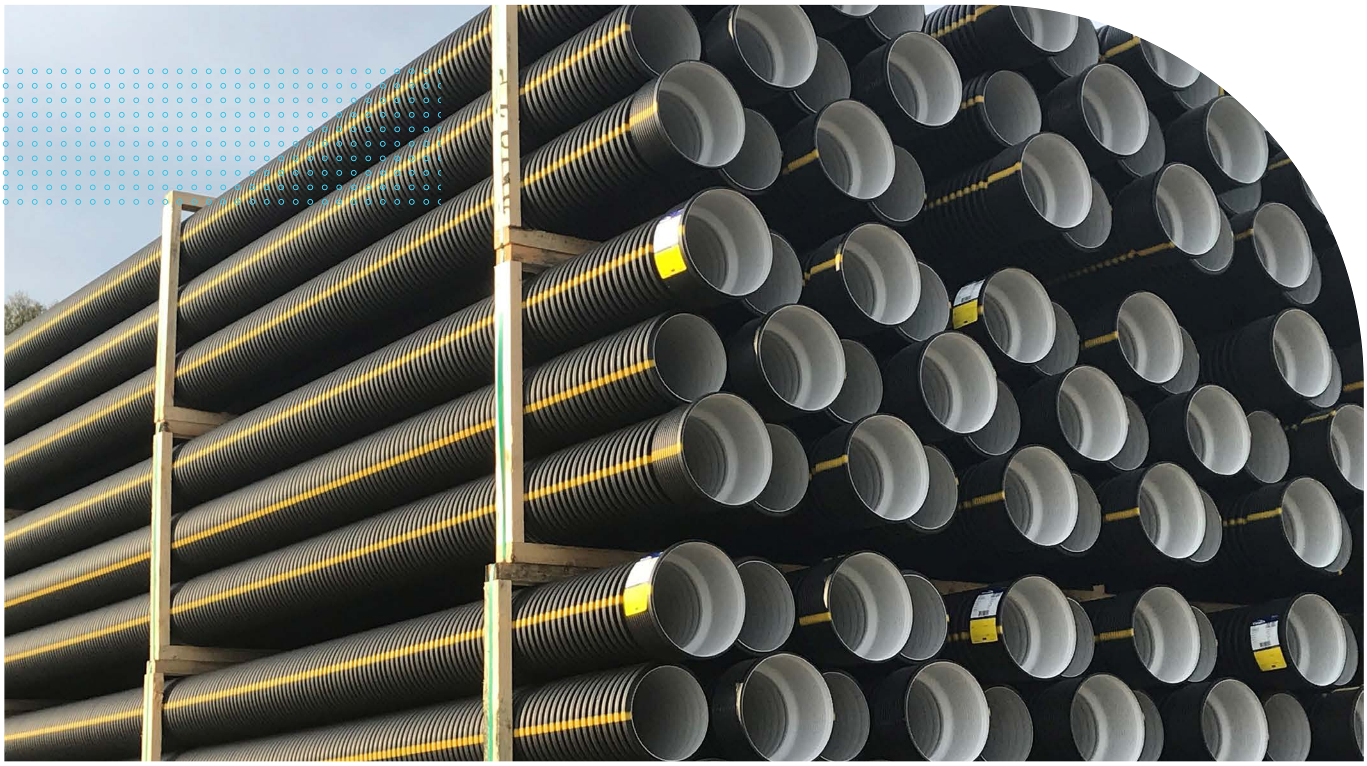
PIPA

ENVIRONMENTAL PERFORMANCE COMPARISON

PLASTIC AND CONCRETE PIPES IN DRAINAGE APPLICATIONS

JUNE 2025



ENVIRONMENTAL PERFORMANCE COMPARISON OF PLASTIC AND CONCRETE PIPES IN DRAINAGE APPLICATIONS

In a landscape where sustainable infrastructure is pivotal to addressing climate challenges, informed material selection plays a critical role in reducing environmental impacts across the built environment. Drainage pipe systems, commonly constructed from plastic or concrete, have varying life cycle profiles influenced by their material characteristics, manufacturing processes, and end-of-life management practices.

To inform evidence-based infrastructure decisions, the Plastics Industry Pipe Association of Australia (PIPA) engaged Edge Impact to perform a comparative Life Cycle Assessment (LCA) of plastic drainage pipes — specifically Polyethylene (PE) and Polypropylene (PP) — and steel-reinforced concrete (SRC) pipes.

