ABOUT TRUCOST

Trucost helps companies and investors to achieve success by understanding environmental issues in business terms. Our data-driven insights enable organizations to manage risks and identify opportunities for growth.

We are the world’s leading experts in quantifying and valuing the environmental impacts of operations, supply chains, products and financial assets. By putting a monetary value on pollution and resource use, we integrate natural capital into business and investment decisions.

With offices in Europe, the US and Asia, Trucost works with businesses worldwide to increase revenues, improve communications, meet marketplace expectations and comply with regulatory requirements.

Trucost’s recent work includes leading the development of the Food and Beverage and Apparel Sector Guides as part of the development of the main Natural Capital Protocol. The work aims to provide international businesses with a standardized way to measure their impacts and dependencies on natural capital. Examples of Trucost’s recent clients include the Food and Agriculture Organization of the United Nations (FAO), The Economics of Ecosystems and Biodiversity (TEEB) hosted by the United Nations Environment Programme (UNEP), as well as a host of other public and private sector clients including:
ABOUT GIST ADVISORY

GIST Advisory provides sustainability consultancy services to enable governments, corporations, civil society organizations, banks and financial institutions to discover, measure, value and manage their impacts on natural, social and human capital. Our goal is to help maximize the effectiveness, efficiency and sustainability of government policy, corporate strategy and financial investment.

GIST Advisory is led by Pavan Sukhdev, Study Leader of TEEB, Lead Author of UNEP’s landmark report “Towards a Green Economy”, author of “Corporation 2020” and Goodwill Ambassador for UN Environment.

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Trucost and GIST Advisory would like to thank Francis Pamminger and Grace Rose-Miller for their time, commitment, and constant support throughout the project. We would also like to thank Carl Obst at IDEEA Group for his contributions regarding the United Nations System of Environmental-Economic Accounting (SEEA).
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Understanding the full value of Yarra Valley Water
## Glossary of Terms

### Table 1: Glossary of Terms That Are Pertinent to Yarra Valley Water's IP&L

<table>
<thead>
<tr>
<th>Topic</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td>IP&amp;L&lt;sup&gt;TM&lt;/sup&gt;</td>
<td>Integrated Profit and Loss, a trademarked term, refers to the monetization of a company's natural, social, and human capital externalities, as well as its financial value addition. These monetary values are then presented together and referred to as an Integrated Profit and Loss statement. In the remainder of this report, integrated profit and loss will be referred to as IP&amp;L.</td>
</tr>
<tr>
<td></td>
<td>Impacts</td>
<td>These can be negative or positive effects that a company has on society or the environment. In places negative impacts have been termed as costs, and positive impacts have been termed as benefits in this report.</td>
</tr>
<tr>
<td></td>
<td>SEEA</td>
<td>The System of Environmental-Economic Accounting (SEEA) contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA framework follows a similar accounting structure as the System of National Accounts (SNA) and uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.</td>
</tr>
<tr>
<td></td>
<td>Shareholder value</td>
<td>A term used to indicate whether or not a company is creating additional wealth for the company's owner/s.</td>
</tr>
<tr>
<td></td>
<td>Societal value</td>
<td>In this report societal value can be understood as the economic, environmental, or social benefits created, degraded, or lost as a result of a businesses' activities. Actions that create or degrade societal value cannot always be assigned a financial value.</td>
</tr>
<tr>
<td></td>
<td>Supply chain</td>
<td>This term is used when referring to the boundary of the analysis and signifies actions that take place 'upstream' from a company's direct activities. For instance, the supply chain refers to suppliers from which a company directly or indirectly purchases goods or services.</td>
</tr>
<tr>
<td><strong>Natural capital</strong></td>
<td>NCX&lt;sup&gt;TM&lt;/sup&gt;</td>
<td>Natural capital externalities (NCX&lt;sup&gt;TM&lt;/sup&gt;, a trademarked term), refers to the third-party costs or benefits that are a result of the environmental impacts of an enterprise, in both its operations and its value chain. In the remainder of this report, natural capital externalities will be referred to as NCX.</td>
</tr>
<tr>
<td></td>
<td>Natural capital</td>
<td>The finite stock of natural assets (air, water, land, habitats) from which goods and services flow to benefit society and the economy. It is made up of ecosystems (providing renewable resources and services), and non-renewable deposits of fossil fuels and minerals. (NCC, 2014)</td>
</tr>
<tr>
<td><strong>Social capital</strong></td>
<td>SCX&lt;sup&gt;TM&lt;/sup&gt;</td>
<td>Social capital externalities (SCX&lt;sup&gt;TM&lt;/sup&gt;, a trademarked term), refers to the third-party costs or benefits of the social impacts of an enterprise, resulting from its business model, CSR programs, and policies. In the remainder of this report, social capital externalities will be referred to as SCX.</td>
</tr>
<tr>
<td></td>
<td>Social capital</td>
<td>The institutions and relationships established within and between communities, groups of stakeholders and other networks, and the ability to share information, to enhance individual and collective wellbeing (ABS, 2002)</td>
</tr>
<tr>
<td></td>
<td>Business model</td>
<td>This is the way the company plans to generate revenue.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>TERM</td>
<td>DEFINITION</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Company policies</td>
<td>Company policy</td>
<td>Formulated by the firm’s board of directors, corporate policy lays down the firm’s response to known situations and circumstances. It also determines the formulation and implementation of strategy, and directs the plans, decisions, and actions of the firm’s officers in achievement of its objectives (Business Dictionary, 2016).</td>
</tr>
<tr>
<td>CSR policies</td>
<td>CSR policy</td>
<td>A corporate social responsibility policy defines areas of concern and initiatives to improve relations with the people and environments affected by business operations. CSR policies often dictate a system for monitoring responsible performance. Successful CSR initiatives take organizations beyond compliance with legislation and leads them to honor ethical values and respect people, communities and the natural environment. (Simply CSR, 2008).</td>
</tr>
<tr>
<td>SROI</td>
<td>SROI</td>
<td>Social return on investment. The ratio of social benefits, in monetary terms, returned per dollar invested by Yarra Valley Water.</td>
</tr>
<tr>
<td>Weighted SROI</td>
<td>Weighted CSR</td>
<td>A qualitative index that ranks social value addition on a scale of 0 to 100. It is applied to CSR programs and business model activities implemented by Yarra Valley Water.</td>
</tr>
<tr>
<td>Human capital</td>
<td>HCX™</td>
<td>Human capital externalities, (HCX™, a trademarked term) refers to third-party costs or benefits of the human capital created by an enterprise, resulting from its human resource development, and its employee health and safety policies. In the remainder of this report, human capital externalities will be referred to as HCX.</td>
</tr>
<tr>
<td>Human capital</td>
<td>Human capital</td>
<td>Human capital can be defined as the stock of competencies, knowledge, social and personal attributes embodied in an individual, relevant for producing economic value (OECD, 1998). It embodies competencies (tacit and implicit knowledge and attitudes, including skills acquired through formal education, childhood education and on the job training), and capabilities (sum of expertise and capacity: ability to carry out an organizational activity) and talent (Forum for the Future, 2009).</td>
</tr>
<tr>
<td>Human capital</td>
<td>HCC</td>
<td>Human capital creation (HCC) is a measure of the increase in an individual’s future earning potential. The increase is due to the training being provided by the employer and as well as the company brand value imparted to the individual.</td>
</tr>
<tr>
<td>Financial capital</td>
<td>Financial capital</td>
<td>Financial capital is broadly understood as the pool of funds available to an organization. This includes both debt and equity finance. This description of financial capital focuses on the source of funds, rather than its application which results in the acquisition of manufactured or other forms of capital (IIRC, 2013).</td>
</tr>
<tr>
<td>Financial value addition</td>
<td>EBIT</td>
<td>Earnings before interest and tax. An indicator of a company's profitability, calculated as revenue minus expenses (excluding tax and interest). EBIT is also referred to as ‘operating earnings’, ‘operating profit’ and ‘profit before interest and taxes’ (PBIT).</td>
</tr>
<tr>
<td></td>
<td>EBITDA</td>
<td>Earnings before interest, taxes, depreciation and amortization. It is an indicator of a company's financial performance which is calculated by deducting expenses (excluding tax, interest, depreciation and amortization) from revenue. EBITDA is essentially net income with interest, taxes, depreciation, and amortization added back to it, and can be used to analyze and compare profitability between companies and industries because it eliminates the effects of financing and accounting decisions (Investopedia, 2016a).</td>
</tr>
<tr>
<td></td>
<td>Depreciation</td>
<td>Depreciation is a method of allocating the cost of a tangible asset over its useful life. Businesses depreciate long-term assets for both tax and accounting purposes (Investopedia, 2016b).</td>
</tr>
<tr>
<td>TOPIC</td>
<td>TERM</td>
<td>DEFINITION</td>
</tr>
<tr>
<td>--------------</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lease rentals</td>
<td>A lease is a legal document outlining the terms under which one party agrees to rent property from another party. A lease guarantees the lessee (the renter) use of an asset and guarantees the lessor (the property owner) regular payments from the lessee for a specified number of months or years (Investopedia, 2016c).</td>
<td></td>
</tr>
<tr>
<td>PAT</td>
<td>Profit after tax. PAT is the net profit earned by the company after deducting all expenses like interest, depreciation and tax. PAT can be fully retained by a company to be used in the business. Dividends, if declared, are paid to the shareholders from this residue (VentureLine, 2016).</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>This is the salaries and other monetary benefits provided to the employee by the company.</td>
<td>compensation</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Yarra Valley Water’s IP&L™

This work has been driven by Yarra Valley Water’s desire to understand the full value it delivers to society. It forms a key part of its Restorative Strategy which aims to answer questions such as ‘what could we do as a business to add greatest value?’ and ‘how do we contribute towards liveability?’

The scope of the work centered on the positive and negative impacts of Yarra Valley Water’s direct operations in all four capitals. It also analyzed the positive and negative natural capital impacts of the services it purchases from its suppliers. Our approach is to consider “value addition” through a holistic lens: measuring impacts across all capitals, not just financial capital, and across all categories of stakeholders affected – including employees, customers and society at large – and not just its shareholder, the Victorian Government. In so doing, we follow all the tenets of integrated reporting whilst simplifying the classification of capitals to the most widely accepted four-capitals framework in environmental economics literature. The analysis pertains to the 2014/15 financial year and the findings are listed and shown in the figure below.

i. **Natural capital** – Yarra Valley Water created $3.8 million negative environmental and societal impacts annually, and delivered positive impacts of $53 million, whereas impacts attributed to its supply chain created $68 million and $46 million respectively\(^1\)

ii. **Social capital** – Yarra Valley Water created $6.4 million of societal benefits through its Choose Tap and Hardship Grants Program

iii. **Human Capital** – Yarra Valley Water created $13 million of human capital benefits annually

iv. **Financial Capital**\(^2\) – Yarra Valley Water’s financial value addition to the Australian economy was $374 million

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1 The provision of water and sanitation services are intricately linked to natural capital. As many companies are involved in the delivery of these services to Yarra Valley Water customers, the natural capital impacts of Yarra Valley Water and its supply chain have been included in this assessment.

2 Refer to “physical capital” (a standard term from environmental economics literature which includes manufactured capital and financial capital) as “financial capital” for convenience and ease of recognition, and also because manufactured and financial capitals are both market-priced and readily convertible from one to the other.
FIGURE 1: YARRA VALLEY WATER IP&L FINDINGS

The results show that there are significant areas of value creation, as well as areas where value is being degraded. Value is degraded when pollutants are discharged into the environment, waste is sent to landfill, and natural land is converted. Yarra Valley Water creates value when society receives free benefits, such as when water is cleaned and recharged back to the environment, when ecosystem services are provided, or when vulnerable families receive waivers on water utility bill payments. However, delivering societal benefits can incur private costs for Yarra Valley Water.

Yarra Valley Water can use the framework of the IP&L to increase the value it delivers to society while maintaining its fiscal responsibility. For instance, it can use monetary values of the costs and benefits it creates within decision-making tools, such as its Community Cost Model. Yarra Valley Water will be able to prioritize and trade-off the costs and benefits of projects such as its waterways investment prioritization project, its backlog program, and stormwater harvesting projects. These types of projects can then be assessed by looking at the full range of values they create or degrade over their lifetime.

The IP&L also highlights additional areas in which Yarra Valley Water can prioritize activities in order to deliver more value to customers and society. This includes working with land owners to maximize the flow of ecosystem services coming from their land which can maintain or increase water quality as well as providing other streams of benefits to society. Integrated land management through the use of natural infrastructure can deliver these benefits as well as reducing costs to the business. Solutions can involve the acquisition of land in upstream water catchments, reforestation of existing land, the building
of riparian buffers, or conservation payments to those that manage or influence key parts of watersheds.

Yarra Valley Water’s IP&L also provides a working example to policy makers of how businesses can change their business models to deliver services more efficiently, more sustainably, and more transparently. The analysis sheds light on the data needed by businesses and government to apply this approach, and lays the foundation for Yarra Valley Water to start measuring its path to becoming ‘restorative’.

The IP&L will be useful in guiding discussions between water companies, government, regulators and customers over the fundamental importance of water to business and society. It can be used to highlight whether the price paid by customers for water reflects the full value that is delivered by Yarra Valley Water. The IP&L aims to address this so that the true value of Yarra Valley Water’s business activities are recognized, communicated, and integrated into decision-making.
INTEGRATED PERFORMANCE

“Constraints on a valuable resource should draw new investment and prompt policies to increase productivity of demand and augment supply. However, for water, arguably one of the most constrained and valuable resources we have, this does not seem to be happening.”

So reads the opening of the 2030 Water Resources Group’s report ‘Charting Our Water Future’ (2030 Water Resources Group, 2009). The national and local importance of properly managing watersheds is clear. Growing populations will require greater supplies of freshwater for direct consumption while businesses, such as agricultural industries and utilities providers, will need increasing amounts of water to provide essential public services. These demands have to be supplied against a backdrop of increasing environmental pressures on water resources – increasing scarcity, decreasing water quality, and changing climatic conditions to name but a few.

Businesses and governments play a critical role in ensuring that the water needs of societies are met sustainably. Policy and regulatory incentives can encourage responsible decision making that accounts for long-term impacts on the environment and human wellbeing. Responsible water providers can adopt this focus while at the same time increasing the efficiency and quality of their water supply and sanitation services, and minimizing their negative impacts on the environment and society.

But businesses do not have to stop there. Owners or guardians of large areas of natural land can do more for society and the environment.

