AUSTRALASIA EPD®

ENVIRONMENTAL PRODUCT DECLARATION

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iPLEX Pipelines

# ENVIRONMENTAL PRODUCT DECLARATION

## PVC PRESSURE PIPES


Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804
Version 1.2 17/10/2017
Approval date 06/12/2015
Registration number S-P-00712
Expiry date 06/12/2020
Geographical area of application of this EPD: Australia
Year taken as a reference for the data: 2014
EPD of Iplex Pipelines PP Pipe Products – In collaboration with the Australian Plastics Industry Pipe Association (PIPA)

PIPA

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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 version of the EPD has been updated to clarify which pipe dimensions the installation results refer to.

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**CEN STANDARD EN 15804 SERVED AS THE CORE PCR**

**PCR:** Construction Products and Services, Version 2, 2015-03-03

**PCR PREPARED BY:**

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**INDEPENDENT EXTERNAL VERIFICATION OF THE DECLARATION AND DATA, ACCORDING TO ISO 14025:2010:**

☐ EPD process certification (Internal)
☑ EPD verification (External)

**ACCREDITED OR APPROVED BY** The Australasian EPD® Programme

# 2.0 GREEN STAR EPD CONFORMITY

- ✓ The 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 Transparency credit points under the GBCA's Green Star rating tools.

The PVC pipe EPD results can also be used to represent PVC 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 (Iplex), Australasia's largest manufacturer and supplier of plastics piping systems, is pleased to publish this Environment Product Declaration, for its Iplex and Key Plastics branded PVC-U, BlueRHINO®/WhiteRHINO® PVC-M and ApolloBLUE™ PVC-O pressure pipe.

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

More than 50 years' experience in the manufacture of PVC pipes makes Iplex an Australian pioneer in the plastics pipe production and a foundation member of the Plastics Industry Pipes Association of Australia. As part of its ongoing commitment to the development of Australian and International Standards for plastics pipe products, company personnel serve on Standards Australia and ISO technical committees and working groups.

PVC pipe manufacturing plants are located close to major development regions in Brisbane, Sydney, Melbourne and Perth 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 in them to facilitate and openly encourage responsible sourcing of raw materials, best practice manufacturing, fully independent third party certification compliance, simpler procurement and easier identification of compliant products. No other Australian or international product standards have taken this step.

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* and the Water Services Association of Australia (WSAA) Reticulation Code WSA 03.

ApolloBLUE™ is a bi-axially oriented PVC (PVC-O) pressure pipe for use in water supply infrastructure. Iplex manufactures the pipe using two new processes known as Biax Extrusion and Super Socketing, both of which are patented. 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.

Modified PVC (PVC-M) is similar in composition to the traditional PVC pressure pipe that has been used in Australia for the past forty years. The difference is that an impact modifier has been added to alter the fracture mechanism, so the material behaves in a ductile manner. Iplex RHINO® pressure pipes are high performance thermoplastic pipes, incorporating the advancements of modified PVC pipe technology.

RHINO® pressure pipes provide superior characteristics over conventional PVC-U pressure pipes, including higher impact resistance and ductility, reduced weight and greater hydraulic capacity. Iplex modified PVC-M pipes do not contain any compounds based on lead, cadmium or mercury. 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 whole 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 CHARACTERISTICS | |
|---|---|
| PRODUCT NAMES | Premium PVC-U pressure pipe<br>ApolloBLUE™ PVC-O pressure pipe<br>RHINO® PVC-M pressure pipe<br>See Tables 14, 15 & 16 for individual product codes |
| DENSITY | 1420-1500 kg/$m^3$ |
| HYDROSTATIC DESIGN STRESS | 11 to 12.3MPa PVC-U<br>22.2 to 28MPa PVC-O<br>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 FOR IPLEX PVC PRESSURE PIPES

| MATERIAL | PREMIUM PVC-U | APOLLOBLUE™ PVC-O | RHINO® PVC-M | CAS NO. |
|---|---|---|---|---|
| POLYVINYL CHLORIDE RESIN | 91.4% | 93.3% | 88.8% | 9002-86-2 |
| CALCIUM CARBONATE | 4.6% | 1.9% | 1.3% | 471-34-1 |
| ORGANIC BASED STABILISER | 2.7% | 3.4% | 3.2% | Confidential (nothing hazardous) |
| TITANIUM DIOXIDE | 1.4% | 1.4% | 1.3% | 13463-67-7 |
| IMPACT MODIFIER | | | 4.7% | 64754-90-1 |
| PROCESSING AID | | | 0.7% | 26221-73-8 |
| PIGMENT | | <0.1% | <0.1% | Various (nothing hazardous) |
| TOTAL | 100% | 100% | 100% | |

## PRODUCT LIFE CYCLE OVERVIEW

The life cycle of a building product is divided into three process modules according to the General Program Instructions (GPI) of the Australiasian EPD Programme (AEPDP, 2015) and four information modules according to ISO 21930 and EN 15804, and supplemented by an optional information module on potential loads and benefits beyond the building life cycle. Table 3 shows the system boundary and scope of the EPD. The scope of this EPD is "cradle to gate with options" as defined by EN 15804. The intent of the EPD is to cover all significant impacts over the full life cycle. Due to the fact that the pipes are left in the ground at end of life with negligible potential environmental impact, modules C1-C4 were deemed not relevant. Due to the durability of PVC pressure pipes, and lack of planned or required maintenance throughout the service life, modules B1-B7 were also deemed not relevant.