The assessment relies primarily on Environmental Product Declarations (EPDs) that reflect Australian production conditions and include data from major suppliers such as Vinidex and RCPA. The study also integrates End-of-Life (EoL) considerations, a critical aspect often overlooked in conventional assessments, by applying material-specific assumptions for recycling, landfill, and reprocessing pathways.

By examining environmental performance across the product life cycle — from raw material extraction through to installation — including Global Warming Potential (GWP), resource depletion, and energy use — this report supports infrastructure professionals, asset owners, and policymakers in identifying materials aligned with environmental, economic, and operational goals.

This briefing paper provides a clear and structured overview of how to interpret Life Cycle Assessment (LCA) results from the PIPA Drainage Pipe Comparison Report. It highlights the foundational assumptions underpinning the assessment and offers guidance on the implications for environmental decision-making in infrastructure planning.

FOUNDATIONAL ASSUMPTIONS

FUNCTIONAL EQUIVALENCY

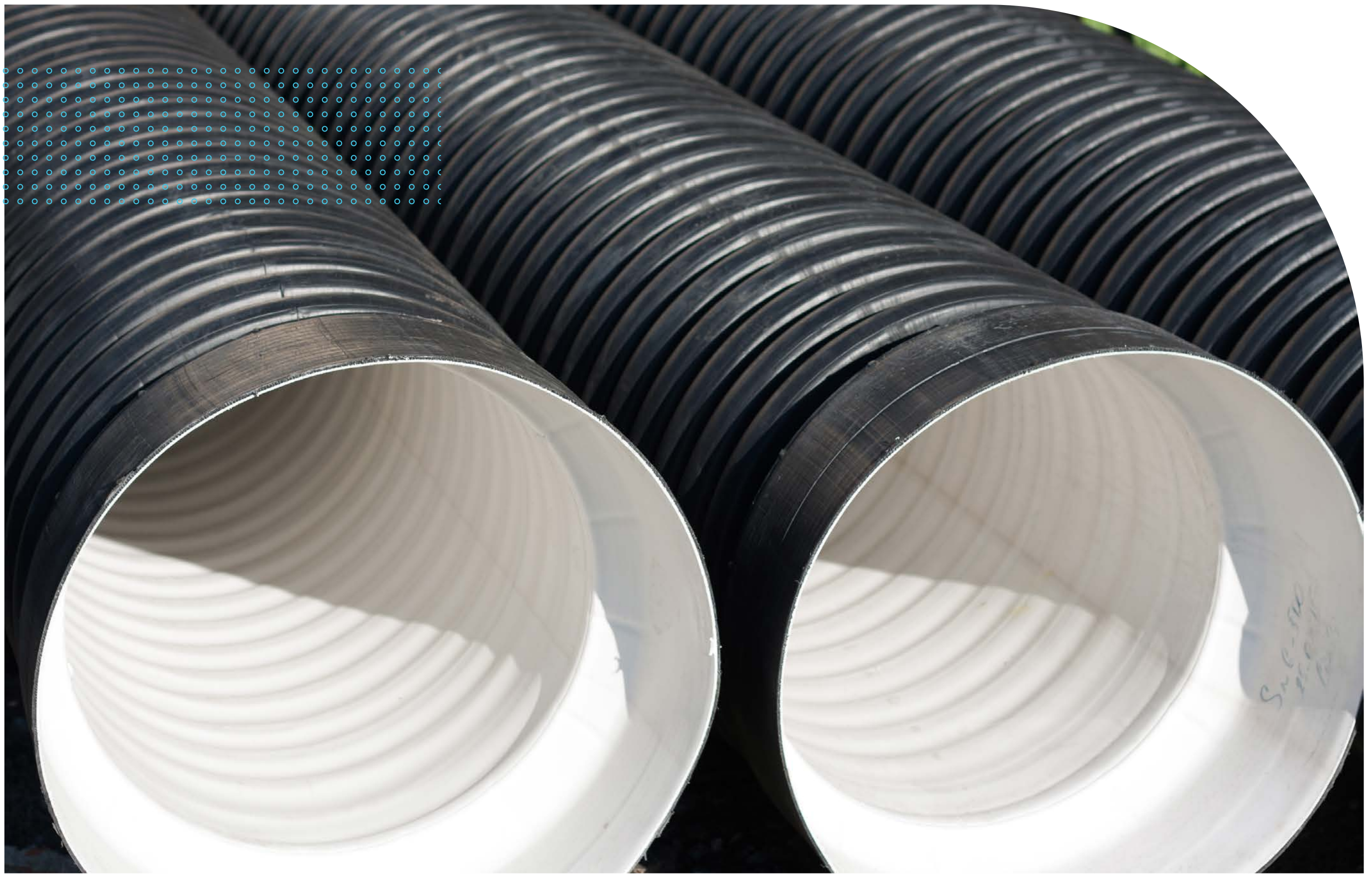
The study ensures an equitable comparison by standardising the functional performance of all pipe materials. Each pipe type is assumed to deliver the same hydraulic function and longevity. This includes an expected **100-year service life** across all evaluated options (plastic and concrete), removing performance bias from the environmental analysis.

