ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14025 and EN 15804:2012+A2:2019 for:

BLACKMAX® AND SEWERMAX® POLYPROPYLENE PIPES

FROM IPLEX PIPELINES AUSTRALIA PTY LIMITED

Programme: EPD Australasia, www.epd-australasia.com
Programme operator: EPD Australasia
EPD registration number: S-P-00714
Publication date: 2015-12-06
Valid until: 2027-11-23
Version 2.0: 2022-11-23
Geographic location: Australia
Reference year for data: 2020-2021
An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

ECO PLATFORM EPD VERIFIED

AUSTRALASIA EPD® ENVIRONMENTAL PRODUCT DECLARATION

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ENVIRONMENTAL PRODUCT DECLARATION

BLACKMAX® AND SEWERMAX® POLYPROPYLENE PIPES

1.0 ENVIRONMENTAL PRODUCT DECLARATION DETAILS

An Environmental Product Declaration, or EPD, is a standardised and verified way of quantifying the environmental impacts of a product based on a consistent set of rules known as a PCR (Product Category Rules). Environmental product declarations within the same product category from different programmes may not be comparable. EPD of construction products may not be comparable if they do not comply with EN 15804.

This EPD has been updated to provide detailed information on the environmental impacts arising from the A5 module (installation module) to reflect largely the factors affecting installation and are significantly influenced by pipeline designers, infrastructure agencies and installing contractors.

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ACCREDITED OR APPROVED BY:	EPD Australasia

CEN STANDARD EN 15804 SERVES AS THE CORE PRODUCT CATEGORY RULES (PCR)

PCR:	Construction Products and Services, (PCR) 2019:14, v1.1 and UN CPC code(s) 36320 according to CPC v2.1, 2015.
PCR PREPARED BY:	The Technical Committee of the International EPD System. A full list of members available on www.environdec.com. The review panel may be contacted via info@environdec.com. Review chair: Claudia A. Peña, University of Concepción, Chile
EPD VERIFICATION (EXTERNAL):	Independent third-party verification of the declaration and data, according to ISO 14025:2006
OTHER EPD'S FROM IPLEX:	Iplex PVC Pressure Pipes EPD, Iplex PVC Non – Pressure Pipes EPD, Iplex Polyethylene Pipes EPD

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

2.0 PRODUCT SUSTAINABILITY CREDIT POINTS

- ✓ EPD conforms to ISO 14025 and EN 15804.
- ✓ The EPD has been verified by an independent third party.
- ✓ The EPD has at least a cradle-to-gate scope.
- ✓ The EPD has product specific results.

This EPD may be used to obtain product sustainability credit points under the Green Building Council of Australia's (GBCA's) Green Star rating tools and the Infrastructure Sustainability (IS) rating tools.

For the purpose of IS ratings, EPDs are Type III environmental declarations which provide valuable environmental impact data towards IS reward.

The BlackMAX® and SewerMAX® polypropylene (PP) pipe EPD results can also be used to represent PP pipe products in Whole of Building Life Cycle Assessments under Green Star rating tools. See the product detail tables to convert the product results from kilogram of installed pipe to length of pipe for individual pipe products.

3.0 IPLEX PIPELINES AUSTRALIA

Iplex Pipelines Australia (Iplex), one of Australasia's largest manufacturers and suppliers of plastic pipeline systems, is pleased to publish this independently verified Environment Product Declaration (EPD) for structured wall polypropylene BlackMAX® SN8 stormwater, SewerMAX® SN10 and SewerMAX+® SN20 sewer pipes.

A wholly owned business unit of the ASX listed company Fletcher Building Limited, with operations nationally and in New Zealand. Iplex supplies pipe and conduit to applications including plumbing, irrigation, mining, industrial and chemical processes, electrical, gas, stormwater, sewer, raw, recycled and potable water.

SUSTAINABILITY AT IPLEX

Iplex polypropylene pipe PP systems are engineered to meet some of the highest standards in the world. With over 80 years' manufacturing history, Iplex is an industry leader that strives to make a difference in sustainability and the manufacturing of environmentally friendly polypropylene pipes.

PP structured wall pipes manufactured by Iplex are made for long service life, and can have a service life longer than 100 years. Resources are carefully managed by Iplex to reduce environmental impacts associated with manufacturing, construction, and operations including the distribution and use of pipe product.

A sustainable feature of Iplex PP structured wall pipes is that they are made from thermoplastic material and are 100% recyclable. Iplex polypropylene pipes deliver essential services that sustain our communities. It is important to Iplex to extend its sustainability agenda beyond environmentalism to include economic and social aspects. Sustainable and safe practices are embedded deep in the Iplex culture and driven by its corporate strategic priority *Sustainability at the Core* and cultural values *Protect, Be Bold, Customer Leading,* and *Better Together.* Iplex company personnel hold a wealth of expertise and experience and continue to work together with the general public, industry, stakeholders and regulatory bodies on sustainability agenda.

TECHNICAL CAPABILITY

Iplex is a pioneer in pipe production and a foundation member of the Plastics Industry Pipes Association of Australia (PIPA).

As part of Iplex's ongoing commitment to sustainability and the development of Australian and International Standards for plastics pipe and fittings, Iplex works collaboratively with the Plastics Industry Pipe Association (PIPA) technical committees and Australian Pipelines and Gas Association working groups.

In addition to WaterMark and StandardsMark product certification to AS/NZS 5065, all operations are conducted under a quality management system, certified by SAI Global to ISO 9001, Licence QEC 0037.

In support of its extensive product range, Iplex employs professional engineers to assist pipe users and designers and publishes comprehensive engineering design guides that are freely available for download via its website: www.iplex.com.au.

The Iplex PocketENGINEER™ is a web portal where registered users can access design software to simplify hydraulic, structural and chemical resistance aspects of pipeline design.

For more information on Iplex's extensive range of pipeline products, visit www.iplex.com.au.

IPLEX BLACKMAX® AND SEWERMAX® PP PIPES

BlackMAX® and SewerMAX® pipes are manufactured using a combined continuous extrusion and vacuum moulding process. The polypropylene pipe wall structure is comprised of a solid smooth inner wall and profiled outer wall. The inner and outer walls are extruded simultaneously and fused together circumferentially at the trough of each corrugation. This innovative construction results in a high-stiffness pipe with a smooth inner bore which can be cut and re-joined anywhere along its length.

BlackMAX® and SewerMAX® pipes and fittings are manufactured to Australian and New Zealand Standard, AS/NZS 5065 'Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications' and carry StandardsMark™ and WaterMark third party product certifications under this standard.

BlackMAX® and SewerMAX® pipes are a fraction of the weight of equivalent concrete or earthen ware pipes, enabling faster installation for contractors, often without the need for mechanical handling equipment.

