iplex™

ENVIRONMENTAL PRODUCT DECLARATION

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

PVC PRESSURE PIPES

FROM IPLEX PIPELINES AUSTRALIA PTY LIMITED

Programme: EPD Australasia, www.epd-australasia.com
Programme operator: EPD Australasia
EPD registration number: S-P-00712
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

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AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

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ENVIRONMENTAL PRODUCT DECLARATION

PVC PRESSURE 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 the factors affecting installation are significantly influenced by pipeline designers, infrastructure agencies and installing contractors.

DECLARATION OWNER:	**Iplex Pipelines Australia Pty Ltd** Corner South Pine and Johnstone Roads, Brendale, QLD 4500 **t:** +61 (07) 3881 9222 **f:** +61 (07) 3881 1127 **e:** info@iplexpipelines.com.au **w:** www.iplex.com.au For the product offering in other markets, please contact local sales representative.
EPD PROGRAMME OPERATOR:	**EPD Australasia** 315a Hardy Street, Nelson 7010, New Zealand **e:** info@epd-australasia.com **w:** www.epd-australasia.com
EPD PRODUCED BY:	**Edge Environment Pty Ltd** Jonas Bengtsson, Sazal Kundu and Leah Nguyen L5, 39 East Esplanade, Manly NSW 2095 Australia **t:** +61 (2) 9438 0100 **e:** info@edgeenvironment.com **w:** www.edgeenvironment.com
THIRD PARTY VERIFIER:	**CATALYST Ltd** Kimberly Robertson Unit A4, 15 Talisman Drive, Katikati 3129 New Zealand **t:** +64 (3) 329 6888 **e:** kimberly.robertson@catalystnz.co.nz **w:** www.catalystnz.co.nz
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 BlackMAX® and SewerMAX® Polypropylene 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 PVC pressure pipe EPD results can also be used to represent PVC pressure pipe products in Whole of Building Life Cycle Assessments under Green Star rating tools. See the product details 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 plastics piping systems, s pleased to publish this Environmental Product Declaration, for its Iplex PVC-U, PVC-M and PVC-O pressure 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.

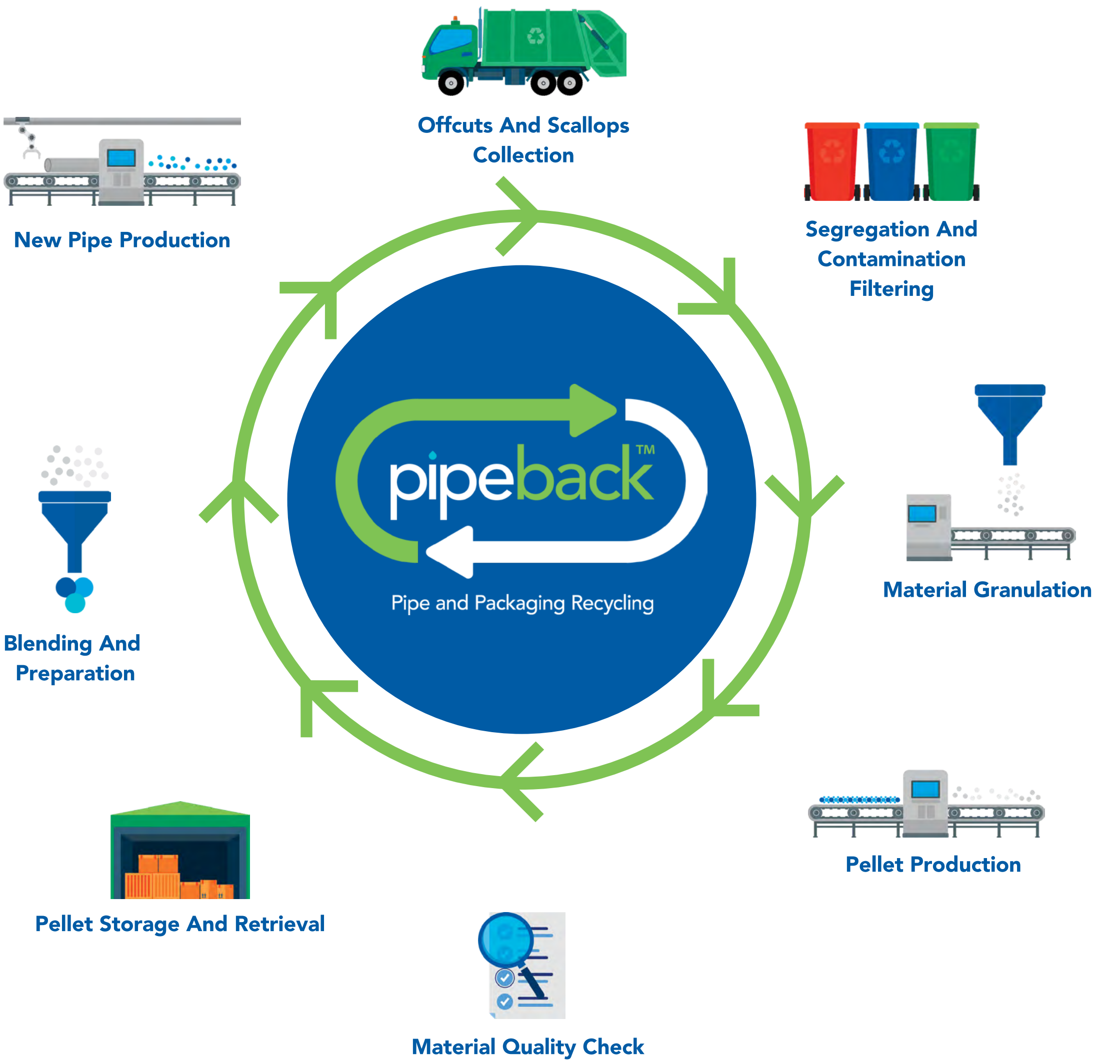
SUSTAINABILITY AT IPLEX

Iplex PVC pipe 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 PVC pipe products.

PVC pipes manufactured by Iplex are made for long service life, and can have a service life longer than 100 years. The responsible use of resources is carefully managed by Iplex reducing impacts associated with manufacturing, construction, extraction operations, including the distribution and use of pipe product.

A sustainable feature of Iplex PVC pipes is that they are made from thermoplastic material and are 100% recyclable. Iplex PVC pipes can be recycled back into the Iplex manufacturing process through its branded Pipeback™ Program. Pipeback™ offers a streamlined service for recycling PVC pipes post consumer use back into the manufacturing process, with collection depots in Queensland, South Australia, Victoria and New South Wales.

Iplex PVC 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 PIPA technical committees and Australian Pipelines and Gas Association working groups.