A focus on value creation, or the creation of positive impacts, can deliver added value to society as well as the business. The preservation or enhancement of ecosystem services, and the associated free environmental benefits provided to society, can for instance deliver better quality drinking water while reducing the cost of water treatment. Working with nature to enhance these benefits can deliver more value to society at the same time as delivering greater value to the business. But current business models mean that these values currently remain hidden and are typically excluded from decision-making.

Trucost, GIST Advisory, and Yarra Valley Water have recognized a new way of assessing a business’ value creation. Placing monetary values on a company’s positive and negative impacts on the environment and society enables objective value assessments that can inform long-term, responsible decision-making. The methodology for assessing these impacts has been applied to four types of capital – natural, social, human, and financial capital. The methodology aligns with the principles of Integrated Reporting (see page 15) and provides a framework for quantifying, monetizing, and integrating the hidden costs and benefits of business activities. The results from all four capitals have been presented together in this Integrated Profit & Loss (IP&L™) statement.

About the IP&L™

The IP&L™ (hereafter referred to simply as IP&L) has the concept of sustainability at its heart and, depending on the relevancy for the company involved, can include the positive and negative impacts
generated in four realms of capital. The IP&L quantifies the third-party impacts created by businesses. Impacts can be both positive – such as supply chain greening, staff training, and community building – and negative – such as freshwater extraction, pollution, and waste generation. Drivers of impacts, such as greenhouse gas (GHG) emissions, have outcomes like climate change, ocean acidification and coral reef destruction which lead to impacts on human wellbeing. The IP&L is a mechanism to measure these impacts in monetary terms. The IP&L analysis quantifies in physical terms, and places monetary values on impacts that are not normally paid for by the person receiving them. These are otherwise termed as externalities and have been phrased throughout this report in the following ways:

i. Natural capital externalities (NCX™, hereafter referred to simply as NCX)
ii. Social capital externalities (SCX™, hereafter referred to simply as SCX)
iii. Human capital externalities (HCX™, hereafter referred to simply as HCX)
iv. Financial value addition (FCX™, hereafter referred to simply as FCX)

By their nature of sharing a common metric, the monetary values that are calculated for the impacts in the four capital realms above can be viewed through a common lens. The approach and philosophy that accompany this are that the values are not to be traded-off against each other. It is not the aim of the IP&L approach to promote the liquidation of the wealth of one capital, such as natural capital, in exchange creation of another, such as financial capital.

About Yarra Valley Water
Yarra Valley Water is a statutory corporation and its activities are overseen by an independent Board of Directors appointed by the State Government of Victoria. It is also accountable to a Government Minister, which at the time of writing was the Minister for Environment, Climate Change and Water. Yarra Valley Water has the stated purpose:

“To provide exemplary water and sanitation services that contribute to the health and wellbeing of current and future generations”

Yarra Valley Water measures the success of achieving this purpose by assessing progress against six commitments. These commitments are enforced by Yarra Valley Water through the adoption of The Natural Step sustainability principles.3 Yarra Valley Water is in the midst of deploying its Restorative Strategy which aims to explore what it means for the company to be ‘restorative’ and how it can create more value than it degrades each year. This work forms a key part of this process.

Yarra Valley Water provides water and sanitation services to more than 1.8 million people in Melbourne, Victoria (see Figure 2). It supplied more than 133 million m³ of water to customers in 2014/15 and works closely with its suppliers who manage Victoria’s water supply catchments and waterways. Melbourne has a wholesale water company that supplied 402 million m³ of drinking water, mainly to Yarra Valley Water and two other water providers in Victoria in 2014/15.

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3 http://www.thenaturalstep.org/sustainability/the-system-conditions/
The performance of Yarra Valley Water and the quality of the service it delivers are closely linked with that of its supply chain. For this reason, the natural capital component of this work focuses on the positive and negative impacts created by both Yarra Valley Water and its suppliers, and an analysis of how water and water pollutants flow around Yarra Valley Water’s water network. This latter piece of work has been guided by the principles of the United Nation’s System of Environmental-Economic Accounting (SEEA) framework.

**Yarra Valley Water’s IP&L**

Yarra Valley Water’s IP&L report aims to build internal support and momentum behind a theme of work that will contribute towards Yarra Valley Water’s Restorative Strategy. The report outlines the findings from the analysis as well as Yarra Valley Water’s aims towards integrating the monetization of the four capitals - natural, social, human, and financial - into its business activities and decision-making. The analysis focuses on the impacts that are generated by Yarra Valley Water that it does not receive a cost or a benefit from. As Yarra Valley Water is a government owned corporation, the natural capital analysis quantifies costs and benefits that arise from meeting and going beyond minimum regulatory standards. The benefits that have been calculated for the other capitals are a result of what Yarra Valley Water delivers beyond its regulatory commitments only. This work centers on two main deliverables:
i. The IP&L report as presented here and;
ii. The delivery of monetary valuations of natural, social, human, and financial capital externalities so that these costs can potentially be incorporated at a project-level

As a socially responsible business and to demonstrate its commitment to sustainability leadership, Yarra Valley Water decided to include in its management practices the production and publication of and IP&L. This evaluation allows Yarra Valley Water to communicate their value creation across all four capitals and can be used as a key management tool. This work aligns with principles of International Integrated Reporting Council’s (IIRC) Integrated Reporting framework (<IR>), and sets the company on a path to quantify its value creation now and in the future.

Yarra Valley Water’s IP&L attempts to demonstrate an alternative business model which can deliver significant private and public benefits. In an environment where national and state governments are providing companies with clear social guidelines and standards, Yarra Valley Water is at the forefront of this movement and hopes to provide an example for others to follow.

**Informing Decision-Making**

Yarra Valley Water has conducted this IP&L work at a company-level as a means to show the proof of concept and to communicate the costs and benefits it is responsible for to a wider audience. It is intended that this type of work, such as the use of monetary valuations of natural capital impacts, is replicated by Yarra Valley Water on a project-level to improve project appraisal processes. Some projects that have been tentatively highlighted as those that can deliver restorative benefits, and that can benefit from using the approach used in this IP&L include Yarra Valley Water’s:

i. Waterways investment prioritization project (WIP)
ii. Backlog program
iii. Septic tank management service

These three projects, out of a sample of nearly 70, combine to have an estimated financial value in the region of $350 million. Therefore the enhancement of project appraisal approaches by Yarra Valley Water can deliver significant benefits, at scale, on large infrastructure and public works projects. Deploying an approach that takes into account Yarra Valley Water’s wider impact on natural, social, and human capital, as well as its wider financial value addition will allow Yarra Valley Water to:

i. Operationalize each of its six commitments
ii. Improve its image and recognition of its economic value addition with the Victorian Government

The measurement of the resulting impacts using the IP&L framework will allow Yarra Valley Water to communicate more effectively to stakeholders the benefits of its business model. One method with which to do this is through the means of integrated reporting.

**Integrated Reporting**

The valuation framework for the IP&L and the methodologies used here to estimate its various components – NCX, SCX, HCX, and FCX – are consistent with the <IR> framework. Integrated reporting is the process by which companies link aspects of the four capitals to relevant or material areas of the
company’s strategy. It is backed in publications such as the Global Sustainable Investment Review which reflects the current thinking of global investors, and highlights companies that are transparent and conduct their reporting in an integrated manner are favored by investors (GSIA, 2014). For Yarra Valley Water, the IP&L provides a stepping stone on the way to integrated reporting and enhancing the quality of communication with stakeholders on how impacts in each of the four capitals can materially affect the business.

Furthermore, estimates of NCX in this study are based on the framework published recently as a draft universal Natural Capital Protocol. The understanding of social capital and human capital externalities that we have used to frame those components of Yarra Valley Water’s IP&L are based on an established body of academic literature that is referenced in the SCX and HCX sections respectively.

However, despite these precautions and careful alignments with international best practice and peer reviewed academic literature, Yarra Valley Water’s IP&L is among the first to be published, and so the results should be treated with caution.

Common Data
Throughout the sections that follow, there are a number of themes and data points common to each of the sections. For instance, all calculations refer to the financial year 2014/15, which runs from July 1st to June 30th, and unless otherwise stated, all monetary values are shown in Australian dollars ($). Table 2 outlines some of the data that is common to all sections present in the IP&L.

**TABLE 2: DATA POINTS THAT ARE COMMON ACROSS THE IP&L**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DATA POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of analysis</td>
<td>July 1st 2014 to June 30th 2015</td>
</tr>
<tr>
<td>Currency</td>
<td>Australian dollars (AUD), $</td>
</tr>
<tr>
<td>Area under Yarra Valley Water control</td>
<td>1,427 hectares</td>
</tr>
<tr>
<td>Population served</td>
<td>1.8 million</td>
</tr>
<tr>
<td>Water supplied to customers</td>
<td>133 million m³</td>
</tr>
</tbody>
</table>

**Compatibility with SEEA**

**Background**

Over the past ten years a number of frameworks have emerged for the assessment of the relationships between the environment on the one hand, and business and economic activity on the other. Often the frameworks are grouped under the general heading of natural capital accounting. The development of different frameworks has stemmed largely from the varying interests of different stakeholders and groups.

In this report, for the purposes of understanding its longer term sustainability, Yarra Valley Water has adopted the Integrated Profit and Loss (IP&L) framework. This approach takes into account a wide range of factors including Yarra Valley Water’s connections to natural, human and social capital.
In addition, Yarra Valley Water was interested to understand the connections between the IP&L approach and the new UN standards for environmental-economic accounting that have been adopted by governments around the world, including the Victorian Government in its recent Strategy on environmental accounting. The new standards are described in two key documents – the System of Environmental-Economic Accounting (SEEA) Central Framework and the SEEA Experimental Ecosystem Accounting. This section describes the connections and the application of the SEEA that was undertaken in the project.

**Types of Sustainability Frameworks**

As shown in Table 3, sustainability frameworks can be applied at multiple levels – national, corporate and investor and focus on accounting or reporting for natural capital. Accounting based frameworks such as the SEEA or CDP (formerly the Carbon Disclosure Project) have a specific intent of integrating information on natural capital with information on other forms of capital that are already included in standard accounts. Reporting frameworks, on the other hand, tend to be more indicator based and incorporate qualitative information. Of course, these distinctions are stylized and in practice there is much overlap in the type of information and general ambitions among different frameworks. Thus the different approaches should be seen as complementary rather than competing. Discussion is ongoing among the various agencies and initiatives about connecting the various approaches.

The different approaches can have different scopes and primary areas of focus. Three broad types can be noted - (i) the assessment of sustainability involving multiple capitals (including the GRI, IIRC and IP&L); (ii) accounting for individual environmental stocks and flows such as water, energy and GHG emissions (including the SEEA Central Framework and CDP); and (iii) measurement and valuation of ecosystem services and the changing capacity of ecosystems (for example, SEEA Ecosystem Accounting).

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4 Valuing and accounting for Victoria’s environment: Strategic Plan 2015-2020

5 For a summary of the history and content of the SEEA see Obst & Vardon (2014)
TABLE 3: LINKAGES BETWEEN NATURAL CAPITAL ACCOUNTING, REPORTING, VALUATION METHODOLOGIES, AND TOOLS (OBST AND TRUCOST, 2015)

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>NATURAL CAPITAL ACCOUNTING OR DECISION-MAKING FRAMEWORKS</th>
<th>PURPOSE</th>
<th>NATURAL CAPITAL REPORTING FRAMEWORKS</th>
<th>NATURAL CAPITAL VALUATION METHODOLOGIES</th>
<th>NATURAL CAPITAL VALUATION TOOLS</th>
</tr>
</thead>
</table>
| National | - SEEA Central Framework  
- WAVES (SEEA) | - Measurement of environmental stocks and flows | Besides the publishing of national accounts:  
- Natural Capital Committee (UK)  
- Global Footprint Network | - Market costs  
- Willingness-to-pay (WTP)  
- Avoided costs  
- Replacement costs  
- Hedonic costs  
- Production function  
- Travel cost method (TCM) | - Ecosystem Service Valuation Database (ESVD)  
- Environmental Valuation Reference Inventory (EVRI)  
- InVEST  
- Ecosystem Valuation Toolkit (EVT) |
| Corporate | - CDP\(^6\)  
- Natural Capital Protocol\(^7\) | - Measurement of environmental stocks and flows | - Global Reporting Initiative (GRI)  
- International Integrated Reporting Council (IIRC)\(^7\) | Mainly used in the private sector:  
- Value transfer (based on the methods above) | |
| Investor | - Natural Capital Declaration (Working Group 3) | Looking at how financial institutions are exposed to material natural capital risks through companies | - Natural Capital Declaration (Working Group 4) | - Market costs | - Soft Commodity Risk Tool  
- Corporate Bonds Water Credit Risk Tool  
- Water Risk Valuation Tool |

For this project, the main point of connection between the IP&L and the SEEA based approaches concerns the assessment of natural capital. SEEA does not encompass assessment of wellbeing, or social and human capital. As well, the project is clearly focused at the corporate-level and, in this context, it is

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\(^6\) Formerly the Carbon Disclosure Project. Please see here for more information: [https://www.cdp.net/en-US/Pages/HomePage.aspx](https://www.cdp.net/en-US/Pages/HomePage.aspx)

\(^7\) The IP&L approach aligns with the Natural Capital Protocol and the IIRC reporting framework. The Natural Capital Protocol is a framework for informing decision-making to include natural capital aspects.
important to recognize that the SEEA has been developed for application at the national level rather
than for individual businesses. At the same time, the project has shown that a number of the core
principles of the SEEA approach can be applied for Yarra Valley Water.

In the assessment of natural capital, the SEEA and the IP&L have a somewhat different focus although
there is a relationship between the two. The starting point for the SEEA is recording environmental
stocks and flows in physical terms, for example, flows of water, GHG emissions or energy. Once these
physical stocks and flows have been recorded, the SEEA estimates the relevant monetary values using
the concept of exchange values or transaction prices. Thus, in cases where there are no observed
transactions in environmental stocks and flows (which is usually the case), the SEEA adopts valuation
approaches that assume a market could be created which covers transactions between individual
economic units and the environment.

The IP&L approach also requires an understanding of physical stocks and flows, but places more focus
on valuing the positive and negative externalities that arise as a result of business activity. Depending in
part on the assumptions used for valuation, externality based valuations will usually differ from SEEA
based valuations, showing that each approach aims to answer different analytical questions.

The differences in valuation reflect, in large part, the different perspectives that accountants and
environmental economists have taken to the valuation of the environment. Traditionally, environmental
economics has considered questions of the effect on social welfare of different environmental
circumstances or scenarios, for example as a result of increased amenity, or the effect of pollution. This
focus can underpin cost-benefit type analysis. Accountants, on the other hand, have tended to focus on
considering the price that an individual business or household would pay for environmental services,
effectively imagining that the environment could sell the services.

