may eventually link into the Townlands Dam, however, based on discussions with

Lafarge, it was indicated that this linkage is uncertain. Therefore, it is assumed that the water discharged to the wetland area is evaporated or seeps into the groundwater reserves.

- The majority of water used at Kiln 4 for cooling processes is returned to the Townlands Dam. Some water is lost to evaporation along the length of the channel linking Kiln 4 to the Townlands Dam.
- Analysis of the proposed Additives and Coal Stockyard PCD's indicated that in order for the dams not to result in a spillage to the environment, water from these dams needs to be recycled and reused in the cement plant. Based on a proposed storage of approximately 20 000 $m^3$ at the Additives PCD and 4 000 $m^3$ at the Coal Stockyard PCD, the total volume of water that should be returned to the process water system equates to 153.2 $m^3$/day (or 4 660 $m^3$/month). In the wet season, due to the increased rainfall and runoff into the dams, the volume of water that needs to be recycled back to the plant equates to approximately 295 $m^3$/day (or 55 914 $m^3$/annum). In order to reintegrate this water into the process water stream, there may be a requirement to treat the water, however, this will only be confirmed once the chemical makeup of the wastewater is known and water quality requirements for the process water used at the cement plant are known.

Based on the water balance study, the following recommendations are provided:

- It was noted that the feasibility of constructing a reservoir to capture and recycle water used for cooling process at the Cement/Raw Mills is being investigated. It is recommended that this receives due attention as it would both reduce the volume of water than needs to be brought onto site from the wellfield, as well as reduce the risk of any contamination to the environment (although it should be noted that the status of the current water being discharged is not known).
- It has also been noted that there is a suggestion (from Lafarge) to capture water discharged from the Kiln 3, which currently recycles through the Townlands Dam and back to the Kiln 3 for cooling purposes, in a reservoir. This would mean that water from the cooling process does not go into the Townlands Dam. As mentioned above, a significant benefit of this would be that the risk of contamination of the Townlands Dam would be reduced.
- The water that will need to be recycled from the PCD's needs to be incorporated into the water management system and water management philosophy in the future. It is stressed that in order to ensure that the proposed PCD's will not spill, there must be an allowance to recycle water back into the process water stream for the plant.

# 4 ALTERNATIVE WATER SOURCES

Based on the water balance study, the water demands for the Lafarge Lichtenburg Cement Plant can be summarised as follows:

- 248 $m^3$/day for potable/domestic water usage, and
- 1 644 $m^3$/day for process water requirements.

The combined average water demand for the cement plant is therefore approximately 1 900 $m^3$/day. This is a significant amount of water. As part of this study, the following alternative sources of water have been identified:

- Townlands Pit (without augmentation from the boreholes),
- Tswana Lime Pits,
- The Ditsobotla Local Municipality, and
- Recycling water within the Cement Plant (including the recycling of water from the wastewater treatment plant).

Each of the above-mentioned alternative water sources are evaluated in the following sections.

## 4.1 Townlands Pit and Sump

In order to determine whether the Townlands Pit is a viable source of water, firstly, an estimate of the volume of the water stored in the pit was made, so that the water demands can be compared to water availability. As presented in **Figure 2-1**, the Townlands Pit is located to the immediate north of the cement plant. This pit is currently not mined. As a result of the pit not being mined, it has become a sump into which stormwater and process water from the cement plant accumulate. It is noted that historically, water from Borehole 3 was pumped into the Townlands Pit, from which water was then abstracted, to augment water supply to the cement plant. Based on information provided by Lafarge, this no longer happens as water is now pumped to the "Main Tank", from which water is supplied to the plant.

As presented in **Plate 4-1**, the Townlands Pit area that is inundated by water is extensive. At the time of this study, a detailed survey of the Townlands Pit was not available. Therefore, in order to estimate the volume of water available in the pit, a calculation was undertaken whereby the surface area of the pit (open water measured in google earth) was multiplied by an assumed average depth across the measured open water areas. Therefore, based on a surface area of approximately 26 000 $m^2$ (measured using google earth imagery) and an average depth of approximately 3 m, the estimated volume/capacity of stored water in the Townlands Pit is 78 000 $m^3$. It is assumed that the areas of wetland grasses are relatively shallow, and are therefore not taken into account in the volume estimate.