PVC pipe manufacturing plants are located close to major development regions in Brisbane, Sydney and Melbourne and all products comply with the stringent requirements of Best Environmental Practice BEP PVC. In addition to WaterMark and StandardsMark product certification to AS/NZS 1477, AS/NZS 4765 and AS/ NZS 4441 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. Visit www.pocketengineer.com.au.

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

IPLEX PVC PRESSURE PIPE PRODUCTS

The Australian Standards for PVC pipe (AS/NZS 1477, AS/NZS 4765 and AS/NZS 4441) have the Best Environmental Practice requirements developed by the Green Building Council of Australia (GBCA) embedded. This encourages responsible sourcing of raw materials, best practice manufacturing, fully independent third party certification compliance.

Iplex premium PVC pressure pipes are manufactured from unplasticised polyvinyl chloride polymer (a thermoplastic material) using the extrusion process. Unplasticised PVC (also known as uPVC and PVC-U) pipes were introduced into Australia in the early 1960's and are now widely accepted for use in water supply, irrigation and sewerage rising mains. Iplex PVC-U pressure pipes meet the requirements of AS/NZS 1477 - PVC pipes and fittings for pressure applications. Iplex modified PVC-M, PVC-O and PVC-U pipes do not contain any compounds based on lead, cadmium or mercury.

ApolloBLUE™ is a bi-axially oriented PVC (PVC-O) pressure pipe for use in water supply infrastructure. Iplex manufactures the pipe using a continuous in-line biaxially orientation process. This method of production results in an exceptionally tough, high performance thermoplastic pipe with greatly enhanced physical characteristics, including greater impact resistance, higher ductility, improved fatigue resistance and reduced weight when compared with other PVC pipes. ApolloBLUE™ also provides increased hydraulic capacity due to its exceptionally smooth and enlarged bore.

Iplex RHINO® Modified PVC (PVC-M) pressure pipes are high performance thermoplastic pipes incorporating the advancements of modified PVC pipe technology. This alters the fracture mechanism by imparting greater ductility and high levels of toughness.

RHINO® pressure pipes provide superior characteristics over conventional PVC-U pressure pipes, including higher impact resistance and ductility, reduced weight and greater hydraulic capacity. Detailed product characteristics are shown in Table 1 and the content of PVC-U, PVC-M and PVC-O pressure pipes are shown in Table 2.

Iplex PVC-U, ApolloBLUE™ PVC-O and RHINO® PVC-M pressure pipes are all suitable for a wide range of pressurised pipe applications, including:

- Major potable water supply trunk and reticulation mains;
- Irrigation and turf watering systems;
- Industrial process pipelines;
- Effluent pipelines for pumped sewage, industrial and rural wastes; and
- Slurry pipelines carrying abrasive and corrosive mine or quarry materials

TABLE 1: PRODUCT CHARACTERISTICS OF PVC PRESSURE PIPES

PRODUCT NAMES	PREMIUM PVC-U PRESSURE PIPE APOLLOBLUE™ PVC-O PRESSURE PIPE RHINO® PVC-M PRESSURE PIPE
DENSITY	1420-1500 kg/m³
UN CPC CODE	36320
HYDROSTATIC DESIGN STRESS	11 to 12.3MPa PVC-U 22.2 to 28MPa PVC-O 17.5MPa PVC-M
COEFFICIENT OF LINEAR THERMAL EXPANSION	7 x 10-5/°C
MAXIMUM WORKING TEMPERATURE	50°C
SPECIFIC HEAT	1045 J/kg.K
POISSON'S RATIO	0.38-0.45
FLEXURAL RING MODULUS, INITIAL	3000MPa

TABLE 2: CONTENT DECLARATION

ITEM	PVC-U PIPE		PVC-M PIPE		PVC-O PIPE	
	MASS (KG)	PERCENTAGE (%)	MASS (KG)	PERCENTAGE (%)	MASS (KG)	PERCENTAGE (%)
PVC RESIN	0.9232	91.41%	0.8966	88.77%	0.9426	93.33%
FILLER	0.0462	4.57%	0.0134	1.33%	0.0189	1.87%
ORGANIC STABILIZER	0.0268	2.65%	0.0323	3.20%	0.0339	3.36%
TITANIUM DIOXIDE WHITE	0.0138	1.37%	0.0134	1.33%	0.0141	1.40%
PROCESSING AID	0.0000	0.00%	0.0067	0.67%	0.0000	0.00%
CPE	0.0000	0.00%	0.0471	4.66%	0.0000	0.00%
PIGMENT	0.0000	0.00%	0.0004	0.04%	0.0005	0.05%

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 PVC pressure 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) V3.01. The target audience for this EPD are businesses or customers who will be using Iplex's PVC pressure pipes. The EPD will provide the information on environmental impact data of Iplex's PVC pressure pipes to its customers. PVC-M pipes are manufactured in Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-U pipes are manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-O pipes are only manufactured in Chipping Norton (NSW) production site. Therefore, this is an average EPD of PVC-M and PVC-U pipes from these production sites. The weighted average calculation was performed considering the production share of specific pipe in each 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/ TW/ CH	AU/ TW/ CH	AU	AU	-	-	-	-	-	-	-	-	-	-	-	-	-
Specific data used	>78%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	< ±10%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	< ±10%					-	-	-	-	-	-	-	-	-	-	-	-