### TABLE 3 - SYSTEM BOUNDARY AND SCOPE OF ASSESSMENT

| PRODUCT STAGE | | | CONSTRUCTION STAGE | | USE STAGE | | | | | | | END OF LIFE STAGE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 |
| RAW MATERIAL SUPPLY | TRANSPORT | MANUFACTURING | TRANSPORT | INSTALLATION | MATERIAL EMISSIONS | MAINTENANCE | REPAIR | REPLACEMENT | REFURBISHMENT | OPERATIONAL ENERGY | OPERATIONAL WATER | DECONSTRUCTION/DEMOLITION | TRANSPORT | WASTE PROCESSING | DISPOSAL |
| X | X | X | X | X | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |

**X =** module included in EPD

**NR =** module not relevant (does not indicate zero impact result) – see text above table for explanation.

## LIFE CYCLE OF IPLEX PVC PIPES

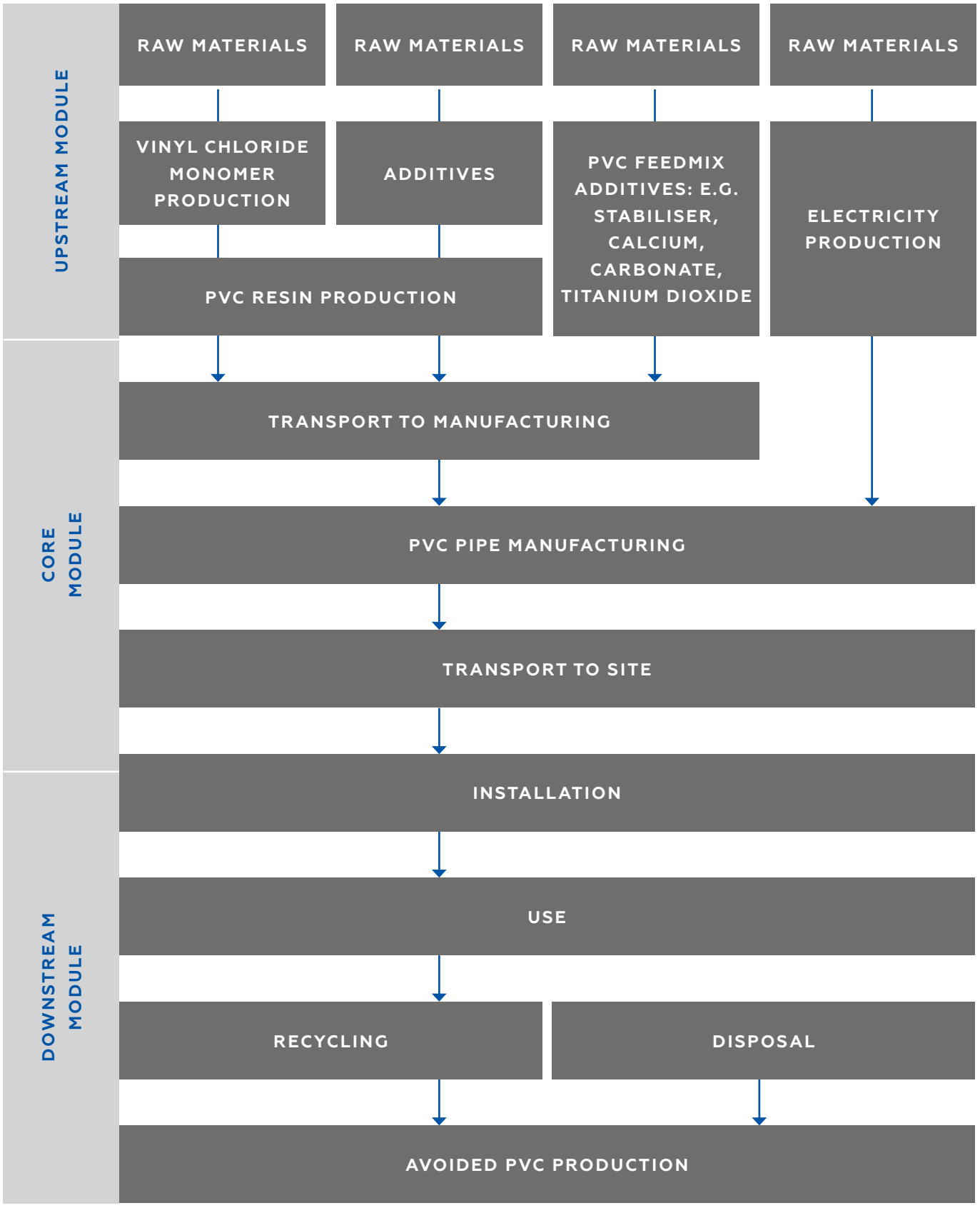



FIGURE 1 - LIFE CYCLE DIAGRAM OF PVC PIPE PRODUCTION

## IPLEX PVC PRESSURE PIPE MANUFACTURING

Pressure PVC pipes are manufactured primarily from PVC resin along with additives, including: calcium carbonate, titanium dioxide, organic stabiliser, lubricants and pigments. In the case of RHINO® PVC-M an impact modifier is used. The PVC resin is the main ingredient in the PVC pipe feed mix, and is manufactured in Australia primarily from imported vinyl chloride monomer. The PVC resin and other additives are delivered to manufacturing site by bulk road tankers and are unloaded by a pneumatic system into storage silos. The mixing system incorporates resin and additives via computer controlled weighing systems. Internal PVC pipe scrap is fed back into the feed mix and utilised in new pipe. The ingredients are then mixed by frictional means until enough heat is generated to incorporate the stabiliser and lubricant necessary for uniform processing at the extruder. Once mixed the blended feed mix is again stored in silos ready for extrusion – where the feed mix is gradually fed into the extruder via a gravimetric weighing system ensuring precise quantities. Through a combination of friction and heat, the feed mix is brought up to the ideal temperature for plastification, at which point it is forced through an annular die to form a tube. The newly formed pipe is then cooled by refrigerated water and the outside of the tube is subjected to a vacuum and brought in contact with a perfectly round sizing sleeve. The wall thickness is controlled with the computerised haul-off speed which also controls the saw which cuts the pipe at predetermined lengths. One end of the pipe is re-heated after cutting and expanded to allow for pipe joining. Finally, the lengths of pipe are palletised, packaged with a softwood timber frame, steel and PET strapping. Iplex PVC manufacturing sites are shown below in Figure 2. PVC-U pressure pipes are manufactured at all sites while ApolloBLUE™ PVC-O pressure pipe is only manufactured in Chipping Norton and RHINO® PVC-M pressure pipes are manufactured in Strathpine (QLD), Reservoir (VIC) and Osbourne Park (WA). The results shown in this EPD are representative of the weighted average production of PVC-U and PVC-M pipe products at respective manufacturing sites.