Polypropylene is a tough, abrasion resistant material with exceptional chemical resistance and will never rust or spall, making these pipes ideally suited for use in marine and corrosive soil environments. Polypropylene pipe used in stormwater applications has no effect on the pH or chemistry of run-off water.

A complementary range of fittings including bends, tees, junctions, saddles and adaptors completes the system and permits seamless integration into existing drainage and sewer pipe networks.

Table 1 shows key product characteristics of Iplex BlackMAX® and SewerMAX®, polypropylene pipes and Table 2 shows the content declaration.

TABLE 1 - PRODUCT CHARACTERISTICS OF PP PIPE

PRODUCT NAMES/APPLICATION	POLYPROPYLENE (PP) PIPES COVERED IN THIS EPD ARE: BLACKMAX® (PP) DRAINAGE PIPE SEWERMAX® (PP) SEWERAGE PIPE SEE TABLE 9 FOR INDIVIDUAL PRODUCT CODES.
UN CPC CODE	36320
RESIN DENSITY	900 kg/m³
CIRCUMFERENTIAL FLEXURAL MODULUS (2MM/MIN)	≥1300 MPa
SHORE D HARDNESS	60
COEFFICIENT OF LINEAR THERMAL EXPANSION	150×10^{-6}/°C
TENSILE YIELD STRESS (50MM/MIN)	28 MPa
POISSON'S RATIO	0.45
RING BENDING STIFFNESS	BlackMAX® 8000 N/m/m (SN8) SewerMAX® 10000 N/m/m (SN10) SewerMAX® 20000 N/m/m (SN20)
NOMINAL DIAMETER	225 - 600

TABLE 2 - CONTENT DECLARATION

ITEM	MASS (KG)	PERCENTAGE (%)
PP RESIN (BLOCK CO-POLYMER)	0.9656	95.60%
COLOUR MASTERBATCH - BLACK	0.0367	3.63%
COLOUR MASTERBATCH - YELLOW	0.0077	0.76%

None of the products contain one or more substances that are listed in the “Candidate List of Substances of Very High Concern for authorisation”. According to the PCR 2019:14, if one or more substances of the “Candidate List of Substances of Very High Concern (SVHC) for authorisation” are present in a product and their total content exceeds 0.1% of the weight of the product, they need to be reported.

PRODUCT LIFE CYCLE OVERVIEW

The scope of this LCA is cradle to gate with module A4. The following life cycle stages have not been declared, as they are deemed not applicable for Iplex PP pipes: Material emissions from usage (B1); Maintenance (B2); Repair (B3); Replacement (B4); Refurbishment (B5), Operational energy use (B6); Operational water use (B7); Deconstruction and demolition (C1); Transport (C2); Waste processing (C3); Disposal and Reuse (C4) and recycle or recovery (D). The EPD is compliant with Product Category Rules – Construction Products (PCR 2019:14), EN 15804+A2 standard, ISO 14025 and General Programme Instructions (GPI). The target audience for this EPD are businesses or customers who will be using Iplex's PP pipes. The EPD will provide the information on environmental impact data of Iplex's PP pipes to its customers. This EPD covers the Strathpine (QLD) manufacturing sites of Iplex. As PP pipe is manufactured in only one site; this is a specific EPD of PP pipes for this production sites and no weighted average calculation was performed for the manufacturing site.

TABLE 3 - SYSTEM BOUNDARY AND SCOPE OF ASSESSMENT

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				RESOURCE RECOVERY STAGE
	RAW MATERIAL SUPPLY	TRANSPORT	MANUFACTURING	TRANSPORT	CONSTRUCTION INSTALLATION	USE	MAINTENANCE	REPAIR	REPLACEMENT	REFURBISHMENT	OPERATIONAL ENERGY USE	OPERATIONAL WATER USE	DE-CONSTRUCTION DEMOLITION	TRANSPORT	WASTE PROCESSING	DISPOSAL	REUSE-RECOVERY-RECYCLING-POTENTIAL
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Geography	AU/ KR	AU/ KR	AU	AU	-	-	-	-	-	-	-	-	-	-	-	-	-
Specific data used	~79%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	Not applicable					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	Not applicable					-	-	-	-	-	-	-	-	-	-	-	-