ND - Not declared
AU = Australia
TW = Taiwan
CH = China

LIFE CYCLE DIAGRAM OF PVC PRESSURE PIPE PRODUCTION

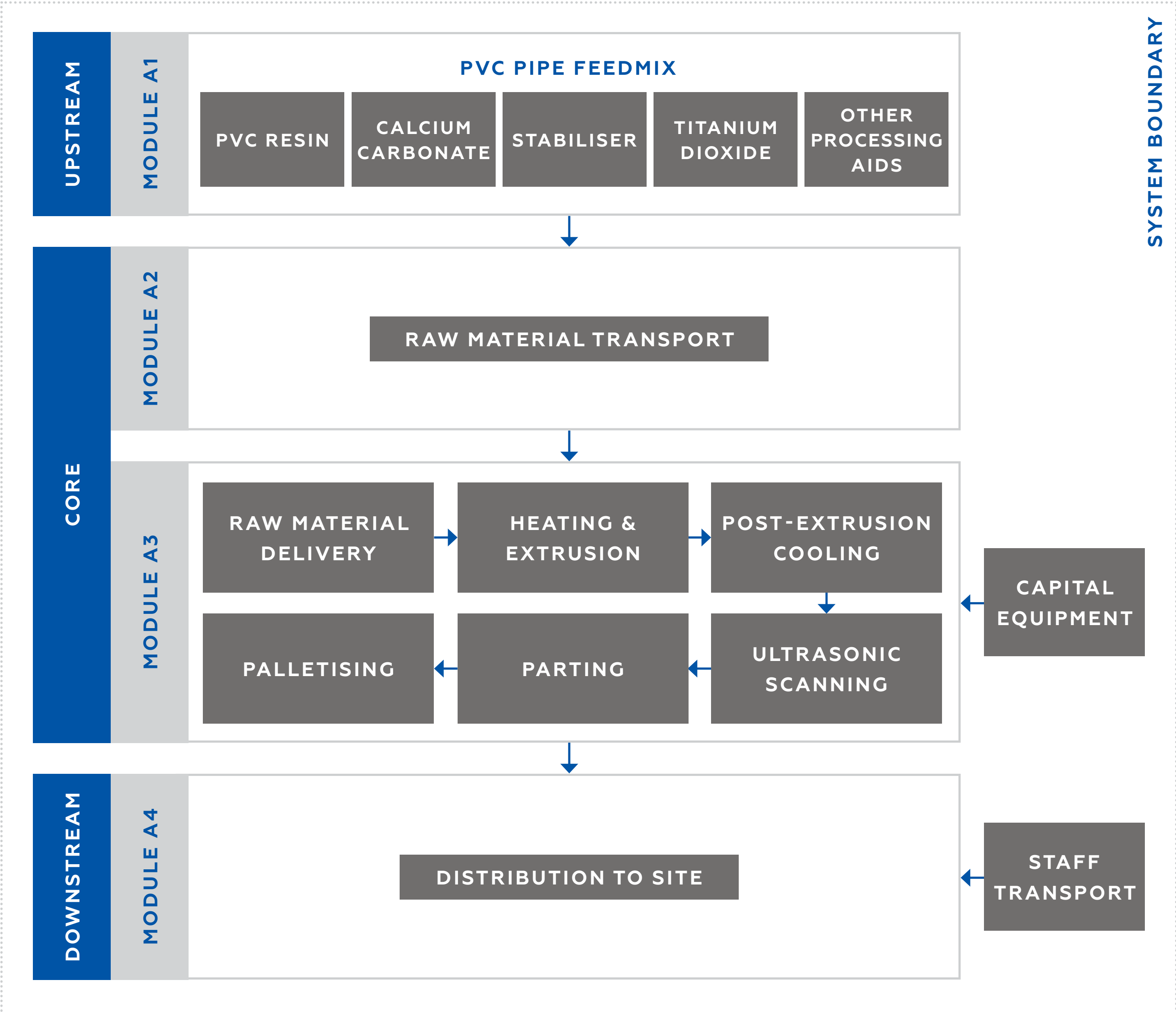


FIGURE 1 | IPLEX PVC PRESSURE PIPE EPD SYSTEM BOUNDARY

IPLEX PVC PRESSURE PIPE MANUFACTURING

PVC pressure pipes are manufactured primarily from PVC resin along with additives, including: calcium carbonate, titanium dioxide, organic stabiliser, lubricants and pigments. PVC-M pipes are manufactured in Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-U pipes are manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-O pipes are only manufactured at the Chipping Norton (NSW) production site. Inputs for each product were allocated based on the weight of product produced in each site and calculated as a weighted average of the different manufacturing sites where each type of product is produced. Since it is assumed that 1% of pipe is wasted during the installation process (see section 5.3), 1.01 kg of pipe is produced for each kg of pipe installed. The total feedmix was calculated based on the weighted average of the feedmix of all production sites. Transport distances to site for key feedmix ingredients were calculated using Google Maps (road transport) and the weighted average transport to each site was calculated. The transport was excluded for materials accounting for

<1% of the feedmix. For example, the transport distance of pigment was excluded in the case of PVC-M and PVC-O pipes.

The electricity, LPG and water manufacturing inputs were all allocated based on 1.01 kg of pipe produced from PVC-U, PVC-O and PVC-M lines. The manufacturing inventory of each manufacturing site was modelled related to 1.01 kg production volume (equivalent to 1 kg installed pipe), taking into account a specific electricity grid mix for each state. This was then modelled for total manufacturing taking into account 1.01 kg production and corresponding manufacturing inputs at each site. For example, Iplex has 3 PVC-U pipe manufacturing sites, consequently total production of 3.03 kg (3x1.01) (equivalent to 3 kg installed pipe) is considered in the model. For LPG, an energy density of 26.5 MJ/L was assumed for modelling. Packaging requirements for PVC-U, PVC-O and PVC-M PVC pipes were calculated using the packaging analysis data, provided by Iplex staff. The primary packaging used for Iplex PVC pressure pipes is PET strapping and softwood timber frame. The waste material of a specific site was distributed to each of the pipe types based on their production share in that site.

DISTRIBUTION STAGE

Iplex has PVC pipe manufacturing facilities in Australia's major markets, and the vast majority of pipe distribution is over short distances within Sydney, Melbourne, Brisbane and Perth metropolitan areas. The average distribution distance was assumed to be 60 km within the metropolitan areas of production site. PVC-O is only manufactured in Sydney and therefore requires significant distribution to other markets. All distances were calculated using Google Maps.

INSTALLATION STAGE

The environmental impacts and other indicators related to the installation stage of PVC 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 PVC pressure pipe systems are usually installed underground in applications such as water supply, irrigation, and pressure sewerage. The pipes are laid in an excavated trench. Uniform guidance on the correct design and installation of PVC pressure pipes and other 'flexible' pipes is given in AS/NZS 2566.2 Buried flexible pipelines – Installation. Pipe materials covered by this Standard are: 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 as 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)