At a corporate level, the development of valuation techniques has been led by environmental
economists and hence has tended to apply valuation perspectives well-established in that community.
The SEEA based frameworks, on the other hand have emerged from a national accounting perspective
and hence have applied accounting valuations. As the frameworks described above develop, a dialogue
has been established aiming to both understand these differences and importantly, determine valuation
techniques that are relevant to each perspective.

**Using the SEEA**

The key point of overlap in the approaches is the requirement for estimates of environmental stocks and
flows in physical terms. Since this is a very well developed aspect of the SEEA, it was possible to extend
the standard reporting of the IP&L and record a more complete set of information concerning the flows
of water through the Yarra Valley Water network. The use of the SEEA accounting approach, which
requires a balance in recording of all exchanges in the supply and use of water, including those external
and internal to Yarra Valley Water, enabled a clear connection to be made between the estimated
values in the IP&L and the detailed knowledge of water flows within the Yarra Valley Water network.
The output of this exercise is shown in Figure 3.
FIGURE 3: A SIMPLIFIED SYSTEM DIAGRAM OF THE WATER FLOWS RELEVANT FOR THIS ANALYSIS FOR YARRA VALLEY WATER

Source: Yarra Valley Water data (2016)
In this way, the SEEA demonstrated its usefulness in providing a platform for connecting measurement in physical terms with monetary valuation. A related outcome of the complete recording of physical flows of water was clearer articulation of the measurement boundaries for valuation, in particular defining the assessment boundary between Yarra Valley Water and its supply chain.

Although not adopted in this project, it would be possible to adopt similar, SEEA-based recording principles in respect of assessing flows of energy, solid waste, emissions to water bodies and GHG emissions – that is, using the physical accounting principles of the SEEA to underpin discussion of valuation. In this project, there is unlikely to have been a material advantage in adopting the SEEA for these other flows but, if there are plans for these types of broader sustainability assessment to be undertaken on an ongoing basis, the use of a standardized recording framework such as the SEEA may well be advantageous. This would especially be the case where there is a desire to ensure coherence in recording between firms within the water supply and treatment sector.

Beyond the recording of physical flows, in the future, there may be interest from Yarra Valley Water in integrating elements of the SEEA Experimental Ecosystem Accounting. Ecosystem accounting focuses directly on assessing changes in condition of ecosystems, such as those within water catchments, and on linking condition to the capacity for the ecosystem to continue to supply relevant ecosystem services, such as water. Ecosystem accounting might be of interest where assessment is required of the connections between Yarra Valley Water’s operations and the dependency on the condition of the catchment managed by upstream suppliers. For example, the accounting can be applied to understand where catchment condition is declining or there are trade-offs between supplying ecosystem services, such as between water from the catchment and the use of the catchment for recreation. In this case, SEEA based ecosystem accounting can support a more integrated understanding of environmental stocks and flows.

**Highlights from Yarra Valley Water’s IP&L**

This section combines the results of the natural, social, human, and financial capital analysis. It displays the annual benefits, or positive impacts, that occur due to Yarra Valley Water activities across all four capitals as well as the costs, or negative impacts that accrue to natural capital from Yarra Valley Water and its suppliers’ activities. Negative social, human, and financial impacts were not deemed material for this study and so have not been included. Figure 4 shows the results but omits the monetary values associated with each capital at this stage (though the monetary values associated with each of the capitals are displayed in the relevant sections later in the report). The values have been excluded here as the main point of the section is to show general trends in value creation – a net gain or loss. The aim is not to emphasize the magnitude of individual values as they cannot be sufficiently contextualized or understood without further reading.
FIGURE 4: TOTAL VALUE CREATION OF YARRA VALLEY WATER PER YEAR

The figure shows that on the whole, value is being created across the four capitals each year, despite accounting for the negative natural capital impacts. These negative impacts consist of pollutant emissions to water (biological oxygen demand and suspended solids), water abstraction, and emissions from biosolids to land. The positive natural capital impacts include the avoided pollution from Yarra Valley Water’s sewage water treatment process, avoided water abstraction, and water being discharged to the environment. The ratio to which value is created is over six times higher than when it is degraded. The results demonstrate the outputs that can be attained if Yarra Valley Water applies this approach at a company or project-level. The following sections discuss in more detail how these values are calculated, the range of values that were calculated, as well as the limitations in calculating monetary values across each of the four capitals.
**Overview**

NCX relates to the positive and negative impacts on the environment that occur due to activities of Yarra Valley Water. This analysis of natural capital impacts focuses on the operations of Yarra Valley Water and the impacts in its supply chain. The analysis quantifies the costs and/or benefits that have been classified into seven impact categories as shown in Table 5. Results relating to the emission of pollutants to land and water have been attributed to a particular flow of water as shown in Figure 3. The results of the analysis have been grouped into three categories:

i. **Impacts created** (negative value) – this refers to the negative impacts created due to either Yarra Valley Water or its supply chain

ii. **Impacts avoided** (positive value) – this refers to the negative impacts avoided due to Yarra Valley Water or its supply chain

iii. **Value preserved** (positive value) – this refers to the positive impacts created due to Yarra Valley Water’s or its supply chain’s provision of ecosystem services

The monetary valuations presented in this study relate to either the positive or negative impacts on human health and/or the environment. For instance, the monetary valuation of negative impacts on the environment relates to the loss of ecosystem services that arise from the emission of pollutants or the use of resources. Pollutants can negatively impact biodiversity within ecosystems which has knock-on effects on the ecosystems’ productivity and the ecosystem services that it can provide. Alternatively, human health can be negatively affected by pollutants which cause disease and in some instances premature death. The impacts on human health in this study has been measured in terms of disability adjusted life years (DALYs). A DALY in this study is valued at approximately $55,700. For more information on how this value was developed, please refer to page 64 of the appendices.

A simplified pathway for establishing impacts on human health used in this study is shown below.

**FIGURE 5: EXAMPLE PROCESS OF VALUING HUMAN HEALTH IMPACTS OF EMITTING A POLLUTANT TO WATER**

Source: Trucost data (2016)
Key Results

The results of the analysis show that almost $100 million of either avoided impacts ($54.4 million) or value preservation ($45.5 million) come from Yarra Valley Water and its supply chain each year. These results are driven by the avoided pollution resulting from Yarra Valley Water’s sewage water treatment process, and from avoided water abstraction coming due to Yarra Valley Water’s recycled water network. Value preservation is driven by the provision of ecosystem services from Yarra Valley Water and its suppliers’ land. The combined impacts created by Yarra Valley Water and its supply chain are in the region of $72 million per year, which are mainly driven by the biological oxygen demand (BOD) and suspended solids (SS) present in water, abstracted water distributed to Yarra Valley Water customers, and the emissions from biosolids to land. The main impact created from Yarra Valley Water’s operations is the purchase of abstracted water which has results in an annual cost of approximately $16.9 million.

<table>
<thead>
<tr>
<th></th>
<th>IMPACTS CREATED AU$ MILLION PER YEAR</th>
<th>IMPACTS AVOIDED AU$ MILLION PER YEAR</th>
<th>VALUE PRESERVED AU$ MILLION PER YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarra Valley Water</td>
<td>$3.8</td>
<td>$53.2</td>
<td>$0.3</td>
</tr>
<tr>
<td>Supply chain</td>
<td>$68.1</td>
<td>$1.1</td>
<td>$45.3</td>
</tr>
<tr>
<td>Total(^8)</td>
<td>$71.8</td>
<td>$54.4</td>
<td>$45.5</td>
</tr>
<tr>
<td>Net impact</td>
<td></td>
<td></td>
<td>$28.1</td>
</tr>
</tbody>
</table>

Figure 6 (as well as Figure 8 and Figure 9) show the impacts created, impacts avoided, and value preserved by Yarra Valley Water and its supply chain. Sensitivity analysis has been conducted which shows how monetary valuations of impacts can change when certain parameters are varied. Examples of the parameters that have been tested include the monetary values of ecosystem service provision and the impact on human health. The results of the sensitivity analysis are shown by the upper and lower bars in the following figures.

\(^8\) Please note that the components of the natural capital results may not add up to the total due to the rounding rules that were applied.
Methodology Overview: Scope, Boundary, and Valuations

The impact categories and practices that are included in the analysis are shown in Table 5. The impacts created that result from Yarra Valley Water’s operations and supply chain relate to a number of practices such as fuel usage in vehicles, discharges from sewage treatment plants as well as the release of pollutants owing to sewer spills. Downstream impacts, such as those associated with the use of water by Yarra Valley Water customers, are not included in this analysis.

As described above, the monetary valuations used in this study reflect the impact on human health and the environment. The specific coverage of the impacts that are valued under each impact category are listed in Table 6.
TABLE 5: SCOPE OF THE NCX ANALYSIS (SEE FIGURE 3 FOR INFORMATION ON WATER FLOWS)

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>IMPACT TYPE</th>
<th>SUPPLY CHAIN</th>
<th>YARRA VALLEY WATER (OPERATIONS)</th>
<th>PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollutants</td>
<td>Cost</td>
<td>✔</td>
<td>✔</td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s and its suppliers’ air pollution is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Fuel use in buildings and vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Business travel(^9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Leakage of refrigerants(^9)</td>
</tr>
<tr>
<td>Greenhouse gases</td>
<td>Cost</td>
<td>✔</td>
<td>✔</td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s and its suppliers’ greenhouse emissions is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Fuel use in buildings and vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Business travel(^9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Leakage of refrigerants(^9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Electricity consumption</td>
</tr>
<tr>
<td>Land pollutants</td>
<td>Cost</td>
<td>✔</td>
<td>✔</td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s and its suppliers’ land pollution is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Leakage from Yarra Valley Water’s drinking water network (Flow I1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Leakage from Yarra Valley Water’s sewerage network (Flow I2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Use of drinking water by Yarra Valley Water customers for irrigation (Flow J)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Use of recycled water by Yarra Valley Water customers for irrigation (Flow K)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Discharge of treated water to land by Yarra Valley Water suppliers (Flow U2-1)</td>
</tr>
<tr>
<td>Land use change</td>
<td>Cost &amp; Benefit</td>
<td>✔</td>
<td>✔</td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s land use is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Conversion of natural ecosystems to managed grassland (i.e. loss of ecosystem services)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The benefit, or <strong>positive impact</strong>, relating to Yarra Valley Water’s and its suppliers’ land use is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Carbon sequestration of Yarra Valley Water owned land</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- General ecosystem service provision by natural ecosystems on land owned by its suppliers</td>
</tr>
</tbody>
</table>

\(^9\) Relates to Yarra Valley Water performance only.

Source: Yarra Valley Water data (2016)
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>IMPACT TYPE</th>
<th>SUPPLY CHAIN</th>
<th>YARRA VALLEY WATER (OPERATIONS)</th>
<th>PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste generation</td>
<td>Cost</td>
<td>✔</td>
<td></td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s and its suppliers’ waste generation is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Production of operational landfill waste by Yarra Valley Water and its suppliers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Production of biosolids by Yarra Valley Water and its suppliers</td>
</tr>
<tr>
<td>Water consumption</td>
<td>Cost &amp; Benefit</td>
<td>✔</td>
<td></td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s water consumption is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Yarra Valley Water purchasing abstracted water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The benefit, or <strong>positive impact</strong>, relating to Yarra Valley Water’s water consumption is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- The recharge of water to waterways by Yarra Valley Water (Flows F and L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- The recharge of water to land by Yarra Valley Water (Flows I, J and K)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- The recharge of water to land by Yarra Valley Water suppliers (Flow U2-1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- The avoided abstraction of water due to Yarra Valley Water’s recycled water network (Flow H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Note that these flows are explained further on page 58.</td>
</tr>
<tr>
<td>Water pollutants</td>
<td>Cost &amp; Benefit</td>
<td>✔</td>
<td></td>
<td>The cost, or <strong>negative impact</strong>, of Yarra Valley Water’s and its suppliers’ water pollution is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Discharge of treated water to waterways by Yarra Valley Water’s treatment plants (Flow F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Sewer spills from Yarra Valley Water’s sewerage network to waterways (Flow L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Discharge of treated water to the Bass Strait (Flow U1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Discharge of treated water to the Port Phillip Bay (Flow U2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The benefit, or <strong>positive impact</strong>, relating to Yarra Valley Water’s water pollution is driven by the following practices:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Avoided water pollution due to pollutant removal from Flow E by Yarra Valley Water treatment plants</td>
</tr>
</tbody>
</table>

10 Flow I2 would also represent some water recharge value but data is not available to quantify this
Figure 7 shows the boundary of the NCX analysis. It includes a section for direct suppliers and where aspects of downstream water use have been covered. This comes from the use of water by Yarra Valley Water’s customers as this has been included in the analysis to some extent.

**FIGURE 7: BOUNDARY OF NCX ANALYSIS**

<table>
<thead>
<tr>
<th>Rest of supply chain</th>
<th>Direct suppliers</th>
<th>Company operations</th>
<th>Downstream use</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 6: ATTRIBUTES OF NATURAL CAPITAL IMPACTS THAT ARE VALUED**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DRIVER OF MONETARY VALUATION</th>
</tr>
</thead>
</table>
| Air pollutants       | - Impact on human health from cancer and non-cancer diseases caused by the ingestion of air pollutants deposited in food and water, or by the inhalation of air pollutants  
                        - Impact on the environment due to air pollutants affecting biodiversity and the provision of ecosystem services received by society |
| Greenhouse gases     | - Changes in agricultural productivity  
                        - Impact on human health  
                        - Tropical and extra-tropical storm damage to infrastructure  
                        - Property damages from increased flood risk |
| Land pollutants      | - Impact on human health from cancer and non-cancer diseases caused by the ingestion of land pollutants that enter into food and water, or by the inhalation of land pollutants that evaporate from the ground into the atmosphere  
                        - Impact on the environment due to land pollutants affecting biodiversity and the provision of ecosystem services received by society |
| Land use change      | - The loss or preservation of ecosystem services that were received by society. The loss is due to the change of land from naturally occurring ecosystems to manmade or altered ecosystems |
| Waste generation     | - The impact of GHG emissions (see above)  
                        - The impact of leachate (liquid run off that passes into the surrounding area) on human health  
                        - Disamenity effects of the site on human health, such as noise, dust, litter, odor, the presence of vermin, visual intrusion and enhanced perceptions of risk |
| Water consumption    | - The impact generated or avoided on human health due to the lack of water for irrigation  
                        - The impact generated or avoided on human health due to the lack of domestic water  
                        - The impact generated or avoided on the environment due to the lack of water affecting biodiversity and the provision of ecosystem services received by society |

Source: Trucost data (2016)
### CATEGORY | DRIVER OF MONETARY VALUATION
---|---
Water pollutants | - Impact generated or avoided on human health from cancer and non-cancer diseases caused by the ingestion of water pollutants deposited in food and water, or by the inhalation of air pollutants  
- Impact generated or avoided on the environment due to air pollutants affecting biodiversity and the provision of ecosystem services received by society

### Supply Chain

#### Costs
The impacts created by suppliers were calculated by using a combination of:

1. Disclosures from Yarra Valley Water
2. Disclosures made in publically available reports
3. Trucost estimated data

Trucost used its environmentally extended input-output (EEIO) model to estimate impacts such as air pollutant emissions using suppliers’ sectors of operation and their revenue generated in each sector. Trucost then apportioned these emissions to Yarra Valley Water based on the level of activity it is responsible for in its supply chain. To create these estimates, Trucost uses data from the United States Bureau of Economic Analysis for its input-output modeling, and a number of sources for the calculation of its emission intensities, such as the United States Energy Information Administration (EIA). For more information on Trucost’s IO modeling and emissions intensities, please refer to page 85 in the appendices.