ND = Not declared KR = Republic of Korea AU = Australia

LIFE CYCLE DIAGRAM OF BLACKMAX® AND SEWERMAX® POLYPROPYLENE PIPE PRODUCTION

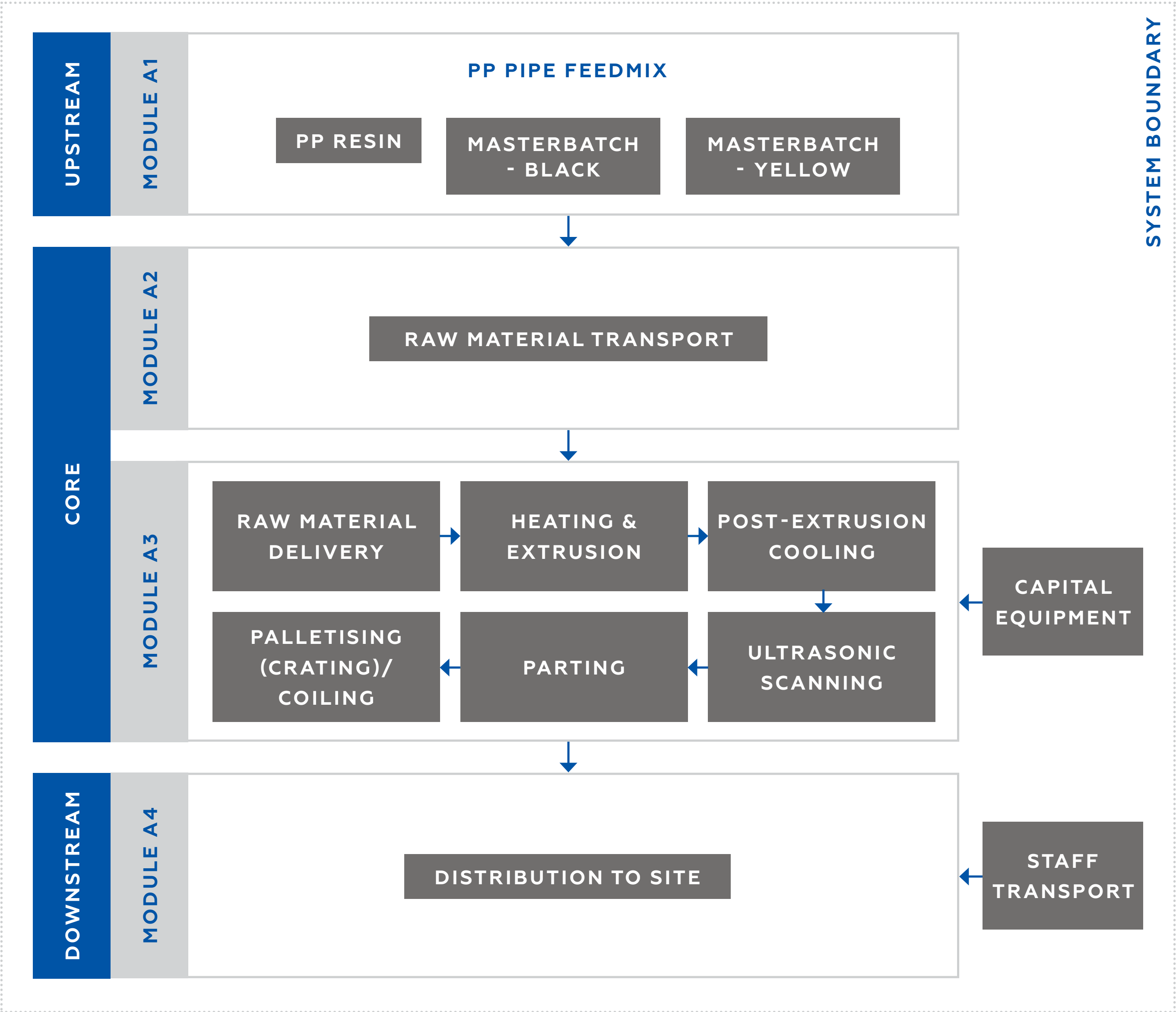


FIGURE 1 - IPLEX PP PIPE EPD SYSTEM BOUNDARY

MANUFACTURE OF IPLEX POLYPROPYLENE STRUCTURED WALL PIPE

PP Structured wall pipe is manufactured in Strathpine, Brisbane. PP resin, Masterbatch - black and Masterbatch - yellow are the raw materials used for the production of PP pipes. The PP resin is sourced from South East Asia whereas both Masterbatches are sourced from Dandenong, VIC. Taking a conservative approach, it was assumed that 50 km of road freight was required from resin supplier to port ("site to port"). For LPG, an energy density of 26.5 MJ/L was assumed for modelling. The primary packaging used for Iplex PP pipes is PET strapping and softwood timber frame. The waste material for PP pipe production was estimated based on the production share in Strathpine site.

DISTRIBUTION STAGE

BlackMAX® and SewerMAX® PP pipes are distributed from the Strathpine (QLD) manufacturing site either directly to customers or to Iplex distribution centres. To calculate the distribution, it was assumed that road transport was used to supply each major market (capital city) and the overall average transport distance calculated based upon the volume of PP pipe supplied to each market (State). Distances from Strathpine to the centre of each capital city were calculated using Google Maps. For distribution within Queensland a distribution distance of 60 km was assumed.

INSTALLATION STAGE

The environmental impacts and other indicators related to the installation stage of PP pipes and other flexible pipes is highly dependent on the specific details relating to a particular pipeline's design. Variables include pipe diameter(s), length of the pipeline, terrain, geology, environmental conditions, trench depth, specified fill and embedment materials and the resultant installation techniques employed by the installing contractor. Given the significant number of variables involved, attempts to define an 'average' or 'typical' pipeline installation for the purpose of calculating environmental and resource impacts will be highly inaccurate. Moreover, it would be potentially misleading for the resultant numbers to be applied across a range of pipe diameters and buried pipelines installations and for these numbers to be used for comparative purposes. The main factors which contribute to the impacts of installation of buried 'flexible' pipes apply across a range of pipe materials. These factors, such as trench excavation and selection of embedment materials are influenced by designers, asset owners and pipeline installers. Consequently, the A5 Installation module will not be covered other than to outline the installation process and highlight those factors that influence the environmental impacts.

Iplex PP structured wall pipe systems are usually buried as part of drainage infrastructure. The pipes are laid in an excavated trench. Uniform guidance on the correct design and installation of PP pipes and other 'flexible' pipes is given in AS/NZS 2566.2 Buried flexible pipelines – Installation. Pipe materials covered by this Standard are as follows; PVC-U, PVC-M and PVC- O, polyethylene, polypropylene, GRP, ABS, ductile iron, and steel.

The AS/NZS 2566.2 Standard covers trench excavation and design, definition of fill and embedment zones and their respective compaction requirements and field testing of the installed pipeline. Installation design is also dependent on other design factors such location, construction and traffic loadings and minimum design requirements specified by Infrastructure Agencies such as Water Authorities. In all cases the diameter of the installed pipe significantly influences installation design which in turn directly influences environmental impacts associated with buried pipeline construction. LCA modelling of one assumed scenario shows the relative contribution of key construction factors in the chart below. In many cases, the specifier and constructor can influence these factors and consequently the overall environmental impact of pipe installation. For example, in the modelled scenario, the embedment material is assumed to be crushed rock. However other embedment materials could be selected which have lower environmental impacts. This is discussed further below in Figure 2.

RELATIVE CONTRIBUTION OF CONSTRUCTION FACTORS TO GLOBAL WARMING POTENTIAL (KG CO_2 EQ)