DECLARED UNIT

Environmental impacts are assessed per **1 metre of installed pipe**, providing a consistent basis for comparison. This cradle-to-installation unit (modules A1–A5) includes:

- A1: Raw material supply
- A2: Transport to manufacturing site
- A3: Manufacturing
- A4: Transport to construction site
- A5: Installation

This standardised approach aligns with typical infrastructure asset expectations and avoids distortions from differing service durations or maintenance demands.



ENVIRONMENTAL BENEFITS OF PLASTIC PIPES

Compared to concrete pipes, plastic pipes offer the following key environmental benefits (Product Stage System A1-A3):

LOWER GLOBAL WARMING POTENTIAL (GWP):

Plastic pipes have a lower carbon footprint during production and transportation. For example, PE and PP pipes emit less CO_2 per meter compared to SRC Class 2 and Class 3 concrete pipes.

DN 375 PIPES:

- PE Corrugated SN8 emits 24 kg CO_2 eq./m
- PP Corrugated SN8 emits 24 kg CO_2 eq./m
- SRC Class 2 emits 34 kg CO_2 eq./m
- SRC Class 3 emits 35 kg CO_2 eq./m

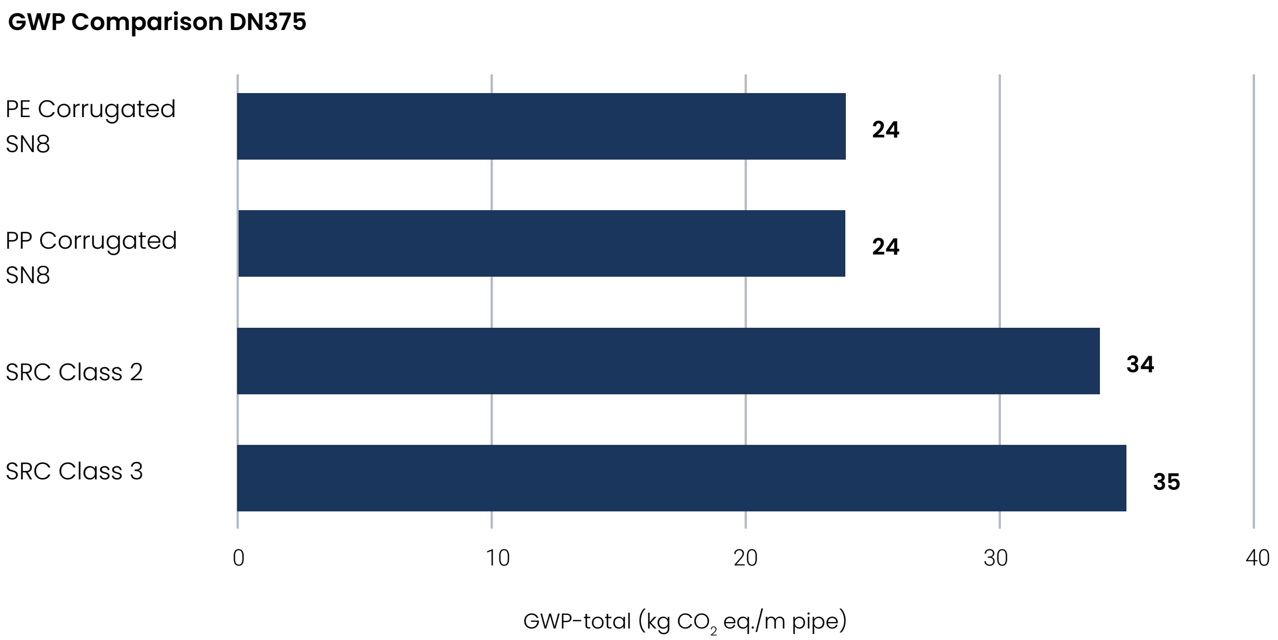


Figure 1: GWP-total comparison of plastic pipes with concrete pipes for the size of DN 375

DN375 plastic pipes emit 31–32% less CO2 compared to concrete pipes.