#### Benefits
To calculate the benefits, or value preserved, by Yarra Valley Water’s supply chain, Trucost calculated the indicative ecosystem service value that is provided by the land managed by its suppliers. This value is then apportioned to Yarra Valley Water. The study Trucost uses gives indicative values of ecosystem services provided by undisturbed ecosystems in Australia which relate to rangelands and temperate forests (Blackwell, 2016). Benefits from suppliers’ operations come are due to factors such as water recharge (Flow U2-1).

### Operations (Yarra Valley Water)

#### Costs
The impacts created for Yarra Valley Water were calculated using disclosures from Yarra Valley Water only. Yarra Valley Water disclosed data from its National Greenhouse and Energy Reporting (NGERs) report and directly to Trucost which related to practices such as fuel use in vehicles, buildings, electricity usage, as well as emissions to land and water. In order to make this work compatible with SEEA principles, Yarra Valley Water disclosed land and water pollutant information according to flows of water relevant to its operations – please see the simplified systems diagram on page 20 for more details.
The disclosure from Yarra Valley Water also included the fuel use of Lend Lease, a company that was contracted throughout 2014/15 to perform some of Yarra Valley Water’s maintenance tasks.

Benefits
To calculate the benefits (the value preserved and impacts avoided) due to Yarra Valley Water’s operations Trucost quantified and monetized the following:

i. Relevant ecosystem services coming from Yarra Valley Water land
ii. Avoided pollution resulting from Yarra Valley Water’s treatment plants (Flow E)
iii. Avoided water abstraction coming from the use of recycled water (Flow H)
iv. Water recharge resulting from water being discharged into waterways or land (Flows F, I1, J, K, and L)

Trucost quantified and monetized the value of carbon sequestration coming from Yarra Valley Water land as this was deemed the only relevant ecosystem service.

Limitations
There are a number of general limitations that affect any sort of valuation exercise regarding natural capital. Trucost has published a discussion paper on these criticisms which includes topics such as the methods employed in primary and secondary valuation techniques, the use of monetary valuations, the uncertainty inherent in monetary valuations as well as a number of other topics (Trucost, 2015). The limitations that specifically apply to this analysis include:

i. The benefit from removing E. Coli from water has not been valued in this study as its pathway through the environment and subsequent human health impact could not be quantified
ii. A number of pollutants present in sewage water could not be valued for the same reason listed above. The pollutants include:
   a. Emissions to land: iron, trihalomethanes, aluminum, and fluoride
   b. Emissions to water: total dissolved solids, iron, trihalomethanes, aluminum, and fluoride
   c. Emissions to seawater: nitrogen and phosphorus
iii. The ecosystem service valuation used in the supply chain analysis only provides indicative values. The disaggregation of natural land into different ecosystem types is not possible, and the specific ecosystem services for the land could not be quantified in physical terms. For a more accurate monetary valuation, a more rigorous data collection and monetary valuation exercise needs to be conducted.
iv. Avoided impacts from the suppliers’ sewage water treatment process has not been included as the pollutant quantities or concentrations in this flow (Flow W) are not currently known.
**Results**

**Supply Chain**

The figure below shows the monetary value of the costs and benefits that occur due to the activities in its supply chain. These costs and benefits directly relate to providing services to Yarra Valley Water.

**FIGURE 8: IMPACTS CREATED, AVOIDED, AND VALUE PRESERVED DUE TO YARRA VALLEY WATER’S SUPPLY CHAIN**

The figure shows that approximately 10% more negative impacts are being created for every unit of positive impact. The negative impacts are being driven by the following three practices:

i. BOD and SS in water (20%)
ii. Water abstraction (20%)
iii. Biosolid emissions to land (15%)

BOD and SS in water have been valued using the greywater footprint approach. This method requires the calculation of the amount of freshwater required to dilute BOD and SS back to safe levels. The amount of freshwater required was then valued using the same approach as for water abstraction (see page 80 for more details). Water abstraction is valued according to the negative impact it has on human health and the environment due to decreasing water availability. Human health impacts are due to the lack of water being available for domestic food production as well as basic hygiene uses. Due to the nature and location of the water abstraction, there is no human health impacts associated with water abstraction in this study. The negative impact is being driven by the potential impact on the environment due to decreasing water availability and the subsequent negative impact that has on
biodiversity and ecosystem service provision. Emissions from biosolids to land have a high monetary valuation because of its high potential impact on human health if it were to enter the food chain. The model used for valuing the substances the could potentially be emitted to land assumes a certain amount of biosolids could enter the food chain or potable water supply through various processes and could ultimately be consumed by a small part of the population. This consumption could then cause a health impact which is measured in terms of disability adjusted life years (DALYs) and valued in dollars. For more information, refer to Figure 5 or to page 61 in the appendices.

The positive impacts are being driven by the provision of ecosystem services that are occurring on suppliers’ land. The value of impacts avoided are low because it has not been possible to quantify aspects like the load of pollutants that are removed by water treatment plants (Flow W).

**Operations (Yarra Valley Water)**

The figure below shows the monetary value of the costs and benefits that occur due to the operational activities of Yarra Valley Water. The practices that drive these impacts are shown in Table 5.

**FIGURE 9: IMPACTS CREATED, AVOIDED, AND VALUE PRESERVED DUE TO THE ACTIVITIES OF YARRA VALLEY WATER**

The figure shows that positive impacts being generated are 14 times higher than the negative impacts. The negative impacts are being driven by the following three practices:

i. Electricity usage (50%)
ii. Land use (21%)
iii. Waste generation (13%)
The impact of electricity usage is driven by the production of GHGs which are valued using a cost of $67 per tonne. This value has been calculated by the US Environmental Protection Agency and represents the monetary value of future impacts that greenhouse gas emissions will have on society.\(^\text{11}\) Land use costs relate to the loss of ecosystem services due to the conversion of naturally occurring undisturbed ecosystems to ones that are altered and have a lower ecosystem service value. The negative impact of waste generation relates to the greenhouse gas emissions produced on landfill sites, as well as aspects such as the disamenity experienced by local residents living in the vicinity of landfill sites.

The positive impacts are driven by the avoided pollution that results from Yarra Valley Water sewage treatment plants removing pollutants from the water that would have otherwise reached waterways. Avoided pollution accounts for 92% of the positive impact, whereas avoided water abstraction from Yarra Valley Water’s recycled water network accounts for 0.7%, and the benefits of water recharging from various water flows back to land or freshwater accounts for 7.2%.\(^\text{12}\) The value preserved by Yarra Valley Water is driven by the carbon sequestration that is occurring in Yarra Valley Water land and is valued using the same cost of carbon as stated above.

**Insights**

**New Impacts**

Yarra Valley Water has previously commissioned life-cycle analysis (LCA) studies in order to calculate the material impacts the business has on the environment. The LCA methodology was introduced in the early 2000s by Yarra Valley Water, but importantly did not have a way of evaluating adverse water abstraction impacts. The normalising method used derived relative comparisons by dividing environmental parameters by the national total to calculate relative proportions.

The present methodology used in this report takes this earlier work one step further by placing a dollar value on the potential impact. For instance, electricity consumption was previously considered Yarra Valley Water’s largest impact, but by using monetary valuations to compare between impacts, BOD and SS discharged to water as well as water abstraction, both impacts coming from Yarra Valley Water’s supply chain, are now understood to be Yarra Valley Water’s greatest environmental impact. Both of these impacts are individually responsible for 19% of Yarra Valley Water’s total impacts, with GHG emissions from fuel combustion and electricity usage representing 2% of the total. The conversion of undisturbed natural ecosystems to altered land uses is also an important impact. Similarly, emissions of substances such as mercury to land and water can have significant impacts on human health and the environment. By applying monetary valuations to these impacts, using a consistent methodology, enables Yarra Valley Water to assess the importance of its impact on human health and natural capital.

**Impact Pathways**

Yarra Valley Water has identified that while collecting information on pollutant concentration and loading is an important factor in measuring its impact, identifying impact pathways are also vital for

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\(^\text{11}\) For more information, please see page 69 in the appendices for more information

\(^\text{12}\) Water discharged to seawater, approximately 101,000 mega litres, is given no recharge value
understanding how each pollutant or substance affects society. Impact pathways illustrate how pollutants affect sections of the population. For instance, pollutants emitted to land or waterways from sewage treatment plants may end up in drinking water or in the food chain and consumed by humans. To calculate the impact that these pollutants have on those that consume it, it is necessary to know where pollutants are released, the amount of pollutant that is ingested, over what time period, and how the pollutant has travelled through the environment to reach the recipient. Yarra Valley Water can use established tools or conduct future research to identify how pollutants travel through the environment and reach human populations so that specific sections of the impacted community may be identified. Aspects of this may already be covered in Yarra Valley Water’s Community Cost Model.

Evolving Business Model

Yarra Valley Water is at the forefront of a business movement that is looking towards more responsible and transparent decision-making. The use of extended monetary valuations of multiple capitals in project appraisal processes forms part of this new approach. Yarra Valley Water can incorporate the valuations provided by Trucost into its decisions regarding the Community Cost Model so that a greater range of impacts on the environment and society can begin to be considered ‘as standard’. It can help with the development or identification of new projects, or the prioritization of existing ones such as stormwater harvesting, waste-to-energy, resource recovery or Yarra Valley Water’s Waterways Investment Prioritization (WIP) program.

Monetary valuations of impacts are only possible if physical quantities, such as the tonnes of chemicals emitted to water, are available. For instance, measuring stream improvements can involve the use of monetary valuations but it will require measurement of the physical improvements in stream quality, such as the reduction in the concentration of chemicals such as zinc or mercury. Monetary valuations can then be applied on top of these quantities so that improvements in stream quality can be communicated in dollar terms.

Monetary valuations can also be used to inform a number of other areas of Yarra Valley Water’s business which include:

i. The concept of liveability
ii. Its Restorative Strategy
iii. Engagement with the regulator

The concept of liveability and Yarra Valley Water’s Restorative Strategy go hand-in-hand. Liveability can mean providing the same service in the future as is being provided today, and to be restorative can mean recreating historical environmental conditions or services that have been lost. Combining these two concepts then creates a clear narrative to guide Yarra Valley Water’s actions to improve the services that it provides to society. Monetary valuations can help monitor progress against these targets but requires the establishment of appropriate biophysical and social baselines to measure progress against. For liveability, the baseline could be the results presented in this IP&L. For Yarra Valley Water’s Restorative Strategy, a baseline that reflects the optimal conditions that Yarra Valley Water wants to recreate could be defined.
Lastly, monetary valuations could be used to guide discussions with the regulator, though not necessarily used in pricing submissions. This is due to the fact that to begin with, a period of capacity building and knowledge transfer with regulators, similar to the one undertaken on this project by Yarra Valley Water, is likely to be required. There may be other factors involved and regulators may want this approach to be expanded to City West Water and South East Water so that a consistent approach is applied across the metropolitan area of the state. The results from this IP&L provide a good starting point to initiate and guide discussions with regulators.

**Communication**

Business reporting of environmental impacts in quantitative terms tends to focus on the production of emissions, in tonnes, or its resource use, in tonnes or cubic meters. These metrics, whilst understandable in isolation, do not lend themselves to being compared to each other. A tonne of carbon and a tonne of sulfur dioxide emitted to the atmosphere have very different impacts, over different timescales, and to different sections of society.

Monetary valuations of impacts allow Yarra Valley Water to enhance its communication with stakeholders as the relative magnitude of each of its impacts has been assessed and interpreted by an independent third party. The relative importance of each of Yarra Valley Water’s impacts are embedded in the valuations, giving customers and regulators confidence in the information that is being presented to them.

Using these valuations and results as a baseline to measure future performance, Yarra Valley Water can communicate the benefits of any new decision-making processes and how it is delivering value beyond regulatory requirements to its stakeholders. Building on this, Yarra Valley Water can communicate its progress with its Restorative Strategy and use the valuations as a guide to answer questions such as “what can Yarra Valley Water do as a business to add greatest value?” The use of monetary valuations could guide decisions on whether Yarra Valley Water invests in green energy projects, integrated water management, improving local streams, or reducing sewer spills, and it will have a robust evidence base to provide to stakeholders to justify its decision-making.

Yarra Valley Water now has the ability to go beyond communicating its value in purely quantitative terms, such as the amount of water it supplies, and to now communicate its value in a robust and transparent manner.
Conclusions and Recommendations

Yarra Valley Water’s NCX analysis has shed light on new environmental and societal impacts, new data points that can provide greater insight into pollutant impacts, how Yarra Valley Water can continue to evolve its business model and improve its decision-making, and how to communicate its true value to stakeholders. To continue to improve its understanding of the positive and negative impacts it has on the community, Yarra Valley Water can enhance this work in a number of ways. Some recommendations for achieving this are listed below:

i. Developing baselines
   a. **Regulatory** – A refinement of this analysis can be done to calculate what value is delivered beyond that set by regulation in terms of water quality
   b. **Restorative** – Definition of the biophysical conditions that Yarra Valley Water would need to meet to become ‘restorative’ would allow the tracking of Yarra Valley Water’s progress. The use of monetary valuations could be used to inform the selection of solutions that could achieve this condition.

ii. Valuing impacts created – new valuations for impacts that could not be monetized in this study could be created. The development of valuations should be prioritized so that impacts that actually occur but have not been monetized in this study, such as the impact of nitrogen to seawater, should be developed first. Emphasis should also be given to those impacts that are considered to have the greatest impact on society. The development of new valuations should follow the process outlined in Figure 5.

iii. Valuing avoided impacts – the valuation of biological impacts avoided, such as E. Coli being removed from water, has not been performed in this study as Trucost does not currently have a valuation methodology for these type of impacts. If these types of avoided impacts are relevant to Yarra Valley Water and if the valuations would improve decision-making in the future, monetary valuations of these potential impacts should be developed. This should again follow process outlined in Figure 5.