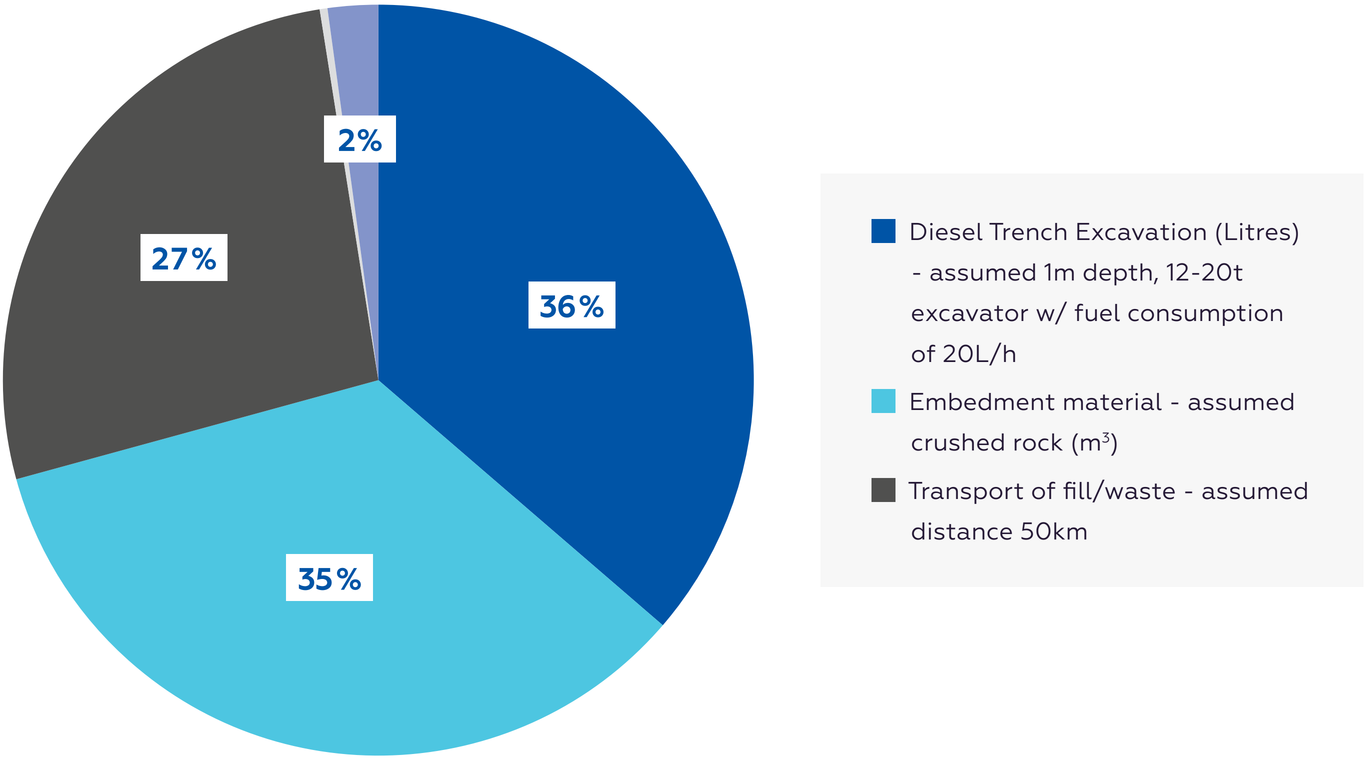


FIGURE 2 - CONTRIBUTION OF CONSTRUCTION FACTORS TO GWP FOR PP PIPES

A more detailed summary of the construction factors influencing environmental impacts are outlined below:

TRENCH EXCAVATION

Trench excavation, in particular diesel consumption by trenching excavators, governs most of the environmental and resource burden for the installation phase and is strongly correlated to the size of the trench and the type and configuration of excavator used. Additionally, there are various factors that affect efficiency of the excavator and speed of the excavation. Factors such as excavator bucket volume, bucket fill rate, cycle time, swing angle, type of excavated ground, as well as site environment and weather conditions, all influence the performance of the excavator. Equipment choice and operational efficiency is under the control of the trenching contractor.

FILL / EMBEDMENT

Type of fill / embedment materials are nominated by the pipeline designer, infrastructure owner or installer, and depend on the pipe application. LCA modelling shows that the use of screened and quarried virgin aggregate material (gravel) results in a higher environmental impact than other materials such as natural sand, recycled glass sand, crusher dust and concrete recycled into aggregate. The impact of different embedment materials in terms of Global Warming Potential (GWP) is shown in Figure 3.

GLOBAL WARMING POTENTIAL (KG CO_2 EQ) PER M³ OF EMBEDMENT MATERIAL

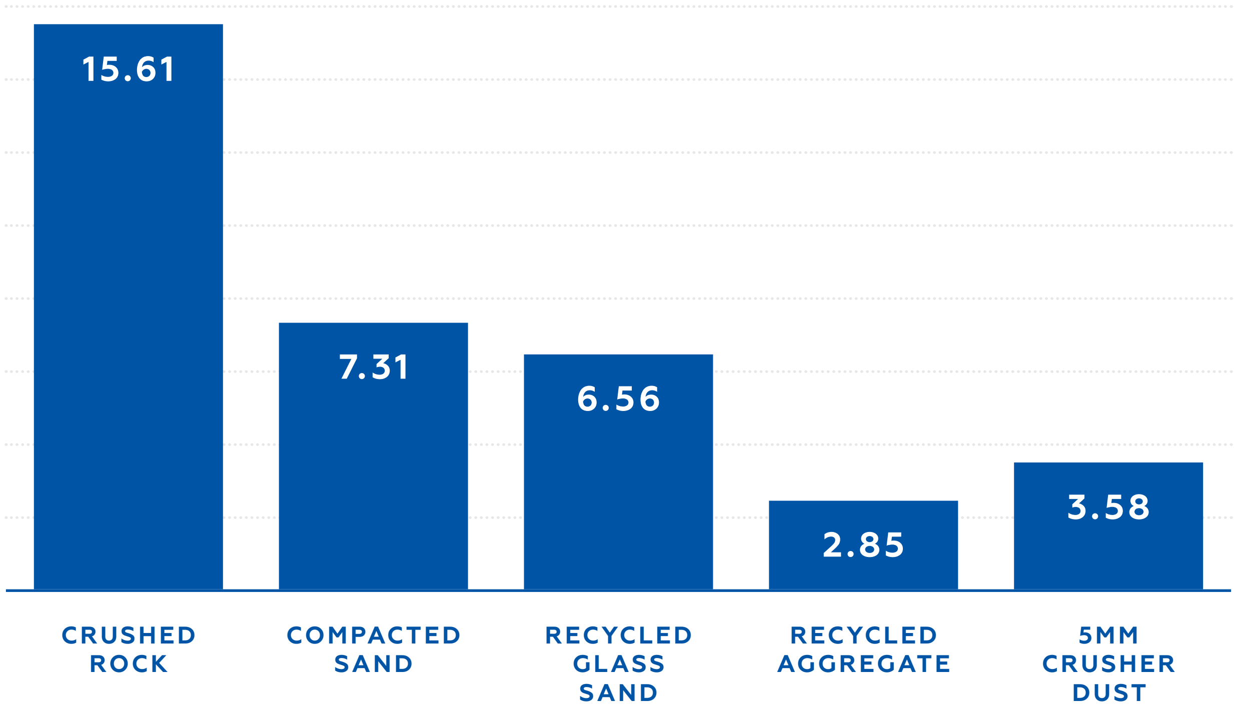


FIGURE 3 | GWP PER CUBIC METER OF EMBEDMENT MATERIAL FOR PP PIPES

- Transportation of fill materials that are required to be imported to site, and of excavated material from the site that cannot be used in the embedment zone will impact carbon footprint and energy consumed.
- The use of equipment for backfilling and compaction will also contribute to the total environmental impact. In terms of backfilling, this can be achieved either by using machinery or may be done manually. Compaction of embedment material can be achieved using powered portable compacting machines such as surface plate vibrators or by manual means using hand tampers in some circumstances. Where single size aggregate is used the required compaction may be achieved during material dumping.