DN 600 PIPES:

- PE Corrugated SN8 emits 59 kg CO_2 eq./m
- PP Corrugated SN8 emits 67 kg CO_2 eq./m
- SRC Class 2 emits 78 kg CO_2 eq./m
- SRC Class 3 emits 82 kg CO_2 eq./m

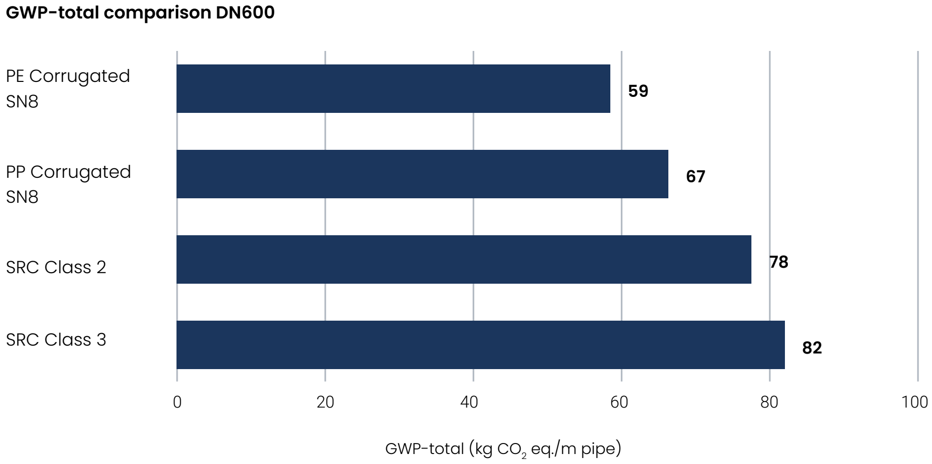


Figure 2: GWP-total comparison of plastic pipes with concrete pipes for the size of DN 600

DN 600 Plastic pipes emit 24–28% less CO_2 compared to concrete pipes.

DN 900 PIPES:

- PE Corrugated SN8 emits 140 kg CO_2 eq./m
- SRC Class 2 emits 159 kg CO_2 eq./m
- SRC Class 3 emits 193 kg CO_2 eq./m

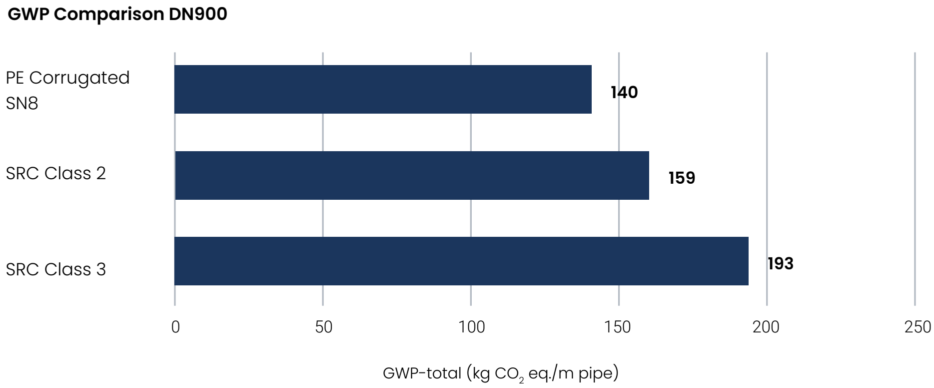


Figure 3: GWP-total comparison of plastic pipes with concrete pipes for the size of DN 900

DN 900 Plastic pipes emit 12–27% less CO_2 compared to concrete pipes.

FOR CONTEXT

One short-haul flight (e.g. Sydney -Melbourne) emits 63kg CO_2 eq. per passenger[1]

Each person every year releases 13.638 tonnes of CO_2 per person per year in Australia[2]

1 Based on ICAO Carbon emissions Calculator and Australian average
2 World Bank (2021), "CO_2 emissions (metric tons per capita) – Australia", https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=AU

REDUCED USE OF NET FRESHWATER (FW):

Plastic pipes require significantly less freshwater during production than concrete pipes, with the majority of water use occurring during the manufacture of the plastic resin.