Using the monetary valuations in this IP&L to identify solutions for mitigating Yarra Valley Water impacts is another recommended use of results. In an ideal situation, pollutants would be removed at source and there would be no need for any remediation. In cases where this is not possible Trucost has suggested solutions, classified as either preventative or remedial, that can be used to reduce the impacts of Yarra Valley Water. Examples include:

i. **Reducing water use** (preventative)
   a. Recycled water – Yarra Valley Water’s recycled water network already provides 3.6 million m³ of water to customers, 2.7% of the total water it provided to customers in 2014/15. Promoting the use of recycled water and methods such as stormwater harvesting can reduce Yarra Valley Water’s impact and pressure it places on the environment. Yarra Valley Water is already engaged in these schemes and can use its Community Cost Model with the valuations gained through this IP&L to monetize the benefits that these alternative approaches can deliver compared to the baseline.
ii. Reducing purchased electricity use (preventative)

a. Waste-to-energy – Yarra Valley Water has begun projects, such as its Aurora waste-to-energy plant, in order to reduce its dependence on purchased electricity. Trucost recommends that while these schemes in general are beneficial to both the company and society, conducting a net benefit analysis of the two methods (grid electricity versus waste-to-energy plants) using the same methodology as deployed in the IP&L can provide an evidence base for scaling such work in the future. See Trucost (2013) for an example case study.

iii. Pollutant removal (remedial)

a. Mercury – this is emitted to land in Yarra Valley Water’s supply chain and can be remediated through microbial action, removal, treatment, immobilization, phytoremediation, or water quality management can be used to remediate mercury in watersheds. Costs can range from US $15,000 per acre to US $1 million depending on the type of treatment and the scale of the impact. See Fuller (2002) for more information.

b. Nitrates, ammonia, and phosphates – the removal of pollutants such as nitrates, ammonia, and phosphates from seawater can be done through deploying oyster beds. Studies have found that oyster beds can filter between 0.02 to 22.6 million m³ of water in coastal bays for an area of oyster beds equivalent to 290 and 3,491 hectares. See zu Ermgassen et al. (2013) for more information.
SOCIAL CAPITAL EXTERNALITIES (SCX™)

Overview

For any large public utility charged with enhancing some vital dimension of the quality of life of citizens, such as health, mobility, energy, freshwater, or sanitation, the concept of ‘value generation’ needs to be viewed (and ideally measured and managed) beyond just the dividends and taxes paid to the government as the utility owner.

However, as most public utilities are incorporated as companies, statutory reporting for them is also usually aligned to that which applies to most companies, and is thus limited to financial reporting. Where the utility or its owner do introduce additional metrics for performance, these metrics are rarely if ever integrated with the mainstay of statutory financial results. Thus, they are not easy to compare with financial results, and to that extent, they may appear less compelling no matter how important they are. This may in turn lead to inadequate recognition of a utility’s value generation, and may distort allocative decisions and further investment. This is a key reason why measuring impacts across all capitals – including social and human capital externalities – is perhaps even more important for a large public utility than it is for any other kind of business or corporation.

GIST’s SCX model estimates monetary values of externalities generated by Yarra Valley Water through its business policies and corporate social responsibility (CSR) initiatives. This SCX report identifies and demonstrates the total economic value of some of the main stakeholder benefits attributable to Yarra Valley Water in the form of social capital externalities. These are measures of value delivered beyond that which is embedded and captured in prices paid for “business as usual” freshwater and sanitation services expected of a typical water utility in Australia. The results contained in this section go to prove that Yarra Valley Water has a clear social focus centered on improving stakeholder health and wellbeing across its area of operation.

Key Results

To enable Yarra Valley Water to better understand its business impacts, GIST has estimated social capital externalities generated by the company based on a scoping workshop organized in Melbourne in December 2015. The following business policies and CSR initiatives were identified as material drivers of positive social capital externalities for Yarra Valley Water:

i. Choose Tap Program

   - The key objective of Choose Tap, a CSR program, is to encourage consumption of tap water among residents, particularly school children, across Yarra Valley Water serviced areas. GIST estimates the monetary benefits generated through the Choose Tap Program at $1.87 million, with a social return on investment (SROI) of 365%.
ii. Hardship Grants Program

- Recognizing that some of its customers occasionally face financial difficulties, Yarra Valley Water has structured realistic and affordable payment schemes (in collaboration with, but not limited to, the Utility Relief Grant scheme (URG)), to ease vulnerable customers' payment obligations. The total economic benefits to the stakeholders of the Hardship Grants Program estimated at $4.84 million, with an SROI of 82%.

iii. Efficiency Program

- Yarra Valley Water intends to re-invigorate its water efficiency program, which heightens consumer awareness around water conservation issues. GIST intends to include in their final report as a management recommendation a measurement framework for this program, together with recommendations for data gathering to enable effective measurement of the social benefits of this program.

GIST's weighted-SROI analysis compares the relative value addition for beneficiaries for up to four complementary measures of social value, including SROI, direct reach of the program, qualitative ranking of all programs, and relative income benefits from the program. Based on these parameters, the Hardship Grants Program adds more relative value (scoring 38 on a scale of 100) versus the Choose Tap Program (scoring 35).

Methodology Overview: Scope, Boundary, and Valuations

Businesses are strongly dependent on social capital for their continued existence and profitability. Public utilities, due to the essential nature of most of their services to citizens, are even more dependent than other business sectors on building and maintaining social capital with their customers – Australian citizens. The value associated with delivering positive externalities for local communities can be significant in building a strong reputation and brand value for Yarra Valley Water.

In summary, appreciating the direct and indirect benefits from creating, maintaining, and utilizing social capital is vital for the success of any company, especially one that is associated with the provision of public goods and services. Consequently, it is essential for Yarra Valley Water to recognize, measure, and manage the impacts that the company has on all its stakeholders, especially local communities living in and around the areas managed by Yarra Valley Water.

The monetary valuations used in this study reflect the positive impact on society from Yarra Valley Water social programs. Examples include the avoided costs of spending money of bottled water and the monetary savings of reduce water use. The specific coverage of the impacts that are valued under each social program are listed in Table 7 below, and the specific drivers of the monetary valuation are listed in Table 8.
### TABLE 7: SCOPE OF THE SCX ASSESSMENT

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>IMPACT TYPE</th>
<th>SUPPLY CHAIN</th>
<th>OPERATIONS</th>
<th>PRACTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose Tap Program</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Increase in water savings due to reduced spending on bottled water</td>
</tr>
<tr>
<td>Water Refill Stations</td>
<td></td>
<td></td>
<td></td>
<td>- Improved water availability due to reduced groundwater extraction by</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>water bottling plants</td>
</tr>
<tr>
<td>Choose Tap Program</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Increase in water savings due to reduced spending on bottled water</td>
</tr>
<tr>
<td>Aquabubbler</td>
<td></td>
<td></td>
<td></td>
<td>- Water savings by the local community</td>
</tr>
<tr>
<td>Choose Tap Program</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Increase in water savings due to reduced spending on bottled water</td>
</tr>
<tr>
<td>Hydration Stations</td>
<td></td>
<td></td>
<td></td>
<td>- Water savings by the local community</td>
</tr>
<tr>
<td>Hardship Grants Program</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Waivers on water utility bill payments and avoidance of restriction and</td>
</tr>
<tr>
<td>Concessions, Utility Relief Grants and Debt</td>
<td></td>
<td></td>
<td></td>
<td>restoration charges</td>
</tr>
<tr>
<td>Waiver</td>
<td></td>
<td></td>
<td></td>
<td>- Uninterrupted water supply</td>
</tr>
<tr>
<td>Hardship Grants Program</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Avoidance of water restriction and restoration charges</td>
</tr>
<tr>
<td>Installment Payment Plan and Bill Extensions</td>
<td></td>
<td></td>
<td></td>
<td>- Investments made by customers as a result of deferred utility bills</td>
</tr>
</tbody>
</table>

Source: Yarra Valley Water data (2016)
TABLE 8: ATTRIBUTES OF SCX THAT ARE VALUED

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DRIVER OF MONETARY VALUATION</th>
</tr>
</thead>
</table>
| Choose Tap Program | - Avoided cost of bottled water purchases, including water savings  
                      - Social benefit of improved water availability |
| Water Refill Stations | Choose Tap Program Aquabubbler | - Avoided cost of bottled water and sugary drinks purchases  
                               - Market price saving due to reduced water usage |
| Choose Tap Program Hydration Stations | - Avoided cost of bottled water purchases  
                               - Market price saving due to reduced water usage |
| Hardship Grants Program Concessions, Utility Relief Grants and Debt Waiver | - Increase in private savings due to waivers on water utility bill payments  
                               - Avoided costs of paying charges associated with restricting the water supply |
| Hardship Grants Program Installment Payment Plan and Bill Extensions | - Avoided costs of paying charges associated with restricting the water supply  
                               - Increased cash flow due to interest from investments of saved utility bill payments |

Limitations

The Choose Tap and Hardship Grants Program were chosen as an outcome of materiality assessment exercise conducted via a workshop with Yarra Valley Water management. It is important to note that these two programs are not the entirety of Yarra Valley Water’s CSR or business policy features, but are pilots chosen on the basis of materiality and data availability. Yarra Valley Water generates significant externalities from other programs and initiatives, such as its Water Efficiency and Water Conservation Programs, and these can be added to an SCX evaluation in future to increase its coverage.

It is important to note that the analysis does not consider negative social externalities associated with Yarra Valley Water’s operations. They are currently excluded on the basis of materiality given that as a public utility provider Yarra Valley Water are expected to deliver social benefits that far outweigh any social costs. However, it is possible that Yarra Valley Water could have a negative impact on wellbeing in some areas. For example, disruptions in water supply and a decline in water quality as a result of accidents can have a negative impact on wellbeing. To justify this assumption, Yarra Valley Water could
evaluate any negative impacts and actual occurrences of such scenarios, which if material, would be included in future analyses.

Results
Operations
Benefits
Figure 11 represents the estimated monetary value of the social capital externalities for the Choose Tap and Hardship Grants Programs. While the Hardship Grants Program delivers higher economic benefits in absolute terms, estimated in the region of $4.84 million, compared to the Choose Tap Program, estimated in the region of $1.87 million, it is important to note that Yarra Valley Water invests significantly greater resources in the Hardship Grants Program. Total investments by Yarra Valley Water in the Hardship Grants Program were $5.9 million in 2014/15 compared to $0.51 million for the Choose Tap Program. Consequently, the Choose Tap Program delivers a greater SROI of 365% than the Hardship Grant Program’s 82%.

A further breakdown of the Choose Tap Program, see Figure 12, reveals that the highest benefits are generated by the Aquabubbler initiative, approximately $1.5 million. This program involved Yarra Valley Water investing in the establishment of drinking water fountains in 96 local schools and educating school children on the benefits of drinking tap water. In 2014/15 Yarra Valley Water also installed 20 water refill stations and 69 hydration stations, thereby generating annual stakeholder benefits of more than $300,000 and $25,000 respectively.
FIGURE 12: STAKEHOLDER BENEFITS FROM INITIATIVES UNDER THE CHOOSE TAP PROGRAM

The results for the Hardship Grants Program, see Figure 13 below, show that the highest benefits are generated through the provision of concessions, URGs and debt waivers, valued at approximately $2.73 million. These benefits are jointly provided by Yarra Valley Water and the state of Victoria. Additionally, Yarra Valley Water provides customized instalments and payment extensions to vulnerable customers, the benefits of which are estimated at $0.7 million. Yarra Valley Water also provides free water audits & concessions to customers with life-support dependency ($0.1 million) while also waiving all water supply restriction and restoration charges for vulnerable customers ($1.3 million) and providing concessions to life support dependent customers.

FIGURE 13: STAKEHOLDER BENEFITS FROM INITIATIVES UNDER THE HARDSHIP GRANTS PROGRAM

GIST recognizes that not all aspects of human wellbeing can be monetized, and ethical concerns may arise with any attempt to do so. A purely monetary assessment of human wellbeing cannot provide a complete picture of all the impacts of a particular CSR program, business policy or business model.
feature. To resolve this, GIST has developed weighted SROI, a weighted index methodology which compares the relative value addition for beneficiaries for up to four complementary measures of social value, thereby presenting a balanced view of social and economic benefits measured using a combination of qualitative and monetary indicators.

Figure 14 below shows the weighted SROI scores for the Choose Tap and Hardship Grants Programs. The latter delivers higher relative value as a result of better performance along the qualitative parameters of human wellbeing. This is in line with expectations, given that the Hardship Grants Program is focused on providing financial relief to Yarra Valley Water’s vulnerable customers, providing them access to uninterrupted supply of water and ensuring that they are treated with dignity and respect. It is important to note that the weighted ranks place both programs at a par, despite the significant SROI benefits of the Choose Tap versus Hardship Grants Program (SROI of 365% vs. 82%). The accuracy of this analysis is dependent on the qualitative data available for the respective programs, for example, the number of direct and indirect beneficiaries and the perceived improvement in their wellbeing.

![Figure 14: Weighted SROI for the Choose Tap and Hardship Grants Programs](source: GIST data (2016))

### Conclusions and Recommendations

At a combined value of $6.7 million, positive social capital externalities for stakeholders are clearly significant across Yarra Valley Water’s Choose Tap and Hardship Grants Programs. It should be emphasized that this is a conservative valuation as it does not account for the health benefits of the Choose Tap Program, and its scope is at present limited to the two programs with the highest impact.

Through this evaluation, Yarra Valley Water now has a toolkit that facilitates the understanding of these programs as drivers of value creation and the positive impacts that Yarra Valley Water generates for the society in which it operates.

The current SCX dashboard, a management information system delivered separately to the IP&L, is designed to enable managers to:

i. Track changes in performance of identified programs over time
ii. Add new programs to the dashboard in the future
iii. Compare performance across programs on the basis of monetary returns (SROI) and qualitative returns (weighted SROI).
This helps the company track its resources and investments and improve efficiency in order to make every cent count.

By encouraging and enabling changes in consumption habits, the Choose Tap Program has the potential for improving target residents’ wellbeing significantly. In addition to improving access to tap water by installing Aquabubblers across schools, increasing awareness and educating young students on the benefits of drinking tap water would help scale benefits significantly at low cost.