PIPE LIFTING EQUIPMENT

In many cases small diameter corrugated PP pipes are light enough to be lifted into the trench by hand i.e., DN225, DN300 and DN375 pipes. However, this will be dependent upon trench depth. Larger diameter corrugated PP pipes will require mechanical lifting equipment and in most cases an excavator is used. The use of mechanical equipment results in environmental and resource impacts due to diesel consumption. Another consideration is the effective length of the pipe, corrugated PP drainage pipes having an effective length of 6m means that fewer mechanical lifts are required vs. pipes of shorter effective lengths, see table 4. This also applies to other pipe lifting operations such as truck load / unload, in which the number of lifts is determined by the number of pipes crated together in a single pack. For corrugated PP pipes this can range from 8 to 1 pipe per crate depending on diameter.

TABLE 4 | LIFTING EQUIPMENT FOR PP PIPES

PIPE TYPE	MECHANICAL LIFTS PER 100M INSTALLED	MANUAL LIFTS (TWO PERSON)
DRAINAGE PIPES (DN450 – 600), 3M EFFECTIVE LENGTH	33	N/A
CORRUGATED PP PIPE (DN450 – 600), 6M EFFECTIVE LENGTH	17	N/A
CORRUGATED PP PIPE (DN225 – 375), 6M EFFECTIVE LENGTH	0	17

PIPE JOINTING

PP pipes are joined using rubber sealed spigot and socket joints. Jointing requires the application of lubricant to reduce jointing forces. PP pipes in smaller diameters are light enough to be joined using hand tools i.e., crowbar and block of wood to lever the last pipe into the preceding socket.

PACKAGING MATERIALS AND WASTE

Packaging materials include timbers and strapping used to protect the pipe during transport. In many cases, these may be reused or recycled rather than disposed of to landfill.

Wastage of pipe is minimal as short lengths are often required elsewhere and easily reused on subsequent sites or within the same site. A very rough estimate puts wastage from unusable offcuts at less than 2%. Waste pipe offcuts which cannot be reused can be recycled.

USE STAGE

PP pipe systems are designed to have a technical service life expectancy of in excess of 100 years (Australian/New Zealand Standard, 2005). The unplanned maintenance activities would involve "jetting". This activity is done to clear blockages in drainage applications. Jetting involves the insertion of a high-pressure water hose and spray nozzle. This requires energy to pressurise the water and there will be water consumed.

Third party interference can be a major risk for pipe systems after installation. Given most PP pipe systems are buried below ground with other pipe services, such as water. and gas reticulation, it is unlikely third parties will encounter these pipe systems. Repairing a damaged PP pipe is simple using either a mechanical fitting or cutting out the affected section and replacing it with a new section of pipe.

4.0 LIFE CYCLE ASSESSMENT METHODOLOGY

This section includes the main details of the Life Cycle Assessment (LCA) study as well as assumptions and methods of the assessment. A summary of the life cycle assessment parameters is given in Table 5.

TABLE 5 - LCA INFORMATION

DECLARED UNIT	1 kg pipe
GEOGRAPHICAL COVERAGE	Australia
LCA SCOPE	Cradle to gate with module A4
TIME REPRESENTATIVENESS	Foreground data on raw material requirements, manufacture, construction, use and end of life inputs and outputs was provided first-hand by Iplex for financial year 2020-2021.
DATABASE (S) AND LCA SOFTWARE USED	The inventory data for the process are entered into the SimaPro (v9.3.0.3) LCA software program and linked to the pre-existing data for the upstream feedstocks and services selected in order of preference from: • For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society ((ALCAS), Australian Life Cycle Inventory (AusLCI) – v1.36, 2021) and the Australasian Unit Process LCI v2014.09. The AusLCI database at the time of this report was 1 year old, while the Australasian Unit Process LCI was 8 years old. • Other authoritative sources (e.g., Ecoinvent v3.8, (Moreno, 2021)), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the Ecoinvent v3.8 database was 1 year old.

Life cycle assessment (LCA) requires a compilation of the inputs, outputs and environmental impacts of a product system throughout its life cycle. LCA can enable businesses to identify resource flows, waste generation and environmental impacts (such as climate change) associated with the provision of products and services.

Life cycle thinking is a core concept in sustainable consumption and production for policy and business. Upstream and downstream consequences of decisions must be taken into account to help avoid the shifting of burdens from one type of environmental impact to another, from one political region to another, or from one stage to another in a product's life cycle from the cradle to the grave.

According to EN 15804, EPDs of construction products may not be comparable if they do not comply with this standard, and EPDs might not be comparable, particularly if different functional units are used.

CORE DATA COLLECTION

All primary (foreground) data collected for this EPD was sourced from Iplex via a Request for Information spreadsheet. This data was collected for the financial year 2020-2021.

BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module and transportation. Background data was adapted to represent Iplex PP pipe as accurately as possible. For Australia, the Australian Life Cycle Inventory (AusLCI) v1.36 compiled by the Australian Life Cycle Assessment Society ((ALCAS), Australian Life Cycle Inventory (AusLCI) – v1.36, 2021) and the Australasian Unit Process LCI v2014.09. The AusLCI database at the time of this report was 1 year old, while the Australasian Unit Process LCI was 8 years old. Other authoritative sources (e.g., Ecoinvent v3.8, (Moreno, 2021)), where necessary adapted for relevance to Australian conditions (energy sources, transport distances and modes and so on, and documented to show how the data is adapted for national relevance). At the time of reporting, the Ecoinvent v3.8 database was 1 year old. Other sources with sensitivity analysis reported to show the significance of this data for the results and conclusions drawn.

DATA QUALITY AND VALIDATION

The primary data used for the study (core module) is based on direct utility bills or feedstock quantities from the Iplex's procurement records. Primary data was carefully reviewed in order to ensure completeness, accuracy and representativeness of the data supplied. Contribution analysis was used to focus on the key pieces of data contributing to the environmental impact categories. The data was benchmarked against relevant benchmark data in Ecoinvent. Overall, the data was deemed to be of high quality for the core module. According to EN15804+A2, the data quality ranking is as follows: geographical representativeness – very good; technical representativeness – very good and time representativeness – very good.

COMPLIANCE WITH STANDARDS

The LCA and EPD have been developed to comply with:

- ISO 14040:2006 and ISO14044:2006+A1:2018 which describe the principles, framework, requirements and provides guidelines for life cycle assessment (LCA) (ISO 14040, 2006) (ISO 14044, 2006).
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations -- Principles and procedures, which establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations (ISO 14025, 2006).
- ISO 14020:2000 Environmental labels and declarations — General principles, which describes the guiding principles for the development and use of environmental labels and declarations (ISO 14020, 2000).
- EN 15804+A2:2019: Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products- hereafter referred to as EN15804+A2 (BS EN 15804+A2, 2020).
- Product Category Rules (PCR) 2019:14, v1.1 – Construction products – hereafter referred to as PCR 2019:14 (PCR 2019:14, PCR 2019:14 Product Category Rules- Construc Products Version 1.11, 2019).
- General Programme Instructions (GPI) for the International EPD System V3.01 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System (Environdec, 2019).
- Instructions of EPD Australasia V3.0 – a regional annex to the general programme instructions of the International EPD System.