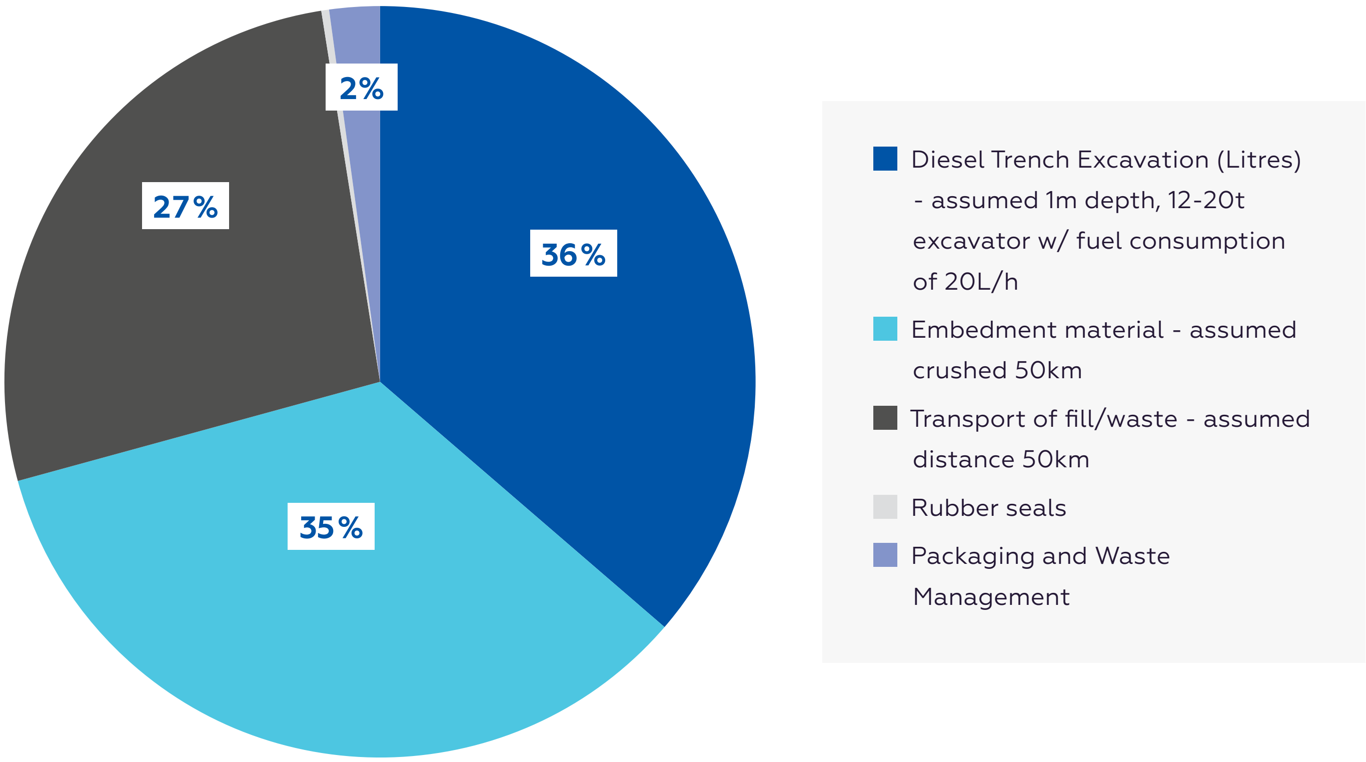


FIGURE 2 - CONTRIBUTION OF CONSTRUCTION FACTORS TO GWP IN PRESSURE PIPES

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

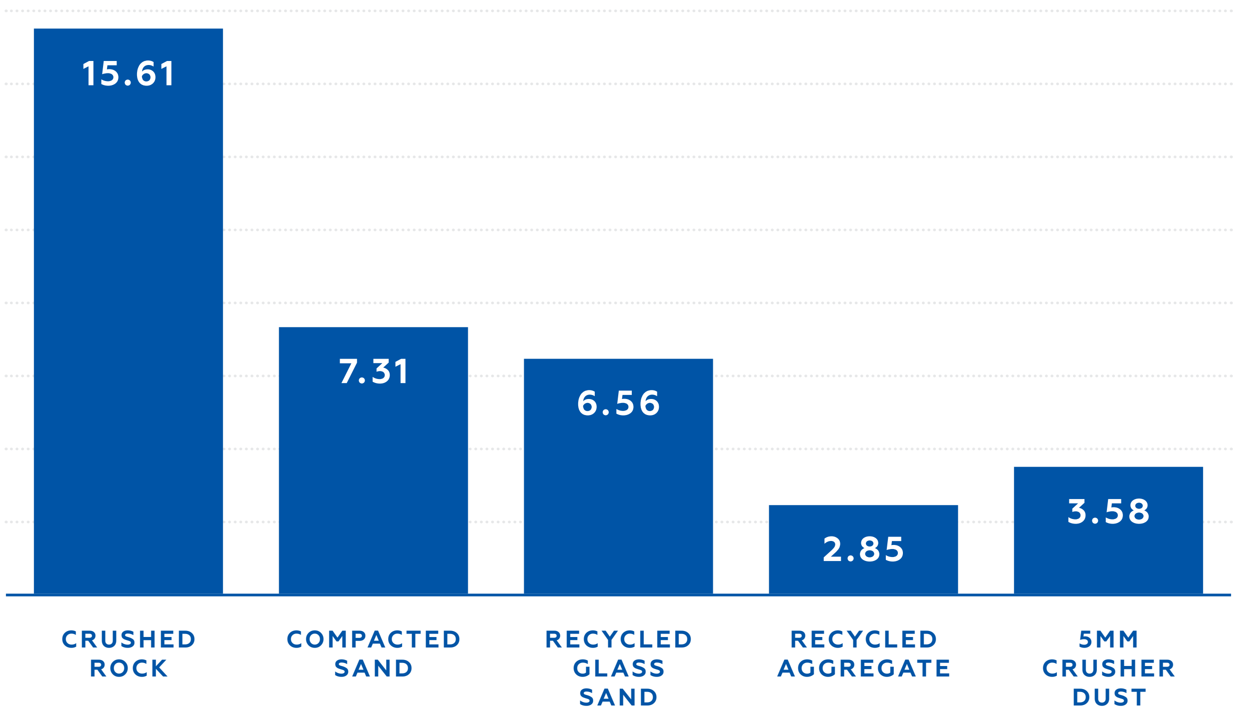


FIGURE 3 - GWP PER CUBIC METER OF EMBEDMENT MATERIAL IN PRESSURE PIPES

- 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 PVC pressure pipes are light enough to be lifted into the trench by hand. However, this will be dependent upon trench depth. Larger diameter pipes will require mechanical lifting equipment, in many cases an excavator is used.

PIPE JOINTING

PVC pressure pipes are jointed using sockets and spigots with either solvent cement joints for the smaller diameters, or rubber ring seals for larger sizes. Rubber ring jointing requires the application of lubricant to reduce jointing forces. PVC 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 rough estimate puts wastage from unusable offcuts at less than 1.2%. Waste pipe offcuts which cannot be reused can be recycled.

USE STAGE

Maintenance of the pipe systems is not required and not planned. The pipe systems are designed to last in excess of 100 years. The failure rate is also extremely low and is considered to be inconsequential (not relevant) in this EPD. PVC pressure pipe is the most reliable pipe system in Australia based on performance data from Australian water agencies. Post installation problems, if any, tend to be linked to third party damage, such as when excavating for gas pipelines. For PVC pipes not containing lead stabilisers, there are no significant emissions from leaching of chemicals during the use stage for PVC pipes (European Commission, 2004).

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 4.

TABLE 4: LCA INFORMATION

DECLARED UNIT	1 kg pipe
GEOGRAPHICAL COVERAGE	Australia
LCA SCOPE	Cradle to gate with option 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.
- A small portion of pipes (1%) become wastage during installation as unusable offcuts.
- The transport distance of pigment was excluded in the case of PVC-M and PVC-O pipes as the material accounting <1% of the feedmix.

BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module and transportation. Background data was adapted to represent Iplex PVC pressure 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, 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.

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

- 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.
- The transport distance of pigment was excluded in the case of PVC-M and PVC-O pipes as the material accounting <1% of the feedmix.

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

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 PVC pressure pipe and therefore allocation issues were avoided. There is no double counting of the impact from any manufacturing or other associated processes.

PVC-M pipes are manufactured in Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-U pipes are manufactured in Chipping Norton (NSW), Strathpine (QLD) and Reservoir (VIC) in Australia. PVC-O pipes are only manufactured in Chipping Norton (NSW) production site. Mass and energy data have been sourced from the manufacturing plant by Iplex. The quantities of materials and electricity required for producing Iplex PVC pressure pipe are calculated on basis of the amount (tonnes) of pipe manufactured on a particular 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 IPLEX PVC PRESSURE PIPE ENVIRONMENTAL PEFORMANCE

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 5 - 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 P_O43^- 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 PVC-M PRESSURE PIPE

TABLE 6: ENVIRONMENTAL IMPACTS FOR PVC-M PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-F	kg CO_2 eq.	3.34E+00	1.01E-01
GWP - B	kg CO_2 eq.	-1.63E-02	6.22E-06
GWP - Luluc	kg CO_2 eq.	2.16E-03	4.08E-07
GWP - T	kg CO_2 eq.	3.33E+00	1.01E-01
ODP	kg CFC 11 eq.	1.04E-06	3.86E-09
AP	mol H^+ eq.	1.94E-02	5.48E-04
EP - F	kg PO_4^{3-} eq.	3.41E-03	5.67E-05
EP - F	kg P eq.	6.67E-04	2.24E-06
EP - M	kg N eq.	3.66E-03	1.38E-04
EP - T	mol N eq.	3.79E-02	1.53E-03
POCP	kg NMVOC eq.	1.00E-02	4.95E-04
ADP	kg Sb eq.	3.46E-05	2.23E-07
ADP - F	MJ	5.48E+01	3.61E-01
WDP	m^3	9.37E+00	5.94E-01

TABLE 7 - RESOURCE USE FOR PVC-M PIPE

INDICATOR	UNIT	A1-A3	A4
PERE	MJ	2.44E+00	7.51E-03
PERM	MJ	0.00E+00	0.00E+00
PERT	MJ	2.44E+00	7.51E-03
PENRE	MJ	5.84E+01	3.78E-01
PENRM	MJ.	0.00E+00	0.00E+00
PENRT	MJ	5.84E+01	3.78E-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	1.92E-02	1.42E-04

TABLE 8 - WASTE PRODUCTION FOR PVC-M PIPE

INDICATOR	UNIT	A1-A3	A4
Hazardous Waste Disposed	kg	3.25E-05	1.02E-06
Non-Hazardous Waste Disposed	kg	3.40E-01	1.01E-02
Radioactive Waste Disposed	kg	5.98E-05	4.75E-09

TABLE 9 - OUTPUT FLOWS FOR PVC-M 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 10 - ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PVC-M PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-GHG	kg CO_2 eq.	3.22E+00	9.95E-02
Particulate Matter	Disease Incidence	1.42E-07	8.29E-09
Ionising Radiation - Human Health	kBq U-235 eq	1.52E-01	3.32E-05
Eco-Toxicity (Freshwater)	CTUe	5.04E+01	2.08E+00
Human Toxicity Potential - Cancer Effects	CTUh	1.60E-09	3.33E-11
Human Toxicity Potential - Non Cancer Effects	CTUh	4.47E-08	1.70E-09
Soil Quality	Dimensionless	3.09E+03	1.43E-01

RESULTS FOR PVC-O PRESSURE PIPE

TABLE 11 - ENVIRONMENTAL IMPACTS FOR PVC-O PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-F	kg CO_2 eq.	3.27E+00	1.21E-01
GWP - B	kg CO_2 eq.	-1.51E-02	7.35E-06
GWP - Luluc	kg CO_2 eq.	2.27E-03	4.90E-07
GWP - T	kg CO_2 eq.	3.26E+00	1.21E-01
ODP	kg CFC 11 eq.	1.09E-06	4.64E-09
AP	mol H^+ eq.	1.73E-02	6.52E-04
EP - F	kg PO_4^{3-} eq.	3.41E-03	6.78E-05
EP - F	kg P eq.	6.97E-04	2.69E-06
EP - M	kg N eq.	3.37E-03	1.66E-04
EP - T	mol N eq.	3.48E-02	1.84E-03
POCP	kg NMVOC eq.	9.13E-03	5.93E-04
ADP	kg Sb eq.	3.62E-05	2.68E-07
ADP - F	MJ	5.97E+01	4.34E-01
WDP	m^3	7.11E+00	7.12E-01

TABLE 12 - RESOURCE USE FOR PVC-O PIPE

INDICATOR	UNIT	A1-A3	A4
PERE	MJ	2.62E+00	8.99E-03
PERM	MJ	0.00E+00	0.00E+00
PERT	MJ	2.62E+00	8.99E-03
PENRE	MJ	6.35E+01	4.54E-01
PENRM	MJ	0.00E+00	0.00E+00
PENRT	MJ	6.35E+01	4.54E-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	1.95E-02	1.70E-04

TABLE 13 - WASTE PRODUCTION FOR PVC-O PIPE

INDICATOR	UNIT	A1-A3	A4
Hazardous Waste Disposed	kg	3.39E-05	1.23E-06
Non-Hazardous Waste Disposed	kg	3.63E-01	1.21E-02
Radioactive Waste Disposed	kg	6.28E-05	5.71E-09

TABLE 14 - OUTPUT FLOWS FOR PVC-O 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 15 - ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PVC-O PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-GHG	kg CO_2 eq.	3.14E+00	1.19E-01
Particulate Matter	Disease Incidence	1.25E-07	9.96E-09
Ionising Radiation - Human Health	kBq U-235 eq	1.60E-01	3.99E-05
Eco-Toxicity (Freshwater)	CTUe	5.22E+01	2.49E+00
Human Toxicity Potential - Cancer Effects	CTUh	1.62E-09	3.99E-11
Human Toxicity Potential - Non Cancer Effects	CTUh	4.61E-08	2.04E-09
Soil Quality	Dimensionless	3.25E+03	1.72E-01