*Plate 4-1 Drone Image of Townlands Pit*

Further to the water stored in the pit, it is noted that return flows (from water discharged from the cement plant) and stormwater runoff need to be accounted for in the Pit water balance. Water losses (in addition to the water being pumped from the pit to the processing plant) include evaporation, evapotranspiration and losses to the groundwater system. Based on a groundwater model of the project area, it has been confirmed that at elevated water levels in the Pit (i.e. water levels exceeding 3m in depth), there is a net loss of water from the Pit to the groundwater system (very limited loss of approximately 0.0019 $m^3$/day). At low levels, (i.e. when the Pit is empty) there is a net gain from groundwater into the Pit. The maximum net gain from groundwater is estimated as 0.1 $m^3$/day, which is insignificant in the context of water requirements for the Cement Plant.

In order to determine whether the Pit is able to sustainably supply water to the plant, a focused water balance of the Pit was configured. Based on a water demand of approximately 1 900 $m^3$/day (average water demand for the cement plant and housing complex), and an estimated storage volume of 78 000 $m^3$, it is estimated that there is approximately 41 days of water supply available in the Townlands Pit. This was confirmed in the water balance where if a demand of 1 900 $m^3$/day was placed on the Pit, the storage in the pit remained at zero over the majority of the simulation period.

However, as a result of return flows from the cement plant to the Pit and wetland area upstream of the Pit, some water can be abstracted from the pit on a sustained basis. Using the focused water balance, it was noted that approximately 200 $m^3$/day can be abstracted from the Pit (assuming return flows from the cement plant) occur on a continuous basis. This is shown in **Figure 4-1**, which shows a timeseries of storage in the Pit between the period of 1950 to 2000 if this abstraction rate was enforced from the Pit. Therefore, if water is sourced from the Pit, the demand for process water to be supplied from the boreholes (Boreholes 1 to 3) could possibly be reduced by 200 $m^3$/day.

**However, it can be concluded that the Townlands Pit is not a sustainable alternative water supply option for the cement plant in the long-term**. This is due to the significant difference in the demand (approximately 1 900 $m^3$/day) compared to the potential sustainable supply (approximately 200 $m^3$/day). The cement plant would therefore still need to source approximately 1 700 $m^3$/day from an outside source to ensure that operations at the plant are not interrupted due to inadequate water supply.

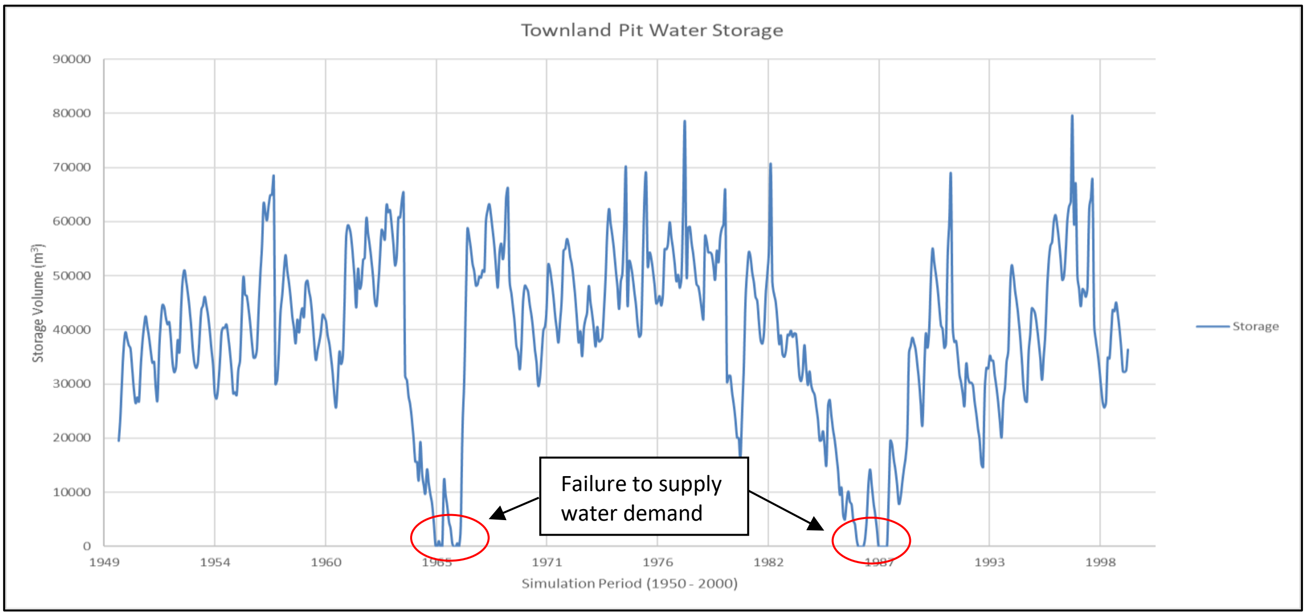


*Figure 4-1 Townlands Open Pit storage between 1950 and 2000, assuming water is abstracted at 200 $m^3$/day*

## 4.2 Tswana Lime Pits

Although the Tswana Lime Pits are a potential source for water supply and have therefore been considered as a potential water supply option for the Cement Plant, the distance between the Tswana Lime Mine and the Cement Plant results in this option being discarded at the first point of analysis. If water were to be sourced from the Tswana Lime, the pipeline that would need to be constructed between Tswana Lime and the Cement Plant would need to be approximately 47 km in length. The costs associated with this make this option prohibitive. Further to this, it is noted that the Tswana Lime Pits are a source of water supply to the mine (used for washing and dust suppression). This further substantiates this option being a non-starter as an alternative for water supply to the Cement Plant.