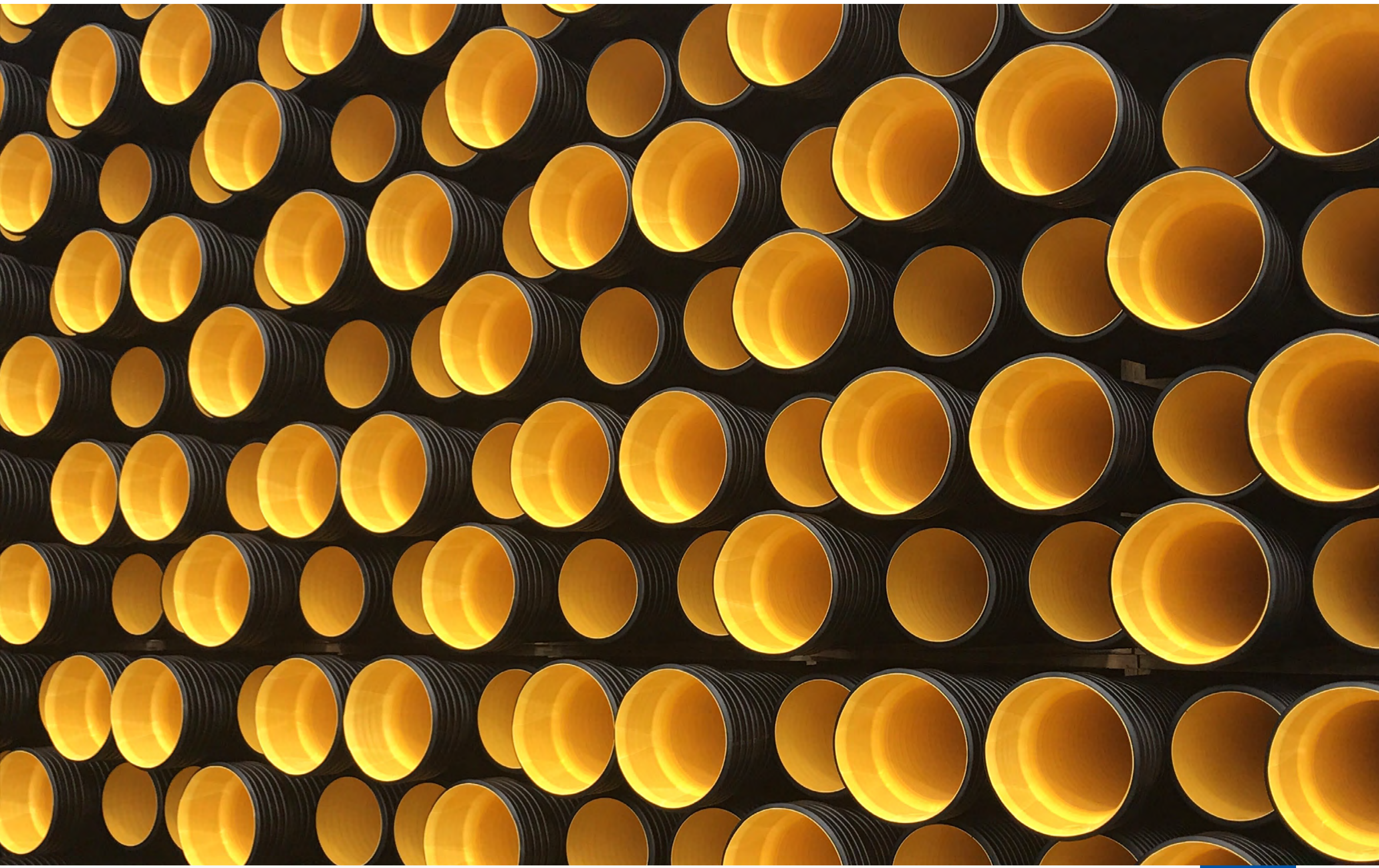
CUT-OFF RULES

It is common practice in LCA/LCI protocols to propose exclusion limits for inputs and outputs that fall below a threshold percentage of the total, but with the exception that where the input/output has a "significant" impact it should be included. According to the PCR 2019:14, the Life Cycle Inventory data for a minimum of 95% of total inflows (mass and energy) per module to the upstream and core module shall be included, accounted as global warming potential (GWP) or energy consumption. Data gaps in included stages in the downstream modules shall be reported in the EPD, including an evaluation of their significance. In accordance with the PCR 2019:14 v1.11, the following system boundaries are applied to manufacturing equipment and employees:

- Environmental impact from infrastructure, construction, production equipment, and tools that are not directly consumed in the production process are not accounted for in the LCI. Capital equipment and buildings typically account for less than a few percent of nearly all LCIs and this is usually smaller than the error in the inventory data itself. For this project, it is assumed that capital equipment makes a negligible contribution to the impacts as per Frischknecht et al.[1] with no further investigation.
- Personnel-related impacts, such as transportation to and from work, are also not accounted for in the LCI. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.

Besides these exclusions, no energy or mass flows were excluded.

[1]Frischknecht et. al., International Journal of Life Cycle Assessment, 12, 1-11, 2007



ALLOCATION

According to EN 15804 A2:2019, in a process step where more than one type of product is generated, it is necessary to allocate the environmental stressors (inputs and outputs) from the process to the different products (functional outputs) in order to get product-based inventory data instead of process-based data. An allocation problem also occurs for multi-input processes. In an allocation procedure, the sum of the allocated inputs and outputs to the products shall be equal to the unallocated inputs and outputs of the unit process.

The following stepwise allocation principles shall be applied for multi-input/output allocations:

- The initial allocation step includes dividing up the system sub-processes and collecting the input and output data related to these sub-processes.
- The first (preferably) allocation procedure step for each sub-process is to partition the inputs and outputs of the system into their different products in a way that reflects the underlying physical relationships between them.
- The second (worst case) allocation procedure step is needed when physical relationship alone cannot be established or used as the basis for allocation. In this case, the remaining environmental inputs and outputs from a sub-process must be allocated between the products in a way that reflects other relationships between them, such as the economic value of the products.

There are no co-products from the production of Iplex PP structured wall pipe and therefore allocation issues were avoided. There is no double counting of the impact from any manufacturing or other associated processes.