RESULTS FOR PVC-U PRESSURE PIPE

TABLE 16 - ENVIRONMENTAL IMPACTS FOR PVC-U PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-F	kg CO_2 eq.	3.28E+00	1.19E-01
GWP - B	kg CO_2 eq.	-1.57E-02	7.22E-06
GWP - Luluc	kg CO_2 eq.	2.23E-03	4.84E-07
GWP - T	kg CO_2 eq.	3.27E+00	1.19E-01
ODP	kg CFC 11 eq.	1.07E-06	4.58E-09
AP	mol H^+ eq.	1.83E-02	6.42E-04
EP - F	kg PO_4^{3-} eq.	3.39E-03	6.69E-05
EP - F	kg P eq.	6.82E-04	2.66E-06
EP - M	kg N eq.	3.48E-03	1.64E-04
EP - T	mol N eq.	3.59E-02	1.81E-03
POCP	kg NMVOC eq.	9.46E-03	5.86E-04
ADP	kg Sb eq.	3.54E-05	2.65E-07
ADP - F	MJ	5.49E+01	4.28E-01
WDP	m^3	8.32E+00	7.02E-01

TABLE 17 - RESOURCE USE FOR PVC-U PIPE

INDICATOR	UNIT	A1-A3	A4
PERE	MJ	2.51E+00	8.87E-03
PERM	MJ	0.00E+00	0.00E+00
PERT	MJ	2.51E+00	8.87E-03
PENRE	MJ	5.87E+01	4.48E-01
PENRM	MJ.	0.00E+00	0.00E+00
PENRT	MJ	5.87E+01	4.48E-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	1.93E-02	1.68E-04

TABLE 18 - WASTE PRODUCTION FOR PVC-U PIPE

INDICATOR	UNIT	A1-A3	A4
Hazardous waste disposed	kg	3.31E-05	1.21E-06
Non-hazardous waste disposed	kg	3.47E-01	1.19E-02
Radioactive waste disposed	kg	6.15E-05	5.64E-09

TABLE 19 - OUTPUT FLOWS FOR PVC-U 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 20 - ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR PVC-U PIPE

INDICATOR	UNIT	A1-A3	A4
GWP-GHG	kg CO_2 eq.	3.16E+00	1.17E-01
Particulate Matter	Disease Incidence	1.34E-07	9.83E-09
Ionising Radiation - Human Health	kBq U-235 eq	1.57E-01	3.94E-05
Eco-Toxicity (Freshwater)	CTUe	5.13E+01	2.46E+00
Human Toxicity Potential - Cancer Effects	CTUh	1.61E-09	3.93E-11
Human Toxicity Potential - Non Cancer Effects	CTUh	4.53E-08	2.01E-09
Soil Quality	Dimensionless	3.18E+03	1.70E-01

INFORMATION ON BIOGENIC CARBON CONTENT

TABLE 21 – BIOGENIC CARBON CONTENT FOR 1 KG OF PVC PRESURE 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 44/12 kg CO2.

INTERPRETATION OF RESULTS FOR PVC-M PRESSURE PIPE

POTENTIAL ENVIRONMENTAL IMPACTS

- The product stage (i.e., **A1-A3**) is the primary contributor to GWPT and water depletion potential (WDP) impacts in the modules **A1-A4. 97.1%** of GWPT arises from the product stage or **A1-A3** modules.
    - **The product stage (A1-A3)** contributes to 95.3-99.7% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 94%.
    - In case of GWPT impacts, PVC resin is the highest contributor of A1-A3 GWPT impacts (67.1%) followed by titanium dioxide white (3.3%).
- In any impact category except WDP, contribution from distribution (A4) is 0.3% to 4.7%.

RESOURCE USE

- The major resource use impacts in the modules A1-A4 originate from the product stages (A1-A3), ranging between 99.3 to 99.7%%.
    - PVC resin the highest renewable resources accounting 73.4% of total lifecycle renewable utilisation. The second largest renewable resources user is the CPE white, accounting 1% of the total lifecycle renewable resources.
    - PVC resin is the largest non-renewable resource user accounting 87.4% of total lifecycle non-renewable resource utilisation. This is followed by CPE that accounts 3.7% of total lifecycle non-renewable resources.
    - The highest contributor to lifecycle Fresh Water use is from PVC resin, accounting for 92.5%. This is followed by stabiliser which uses 1.3% Fresh Water of whole lifecycle.
- There is no use of renewable secondary fuels.
- The renewable resource use impact is 4% of total renewable and non-renewable resource use impacts.

WASTE AND OUTPUT FLOWS

- 100% of all waste generated in the modules A1-A4 is non-hazardous.
    - The product stage (A1-A3) contributes to 97.1% of all non-hazardous waste generated. PVC resin is highest contributor to non-hazardous waste, accounting about 80.6%.
    - CPE is the second largest contributor to non-hazardous waste, sharing about 1.3%.

INTERPRETATION OF RESULTS FOR PVC-O PRESSURE PIPE

POTENTIAL ENVIRONMENTAL IMPACTS

- The product stage (i.e., **A1-A3**) is the primary contributor to GWPT and water depletion potential (WDP) impacts in the modules **A1-A4,. 96.4%** of GWPT arises from the product stage or **A1-A3** modules.
    - The product stage (A1-A3) contributes to 93.9-99.6% of all other environmental impact categories except WDP.
    - WDP impacts from A1-A3 modules account 90.9%.
    - In case of GWPT impacts, PVC resin is the highest contributor of A1-A3 GWPT impacts (72.1%) followed by titanium dioxide white (3.5%).
- In any impact category except WDP, contributions from distribution (A4) is 0.4% to 6.1%.

RESOURCE USE

- The major resource use impacts in the modules A1-A4 originate from the product stages (A1-A3), ranging between 99.1 to 99.7%.
    - PVC resin the highest renewable resources accounting 72% of total lifecycle renewable utilisation. The second largest renewable resources user is the stabiliser, accounting 0.1% of the total lifecycle renewable resources.
    - PVC resin is the largest non-renewable resource user accounting 84.6% of total lifecycle non-renewable resource utilisation. This is followed by stabiliser that accounts 2.9% of total lifecycle non-renewable resources.
    - The highest contributor to lifecycle Fresh Water use is from PVC resin, accounting for 95.7%. This is followed by stabiliser which uses 1.4% Fresh Water of whole lifecycle.
- There is no use of renewable secondary fuels.
- The renewable resource use impact is 3.9% of total renewable and non-renewable resource use impacts.

WASTE AND OUTPUT FLOWS

- 100% of all waste generated in the modules A1-A4 is non-hazardous.
    - The product stage (A1-A3) contributes to 96.8% of all non-hazardous waste generated. PVC resin is highest contributor to non-hazardous waste, accounting about 78.9%.
    - Stabiliser is the second largest contributor to non-hazardous waste, sharing about 1.3%.

INTERPRETATION OF RESULTS FOR PVC-U PRESSURE PIPE

POTENTIAL ENVIRONMENTAL IMPACTS

- The product stage (i.e., **A1-A3**) is the primary contributor to GWPT and water depletion potential (WDP) impacts in the modules **A1-A4,. 96.5%** of GWPT arises from the product stage or **A1-A3** modules.
    - **The product stage (A1-A3)** contributes to 94.2-99.6% of all other environmental impact categories except WDP.