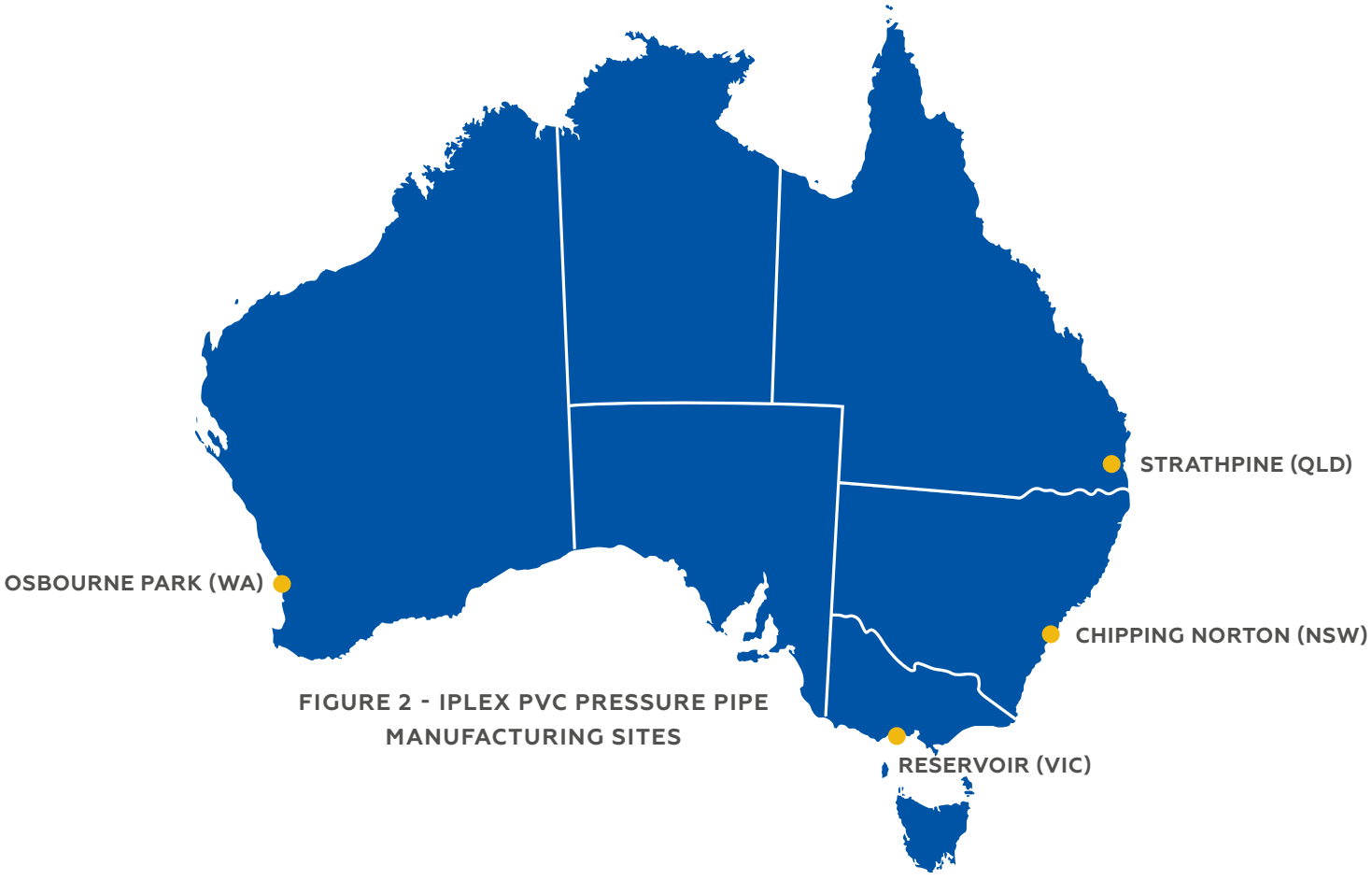


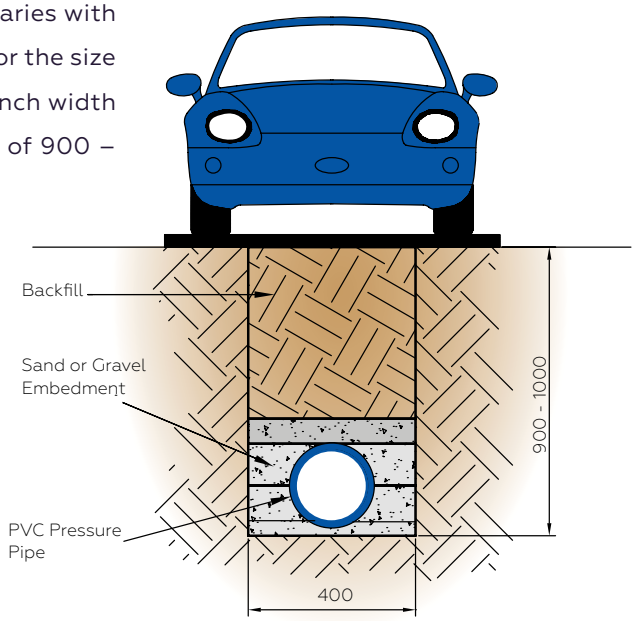

FIGURE 2 - IPLEX PVC PRESSURE PIPE MANUFACTURING SITES

## 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 ApolloBLUE™ PVC-O pipe is only manufactured in Sydney and therefore requires significant distribution to other markets.

## INSTALLATION STAGE

The majority of this type of pipe is installed underground. The pipes are laid in an excavated trench. The trench width and depth varies with pipe size and will be specified by the infrastructure agency. For the size ranges nominated for these EPDs we suggest an average trench width of around 400mm would be appropriate and a trench depth of 900 – 1000mm would be typical; noting that 97.5% of pipes sold are smaller than DN200 so would need narrower trenches. The results in module A5 do not apply to pipe sizes larger than DN200. The energy required for trench excavation leads to significant impact during the installation of PVC pressure pipe.




Bedding and backfill materials vary in specification. In many cases no imported material is used but for many city based agencies sand bedding and gravel are used in the areas immediately below and at the sides of the pipe. It is estimated that imported backfill materials amount 0.3m$^3$ of material per metre of pipeline. This material will need to be transported to site and given the predominance of this approach to city based installation it was estimated the typical transport distance is 30-50km.