PP structured wall pipe is manufactured only in the Strathpine (QLD) production site in Australia. Mass and energy data have been sourced from the manufacturing plant by Iplex. The quantities of materials and electricity required for producing PP structured wall pipe are calculated on basis of the amount (tonnes) of pipe manufactured on the site in financial year 2020-2021 and the associated electricity consumption for that particular product line. This data is also recorded as part of the standard quality assurance purpose.

The allocation approach for the background LCA databases utilised in this report is also compliant with the PCR. More specifically, the burden of primary production of materials is always allocated to the primary user of a material, while secondary (recycled) materials bear only the impacts of the recycling processes. There is no use of secondary materials and fuels.

5.0 ENVIRONMENTAL PERFORMANCE OF IPLEX PP STRUCTURED WALL PIPE

The estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks. Most LCA tools have libraries of impact assessment methods that can completely automate the impact assessment. The following potential environmental impacts, use of resources and waste categories have been calculated in the SimaPro (v9.1.1.1) tool.

TABLE 6 - LIFE CYCLE IMPACT, RESOURCE AND WASTE ASSESSMENT CATEGORIES, MEASUREMENTS AND METHODS

IMPACT CATEGORY	ABBREVIATION	MEASUREMENT UNIT	ASSESSMENT METHOD AND IMPLEMENTATION
POTENTIAL ENVIRONMENTAL IMPACTS			
Global Warming Potential (Fossil)	GWPF	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Global Warming Potential (Biogenic)	GWPB	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Land Use/Land Transformation	GWPL	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Total Global Warming Potential	GWPT	kg CO_2 equivalents (GWP100)	Baseline model of 100 years of the IPCC based on IPCC 2013
Acidification Potential	AP	mol H^+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008
Eutrophication – Aquatic Freshwater	EP – Freshwater	kg PO_4^{3-} equivalents	CML (v4.1)
Eutrophication – Aquatic Freshwater	EP – Freshwater	kg P equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe[2]
Eutrophication – Aquatic Marine	EP – Marine	kg N equivalent	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication – Terrestrial	EP – terrestrial	mol N equivalent	Accumulated Exceedance, Seppälä et al. 2006, Posch et al.
Photochemical Ozone Creation Potential	POCP	kg NMVOC equivalents	LOTOS-EUROS, Van Zelm et al., 2008, as applied in ReCiPe

Abiotic Depletion Potential (Elements)*	ADPE	kg Sb equivalents	CML (v4.1)
Abiotic Depletion Potential (Fossil Fuels)*	ADPF	MJ net calorific value	CML (v4.1)
Ozone Depletion Potential	ODP	kg CFC 11 equivalents	Steady-state ODPs, WMO 2014
Water Depletion Potential*	WDP	m^3 equivalent deprived	Available WAter REmaining (AWARE) Boulay et al., 2016
Global Warming Potential, Excluding Biogenic Uptake, Emissions and Storage	GWP-GHG	kg CO_2 equivalents (GWP100)	CML (v4.1)
RESOURCE USE			
Use of Renewable Primary Energy Excluding Renewable Primary Energy Resources Used as Raw Materials	PERE	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants[3]
Use of Renewable Primary Energy Resources Used as Raw Materials	PERM	MJ, net calorific value	Manual for direct inputs [4]
Total Use Of Renewable Primary Energy Resources (Primary Energy and Primary Energy Resources Used as Raw Materials)	PERT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants
Use of Non-Renewable Primary Energy Excluding Non-Renewable Primary Energy Resources Used as Raw Materials	PENRE	MJ, net calorific value	Manual for direct inputs[5]
Use of Non-Renewable Primary Energy Resources Used as Raw Materials	PENRM	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants
Total Use of Non- Renewable Primary Energy Resources (Primary Energy and Primary Energy Resources Used as Raw Materials)	PENRT	MJ, net calorific value	ecoinvent version 3.6 and expanded by PRé Consultants[6]
Use of Secondary Material	SM	kg	Manual for direct inputs
Use of Renewable Secondary Fuels	RSF	MJ, net calorific value	Manual for direct inputs
Use of Non-Renewable Secondary Fuels	NRSF	MJ, net calorific value	Manual for direct inputs
Use of Net Fresh Water	FW	m^3	ReCiPe 2016
WASTE CATEGORIES			
Hazardous Waste Disposed	HWD	kg	EDIP 2003 (v1.05)
Non-Hazardous Waste Disposed	NHWD	kg	EDIP 2003 (v1.05)[7]
Radioactive Waste Disposed/ Stored	RWD	kg	EDIP 2003 (v1.05)

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS			
Particulate Matter	Potential incidence of disease due to PM emissions (PM)	Disease Incidence	SETAC-UNEP, Fantke et al. 2016
Ionising Radiation - Human Health**	Potential Human exposure efficiency relative to U235 (IRP)	kBq U-235 eq	Human Health Effect model
Eco-Toxicity (Freshwater)*	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe	USEtox version 2
Human Toxicity Potential - Cancer Effects*	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh	USEtox version 2
Human Toxicity Potential - Non Cancer Effects*	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh	USEtox version 2
Soil Quality*	Potential soil quality index (SQP)	Dimensionless	Soil quality index (LANCA®)

[2]EN 15804:2012+A2:2019 specifies that the unit for the indicator for Eutrophication aquatic freshwater shall be kg PO4 eq, although the reference given ("EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe") uses the unit kg P eq. This is likely a typographical error in EN 15804, which is expected to be corrected in a future revision. Until this has been corrected, results for Eutrophication aquatic freshwater shall be given in both kg PO4 eq and kg P eq. in the EPD. [3]Method to calculate Cumulative Energy Demand (CED), based on the method published by Ecoinvent version 2.0 and expanded by PRé Consultants for raw materials available in the SimaPro database. [4]Calculated based on the lower heating value of renewable raw materials. [5]Calculated based on the lower heating value of non-renewable raw materials. [6]Calculated as sum of Non-renewable, fossil, Non-renewable, nuclear and Non-renewable, biomass. [7]Calculated as sum of Bulk waste and Slags/ash.