DN 375 PIPES:

- → PE Corrugated SN8
  110 litres/metre pipe
- → PP Corrugated SN8
  90 litres/metre pipe
- → SRC Class 2
  220 litres/metre pipe
- → SRC Class 3
  220 litres/metre pipe

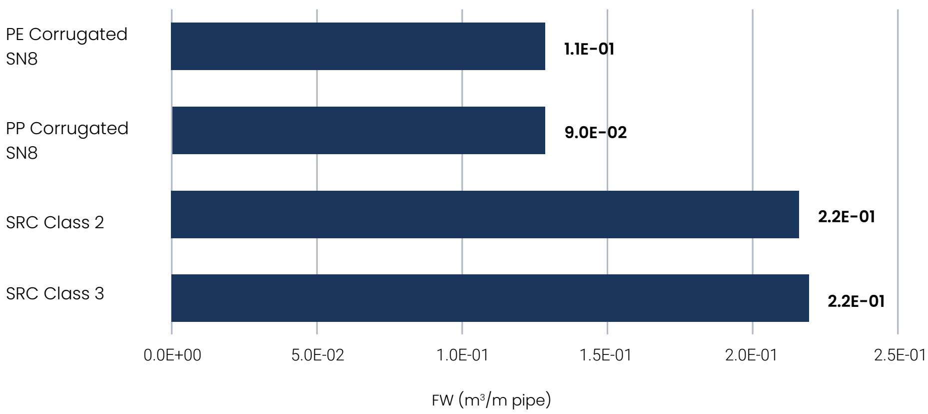


Figure 4: Use of net freshwater comparison of plastic pipes with concrete pipes for the size of DN 375

DN 600 PIPES:

- → PE Corrugated SN8
  270 litres/metre
- → PP Corrugated SN8
  250 litres/metre
- → SRC Class 2
  490 litres/metre
- → SRC Class 3
  510 litres/metre

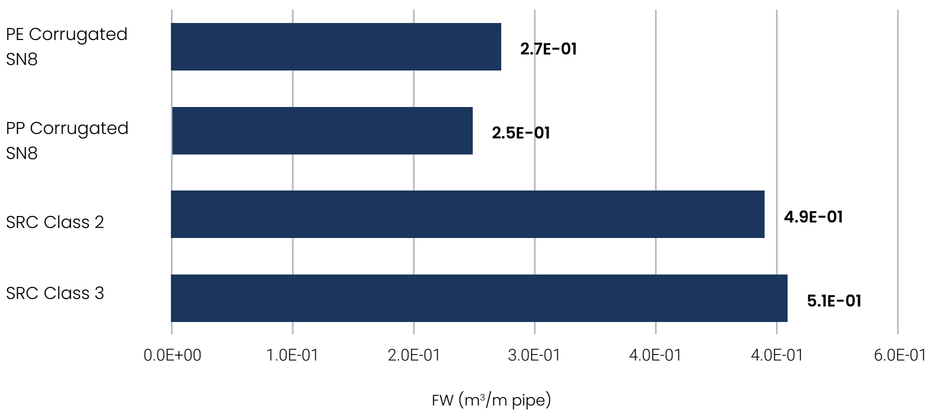


Figure 5: Use of net freshwater comparison of plastic pipes with concrete pipes for the size of DN 600

DN 900 PIPES:

- → PE Corrugated SN8:
  530 litres/metre pipe
- → SRC Class 2:
  1,000 litres/metre pipe
- → SRC Class 3:
  1,200 litres/metre pipe