The joints for PVC pressure pipes of this type are almost exclusively all rubber sealed spigot and socket joints – there is no heat used, no thermal or chemical welding and no solvent used. Jointing is achieved by hand. The installer typically uses a bar and a block of wood to lever the end of the last pipe into the preceding pipe socket. Each joint (one every 6m) requires a rubber seal. Wastage of pipe is minimal as short lengths are often required elsewhere and easily reused on subsequent sites or within the same site. PIPA estimates put wastage from unusable offcuts at less than 1%.

## 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).

## END OF LIFE

PVC pressure pipes are generally installed underground are assumed to remain underground at end of life. PVC pipes are inert and there is no incentive to dig them up to send for waste treatment.

# 4.0 LIFE CYCLE ASSESSMENT METHODOLOGY

This section includes the main details of the 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 - DETAILS OF LCA**

| PRODUCT CHARACTERISTICS | |
|---|---|
| DECLARED UNIT | 1kg of installed pipe |
| GEOGRAPHICAL COVERAGE | Australia |
| LCA SCOPE | Cradle to grave |
| REFERENCE SERVICE LIFE | 100 years |

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.

LCA is the compilation of the inputs, outputs and environmental impacts of a product system throughout its life cycle. It is a technique that enables industries to identify the resource flows and environmental impacts (such as greenhouse gas emissions, water and energy use) associated with the provision of products and services.

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

Life cycle data has been sourced from material quantity data and production process data from:

- Iplex's reporting systems and staff
- Iplex feed mix suppliers, including the Australian Vinyl Corporation, Sun Ace and Omya Australia.

Core manufacturing data was collected directly from Iplex manufacturing sites. Electricity consumption was allocated to pipe via mass of pipe produced.

## BACKGROUND DATA

Generic background data was sourced for raw materials in the upstream module, transportation and end of life waste treatment. Background data was adapted to represent Iplex PVC pressure pipe product as accurately as possible. Australian inputs were primarily modelled with the AusLCI database (AusLCI, 2009) and the Australasian Unit Process LCI (Life Cycle Strategies, 2015) and the ecoinvent v3 database where suitable Australian data was not available. Materials sourced from outside Australia were modelled based on global averages using the ecoinvent v3 database. Global averages were used since the sourcing of these materials often changes from year to year. All background data used was less than 10 years old.

## CUT OFF CRITERIA

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary as per the PCR (IEPDS, 2015), section 6.6. All other reported data were incorporated and modelled using the best available life cycle inventory data.

## ALLOCATION

Allocation was carried out in accordance with the PCR (IEPDS, 2015), section 6.7. No-allocation between co-products in the core module as there were no co-products created during manufacturing.

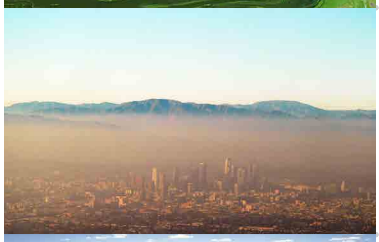
## VARIATION

The background LCA report tested the variation in results between manufacturing locations. The manufacturing location lead to significant variance between the production impacts at Iplex sites, however the purpose of this EPD is to represent the average Iplex PVC pipe product supplied to the Australian market. By including all manufacturing sites for Premium PVC-U and RHINO® PVC-M pressure pipe, this EPD is representative of the average production and is less susceptible to variation when production volumes alter. For ApolloBLUE™ PVC-O pressure pipe there is only one manufacturing site and therefore no variation due to manufacturing location.

# 5.0 PVC PIPE ENVIRONMENTAL PERFORMANCE

The potential environmental impacts used in this EPD are explained in Table 5 and the results shown in Table 9 and Table 12 (for Premium PVC-U, ApolloBLUE™ PVC-O and RHINO® PVC-M pressure pipes respectively). The use of energy and fresh water resources is shown in Table 7, Table 10 and Table 13. The use of secondary material and secondary material used as energy resources is listed as 'INA' (indicator not assessed). Although Iplex do not directly use secondary material, it is possible that secondary material is used in the supply chain and therefore exists in the product life cycle. Table 8, Table 11 and Table 14 shows the generation of waste throughout the product life cycle.

## TABLE 5 - ENVIRONMENTAL INDICATORS USED IN THE EPD

| | ENVIRONMENTAL INDICATOR | UNIT | DESCRIPTION |
|---|---|---|---|
|  | **GLOBAL WARMING POTENTIAL** [A] | KG CARBON DIOXIDE EQUIVALENTS | Increase in the Earth's average temperature, mostly through the release of greenhouse gases. A common outcome of this is an increase in natural disasters and sea level rise. |
|  | **OZONE DEPLETION POTENTIAL** [B] | KG CFC-11 EQUIVALENTS | The decline in ozone in the Earth's stratosphere. The depletion of the ozone layer increases the amount of UVB that reaches the Earth's surface. UVB is generally accepted to be a contributing factor to skin cancer, cataracts and decreased crop yields. |
|  | **ACIDIFICATION POTENTIAL** [C] | KG SULPHUR DIOXIDE EQUIVALENTS | A process whereby pollutants are converted into acidic substances which degrade the natural environment. Common outcomes of this are acidified lakes and rivers, toxic metal leaching, forest damage and destruction of buildings. |
|  | **EUTROPHICATION POTENTIAL** [C] | KG PHOSPHATE EQUIVALENTS | An increase in the levels of nutrients released to the environment. A common outcome of this is high biological productivity that can lead to oxygen depletion, as well as significant impacts on water quality, affecting all forms of aquatic and plant life. |
|  | **PHOTOCHEMICAL OZONE CREATION POTENTIAL** [C] | KG ETHYLENE EQUIVALENTS | Ozone in the troposphere is a constituent of smog that is caused by a reaction between sunlight, nitrogen oxide and volatile organic compounds (VOCs). This is a known cause for respiratory health problems and damage to vegetation. |
|  | **ABIOTIC DEPLETION POTENTIAL – ELEMENTS / MINERALS** [C] | KG ANTIMONY EQUIVALENTS | The extraction of non-living and non-renewable elements and minerals. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate. |
|  | **ABIOTIC DEPLETION POTENTIAL – FOSSIL FUELS** [C] | MJ NET CALORIFIC VALUE | The extraction of non-living and non-renewable fossil fuels. These resources are essential in our everyday lives and many are currently being extracted at an unsustainable rate. |