RESULTS FOR IPLEX PP STRUCTURED WALL PIPE

TABLE 7 - ENVIRONMENTAL IMPACTS FOR PP STRUCTURED WALL PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-F	kg CO_2 eq.	3.30E+00	5.89E-01
GWP-B	kg CO_2 eq.	-2.10E-02	2.48E-05
GWP-Luluc	kg CO_2 eq.	1.13E-03	7.55E-07
GWP-T	kg CO_2 eq.	3.28E+00	5.89E-01
ODP	kg CFC 11 eq.	5.17E-08	7.15E-09
AP	mol H^+ eq.	1.66E-02	3.06E-03
EP-F	kg PO_4^{3-} eq.	2.55E-03	2.96E-04
EP-F	kg P eq.	4.22E-04	4.42E-06
EP-M	kg N eq.	3.43E-03	7.99E-04
EP-T	mol N eq.	3.68E-02	8.86E-03
POCP	kg NMVOC eq.	9.74E-03	2.70E-03
ADP	kg Sb eq.	1.51E-05	4.19E-07
ADP - F	MJ	7.79E+01	8.09E-01
WDP	m^3	6.87E+00	1.29E+00

TABLE 8 - RESOURCE USE FOR PP STRUCTURED WALL PIPE

INDICATOR	UNIT	A1-A3	A4
PERE	MJ	1.50E+00	1.72E-02
PERM	MJ	0.00E+00	0.00E+00
PERT	MJ	1.50E+00	1.72E-02
PENRE	MJ	8.35E+01	8.41E-01
PENRM	MJ.	0.00E+00	0.00E+00
PENRT	MJ	8.35E+01	8.41E-01
SM	kg	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00
FW	m^3	1.26E-02	2.88E-04

TABLE 9 - WASTE PRODUCTION FOR PP STRUCTURED WALL PIPE

INDICATOR	UNIT	A1-A3	A4
Hazardous waste disposed	kg	1.31E-05	1.92E-06
Non-hazardous waste disposed	kg	2.45E-01	1.90E-02
Radioactive waste disposed	kg	2.65E-05	9.18E-09

TABLE 10 - OUTPUT FLOWS FOR PP STRUCTURED WALL PIPE

INDICATOR	UNIT	A1-A3	A4
Components for re-use	kg	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00

TABLE 11 - ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PP STRUCTURED WALL PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-GHG	kg CO_2 eq.	3.13E+00	5.82E-01
Particulate matter	disease incidence	1.20E-07	4.85E-08
Ionising radiation - human health	kBq U-235 eq	6.12E-02	6.42E-05
Eco-toxicity (freshwater)	CTUe	3.11E+01	1.34E+01
Human toxicity potential - cancer effects	CTUh	8.71E-10	1.37E-10
Human toxicity potential - non cancer effects	CTUh	2.36E-08	8.84E-09
Soil quality	dimensionless	7.65E+00	2.88E-01

INFORMATION ON BIOGENIC CARBON CONTENT

TABLE 12 – BIOGENIC CARBON CONTENT FOR 1 KG OF PP STRUCTURED WALL PIPE

BIOGENIC CARBON CONTENT	UNIT	QUANTITY
Biogenic carbon content in product	kg C	0.00E+00
Biogenic carbon content in packaging	kg C	6.23E-03

Note: 1 kg biogenic carbon is equivalent to 44/12kg CO_2.

INTERPRETATION OF RESULTS

POTENTIAL ENVIRONMENTAL IMPACTS

- The product stage (i.e., **A1-A3**) is the primary contributor to GWPT impacts and water depletion potential (WDP) in the modules **A1-A4. 84.8%** of GWPT arises from the product stage or **A1-A3** modules.

The product stage (A1-A3) contributes to 78.3-99% of all other environmental impact categories except WDP. WDP impacts from A1-A3 modules account 84%.

In case of GWPT impacts, PP resin is the highest contributor of A1-A3 GWPT impacts (59.4%) followed by black colour (2.3%).

- The distribution stage (A4) shares 15.2% to GWPT and 15.8% to the WDP.
- In any impact category except WDP, contributions from distribution (A4) Ranges from 1 to 21.7%.

RESOURCE USE

- The major resource use impacts in the modules A1-A4 and B2 originate from the product stages (A1-A3), ranging between 97.8-99%.

PP resin the highest renewable resources accounting 56.4% of total lifecycle renewable utilisation. The second largest renewable resources user is the black colour, accounting 2.1% of the total lifecycle renewable resources.

PP resin is the largest non-renewable resource user accounting 92.5% of total lifecycle non-renewable resource utilisation. This is followed by black colour that accounts 3.5% of total lifecycle non-renewable resources.

The highest contributor to lifecycle Fresh Water use is from PP resin, accounting for 87.9%. This is followed by black colour which uses 3.3% Fresh Water of whole lifecycle.

- There is no use of renewable secondary fuels.
- The renewable resource use impact is 1.8% of total renewable and non-renewable resource use impacts.

WASTE AND OUTPUT FLOWS

- 100% of all waste generated in the modules A1-A4 and B2 is non-hazardous.

The product stage (A1-A3) contributes to 92.8% of all non-hazardous waste generated. PP resin is highest contributor to non-hazardous waste, accounting about 65.7%.

Black colour is the second largest contributor to non-hazardous waste, sharing about 2.5%.

6.0 ADDITIONAL ENVIRONMENTAL INFORMATION

The plastic products are highly inert and are used predominantly in outdoor applications. They do not release any dangerous substances to indoor air, soil, or water.

GUIDANCE FOR PE PIPE RECYCLING

All PP pipe offcuts from installation can be completely recycled back into new pipe products. Although the PP pipes covered in this EPD are most likely to be left in the ground at end of life, PP has a high recyclability and can be mechanically or chemically recycled to replace virgin polypropylene in new products.

7.0 PRODUCT SPECIFICATIONS

Table 13 can be used to calculate the environmental results for specific Iplex PP structured wall pipe products. The density and length of pipe give the total mass of pipe for each product code.

TABLE 13 - PP STRUCTURED WALL PIPE PRODUCT SPECIFICATIONS

APPLICATION	PRODUCT CODE	DN	PIPE STIFFNESS CLASSIFICATION	NOMINAL LENGTH	MEAN OUTSIDE DIAMETER	MEAN INSIDE DIAMETER	MASS
Drainage	GR8225	225	SN8	6	259	225	3.56
Drainage	GR8300	300	SN8	6	344	300	6.28
Drainage	GR8375	375	SN8	6	428	373	9.11
Drainage	GR8450	450	SN8	6	514	447	12.7
Drainage	GR8525	525	SN8	6	600	522	15.3
Drainage	GR8600	600	SN8	6	682	596	20.6
Sewerage	GR10225C	225	SN10	3	259	225	4.27
Sewerage	GR10300C	300	SN10	3	344	300	7.65
Sewerage	GR10375C	375	SN10	3	428	373	11.1
Sewerage	GR10450C	450	SN10	3	514	447	14.0
Sewerage	GR10525C	525	SN10	3	600	522	18.5
Sewerage	GR10600C	600	SN10	3	682	596	25.0
Sewerage	GR20225C	225	SN20	3	259	224	5.25
Sewerage	GR20300C	300	SN20	3	344	297	9.54
Sewerage	GR20375C	375	SN20	3	428	370	16.11
Sewerage	GR20450C	450	SN20	3	514	443	19.84
Sewerage	GR20525C	525	SN20	3	600	516	26.71

8.0 REFERENCES

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NOVEMBER 2022