## 4.3 Ditsobotla Local Municipality Water Supply

A number of considerations need to be taken into account in assessing whether the Ditsobotla Local Municipality is a viable option for water supply to the Lafarge Cement Plant. This includes answering the following questions:

- Does the municipality have water resources available to supply the water demand for the cement plant?
- Is there infrastructure (pipelines) that would allow for water to be seamlessly connected to the cement plant?
- What are the cost implications to Lafarge if water is sourced from the municipality?

In order to answer these questions, a meeting with Mr Thabiso Tshabalala, who is the manager of the Project Management Unit (PMU) at the Ditsobotla Local Municipality, was held in August 2022. Based on this meeting, the following was noted:

- The majority of water supplied within the Ditsobotla Local Municipality is sourced from group of boreholes known as the Klipveld Boreholes, located near to the Malapo Oog Game Reserve. Water is then treated at a water treatment works located near Bakerville, from which treated water is transferred to Lichtenburg Town.
- The primary source of water for the municipal area is therefore from groundwater resources.
- Due to current shortages in water supply, the municipality has plans to develop a further six boreholes (the municipality is in negotiations with the Water Services Authority for this to be authorised).

- Current demands for water supply are estimated to be approximately 12 Ml/day (12 000 $m^3$/day).
- Plans to replace asbestos pipes (that are a regular problem due to leaks) with PVC pipes are expected to be implemented in the near future (to be completed in the year 2023). This will reduce the volume of water wasted due to leaks in the conveyance pipes from Bakerville to Lichtenburg.
- The location of existing municipal water supply pipelines in the vicinity of Lafarge means that there should be no issues in connecting Lafarge to the municipal water supply system.

Further to the interview with Mr Tshabalala, bulk water costs for water supply in the municipality were also obtained. **Table 4-1** presents the tariffs for businesses and industries in the municipal area.

*Table 4-1 Ditsobotla Local Municipality Tariffs (for the period 2021/22)*

| Water Usage Thresholds | Tariffs Per Unit (For the year 2021/22) |
|---|---|
| 1-50 | R10 |
| 51-100 | R12 |
| 101-500 | R14 |
| 501-1000 | R18 |
| 1000 + | R23 |
| Bulk Meter Charge | R13 |

Based on the total water requirement for the Lafarge Cement Plant, equating approximately 1 900 $m^3$/day (for both process and domestic purposes), the Lafarge water demand would equate to approximately 16 % of the current total local municipality water demand. This is significant in the context of water supply in the region. Further to this, based on discussions with the Mr Tshabalala, it is understood that water demands are close to what can be obtained from the boreholes, by the municipality. If additional water demands, especially considering the quantity required by Lafarge, are put on the municipality, the risk of failure to supply the greater region will be increased.

Considering the tariffs provided in **Table 4-1**, the cost of water for the cement plant (based on current water usage scenarios) would equate to approximately R24 700/day. Therefore, on a monthly basis the cost for water supply to the cement plant and associated housing complex could equate to as much as R765 700.

## 4.4 Recycling of water within the Cement Plant

Although recycling of water within the cement plant is not strictly an alternative water source, implementing an effective water conservation and water recycling system will significantly reduce the Cement Plant's dependency on alternative water supply options. It is therefore important to identify the areas in which water can be recycled.

As presented in **Section 3** and **Figure 3-2**, there are a number of areas where water can be recycled. This includes:

- Water that is discharged into the wetland area in the back of the quarry, equates to approximately 1 468 $m^3$/day (as per the water balance in **Figure 3-2**). It is our understanding that this water is from the cooling process at the Cement/Raw Mills (Trunnion Bearings). Although not confirmed, it is postulated that water that is discharged to the wetland area at the back of the Townlands Pit, eventually recharges water stored in the pit (through surface or sub-surface flows, depending on the level of water stored in the Pit).
- Water that is sent to the water treatment works is estimated to equate to approximately 144 $m^3$/day. Currently wastewater is taken away from site through contractors that extract the wastewater from septic pits located throughout the project area. It is noted that Lafarge are in the process of upgrading the wastewater treatment works located on site so that this water can be treated on site. It is therefore proposed that instead of discharging the treated wastewater back into the environment, it is used to augment process water supply to the plant.
- Based on the water balance, the volume of water that can be recycled from the PCD's equates to approximately 153 $m^3$/day. It is noted that this is an average amount as the water balance is based on monthly water values disaggregated to daily values. However, this figure is indicative of the fact that a significant amount of water can and should be sourced from the PCD's in the future.