Through its Hardship Grants Program, Yarra Valley Water provides concessions and waivers under the state-funded URG scheme. In addition to this, Yarra Valley Water also contributes towards bill waivers for vulnerable customers and provides free water audits, including maintaining and operating a customer support team for identifying and delivering services to vulnerable customers. These expenses incurred by Yarra Valley Water help ensure the efficient and effective use of public funds.

Moving forwards, GIST recommends that Yarra Valley Water improves the current evaluation to include additional parameters for both, the Choose Tap and Hardship Grants Programs, by collecting primary data and building internal capacity. For Choose Tap, GIST recommends future analysis to include health benefits as a result of the reduction in the consumption of sugary drinks and from avoided cost of obesity and diabetes related ailments to the economy. Estimating the benefits from imitation and replication of Choose Tap Program initiatives by other water utility providers in the region is a further parameter that Yarra Valley Water may wish to evaluate in future.

The main objective of the current IP&L is to develop a dashboard of performance indicators that enables management at Yarra Valley Water to gain strategic insight into its societal impacts and help prioritize decision-making across multiple engagements.

The SCX model provides Yarra Valley Water not only with the total economic value of benefits being generated by a particular CSR program or business policy, but also enables comparison across these diverse activities on the basis of their SROI. By doing so, the SCX model translates relative changes in stakeholder wellbeing on the ground to a language more aligned with management and business decision-making.

Furthermore, the SCX model is developed specifically to integrate social capital externalities evaluation with externalities across the natural, human and financial capital dimensions – thereby enabling Yarra Valley Water to report its business impacts in a fully integrated manner - one that is aligned with global standards such as the IIRC’s <IR> framework.
HUMAN CAPITAL EXTERNALITIES (HCXTM)

Overview

To better quantify its commitment to sustainable leadership, Yarra Valley Water have decided to quantify the human capital it creates as part of its first annual IP&L report.

Yarra Valley Water is aware that its business performance and profitability are functions of how efficiently its physical and human resources are deployed. One of its six business commitments is to ‘Enable Extraordinary Performance’ and to help this commitment, Yarra Valley Water is investing heavily in training and development of employees. GIST’s HCX model helps Yarra Valley Water track and understand this investment in the training of their workforce, and the effect of that investment on employees.

Yarra Valley Water’s operations generate significant benefits for its employees by means of their training and skills development and health and safety. Moreover, it lends its brand value and reputation to its employees for when they move on from Yarra Valley Water in their careers. The company collects comprehensive data on its human resources, across all its cohorts – Executives, Senior Managers and Enterprise Agreement (EA) Staff. It recognizes that measuring headcount flows is an effective way of appreciating the company’s dependencies and impacts on human resources, but that estimating a monetary value of its human capital created and human capital externalities adds valuable information for the company and its employees.

GIST Advisory’s HCX evaluations are based on the Organization for Economic Co-operation and Development definition of human capital (OECD, 1998):

“The stock of competencies, knowledge, social and personal attributes embodied in an individual and relevant for producing economic value”

Key Results

Human capital creation (HCC) and human capital externalities (HCX) together are the positive impacts of Yarra Valley Water training and reputation has on employees. A summary of the main results for the latest financial year are listed below:

i. Yearly flows of HCC and HCX are $12.2 million and $0.8 million respectively
ii. Total lifetime HCC for Yarra Valley Water is estimated at $118 million
iii. Employee attrition led to total positive HCX of $7.7 million
iv. With the largest number of employees among all cohorts – 431 – the EA Staff cohort saw the highest HCC of $80.9 million, and positive HCX of $4.6 million
v. Combined HCC and HCX per employee is highest for the Executive cohort, totaling more than $0.33 million. This compares to a company average of $0.21 million per employee.
vi. Yarra Valley Water generates HCC and HCX of $3.8 million and $0.05 million annually through its key sub-contractor - Ventia
Methodology Overview: Scope, Boundary, and Valuations

Training and on the job skill development are vital elements of human capital formation at any leading business. They are not only relevant to the enterprise and its operations, but also to the individual’s future earnings potential, the local community, nationally and sometimes internationally. It is therefore essential to measure and maximize the returns on investment from human capital, instead of merely treating them as a cost to the company. GIST’s HCX model calculates these returns and their impacts by estimating the lifetime income earning capacity of employees, using an income-based approach. The model captures both the human capital created by Yarra Valley Water when employees receive training and the value that employees carry forward into society once they leave the company.

The HCX model has built on data collected from Yarra Valley Water to generate values of human capital created and human capital externalities. The model covers data from gate-to-grave, in other words, from the point of hiring the employee at Yarra Valley Water up until the exit of the employee from the company or until their retirement (See Figure 15).

The model accounts for the changes in present value of the income of current employees in a financial year until the year of their retirement, irrespective of whether they continue to work for Yarra Valley Water or not. This is because employees continue to receive significant benefits from the training, skills development, and health and safety standards of Yarra Valley Water. For human capital externality calculations, the model used for all three cohorts of Yarra Valley Water considers a 20-year boundary, with externalities accruing to the employee for a period of 5-years from the time of his or her exit from the company.

Although the scope for capital calculations are for direct employees of Yarra Valley Water, subcontractors who are part of the EA staff cohort were also accounted for in the analysis. This is because these subcontractors form an integral part of the services being provided by Yarra Valley Water to its customers, and are as such, trained by Yarra Valley Water to render services to customers on behalf of the company.

Along with these values, the values also represent the benefit of Yarra Valley Water’s brand value and reputation to its employees. Table 9 shows the training programs that drive Yarra Valley Water’s human capital creation, Figure 15 depicts the boundary of the human capital study, and Table 10 outlines the drivers of the monetary valuation in this analysis.

TABLE 9: SCOPE OF THE HCX ASSESSMENT

<table>
<thead>
<tr>
<th>Category</th>
<th>Impact type</th>
<th>Supply chain</th>
<th>Operations</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarra Valley Water training programs</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Increase in future earnings due to general training provided by Yarra Valley Water</td>
</tr>
<tr>
<td>Ventia training programs</td>
<td>Benefit</td>
<td>✓</td>
<td>✗</td>
<td>- Increase in future earnings due to general training provided by Ventia attributable to Yarra Valley Water</td>
</tr>
</tbody>
</table>

Source: Yarra Valley Water data (2016)
TABLE 10: ATTRIBUTES OF HCX THAT ARE VALUED

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DRIVER OF MONETARY VALUATION</th>
<th>Source: GIST data (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarra Valley Water and Ventia training programs</td>
<td>Present value of increase in future income</td>
<td></td>
</tr>
</tbody>
</table>

**Operations**

**Benefits**

GIST’s HCX model captures the flow of benefits from Yarra Valley Water to its employees by using salaries and increments as proxies for employees’ skills and development. The key data points used for this study are:

i. Types of cohorts and the number of employees in each cohort  
ii. Average age of employees in each cohort  
iii. Average annual salary of employees in each cohort  
iv. Cost of training in each cohort  
v. Attrition rate for the cohort  
vi. Annual salary growth rates of employees in each cohort

Further details of the parameters and modeling of HCC and HCX shall be discussed separately along with the management information system installed for Yarra Valley Water’s use. This will be delivered separately from the IP&L report.

The HCX model quantifies the value of human capital created by Yarra Valley Water. In the case of lateral hires from the market, the new employees bring the skillsets of the old company into Yarra Valley Water. This is an externality of the old company and is subtracted from the HCC estimate for Yarra Valley Water. The model accounts for this externality in order to obtain the true human capital creation by Yarra Valley Water. The following section gives the results of the analysis for Yarra Valley Water after deducting the externalities of the last company for lateral hires.

**Limitations**

Yarra Valley Water may be generating negative human capital impacts that have not been captured in this analysis. These impacts could occur due to injuries and fatalities occurring in the work place,
reported by Yarra Valley Water as significant injury frequency rate (SIFR). Yarra Valley Water’s SIFR in 2014/15 was 3.3 per million work hours (compared to 10.6 the previous year). The negative impact resulting from health and safety issues has been excluded from the analysis as the current scope focuses only on the benefits generated due to training and education of Yarra Valley Water employees. However, quantification and valuation of these human capital impacts should be considered in the future if Yarra Valley Water deem them to be material.

**Results**

**Operations**

**Benefits**

The results for HCC and HCX generated by Yarra Valley Water across the three cohorts is shown in Figure 16.

![Figure 16: Total Value of HCC and HCX for Yarra Valley Water](source: GIST Analysis using Yarra Valley Water data (2016))

Total HCC and HCX for Yarra Valley Water employees across all cohorts totals more than $114 million and $7.6 million respectively. Total HCC values are a summation of the increase in future earnings over the employee’s lifetime (up until retirement) across the three cohorts. The total value of HCC and HCX per employee is $0.21 million per employee. This is a useful indicator and an internal benchmark of how employees are benefitting from joining Yarra Valley Water. The average value of human capital per employee should increase naturally each year which indicates average progress in employee development and benefits.

Important parameters considered for the analysis include the long term inflation rate based on World Bank data, and a discount rate for each employee cohort based on their perceived willingness to forego...
consumption expenditure in the present to save it for the future. The time period considered for HCX analysis is 20 years since by that time the value imparted by the current company becomes negligible.

Similar analysis has been done for Yarra Valley Water’s key sub-contractor-Ventia. Yarra Valley Water trains employees of Ventia in order to deliver services to Yarra Valley Water’s clients. Ventia generates 10% of its revenue from Yarra Valley Water. Since Yarra Valley Water is training employees of Ventia, there is generation of human capital which is calculated by the HCX model. Four cohorts are considered for Ventia - professionals, operations and engineers, technicians, and trade and maintenance workers. With similar data and assumptions, by way of attribution, Yarra Valley Water generates HCC and HCX of $3.8 million and $0.05 million respectively through Ventia.

Conclusions
The results of the human capital study can be used by Yarra Valley Water in a number of areas that will enable better management and future analysis of human capital creation. The areas that Yarra Valley Water can use and develop this approach are listed below.

i. **Internal benchmarking**: The average value of HCC and HCX per employee is a useful indicator of value addition for employees. Its company-wide value in this assessment was $0.21 million per employee. A time series of this data can be created through annual measurements, and used as a measure of corporate performance in the human resource domain.

ii. **Attrition management**: Higher HCX for EA staff reflects the fact that the employees of this cohort have a higher tendency to move on for other employment. Measuring attrition rates and HCX in sub-cohort groups, based on staff ratings for example, can help senior managers focus on specific areas of staff development to reduce attrition rates. This will also help to improve value creation inside the company.

iii. **Training return on investment (ROI)**: This can be measured as the ratio between either HCC or HCX and the total training and development costs. It is useful to assess improvements in employees’ future performance with this indicator. It is recommended that the time spent by senior management in developing their juniors’ skills as well as the external costs of training, be recorded consistently and comprehensively to evaluate the ROI of training and to guide appropriate investments.

iv. **Next Steps**: The transfer of the HCX model built for Yarra Valley Water will be handed over to Yarra Valley Water management. The management will be trained to operate the model for future assessments. This will build capacity inside Yarra Valley Water to carry out their own human capital analysis, embedding its use and achieving a better understanding of its application within the company. Future results generated from the model can be used for operational and management decisions. The data collection framework built for the analysis has also added important parameters to the current data being collected by the human resources department at Yarra Valley Water.
FINANCIAL VALUE ADDITION (FCX™)

Overview

Key Results

At a corporate level value addition is generally defined as the enhancement a company gives to the various inputs it purchases from other companies before offering the final product or service to customers. To enable Yarra Valley Water to better understand its financial value addition, GIST has estimated its contributions in eight areas. The main results from this analysis are:

i. The total primary value addition by Yarra Valley Water is $374.2 million

ii. The largest driver of financial value addition are interest payments which contribute 32% of the total value addition. This is the interest paid by Yarra Valley Water on $2.0 billion of borrowings (Yarra Valley Water, 2015).

Methodology Overview: Scope, Boundary, and Valuations

At a macro-economic level, value addition is usually measured using the macro-indicator gross domestic product (GDP). GDP is defined by the Organisation for Economic Co-operation and Development (OECD) as "an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs" (OECD, 2001).

A closely related term to value addition at the micro-level of the company is the operating or gross margin, measured as the difference between the total sales revenue of a firm and the total cost of components, materials and services purchased from other firms. Operating margin can be further broken into profit after tax (PAT), taxes payable, staff compensation, net interest, net rentals and depreciation. Such value addition at the company level can be aggregated at the industry level, and also at a national level using the so-called “income method” of GDP computation, and it represents the firm’s contribution to GDP.

Most international and national accountancy regulators do not require value addition to be reported in annual financial statements of companies, other than shareholder value addition (PAT) and taxes. Therefore, Yarra Valley Water’s IP&L statement addresses this deficiency by reporting all components of the company’s value addition (PAT plus FCX) and its contribution to Australia’s GDP. Table 11 shows the scope of the FCX assessment and Figure 17 highlights the boundary of the analysis.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>IMPACT TYPE</th>
<th>SUPPLY CHAIN</th>
<th>OPERATIONS</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial value added</td>
<td>Benefit</td>
<td>✗</td>
<td>✓</td>
<td>- Shareholder value addition (PAT)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Payment of interest, taxes, salaries, bonuses, and benefits</td>
</tr>
</tbody>
</table>

Source: Yarra Valley Water data (2016)
Results

Operations

Benefits

All the elements listed below are known as ‘primary value addition’. There is also ‘secondary value addition’ created by these stakeholders through spending some of the payments received by Yarra Valley Water. To estimate secondary value addition appropriate multipliers would have to be used which has not been done in this study.

The primary value addition contributions of Yarra Valley Water to Australia’s GDP are summarized in Table 12. This table provides both the PAT as well as FCX - the generally unreported items being disclosed by Yarra Valley Water in its IP&L.