**Life cycle impact assessment methods used: a** - CML (v4.1) – based on IPCC AR4 (GWP 100); **b** - CML (v4.1) – based on WMO 1999; **c** - CML (v4.1)

## PREMIUM PVC-U PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

### TABLE 6 - POTENTIAL ENVIRONMENTAL IMPACT OF 1KG OF INSTALLED PREMIUM PVC-U PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| GWP ($kgCO_2$ eq) | 2.75 | 0.838 | 8.76E-03 | 1.04 |
| ODP (kgCFC11 eq) | 4.53E-08 | 1.16E-09 | 2.84E-10 | 4.55E-08 |
| AP ($kgSO_2$ eq) | 8.37E-03 | 1.25E-03 | 2.17E-05 | 3.28E-03 |
| EP ($kgPO_4^{3}$- eq) | 2.00E-03 | 3.94E-04 | 5.42E-06 | 8.03E-04 |
| POCP ($kgC_2H_2$ eq) | 3.13E-04 | 8.40E-05 | 1.40E-06 | 1.66E-04 |
| ADPE (kgSb eq) | 4.00E-06 | 6.05E-07 | 1.98E-08 | 2.42E-06 |
| ADPF (MJ) | 14.4 | 7.62 | 0.14 | 13.5 |

**GWP =** Global Warming Potential, **ODP =** Ozone Depletion Potential, **AP =** Acidification Potential, **EP =** Eutrophication Potential, **POCP =** Photochemical Oxidant Formation Potential, **ADPE =** Abiotic Resource Depletion Potential – Elements, **ADPF =** Abiotic Resource Depletion Potential – Fossil Fuel

### TABLE 7 - USE OF RESOURCES OF 1KG OF INSTALLED PREMIUM PVC-U PRESSURE PIPE

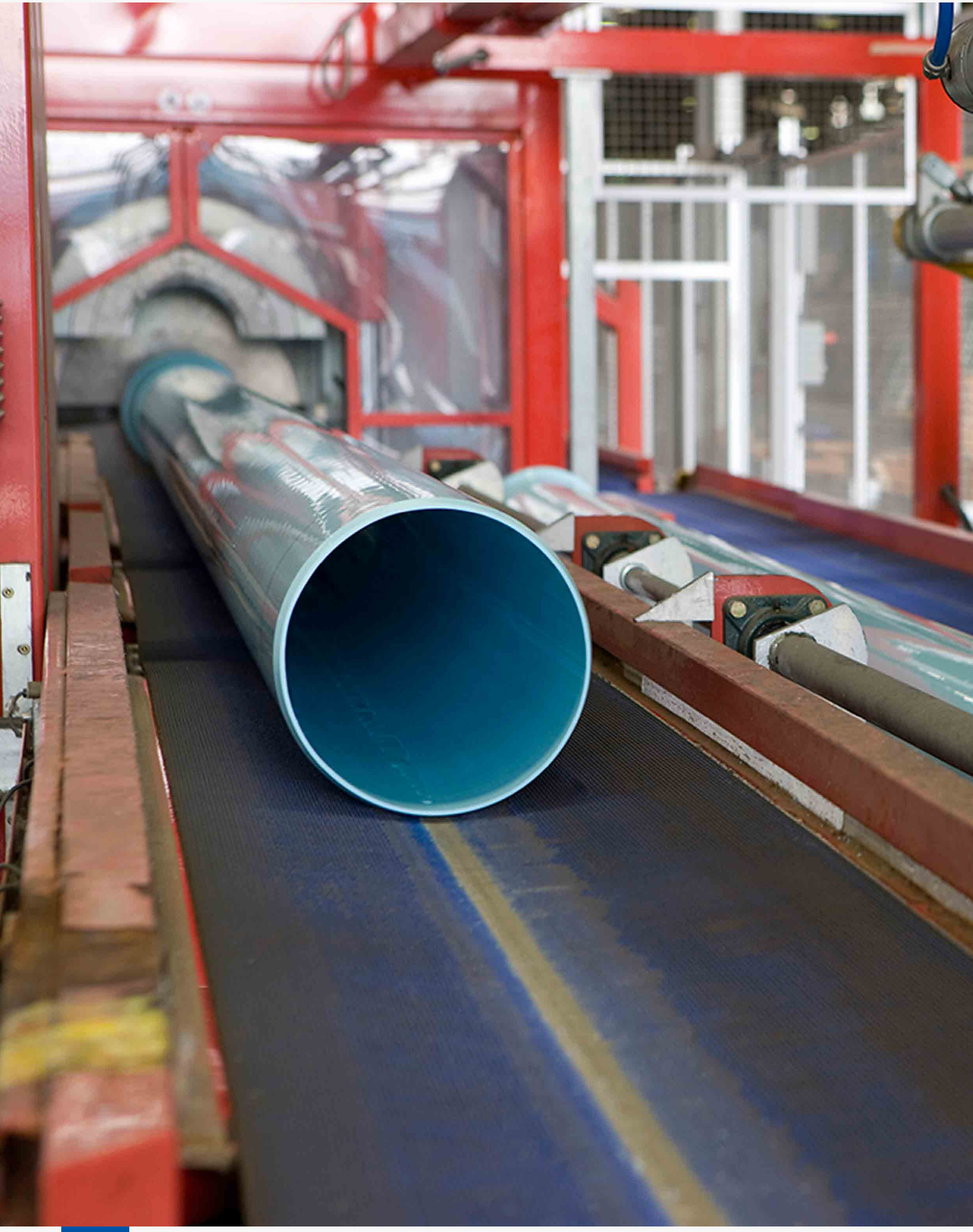
| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| PERE (MJ) | 1.74 | 0.490 | 7.50E-04 | 0.362 |
| PERM (MJ) | 0 | 0 | 0 | 0 |
| PERT (MJ) | 1.74 | 0.490 | 7.50E-04 | 0.362 |
| PENRE (MJ) | 61.8 | 7.66 | 0.139 | 13.8 |
| PENRM (MJ) | 0 | 0 | 0 | 0 |
| PENRT (MJ) | 61.8 | 7.66 | 0.14 | 13.75 |
| SM (kg) | INA | INA | INA | INA |
| RSF (MJ) | INA | INA | INA | INA |
| NRSF (MJ) | INA | INA | INA | INA |
| FW ($m^3$) | 0.678 | 0.0536 | 2.48E-03 | 0.869 |