Based on the above, it is noted that the potential volume of water that can be recycled back into the Lafarge Cement Plan process water system equates to approximately 1 765 $m^3$/day. If 80% of this water could effectively be recycled, the demand for outside water sources could potentially drop by as much as 74% (1 412 $m^3$/day divided by 1 900 $m^3$/day). This is a significant reduction on the Cement Plants dependence on outside sources of water. It is, however, noted that in order to implement the proposed recycling of water, particularly from the PCD's and process water currently discharged to the wetland area, effective water treatment processes would need to be implemented, and so this option is not without its complications.

## 5 DISCUSSION AND CONCLUSION

JG Afrika were appointed by Lafarge to undertake a study to identify potential alternative water sources for the Lichtenburg Lafarge Cement Plant, located in the North West Province. This specialist study is required as part of a Water Use Licence Application (WULA) for the cement plant.

Based on a water balance study, it was noted that the total water demand for the cement plant and associated housing complex equated to approximately 1 900 $m^3$/day. This is comprised of approximately 248 $m^3$/day for potable/domestic water usage and 1 644 $m^3$/day for process water requirements.

The potential alternative sources of water for the cement plant were identified as the Townlands Pit, Tswana Lime Pit, Ditsobotla Local Municipality, and recycling of water within the cement plant. The objectives of this alternative water sources study were therefore to determine the following:

- The long-term water resource potential of water stored in the Townlands Pit (without augmentation from the boreholes).
- The water resource potential of water stored in the Tswana Lime Pits and limits associated with using this water (such as the transfer of water from Tswana to Lichtenburg).
- The potential and complexities associated with sourcing water from the Ditsobotla Local Municipality. This included whether the municipality has the capacity to supply the required demand from Lafarge, as well as identifying any cost implications of using water from the municipality.
- The potential for recycling water within the Cement Plant (particularly water used in the Kilns and for cooling purposes).

Based on the analysis, the following was noted:

- The volume of water that can be sustainably abstracted from the Townlands Pit equated to approximately 200 $m^3$/day (assuming return flows from the cement plant occur on a continuous basis). However, it was concluded that the Townlands Pit is not a sustainable alternative water supply option for the cement plant in the long-term.
- Due to the distance between the Cement Plant and the Tswana Lime Mine, equating to approximately 47 km (along the current rail reserve), the potential for water to be sourced from Twana Lime was disregarded.
- Based on an interview with Mr Thabiso Tshabalala, who is the manager of the PMU at the Ditsobotla Local Municipality, it was noted that current water supply to the municipality is strained. In order to

ensure that the municipality is able to provide for the current water demands, requests to drill an additional 6 boreholes have been applied for with the WSA. If Lafarge were to source its entire water requirement from the municipality, this would increase the volume of water that the municipality would need to source by approximately 16%. Considering the currently strained situation of water supply in the municipality, sourcing water from the municipality may result in an increase in its risk of not being able to supply water to the region. Further to this, it was noted that the costs associated with sourcing water from the municipality would be high (equating to approximately R765 700/month).

- It was noted that the potential volume of water that can be recycled back into the Lafarge Cement Plan process water system equates to approximately 1 765 $m^3$/day. If 80% of this water could effectively be recycled, the demand for outside water sources could potentially drop by as much as 74% (1 412 $m^3$/day divided by 1 900 $m^3$/day). This is a significant reduction on the Cement Plants dependence on outside sources of water. It is, however, noted that in order to implement the proposed recycling of water, particularly from the PCD's and process water currently discharged to the wetland area, effective water treatment processes would need to be implemented, and so this option is not without its complications.

Based on this alternative water sources study, it is recommended instead of sourcing a high volume of water from outside of the factory, a water reuse and recycling initiative is implemented. This would result in significant reductions in water demands from an outside source. If this is implemented, the remainder of the water that is required for the factory could be obtained from the municipality, as the volume and costs of sourcing water from the municipality would be significantly reduced. It should be noted that if water is being effectively recycled within the plant, water sourced from the Townlands Pit would not be sustainable (as the return flows to the Pit would be limited).

## 6 REFERENCES

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