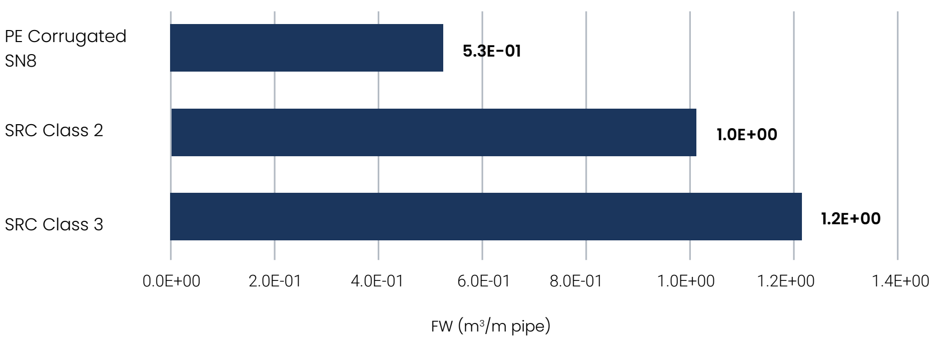


Figure 6: Use of net freshwater comparison of plastic pipes with concrete pipes for the size of DN 900

TRANSPORTATION EFFICIENCY:

Due to their lighter weight, plastic pipes have lower GWP for transportation compared to concrete pipes (Product Stage System A4):

DN 375 PIPES:

- PP/PE: 2.3 kg CO_2 eq./m pipe
- SRC Class 2: 4.4 kg CO_2 eq./m pipe
- SRC Class 3: 7.1 kg CO_2 eq./m pipe

DN 600 PIPES:

- PP/PE: 6.4 kg CO_2 eq./m
- SRC Class 2: 8.7 kg CO_2 eq./m
- SRC Class 3: 15.8 kg CO_2 eq./m

DN 900 PIPES:

- PP: 13.4 kg CO_2 eq./m pipe
- SRC Class 2: 19.4 kg CO_2 eq./m pipe
- SRC Class 3: 32.1 kg CO_2 eq./m pipe

Plastic pipes overall have 26–67% lower transportation emissions compared to concrete pipes.

These numbers demonstrate the environmental advantages of plastic pipes in specific categories compared to concrete pipes.

MATERIAL COMPOSITION AND RECYCLED CONTENT

Plastic pipes are 100% recyclable, although their long service life limits the availability of recycled material for manufacturing. Concrete pipes contain recycled steel, but plastic pipes still outperform in certain categories.

The plastic pipes (PE and PP) assessed were manufactured using 100% virgin materials, as current market availability and application standards (e.g., for long-life infrastructure) do not support the widespread use of recycled content.

In contrast, concrete pipes incorporated steel with 70% recycled content, which partially offsets their environmental burden. Despite this advantage, plastic pipes performed better in key categories such as global warming potential (GWP) and use of net freshwater (FW).

To demonstrate the potential for improvement, the study also modelled the environmental performance of plastic pipes assuming varying levels of recycled content. The table below highlights reductions in GWP with increased recycled input:

Recycled Content (%)	GWP Reduction (PE pipes) (%)	GWP Reduction (PP pipes) (%)
10%	6.9%	5.9%
20%	13.8%	11.8%
30%	20.7%	17.7%

This demonstrates that integrating recycled content into plastic pipe production could further enhance their sustainability profile.

ENERGY SOURCE INFLUENCE

The source of electricity used in manufacturing processes significantly influences LCA outcomes. For plastic pipes, environmental impacts such as radioactive waste are primarily attributable to the use of global LCA data for plastic resin manufacturing. Where global data includes electricity generation from nuclear energy sources for a range of countries e.g., China, USA, Europe).

While this contributes to higher radioactive waste scores for plastic pipes, the overall environmental burden remains lower due to lighter weight, reduced transport emissions, and lower energy demands during production compared to concrete pipes.

SUSTAINABILITY IN PRIORITY CATEGORIES:

Plastic drainage pipes demonstrate stronger environmental performance than steel-reinforced concrete (SRC) pipes across multiple impact categories in the Life Cycle Assessment (LCA) including highest priority environmental categories (GWP and FW).

DN 375, plastic pipes lead in 6 out of 12 categories, maintaining a strong performance in GWP, water consumption, and ozone-related emissions.

DN 600, plastic pipes show superior outcomes in 7 out of 12 categories, reaffirming their environmental efficiency across a broader range of diameters and system applications.

DN 900, plastic pipes performed better in 6 out of the 12 categories, demonstrating consistent environmental advantages as pipe diameters increase, particularly in emissions, resource use, and ecological impact indicators.

These results reflect not only the material and energy efficiency of plastic manufacturing processes but also improved end-of-life recycling assumptions. The findings support plastic pipes as a lower-impact alternative for sustainable infrastructure planning.

Note – there are 13 impact categories, however Acidification potential (AP) was inconclusive and not used.