**PERE =** Use of renewable primary energy excluding raw materials, **PERM =** Use of renewable primary energy resources used as raw materials, **PERT =** Total use of renewable primary energy resources, **PENRE =** Use of non-renewable primary energy excluding raw materials, **PENRM =** Use of non-renewable primary energy resources used as raw materials, **PENRT =** Total use of non-renewable primary energy resources, **SM =** Use of secondary material, **RSF =** Use of renewable secondary fuels, **NRSF =** Use of non-renewable secondary fuels, **FW =** Use of net fresh water, **INA =** Indicator not accessed due to a limitation of the LCA tools and databases used to calculate the required resource flows. INA does not imply zero impact

### TABLE 8 - GENERATION OF WASTE FOR 1KG OF INSTALLED PREMIUM PVC-U PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| HWD (kg) | 0.0104 | 1.12E-06 | 9.29E-08 | 1.36E-05 |
| NHWD (kg) | 0.150 | 0.131 | 8.90E-04 | 0.254 |
| RWD (kg) | 3.56E-06 | 1.82E-08 | 2.26E-09 | 4.40E-07 |

**HWD =** Hazardous waste disposed, **NHWD =** Non-hazardous waste disposed, **RWD =** Radioactive waste disposed



## APOLLOBLUE™ PVC-O PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

### TABLE 9 - POTENTIAL ENVIRONMENTAL IMPACTS OF 1KG OF INSTALLED APOLLOBLUE™ PVC-O PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| GWP ($kgCO_2$ eq) | 2.81 | 0.895 | 0.102 | 1.04 |
| ODP (kgCFC11 eq) | 4.63E-08 | 1.45E-09 | 3.27E-09 | 4.55E-08 |
| AP ($kgSO_2$ eq) | 8.57E-03 | 1.35E-03 | 2.51E-04 | 3.28E-03 |
| EP ($kgPO_4^{3-}$ eq) | 2.05E-03 | 4.45E-04 | 6.31E-05 | 8.03E-04 |
| POCP ($kgC_2H_2$ eq) | 3.22E-04 | 5.84E-05 | 1.63E-05 | 1.66E-04 |
| ADPE (kgSb eq) | 4.09E-06 | 6.91E-07 | 2.28E-07 | 2.42E-06 |
| ADPF (MJ) | 14.9 | 8.92 | 1.61 | 13.5 |

**GWP =** Global Warming Potential, **ODP =** Ozone Depletion Potential, **AP =** Acidification Potential, **EP =** Eutrophication Potential, **POCP =** Photochemical Oxidant Formation Potential, **ADPE =** Abiotic Resource Depletion Potential – Elements, **ADPF =** Abiotic Resource Depletion Potential – Fossil Fuel

### TABLE 10 - USE OF RESOURCES FOR 1KG OF INSTALLED APOLLOBLUE™ PVC-O PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| PERE (MJ) | 1.77 | 0.325 | 0.0087 | 0.362 |
| PERM (MJ) | 0 | 0 | 0 | 0 |
| PERT (MJ) | 1.77 | 0.325 | 0.0087 | 0.362 |
| PENRE (MJ) | 63.4 | 8.95 | 1.62 | 13.8 |
| PENRM (MJ) | 0 | 0 | 0 | 0 |
| PENRT (MJ) | 63.4 | 8.95 | 1.62 | 13.8 |
| SM (kg) | INA | INA | INA | INA |
| RSF (MJ) | INA | INA | INA | INA |
| NRSF (MJ) | INA | INA | INA | INA |
| FW ($m^3$) | 0.673 | 0.0576 | 0.0286 | 0.869 |

**PERE =** Use of renewable primary energy excluding raw materials, **PERM =** Use of renewable primary energy resources used as raw materials, **PERT =** Total use of renewable primary energy resources, **PENRE =** Use of non-renewable primary energy excluding raw materials, **PENRM =** Use of non-renewable primary energy resources used as raw materials, **PENRT =** Total use of non-renewable primary energy resources, **SM =** Use of secondary material, **RSF =** Use of renewable secondary fuels, **NRSF =** Use of non-renewable secondary fuels, **FW =** Use of net fresh water, **INA =** Indicator not accessed due to a limitation of the LCA tools and databases used to calculate the required resource flows. INA does not imply zero impact

### TABLE 11 - GENERATION OF WASTE FOR 1KG OF INSTALLED APOLLOBLUE™ PVC-O PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| HWD (kg) | 0.0106 | 1.17E-06 | 1.07E-06 | 1.36E-05 |
| NHWD (kg) | 0.153 | 0.117 | 0.0103 | 0.254 |
| RWD (kg) | 3.64E-06 | 1.64E-08 | 2.60E-08 | 4.40E-07 |

**HWD =** Hazardous waste disposed, **NHWD =** Non-hazardous waste disposed, **RWD =** Radioactive waste disposed

## RHINO® PVC-M PRESSURE PIPE ENVIRONMENTAL PERFORMANCE

### TABLE 12 - POTENTIAL ENVIRONMENTAL IMPACTS FOR 1KG OF INSTALLED RHINO® PVC-M PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| GWP ($kgCO^2$ eq) | 2.75 | 0.770 | 0.0509 | 1.04 |
| ODP (kgCFC11 eq) | 4.58E-08 | 1.05E-09 | 1.64E-09 | 4.55E-08 |
| AP ($kgSO^2$ eq) | 8.41E-03 | 1.15E-03 | 1.26E-04 | 3.28E-03 |
| EP ($kgPO_4^{3-}$ eq) | 2.01E-03 | 3.66E-04 | 3.14E-05 | 8.03E-04 |
| POCP ($kgC^2H^2$ eq) | 3.14E-04 | 6.35E-05 | 8.14E-06 | 1.66E-04 |
| ADPE (kgSb eq) | 4.05E-06 | 5.87E-07 | 1.15E-07 | 2.42E-06 |
| ADPF (MJ) | 17.5 | 7.64 | 0.80 | 13.48 |