- WDP impacts from A1-A3 modules account 92.2%.
- In case of GWPT impacts, PVC resin is the highest contributor of A1-A3 GWPT impacts (70.3%) followed by titanium dioxide white (3.5%).

- The product stage (A1-3) shares 3.5% total WDP impacts.
- In any impact category except WDP, contributions from distribution (A4) ranges from 0.4 to 5.8%.

RESOURCE USE

- The major resource use impacts in the modules A1-A4 originate from the product stages (A1-A3), ranging between 99.1-99.6%.
    - PVC resin the highest renewable resources accounting 73.5% of total lifecycle renewable utilisation. The second largest renewable resources user is the stabiliser, accounting 0.7% of the total lifecycle renewable resources.
    - PVC resin is the largest non-renewable resource user accounting 89.6% of total lifecycle non-renewable resource utilisation. This is followed by stabiliser that accounts 2.4% of total lifecycle non-renewable resources.
    - The highest contributor to lifecycle Fresh Water use is from PVC resin, accounting for 94.6%. This is followed by stabiliser which uses 1.1% Fresh Water of whole lifecycle.
- There is no use of renewable secondary fuels.
- The renewable resource use impact is 4.1% of total renewable and non-renewable resource use impacts.

WASTE AND OUTPUT FLOWS

- 100% of all waste generated in the modules A1-A4 is non-hazardous.
    - The product stage (A1-A3) contributes to 96.7% of all non-hazardous waste generated. PVC resin is highest contributor to non-hazardous waste, accounting about 80.9%.
    - Stabiliser is the second largest contributor to non-hazardous waste, sharing about 1%.

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.

BEST ENVIRONMENTAL PRACTICE PVC

In 2010 the GBCA reviewed its Green Star rating tool and under a new approach, the use of Iplex PVC pressure and non-pressure pipe, conduit and fittings can assist buildings to qualify for up to two positive credit points where pipe and fittings can be shown to comply with the GBCA "Best Practice Guidelines for PVC in the Built Environment."

As a means of demonstrating Best Environmental Practice PVC (BEP PVC), Iplex was subjected to an extensive audit process by independent third party certifier, Approval Mark. On Monday 9th February 2022, Iplex was reissued with BEP PVC Certificate of Compliance No. 037.

HEALTH RISK ASSESSMENT

The GBCA's Literature Review and Best Practice Guidelines for the Life Cycle of PVC Building Products (GBCA, 2010) provides an overview of health and environmental concerns that have been voiced by stakeholders relating to PVC production and end of life product management. Regarding concerns about additives, Iplex PVC pipe material is itself unplasticised PVC, and hence does not contain plasticisers – including phthalates. Australia Standards for PVC pipe, as the only national PVC pipe product standards to do so worldwide, specifically exclude heavy metal (e.g. lead and cadmium) additives (PIPA, 2014). Furthermore, the Adaptation of the USGBC TSAC Report for Relevance to Australian DWV Pipe (BRANZ, 2008) found that for typical pipe products "No single material shows up as the best across all the human health and environmental impact categories, nor the worst". The GBCA further found that the level of dioxins emitted due to best practice production of PVC and its constituents is much less than that from other sources. Therefore, there is insufficient rationale for discrimination against PVC building products on the basis of dioxin emissions (GBCA, 2010).

GUIDANCE FOR PVC PIPE RECYCLING

PVC pressure pipe that is installed in the ground, is economically unfeasible to excavate at end of life for the purpose of recycling. Additionally, the energy required for excavation would counteract benefits of recycling. However, PVC pressure pipe excavated for other reasons (e.g. new construction) has a high recyclability and can be mechanically recycled back into a pipe product performing the same structural function as one made only from virgin material. Due to the long life of rigid PVC products and low volume in waste streams, there is also no current limitation for the amount of recycled PVC that can be utilised.

Iplex Pipeback™ Program offers a streamlined service for recycling polyethylene pipes post-consumer back into manufacturing process with collection depots in Queensland, South Australia, Victoria and New South Wales.

Iplex recycling facilities will accept clean and unused pipe offcuts and fittings. For more information and to arrange a convenient drop-off time (by appointment only) please complete the 'contact us' form on the Iplex website. Once Iplex has received your request a recycling team member will be in touch.

7.0 PRODUCT SPECIFICATIONS

The following tables can be used to calculate the environmental results for specific Iplex pipe products. The density and length of pipe give the total mass of pipe for each product code.

TABLE 22 - PRODUCT SPECIFICATIONS FOR PREMIUM PVC-U PRESSURE PIPE

PRODUCT CODE	DN NOMINAL SIZE (MM)	STIFFNESS / PRESSURE RATING	LENGTH (M)	MINIMUM MEAN OUTSIDE DIAMETER (MM)	MASS PER PIPE LENGTH (KG/M)
PPSO1815	15MM	PN 18	6.0M	21.2	0.16
PPSO1220	20MM	PN 12	6.0M	26.6	0.17
PPSO1820	20MM	PN 18	6.0M	26.6	0.24
PPSO925	25MM	PN 9	6.0M	33.4	0.22
PPSO1225	25MM	PN 12	6.0M	33.4	0.27
PPSO1825	25MM	PN 18	6.0M	33.4	0.38
PPSO932	32MM	PN 9	6.0M	42.1	0.34
PPSO1232	32MM	PN 12	6.0M	42.1	0.43
PPSO1832	32MM	PN 18	6.0M	42.1	0.60
PPSO640	40MM	PN 6	6.0M	48.1	0.32
PPSO940	40MM	PN 9	6.0M	48.1	0.43
PPSO1240	40MM	PN 12	6.0M	48.1	0.56
PPSO1840	40MM	PN 18	6.0M	48.1	0.78
PPSO650	50MM	PN 6	6.0M	60.2	0.47
PPSO950	50MM	PN 9	6.0M	60.2	0.68
PPSO1250	50MM	PN 12	6.0M	60.2	0.86
PPSO1850	50MM	PN 18	6.0M	60.2	1.24
PPSO1265	65MM	PN 12	6.0M	75.2	1.35
PPSO1865	65MM	PN 18	6.0M	75.2	1.91
PPSO680	80MM	PN 6	6.0M	88.7	1.01
PPSO980	80MM	PN 9	6.0M	88.7	1.46
PPSO1280	80MM	PN 12	6.0M	88.7	1.88
PPSO1880	80MM	PN 18	6.0M	88.7	2.65
PPSO6100	100MM	PN 6	6.0M	114.1	1.64
PPSO9100	100MM	PN 9	6.0M	114.1	2.41
PPSO12100	100MM	PN 12	6.0M	114.1	3.09
PPSO18100	100MM	PN 18	6.0M	114.1	4.38
PPSO6125	125MM	PN 6	6.0M	140	2.48
PPSO9125	125MM	PN 9	6.0M	140	3.61
PPSO12125	125MM	PN 12	6.0M	140	4.63
PPSO6150	150MM	PN 6	6.0M	160	3.20
PPSO9150	150MM	PN 9	6.0M	160	4.70
PPSO12150	150MM	PN 12	6.0M	160	6.09
PPSO18150	150MM	PN 18	6.0M	160	8.63