IMPORTANT CONSIDERATIONS FOR COMPARING PIPE MATERIALS

When assessing environmental performance between different pipe products, it is essential to consider several broader influences that shape Life Cycle Assessment (LCA) outcomes. These extend beyond direct material inputs and include geographic, methodological, and functional dimensions:

MATERIAL LONGEVITY AND RECYCLABILITY

Plastic pipes are designed for long service lives, often exceeding 100 years. This durability, along with compliance to strict industry standards, means recycled content is generally not used during production. While materials such as concrete may appear more favourable in LCA due to higher recycled content, plastic pipes often perform better in key environmental impact categories like global warming and water use due to their efficiency in production and lighter weight.

SOURCE DATA VARIABILITY

LCA outcomes depend heavily on data origin and assumptions. For example, plastic resin data typically uses global averages, which may not reflect actual impacts from specific regional suppliers. Locally sourced data for both materials allow for a more accurate and equitable comparison.

PRODUCT SPECIFICATIONS

Differences in pipe design, composition, and manufacturing processes can significantly alter environmental profiles. LCAs are sensitive to these variables, and accurate comparisons require a clear understanding of product specifications across assessed alternatives.

ENERGY MIX AND REGIONAL VARIABILITY

The electricity mix used in resin production (e.g., fossil vs. nuclear vs. renewable sources) significantly affects LCA outcomes. As grid decarbonisation advances, especially in resin-manufacturing countries, the environmental performance of plastic pipes is likely to further improve.

EXCLUSIONS AND BOUNDARIES

This study focuses on the cradle-to-installation stages. Use-phase and end-of-life impacts were excluded, which limits a full cradle-to-grave understanding but provides robust insight into embodied impacts.

VARYING STANDARDS AND METHODOLOGIES

Differences in environmental assessment methods, such as between European EN standards and the ISO framework, can lead to variation in LCA outputs. Harmonisation is essential when comparing international products or using rating schemes that rely on older standards.

This structured and critical approach to interpreting LCA results ensures that comparisons between pipe materials are meaningful and grounded in real-world infrastructure contexts. It supports transparency and confidence in decision-making.

KEY CONSIDERATIONS WHEN COMPARING ENVIRONMENTAL PRODUCT DECLARATIONS (EPDS)

Comparing EPDs across different pipe materials or suppliers requires careful attention to consistency, methodology, and scope to ensure a meaningful and fair analysis:

FUNCTIONAL EQUIVALENCE

Confirm that the products being compared serve the same function (e.g., drainage, pressure capacity) and have similar service lives. Without this, results may reflect performance discrepancies rather than material impacts.

DECLARED UNIT CONSISTENCY

EPDs must use the same declared unit (e.g., per metre of pipe) for a valid comparison. Differences in units can significantly distort comparative results.

SYSTEM BOUNDARIES

Ensure that the EPDs cover equivalent life cycle stages. This study uses cradle-to-installation (A1–A5). Some EPDs may only include cradle-to-gate (A1–A3), which can underestimate total impacts.

DATA QUALITY AND SOURCE

LCA results vary based on data sources. For example, resin data in plastic pipe EPDs may reflect global averages, whereas concrete EPDs might use locally sourced information. For accurate comparisons, data origin and type (primary vs. secondary) must be aligned.

- → **Methodological Alignment:** Check that EPDs follow the same methodological framework (e.g., EN 15804+A2). Older EPDs using EN 15804+A1 or ISO 14025 may not be directly comparable due to differences in impact assessment approaches.
- → **Impact Category Coverage:** Confirm that the EPDs include the same set of environmental indicators, such as global warming potential (GWP), water use, eutrophication, and waste generation. Gaps in impact categories may skew comparison.
- → **Recycled Content Treatment** Some materials like concrete incorporate significant recycled content (e.g., steel reinforcement), whereas plastic pipes currently use virgin resins. Understanding how recycled content is treated in each EPD is essential for fair evaluation.

By carefully considering these elements, stakeholders can make more accurate and transparent comparisons between pipe materials using EPDs.

CONCLUSION

While no single material is superior in every environmental category, plastic pipes present a strong case for sustainable infrastructure in Australia, particularly where reduced carbon emissions and water consumption are prioritised. This LCA study helps support informed choices in the transition toward environmentally responsible asset management and procurement.

For more information download the PIPA Drainage Pipe Comparison Report (2025).

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