**GWP =** Global Warming Potential, **ODP =** Ozone Depletion Potential, **AP =** Acidification Potential, **EP =** Eutrophication Potential, **POCP =** Photochemical Oxidant Formation Potential, **ADPE =** Abiotic Resource Depletion Potential – Elements, **ADPF =** Abiotic Resource Depletion Potential – Fossil Fuel

### TABLE 13 - USE OF RESOURCES FOR 1KG OF INSTALLED RHINO® PVC-M PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| PERE (MJ) | 1.71 | 0.369 | 4.35E-03 | 0.362 |
| PERM (MJ) | 0 | 0 | 0 | 0 |
| PERT (MJ) | 1.71 | 0.369 | 4.35E-03 | 0.362 |
| PENRE (MJ) | 63.6 | 7.68 | 0.81 | 13.8 |
| PENRM (MJ) | 0 | 0 | 0 | 0 |
| PENRT (MJ) | 63.6 | 7.68 | 0.81 | 13.8 |
| SM (kg) | INA | INA | INA | INA |
| RSF (MJ) | INA | INA | INA | INA |
| NRSF (MJ) | INA | INA | INA | INA |
| FW ($m^3$) | 0.682 | 0.0659 | 0.0144 | 0.869 |

**PERE =** Use of renewable primary energy excluding raw materials, **PERM =** Use of renewable primary energy resources used as raw materials, **PERT =** Total use of renewable primary energy resources, **PENRE =** Use of non-renewable primary energy excluding raw materials, **PENRM =** Use of non-renewable primary energy resources used as raw materials, **PENRT =** Total use of non-renewable primary energy resources, **SM =** Use of secondary material, **RSF =** Use of renewable secondary fuels, **NRSF =** Use of non-renewable secondary fuels, **FW =** Use of net fresh water, **INA =** Indicator not accessed due to a limitation of the LCA tools and databases used to calculate the required resource flows. INA does not imply zero impact

### TABLE 14 - GENERATION OF WASTE FOR 1KG OF INSTALLED RHINO® PVC-M PRESSURE PIPE

| | A1 & A2 | A3 | A4 | A5 |
|---|---|---|---|---|
| HWD (kg) | 0.0101 | 1.10E-06 | 5.37E-07 | 1.36E-05 |
| NHWD (kg) | 0.152 | 0.087 | 5.15E-03 | 0.254 |
| RWD (kg) | 3.48E-06 | 1.83E-08 | 1.31E-08 | 4.40E-07 |

**HWD =** Hazardous waste disposed, **NHWD =** Non-hazardous waste disposed, **RWD =** Radioactive waste disposed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APOLLO BLUE PVC-O 450
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### INTERPRETATION OF LCA RESULTS

The majority of environmental impact lies within the raw material supplied to Iplex manufacturing sites and the installation of pipes in ground – comparatively little impact is caused by the PVC pressure pipe manufacturing at Iplex sites. From the feedmix ingredients, PVC resin is responsible for the majority of all environmental impacts and use of resources, although additives were still found to have a significant impact. From installation, it is diesel consumed during the operation of excavator which is responsible for significant impact.

## 6.0 ADDITIONAL ENVIRONMENTAL INFORMATION

### 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 20th February 2012, Iplex was issued 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

Due to PVC pressure pipes being installed in the ground, it 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. The following key properties of Iplex PVC pipe aid recyclability:

- Iplex PVC pipe contains no plasticiser – so no phthalates
- There are no dioxins in Iplex PVC pipe
- Iplex PVC pipe contains no heavy metal additives – so no lead and no cadmium.

Specific PVC recycling locations are available in Sydney, Melbourne and Brisbane and PVC pipe can be recycled at general plastic recycling stations throughout Australia.

# 7.0 PRODUCT SPECIFICATIONS

The following tables (Table 15, Table 16 and Table 17) 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 15 - PRODUCT SPECIFICATIONS FOR PREMIUM PVC-U PRESSURE PIPE

| PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS / PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | ASS PER PIPE LENGTH (KG/M) |
|---|---|---|---|---|---|
| PPSO1515 | 15 | PN15 | 6 | 21.2 | 0.138 |
| PPSO1815 | 15 | PN18 | 6 | 21.2 | 0.158 |
| PPSO1220 | 20 | PN12 | 6 | 26.6 | 0.175 |
| PPSO1820 | 20 | PN18 | 6 | 26.6 | 0.242 |
| PPSO925 | 25 | PN9 | 6 | 33.4 | 0.222 |
| PPSO1225 | 25 | PN12 | 6 | 33.4 | 0.270 |
| PPSO1825 | 25 | PN18 | 6 | 33.4 | 0.380 |
| PPSO932 | 32 | PN9 | 6 | 42.1 | 0.343 |
| PPSO1232 | 32 | PN12 | 6 | 42.1 | 0.430 |
| PPSO1832 | 32 | PN18 | 6 | 42.1 | 0.602 |
| PPSO640 | 40 | PN6 | 6 | 48.1 | 0.325 |
| PPSO940 | 40 | PN9 | 6 | 48.1 | 0.435 |
| PPSO1240 | 40 | PN12 | 6 | 48.1 | 0.562 |
| PPSO1840 | 40 | PN18 | 6 | 48.1 | 0.778 |
| PPSO650 | 50 | PN6 | 6 | 60.2 | 0.473 |
| PPSO950 | 50 | PN9 | 6 | 60.2 | 0.677 |
| PPSO1250 | 50 | PN12 | 6 | 60.2 | 0.862 |
| PPSO1850 | 50 | PN18 | 6 | 60.2 | 1.24 |
| PPSO1265 | 65 | PN12 | 6 | 75.2 | 1.35 |
| PPSO680 | 80 | PN6 | 6 | 88.7 | 1.01 |
| PPSO980 | 80 | PN9 | 6 | 88.7 | 1.46 |
| PPSO1280 | 80 | PN12 | 6 | 88.7 | 1.88 |
| PPSO1880 | 80 | PN18 | 6 | 88.7 | 2.65 |
| PPSO6100 | 100 | PN6 | 6 | 114 | 1.64 |
| PPSO9100 | 100 | PN9 | 6 | 114 | 2.41 |
| PPSO12100 | 100 | PN12 | 6 | 114 | 3.09 |
| PPSO18100 | 100 | PN18 | 6 | 114 | 4.38 |
| PPSO6125 | 125 | PN6 | 6 | 140 | 2.48 |
| PPSO9125 | 125 | PN9 | 6 | 140 | 3.61 |
| PPSO12125 | 125 | PN12 | 6 | 140 | 4.63 |
| PPSO6150 | 150 | PN6 | 6 | 160 | 3.20 |
| PPSO9150 | 150 | PN9 | 6 | 160 | 4.70 |