TABLE 22 - PRODUCT SPECIFICATIONS FOR PREMIUM PVC-U PRESSURE PIPE *CONTINUED*

PRODUCT CODE	DN NOMINAL SIZE (MM)	STIFFNESS / PRESSURE RATING	LENGTH (M)	MINIMUM MEAN OUTSIDE DIAMETER (MM)	MASS PER PIPE LENGTH (KG/M)
PPSO9175	175MM	PN 9	6.0M	200	6.67
PPSO12175	175MM	PN 12	6.0M	200	8.68
PPSO9177	177MM	PN 9	6.0M	177.1	5.79
PPSO12177	177MM	PN 12	6.0M	177.1	7.48
PPSO9200	200MM	PN 9	6.0M	225	8.35
PPSO12200	200MM	PN 12	6.0M	225	10.91
PPSO12250	250MM	PN 12	6.0M	280	16.96
PPSO9300	300MM	PN 9	6.0M	315	16.65
PPSO12300	300MM	PN 12	6.0M	315	21.70

TABLE 23 - PRODUCT SPECIFICATIONS OF APOLLOBLUE™ PVC-O PRESSURE PIPE

PRODUCT CODE	DN NOMINAL SIZE (MM)	STIFFNESS / PRESSURE RATING	LENGTH (M)	MINIMUM MEAN OUTSIDE DIAMETER (MM)	MASS PER PIPE LENGTH (KG/M)
PDRA12100	100MM	PN 12.5	6.0M	121.7	2.04
PDRA16100	100MM	PN 16	6.0M	121.7	2.04
PDRA12150	150MM	PN 12.5	6.0M	177.1	4.20
PDRA16150	150MM	PN 16	6.0M	177.1	4.20
PDRA12200	200MM	PN 12.5	6.0M	231.9	7.33
PDRA16200	200MM	PN 16	6.0M	231.9	7.33
PDRA12225	225MM	PN 12.5	6.0M	258.9	8.82
PDRA16225	225MM	PN 16	6.0M	258.9	8.82
PDRA12250	250MM	PN 12.5	6.0M	285.8	10.80
PDRA16250	250MM	PN 16	6.0M	285.8	10.80
PDRA12300	300MM	PN 12.5	6.0M	344.9	16.31
PDRA16300	300MM	PN 16	6.0M	344.9	16.31

TABLE 24 - PRODUCT SPECIFICATIONS FOR RHINO® PVC-M – SERIES 1

PRODUCT CODE	DN NOMINAL SIZE (MM)	STIFFNESS / PRESSURE RATING	LENGTH (M)	MINIMUM MEAN OUTSIDE DIAMETER (MM)	MASS PER PIPE LENGTH (KG/M)
PPHR09100	100MM	PN 9	6.0M	114.1	1.58
PPHR12100	100MM	PN 12	6.0M	114.1	2.06
PPHR09150	150MM	PN 9	6.0M	160	3.11
PPHR12150	150MM	PN 12	6.0M	160	4.02
PPHR09200	200MM	PN 9	6.0M	225	6.11
PPHR12200	200MM	PN 12	6.0M	225	8.00
PPHR09225	225MM	PN 9	6.0M	250	7.47
PPHR12225	225MM	PN 12	6.0M	250	9.80
PPHR09250	250MM	PN 9	6.0M	280	9.45

TABLE 24 - PRODUCT SPECIFICATIONS FOR RHINO® PVC-M – SERIES 1 (CONTINUED)

PPHR12250	250MM	PN 12	6.0M	280	12.28
PPHR09300	300MM	PN 9	6.0M	315	11.84
PPHR12300	300MM	PN 12	6.0M	315	15.72
PPHR09375	375MM	PN 9	6.0M	400	19.27
PPHR12375	375MM	PN 12	6.0M	400	26.08
PPHR06500	500MM	PN 6	6.0M	560	33.80
PPHR09500	500MM	PN 9	6.0M	56	39.55

TABLE 25 - PRODUCT SPECIFICATIONS FOR RHINO® PVC-M – SERIES 2

PRODUCT CODE	DN NOMINAL SIZE (MM)	STIFFNESS / PRESSURE RATING	LENGTH (M)	MINIMUM MEAN OUTSIDE DIAMETER (MM)	MASS PER PIPE LENGTH (KG/M)
PDHR16100	100MM	PN 16	6	121.7	3.07
PDHR18100	100MM	PN 18	6	121.7	3.37
PDHR20100	100MM	PN 20	6	121.7	3.62
PDHR12150	150MM	PN 12	6	177.1	4.94
PDHR16150	150MM	PN 16	6	177.1	6.43
PDHR18150	150MM	PN 18	6	177.1	7.13
PDHR20150	150MM	PN 20	6	177.1	7.63
PDHR12200	200MM	PN 12	6	231.9	8.46
PDHR16200	200MM	PN 16	6	231.9	11.03
PDHR18200	200MM	PN 18	6	231.9	1.28
PDHR20200	200MM	PN 20	6	231.9	13.50
PDHR12225	225MM	PN 12	6	258.9	10.56
PDHR16225	225MM	PN 16	6	258.9	13.81
PDHR18225	225MM	PN 18	6	258.9	15.27
PDHR16250	250MM	PN 16	6	285.8	16.18
PDHR09300	300MM	PN 9	6	344.9	14.92
PDHR12300	300MM	PN 12	6	344.9	18.87
PDHR16300	300MM	PN 16	6	344.9	24.40
PDHR18300	300MM	PN 18	6	344.9	27.09
PDHR09375	375MM	PN 9	6	425.7	22.74
PDHR12375	375MM	PN 12	6	425.7	28.90
PDHR16375	375MM	PN 16	6	425.7	37.61
PDHR18375	375MM	PN 18	6	425.7	41.58
PDHR09450	450MM	PN 9	6	506.5	32.17
PDHR12450	450MM	PN 12	6	506.5	42.03

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FOR ALL ENQUIRIES AND ORDERS CONTACT IPLEX PIPELINES
WWW.IPLEX.COM.AU
Plumbing and Irrigation **1300 0 IPLEX**
Civil **13 10 86**
Email **info@iplexpipelines.com.au**

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