Table 12: Summary of Financial Value Addition by Yarra Valley Water

<table>
<thead>
<tr>
<th>Financial Value Addition Components</th>
<th>Value, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBITDA = P + I + T + D</td>
<td>313,304,422</td>
</tr>
<tr>
<td>EBIT = P + I + T</td>
<td>217,772,822</td>
</tr>
<tr>
<td>1 PAT</td>
<td>P 50,791,700</td>
</tr>
<tr>
<td>2 Interest</td>
<td>I 121,361,000</td>
</tr>
<tr>
<td>3 Taxes payable</td>
<td>T 45,620,122</td>
</tr>
<tr>
<td>4 Depreciation</td>
<td>D 95,531,600</td>
</tr>
<tr>
<td>Staff compensation (a + b)</td>
<td>- 60,451,548</td>
</tr>
<tr>
<td>5 Salaries and bonuses (a)</td>
<td>- 59,707,348</td>
</tr>
<tr>
<td>Benefits (b)</td>
<td>- 744,200</td>
</tr>
<tr>
<td>6 Lease rentals</td>
<td>- 472,714</td>
</tr>
<tr>
<td>Financial valued added (FCX)</td>
<td>323,436,984</td>
</tr>
<tr>
<td>Total financial value added (FCX plus PAT)</td>
<td>374,228,684</td>
</tr>
</tbody>
</table>

Source: GIST Analysis using Yarra Valley Water data (2016)
CONCLUSIONS

Yarra Valley Water’s IP&L provides the appropriate tools to improve business decision-making and its engagement with key stakeholders. The use of valuation results can be used within project appraisal tools, such as the Community Cost Model, to identify projects that deliver greater societal value than those that might have been commissioned otherwise. The use of monetary valuations can help Yarra Valley Water monitor progress on how it contributes to liveability and how it is meeting the targets outlined in its Restorative Strategy.

The analysis has demonstrated a proof of concept and has laid the foundation for deploying this approach more widely throughout the organization. The benefits of using this approach within Yarra Valley Water has been discussed in the relevant sections above, and so the focus of this section answers ‘what as an organization should Yarra Valley Water do next?’ The answer to this entails undertaking three steps:

i. Embedding the approach
ii. Valuation development
iii. Capacity building

Next Steps

These steps focus on actions within Yarra Valley Water and externally with stakeholders and should take place sequentially. Yarra Valley Water should first of all focus on embedding the approach within the organization to ensure this approach is practically applied within the business. Yarra Valley Water should then focus on gaining traction and support for this approach outside the company so that the industry can work towards a more integrated approach to water management. This includes working with other utility companies in the industry so that the benefits of the approach can be widened, and the limitations overcome. The following sections provide more detail on each of these steps.

Embedding the Approach

Throughout the process of developing the IP&L, from the workshop in Melbourne through to publishing the final report, areas where decision-making could be influenced were identified. This information was gained through workshop participants and from discussions with those involved in the creation of the IP&L. To embed this approach within Yarra Valley Water the same people and departments should be involved in order to disseminate the lessons and findings from the process. A similar workshop approach or smaller dissemination groups could be used to achieve this.

Embedding the lessons and approaches demonstrated in the IP&L will center on integrating valuations into existing decision-making tools, such as the Community Cost Model. Upgrading existing decision-making tools to incorporate the new valuations should be seen as a priority for Yarra Valley Water as this will integrate with existing work practices, cause minimal disruption to Yarra Valley Water employees, and smooth any transition process that uses this new approach.
Embedding the IP&L methodologies and outputs in this way will develop ‘champions’ in the business that will facilitate the internal integration of this approach. It will empower employees to share their knowledge with other department and organizations which will complement latter capacity building.

**Valuation Development**

Embedding the valuations delivered in this analysis into existing tools will be a key step to changing the way decisions are made within Yarra Valley Water. However, not all impacts that could have been valued were, and so developing valuation methodologies and coefficients should be a priority for Yarra Valley Water. This is because the aim of embedding valuations within decision-making tools is to start making more informed decisions with a complete understanding of the costs and benefits that could be delivered through certain projects. What should be avoided is the use of decisions-making tools with only a partial set of impact valuations. This could result in decisions and outcomes that have material impacts which have not been factored in. This could delegitimize the work that has been completed to date and create a significant barrier to overcome in the future.

This process can go hand-in-hand with embedding the IP&L approach so that as tools are upgraded to accommodate new valuations, the remaining valuation coefficients can be developed and integrated simultaneously. This work could also include identifying impact pathways, in other words, identifying how a pollutant or organism moves through the environment to cause an impact on humans. This includes identifying how humans are exposed to and absorb pollutants that can cause negative effects. The valuations should link to changes in upstream and downstream environmental condition so that Yarra Valley Water can begin to understand the actual, on the ground, impacts it is having.

The natural capital valuations that should be developed for the Community Cost Model include the impact of nitrogen and phosphorus going to seawater, the impact of biological organisms such as E. Coli, as well as the other impacts listed on page 30.

**Capacity Building**

This step focuses on building capacity and knowledge with Yarra Valley Water’s peers in the water industry, as well as its regulator. This step should be initiated once the approach has been established internally within Yarra Valley Water, and once the process of using impact valuations becomes more widely accepted.

This process could involve Yarra Valley Water running a workshop to present the approach and results of the IP&L, how the methodology has been applied, and how it has led to a new way of doing business. This will rely on Yarra Valley Water transparently presenting the benefits and limitations of such an approach as well as providing case studies on how Yarra Valley Water has changed its processes and decision-making as a result. Yarra Valley Water’s peers and regulators should be involved in such capacity building efforts so that an open and frank dialogue can discuss the practicalities of deploying the approach across the State of Victoria. The capacity building should focus on aspects such as how monetary valuations have been developed, what the values represent, how the SEEA has been used in
this approach, and how this approach has been practically applied to measure a greater range of societal costs and benefits.

Yarra Valley Water should now champion this approach and be bold enough to integrate it into internal processes so that it becomes ‘the new normal’. To proliferate the concept and methodology amongst key stakeholders, Yarra Valley Water should act as the focal point in Victoria to enable dialogue and capacity building between other water companies and its regulator. Successfully achieving this will deliver benefits to Yarra Valley Water, society, and the environment in a way that can be measured. It is a process that will ultimately begin to demonstrate the full value of Yarra Valley Water.
REFERENCES


APPENDIX I: NCX METHODOLOGIES, ASSUMPTIONS, AND ADDITIONAL RESULTS

Summary Natural Capital Methodology

Overview
Trucost has worked with Yarra Valley Water in order to create a true reflection of its business activities. This has resulted in the mapping of water flows associated with different stages of the water supply and treatment process and this diagram is shown in Figure 3. The flows have been given a number as well as a color which correspond to different types of water flow which are outlined here:

i. **Grey** – water from the environment that has no direct intervention from business activities
ii. **Blue** – water abstracted directly from the environment that is purchased by Yarra Valley Water
iii. **Brown** – wastewater collected from residential and industrial customers
iv. **Purple** – recycled water
v. **Green** – treated water that is discharged back into the environment

The physical quantities and monetary values that have been calculated as part of this assessment have been provided in a separate Microsoft Excel document.

Scope
The sections below outline the categories that are included when quantifying and monetizing the negative impacts created and avoided, as well as the natural capital value preserved by Yarra Valley Water operations. Most of the data for quantifying the physical impacts has come from Yarra Valley Water disclosures or estimated from disclosed data. Estimating the value preserved by Yarra Valley Water has relied on data from the IPCC. Monetary valuations have been conducted using Trucost methodologies.

Impacts Created
The negative impacts that have been calculated owing to Yarra Valley Water’s direct and supply chain operations fall under the categories listed in the table below and are driven by the activities indicated.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ACTIVITIES CAUSING THE IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse gases</td>
<td>- Direct fuel consumption by Yarra Valley Water vehicles and buildings</td>
</tr>
<tr>
<td></td>
<td>- Direct fuel consumption by Lend Lease vehicles</td>
</tr>
<tr>
<td></td>
<td>- Purchased electricity consumption</td>
</tr>
<tr>
<td></td>
<td>- Air travel</td>
</tr>
<tr>
<td>Air pollution</td>
<td>- Direct fuel consumption by Yarra Valley Water vehicles and buildings</td>
</tr>
<tr>
<td></td>
<td>- Direct fuel consumption by Lend Lease vehicles</td>
</tr>
</tbody>
</table>

58
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ACTIVITIES CAUSING THE IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land pollution</td>
<td>Pollutants that are emitted directly to land that come from:</td>
</tr>
<tr>
<td></td>
<td>- Flow I1: Leakage from Yarra Valley Water’s drinking water network</td>
</tr>
<tr>
<td></td>
<td>- Flow I2: Leakage from Yarra Valley Water’s sewerage network</td>
</tr>
<tr>
<td></td>
<td>- Flow J: Discharge of drinking water into gardens by Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>- Flow K: Discharge of recycled water into gardens by Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>- Flow R: Discharge of rainwater into gardens by Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>- Flow U2-1: Release of treated water by Yarra Valley Water suppliers</td>
</tr>
<tr>
<td></td>
<td>- Flow U2: Leakage of drinking water from Yarra Valley Water suppliers</td>
</tr>
<tr>
<td>Water pollution</td>
<td>Pollutants that are emitted directly to water that come from:</td>
</tr>
<tr>
<td></td>
<td>- Flow F: Release of treated water by Yarra Valley Water treatment plants</td>
</tr>
<tr>
<td></td>
<td>- Flow L: Leakage from Yarra Valley Water’s sewerage network</td>
</tr>
<tr>
<td></td>
<td>- Flow U1: Release of treated water by Yarra Valley Water suppliers Flow U2: Release of treated water by Yarra Valley Water suppliers</td>
</tr>
<tr>
<td>Waste generation</td>
<td>- Waste produced by operational facilities</td>
</tr>
<tr>
<td></td>
<td>- Disposal of biosolids from sewage treatment process</td>
</tr>
<tr>
<td>Water consumption</td>
<td>- Water abstracted from the environment by Yarra Valley Water suppliers</td>
</tr>
<tr>
<td>Land use change</td>
<td>- The estimated loss of ecosystem services by changing land from naturally occurring ecosystems to another state</td>
</tr>
</tbody>
</table>

**Impacts Avoided**

The impacts that are avoided due to Yarra Valley Water operations relate to pollutants that would have reached the environment and caused a negative environmental or human health impact. The impacts that have been avoided due to Yarra Valley Water operations are summarized in the table below.

**TABLE 14: IMPACTS THAT HAVE BEEN AVOIDED DUE TO YARRA VALLEY WATER OPERATIONS**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ACTIVITIES CAUSING THE AVOIDED IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution</td>
<td>Pollutants that are not emitted directly to water because of pollutants removed from:</td>
</tr>
<tr>
<td></td>
<td>- Flow E: Sewage water inflows to Yarra Valley Water treatment plants. The pollutants that are removed would have otherwise gone to freshwater bodies and waterways</td>
</tr>
<tr>
<td>Water use</td>
<td>Reduction in abstracted water due to recycled water from:</td>
</tr>
<tr>
<td></td>
<td>- Flow H: Recycled water distributed to Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>Drinking water, treated water, or sewage water that is discharge back to the environment from:</td>
</tr>
<tr>
<td></td>
<td>- Flow F: Release of treated water by Yarra Valley Water treatment plants</td>
</tr>
<tr>
<td></td>
<td>- Flow I1: Leakage from Yarra Valley Water’s drinking water network</td>
</tr>
<tr>
<td></td>
<td>- Flow J: Discharge of drinking water into gardens by Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>- Flow K: Discharge of recycled water into gardens by Yarra Valley Water customers</td>
</tr>
<tr>
<td></td>
<td>- Flow L: Leakage from Yarra Valley Water’s sewerage network</td>
</tr>
</tbody>
</table>
Pollutants that reach Yarra Valley Water treatment plants follow one of three paths:

i. Water is treated at the treatment plants and the pollutants are removed as biosolids

ii. The subsequently treated, and hence cleaner water, is either sent to:
   a. Freshwater bodies and waterways or,
   b. To Yarra Valley Water’s recycled water network

The pollutants that are removed from the water as biosolids are valued as avoided impacts. The mass of the biosolids are then valued as waste that is sent to landfill. The negative impacts of the pollutants that are present in water that is sent to freshwater or to Yarra Valley Water’s recycled water network are valued separately once they reach the environment.

Value Preserved

The value that Yarra Valley Water preserves relates to ecosystem services that are provided by the land that Yarra Valley Water owns. Water that is discharged back to the environment, by Yarra Valley Water customers for example, is covered in the avoid impacts section above. The table below outlines the ecosystem services that have been quantified and valued as part of this assessment.

<table>
<thead>
<tr>
<th>ECOSYSTEM SERVICE TYPE</th>
<th>ECOSYSTEM SERVICE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulating service</td>
<td>Carbon sequestration</td>
<td>The value of carbon sequestration relates to the land that is owned and managed by Yarra Valley Water which has the ability to sequester carbon from the atmosphere.</td>
</tr>
</tbody>
</table>

Carbon sequestration was considered the only material or relevant ecosystem service in this category after consultation with Yarra Valley Water staff. It has been calculated for 1,136 hectares of natural land that Yarra Valley Water owns which is considered to be grassland that is classified by the IPCC as ‘subtropical steppe’.
Valuation Framework – An Introduction to Trucost’s Valuation Methodologies

Overview

Trucost’s valuation framework builds on an approach proposed by Keeler et al. (2012). The approach follows a four-step process which is outlined in the table below.

<table>
<thead>
<tr>
<th>VALUATION FRAMEWORK STEPS</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify actions and beneficiaries of interest</td>
<td>Local communities or users of specific natural resources</td>
</tr>
<tr>
<td>Identify shared physical characteristics of the biophysical</td>
<td>The identification of the attribute you are valuing, such as the changing</td>
</tr>
<tr>
<td>and economic models</td>
<td>concentration of pollutants, or change in water clarity</td>
</tr>
<tr>
<td>Select appropriate biophysical models</td>
<td>The identification of how the changing biophysical conditions affect the</td>
</tr>
<tr>
<td></td>
<td>selected beneficiaries. For instance, how the changing concentration of</td>
</tr>
<tr>
<td></td>
<td>pollutants reduces life expectancy and quality of life, measured in terms</td>
</tr>
<tr>
<td></td>
<td>of disability adjusted life years (DALY)</td>
</tr>
<tr>
<td>Select appropriate economic models</td>
<td>Selecting the appropriate monetary valuation method to value the change</td>
</tr>
<tr>
<td></td>
<td>in biophysical conditions, such as the value of a life year (VOLY) to value</td>
</tr>
<tr>
<td></td>
<td>human health impacts</td>
</tr>
</tbody>
</table>

The following steps highlight how the approach described above can be applied to assign monetary values to the impacts on human health and ecosystems resulting from increasing chemical concentrations in the atmosphere due to the use of pesticides:

i.  The first step involves measuring changes in physical conditions, such as an increase in the concentration of a pollutant in the atmosphere, land, or water.

ii. The second step requires biophysical modelling of the impacts caused by changing physical conditions. This includes identifying factors such as the endpoint of pesticides in the environment, for example human beings, and quantifying the change in the biophysical indicator that is to be valued, for example the change in the quality of human health. This is measured by the change in disability adjusted life years (DALYs) and can be caused by the ingestion or inhalation of pesticides. Another endpoint for pollutants could be terrestrial ecosystems, and the quantification of the subsequent biophysical change is its effect on biodiversity, measured in terms of the potentially disappeared fraction of species (PDF).

iii. The final step involves the economic modelling component of the valuation. This includes the identification of the final recipient of the impact, such as local populations who are negatively impacted by ingesting or inhaling pesticides, and then selecting an appropriate valuation technique to monetize the change in biophysical conditions. In this instance, Trucost uses the value of a life year (VOLY) to assign monetary values to the change in human health. For the effect on ecosystems in this example, Trucost values the loss of ecosystem services resulting from the impact on biodiversity and the decreased functioning of those ecosystems.
In general, Trucost assesses the change in the quality of human health by measuring disability adjusted life years, or DALYs, and monetizes the impacts by using a global average value for the value of a life year (VOLY). The DALY quantifies the burden of disease on human populations and can be thought of as one year of healthy life lost. The measure includes both the years of life lost due to illness (mortality) and the years of healthy life lost due to disability (morbidity). The method used to calculate the VOLY uses a willingness-to-pay (WTP) approach, which elicits values from society based on changes in factors such as reduced income due to ill health, the pain and discomfort caused, as well as decreased life expectancy.