## TABLE 15 - 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) | ASS PER PIPE LENGTH (KG/M) |
|---|---|---|---|---|---|
| PPSO12150 | 150 | PN12 | 6 | 160 | 6.09 |
| PPSO18150 | 150 | PN18 | 6 | 160 | 8.63 |
| PPSO9200 | 200 | PN9 | 6 | 225 | 8.35 |
| PPSO12200 | 200 | PN12 | 6 | 225 | 10.91 |
| PPSO12250 | 250 | PN12 | 6 | 280 | 16.96 |
| PPSO12300 | 300 | PN12 | 6 | 315 | 21.70 |

## TABLE 16 - PRODUCT SPECIFICATIONS OF APOLLOBLUE™ PVC-O PRESSURE PIPE

| PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS / PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | ASS PER PIPE LENGTH (KG/M) |
|---|---|---|---|---|---|
| PDRA12100 | 100 | PN12.5 | 6 | 122 | 2.04 |
| PDRA16100 | 100 | PN16 | 6 | 122 | 2.04 |
| PDRA12150 | 150 | PN12.5 | 6 | 177 | 4.2 |
| PDRA16150 | 150 | PN16 | 6 | 177 | 4.2 |
| PDRA12200 | 200 | PN12.5 | 6 | 232 | 7.33 |
| PDRA16200 | 200 | PN16 | 6 | 232 | 7.33 |
| PDRA12225 | 225 | PN12.5 | 6 | 259 | 8.82 |
| PDRA16225 | 225 | PN16 | 6 | 259 | 8.82 |
| PDRA12250 | 250 | PN12.5 | 6 | 286 | 10.8 |
| PDRA16250 | 250 | PN16 | 6 | 286 | 10.8 |
| PDRA12300 | 300 | PN12.5 | 6 | 345 | 16.4 |
| PDRA16300 | 300 | PN16 | 6 | 345 | 16.4 |

## TABLE 17 - PRODUCT SPECIFICATIONS FOR RHINO® PVC-M PRESSURE PIPE

| PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS / PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | ASS PER PIPE LENGTH (KG/M) |
|---|---|---|---|---|---|
| PPHR09100 | 100 | PN9 | 6 | 114 | 1.59 |
| PPHR12100 | 100 | PN12 | 6 | 114 | 2.06 |
| PPHR15100 | 100 | PN15 | 6 | 114 | 2.62 |
| PPHR09150 | 150 | PN9 | 6 | 160 | 3.11 |
| PPHR12150 | 150 | PN12 | 6 | 160 | 4.03 |
| PPHR15150 | 150 | PN15 | 6 | 160 | 4.91 |
| PPHR18150 | 150 | PN18 | 6 | 160 | 5.27 |

## TABLE 17 – PRODUCT SPECIFICATIONS FOR RHINO® PVC-M *CONTINUED*

| PRODUCT CODE | DN NOMINAL SIZE (MM) | STIFFNESS / PRESSURE RATING | LENGTH (M) | MINIMUM MEAN OUTSIDE DIAMETER (MM) | ASS PER PIPE LENGTH (KG/M) |
|---|---|---|---|---|---|
| PPHR09200 | 200 | PN9 | 6 | 225 | 6.11 |
| PPHR12200 | 200 | PN12 | 6 | 225 | 8.00 |
| PPHR15200 | 200 | PN15 | 6 | 225 | 10.0 |
| PPHR18200 | 200 | PN18 | 6 | 225 | 11.9 |
| PPHR09225 | 225 | PN9 | 6 | 250 | 7.47 |
| PPHR12225 | 225 | PN12 | 6 | 250 | 9.80 |
| PPHR09250 | 250 | PN9 | 6 | 280 | 9.45 |
| PPHR12250 | 250 | PN12 | 6 | 280 | 12.3 |
| PPHR09300 | 300 | PN9 | 6 | 315 | 11.8 |
| PPHR12300 | 300 | PN12 | 6 | 315 | 15.7 |
| PDHR12100 | 100 | PN12 | 6 | 122 | 2.36 |
| PDHR16100 | 100 | PN16 | 6 | 122 | 3.05 |
| PDHR18100 | 100 | PN18 | 6 | 122 | 3.37 |
| PDHR20100 | 100 | PN20 | 6 | 122 | 3.73 |
| PDHR12150 | 150 | PN12 | 6 | 177 | 4.94 |
| PDHR16150 | 150 | PN16 | 6 | 177 | 6.43 |
| PDHR18150 | 150 | PN18 | 6 | 177 | 7.13 |
| PDHR20150 | 150 | PN20 | 6 | 177 | 7.89 |
| PDHR12200 | 200 | PN12 | 6 | 232 | 8.46 |
| PDHR16200 | 200 | PN16 | 6 | 232 | 11.0 |
| PDHR18200 | 200 | PN18 | 6 | 232 | 12.3 |
| PDHR20200 | 200 | PN20 | 6 | 232 | 13.5 |
| PDHR16225 | 225 | PN16 | 6 | 259 | 13.8 |
| PDHR18225 | 225 | PN18 | 6 | 259 | 15.3 |
| PDHR12250 | 250 | PN12 | 6 | 286 | 12.9 |
| PDHR16250 | 250 | PN16 | 6 | 286 | 16.7 |
| PDHR18250 | 250 | PN18 | 6 | 286 | 18.6 |
| PDHR20250 | 250 | PN20 | 6 | 286 | 20.5 |
| PDHR09300 | 300 | PN9 | 6 | 345 | 14.9 |
| PDHR12300 | 300 | PN12 | 6 | 345 | 18.9 |
| PDHR16300 | 300 | PN16 | 6 | 345 | 24.4 |
| PDHR20300 | 300 | PN20 | 6 | 345 | 30.1 |

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