For a detailed description of the methods and data employed by Trucost, please refer to the valuation methodology documents highlighted in the table below. The drivers listed can refer to the emissions of a company or its resource use.

<table>
<thead>
<tr>
<th>DRIVER OF IMPACTS</th>
<th>TRUCOST VALUATION METHODOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions of other air pollutants</td>
<td>- Air, Land, and Water Pollutants Summary Valuation Methodology</td>
</tr>
<tr>
<td>Emission of pollutants to land</td>
<td>- Air, Land, and Water Pollutants Summary Valuation Methodology</td>
</tr>
<tr>
<td>Emission of pollutants to water</td>
<td>- Air, Land, and Water Pollutants Summary Valuation Methodology</td>
</tr>
<tr>
<td>- Eutrophication Summary Valuation Methodology</td>
<td></td>
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<tr>
<td>Greenhouse gas emissions to air</td>
<td>- Greenhouse Gas Emissions Summary Valuation Methodology</td>
</tr>
<tr>
<td>Waste generation</td>
<td>- Waste Generation Summary Valuation Methodology</td>
</tr>
<tr>
<td>Water use</td>
<td>- Water Consumption Summary Valuation Methodology</td>
</tr>
</tbody>
</table>

Note: The following flowcharts and valuation methodologies contain valuations that refer to various years. When applying these valuations to this project, the valuations have been adjusted to reflect the year of study.

References
Air, Land, and Water Pollutants Summary Valuation Methodology

Overview

General Process

Figure 18 summarizes the overall approach used to value the emission of air, land, and water pollutants. The first shaded box indicates the steps taken to quantify the environmental impacts of these pollutants, while the second indicates the steps taken to value these impacts.

FIGURE 18: GENERAL OVERVIEW OF THE TRUCOST VALUATION PROCESS FOR AIR, LAND, AND WATER POLLUTANTS
Valuation Methodology Summary

Impact on Human Health

Biophysical Modelling

**Organic Substances and Heavy Metals**

Trucost uses disability adjusted life years (DALYs) as a measure of the impact on human health from environmental impacts. In order to calculate the quantity of DALYs lost due to the emission of pollutants to air, land and water, Trucost used USES-LCA2.0 (EC, 2004; National Institute of Public Health and the Environment, 2004). This model, originally developed in the context of life cycle assessment (LCA) studies, calculates the quantity of DALYs lost due to emission of over 3,300 chemicals to: freshwater and seawater; natural, agricultural and industrial soil; and rural, urban and natural air. USES-LCA2.0 takes into account the impact of cancer and non-cancer diseases caused by the ingestion of food and water, and the inhalation of chemicals. It was chosen over other models as it calculates biophysical impacts for a large number of pollutants that can be valued by Trucost, whereas other models calculate impacts that cannot currently be valued by Trucost.

The output of this analysis step is the number of DALYs lost due to the emission of each pollutant, to a specific media, at the continental level.

Note that organic substances and heavy metals are grouped together due to the similarity in methodology, not their chemical properties.

**Inorganic Substances - Sulphur Dioxide, Nitrogen Oxide, and Particulate Matter (PM10)**

USES-LCA2.0 does not estimate DALY impacts for common inorganic air pollutants such as sulfur dioxide, nitrogen oxide and PM10. Adaptation of USES-LCA2.0 to model these substances would result in higher than acceptable uncertainty due to the different characteristics of organic and inorganic substances. Trucost conducted a literature review to find an alternative method to quantify the DALY impact of emission of these pollutants.

**Economic Modelling**

Once the quantity of DALYs lost is calculated, several valuation methods can be used to put a monetary value on a DALY, such as the cost of illness, the value of a statistical life (VSL), and the value of a statistical life year (VOLY).
Trucost decided to use the willingness-to-pay (WTP) technique utilized in the VOLY method to value DALYs, as it encompasses most aspects relating to illness and expresses the value of a year of life to the wider population. To value DALYs, Trucost used the results of a stated preference study conducted for the New Energy Externalities Development for Sustainability (NEEDS) project (Desaigues et al., 2006; 2011). This is a proactive cost estimate, which takes into account the perceived effects of morbidity. The value of a life year used in this methodology is just in excess of $46,500.

**Impact on Ecosystems**

**Biophysical Modelling**

**Organic Substances and Heavy Metals**

USES-LCA2.0 models the impact of polluting substances emitted to air, land and water, on terrestrial, freshwater and marine ecosystems. This model was adopted by Trucost for assessing the ecosystem damage caused by organic substances and heavy metals. It follows the same modelling steps as for human toxicity, namely exposure assessment, effect assessment, and risk characterization. USES-LCA2.0 has also been adapted to generate results at a continental level.

USES-LCA2.0 estimates the potentially affected fraction of species (PAF) due to the emission of pollutants to air, land and water. It is important to note that affected species need not disappear. Trucost adjusted the PAF results to reflect the proportion of species disappeared (PDF) using assumptions from the Eco-Indicator 99 model (Goedkoop & Spriensma, 2000). This was done to match the valuation methodology, which uses PDF (and not PAF) as an input due to data availability.

**Inorganic Substances - Sulphur Dioxide, Nitrogen Oxide, and Particulate Matter (PM10)**

Impact on ecosystems has not been included for ozone, sulphur dioxide, nitrogen oxides and PM10.

**Economic Modelling**

**Valuing the Impact on Ecosystems in this Study**

Trucost’s approach to valuing a change in the PDF of species follows a three-step process, as shown in Figure 19.

In this methodology, Trucost decided to assess the link between biodiversity, measured species richness (IUCN, 2015), net primary productivity (NPP) (Costanza et al., 2007), and ecosystem service value (ESV). NPP was chosen over other ecosystem processes, such as nutrient cycling, due to data availability and its direct link with key ecosystem services. A monetary value for the provisioning, regulating and cultural
services by terrestrial ecosystem type was first calculated based on the analysis of De Groot et al. (2012) using the specific ecosystem split per country (Olson et al., 2004). De Groot et al. calculate the minimum, maximum, median, average and standard deviation for each service provided by key terrestrial and aquatic ecosystems. Finally, Trucost calculated the percentage difference pre- and post-change of ESV at a country and substance level, and applied this percentage to the average value of one square meter of natural ecosystem in a given region. This aligns with the results of USES-LCA2.0, which calculates change of species richness, or PDF, at a continental level.

For more information on the above, as well as sensitivity analysis for selected parameters, please refer to the full Trucost valuation methodology. This is available on request by emailing info@trucost.com

References


IUCN. (2015) Table 6a - Number of animal species in each IUCN Red List Category by country. Table 6b - Number of plant species in each IUCN Red List Category by country. [Online] Available from: http://www.iucnredlist.org/about/summary-statistics [Accessed on: 06.06.15]

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D’Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y.,
Greenhouse Gas Emissions Summary Valuation Methodology

Overview

General Process
Trucost values greenhouse gas (GHG) emissions using the social cost of carbon (SCC). The SCC is typically considered best practice as it reflects the full global cost of the damage generated by GHG emissions over their lifetime in the atmosphere. The SCC can be used to monetize the impact of GHG emissions globally, which is not the case when using market prices found in emissions trading schemes (ETS), nor when using the marginal abatement cost (MAC). GHG emissions are usually expressed in metric tons of carbon dioxide equivalents (CO₂e)\(^{13}\).

Emission trading schemes are generally promoted for their flexibility to reduce emissions at the lowest cost for the economy, as well as their steadily increasing global reach (World Bank Group, 2014). However, traded market prices currently face a number of limitations which restrict their effectiveness in decision-making. For example, they do not reflect non-traded carbon costs nor the impact of other market-based mechanisms such as subsidies for fossil fuels or low-carbon technologies (Krukowska, 2014). Traded carbon prices have also been historically slow to come about, schemes have not been distributed equally, and they can be impacted by sudden economic changes which reduces the carbon price to levels that undermine the incentive for polluters to cut emissions (Ibid).

The marginal abatement cost is based on the known actual costs of existing reduction efforts. This renders it a valuable tool for informing policy discussions, prioritizing investment opportunities and driving forecasts of carbon allowance prices. Despite this, it too does not reflect non-traded carbon costs, and thus severely underestimates the true cost of GHG emissions. The MAC is highly time and geography specific with costs of reduction fluctuating over time, by sector and by geography, and estimates are influenced by fossil fuel prices, carbon prices and other policy measures.

The SCC is an estimate of the monetized damages associated with an incremental increase in GHG emissions in a given year. To estimate the SCC, Integrated Assessment Models (IAMS) are used to translate economic and population growth scenarios, and the resulting GHG emissions, into changes in atmospheric composition and global mean temperature. Trucost bases its SCC valuation on the work conducted by the Interagency Working Group on the Social Cost of Carbon. Trucost normally uses the values reported at the 95th percentile under a 3% discount rate, which represents higher than expected impacts from temperature change (IWGSCC, 2013). This decision has been taken to address material methodological omissions that arise due to modelling and data limitations, such as the unknown nature of resulting damages, and because the latest scientific data and methods incorporated into these models naturally lags behind the most recent research. Table 18 summarizes the valuation of GHG emissions.

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\(^{13}\) Carbon dioxide is only one of many GHGs, such as methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Carbon dioxide equivalents (CO₂e) is a measure that relates the impact of other GHGs to carbon dioxide over the same lifetime, usually 100 years.
TABLE 18: YEARLY U.S EPA REVISED SCC, 2010 – 2014 (USD PER METRIC TON OF CO₂)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SOCIAL COST OF CARBON, US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>93</td>
</tr>
<tr>
<td>2011</td>
<td>101</td>
</tr>
<tr>
<td>2012</td>
<td>107</td>
</tr>
<tr>
<td>2013</td>
<td>113</td>
</tr>
<tr>
<td>2014</td>
<td>120</td>
</tr>
</tbody>
</table>

Valuation Methodology Summary

*Impacts on Human Health and Ecosystems*

*Biophysical and Economic Modelling*

Over 300 studies attempt to put a price on carbon, quantifying and valuing the impact of climate change on agricultural productivity, forestry, water resources, coastal zones, energy consumption, air quality, tropical and extra-tropical storms, property damages from increased flood risk and human health. The IAMs approximate the relationship between temperature changes and the economic costs of impacts. These economic costs arise from changes in energy demand, changes in agricultural and forestry output, property lost due to sea level rise, coastal storms, heat-related illnesses, and diseases such as malaria.

Out of the many studies that attempt to calculate the SCC, Trucost has chosen to use SCC estimates provided by the Interagency Working Group on the Social Cost of Carbon based in the United States (IWGSCC, 2013). The reasons for this include:

i. Calculations are based on three well-established Integrated Assessment Models, which render the estimate more robust and credible than other approaches.

ii. The SCC takes into account the timing of emissions, which is key to the estimation of the SCC. For example, the SCC for the year 2020 represents the present value of the climate change damages that occur between the years 2020 and 2300, and are associated with the release of GHGs in 2020.

iii. Results are presented across multiple discount rates (2.5%, 3% and 5%) because no consensus exists on the appropriate rate to use. This allows flexibility in the choice of discount rate according to project objectives.

iv. The methodologies employed are continuously improved through regular feedback workshops, engagement with experts, and integrating the latest scientific evidence. As a result, the latest 2013 update provides higher values than those reported in the 2010 technical support document, and incorporates updates of the new versions of each underlying IAM.

**Limitations**

SCC valuations are contingent on assumptions, and in particular the discount rate chosen, the emission scenarios and equity weighting. These are highlighted briefly below.
Despite being the most complete measure of the damage caused by GHG emissions, SCC estimates have attracted criticism as they omit or poorly quantify some major risks associated with climate change. For instance, Tol’s FUND model (FUND, 2015) omits social unrest, disruptions to economic growth, and ocean acidification. Other impacts that have been omitted in similar approaches include the loss of biodiversity, habitat and species extinction, and damages from Arctic sea ice loss and changing ocean circulation patterns (Howard, 2014; Kopits, 2014).

Three well-established IAMs, which form the foundation of the IWGSCC’s estimates, have received most attention in the literature: DICE 2010, FUND 3.8, and PAGE09. Some of the limitations of these models are summarized below:

i. Extensive experiments with DICE have shown that with small, reasonable changes to the basic data, DICE can yield very different projections.

ii. The FUND model was found by the Heritage Foundation’s Centre for Data Analysis (CDA) to be extremely sensitive to assumptions; so sensitive that at times it even suggests net economic benefits to GHG emissions (Dayaratna and Kreutzer, 2014). According to the FUND model, change in temperature up to 3°C is contributing beneficially to the environment (IWGSCC, 2010).

iii. PAGE sets a relatively high temperature threshold for the onset of catastrophic damages.

SCC estimates also range from negative values up to four-figure estimates. This is mainly due to four factors that are outlined below:

i. **Emissions scenarios**: The assumptions made on future emissions, the extent and pattern of warming, and other possible impacts of climate change, then deriving how these factors translate into economic impacts.

ii. **Equity weighting**: This refers to the spatial and temporal dimensions of climate change impacts. Some studies take account of equity weightings which adjust SCC estimates for differences in climate change impacts depending on the development and wealth of nations (Stern, 2006; Tol, 2011).

iii. **Uncertainties**: The variation in SCC valuations is influenced by uncertainties surrounding estimates of climate change damages and related costs.

iv. **Discount rate**: Higher discount rates result in lower present day values for the future damage costs of climate change. The long time horizon of climate change impacts makes the choice discount rate crucial as well as controversial (IPCC, 2014). For example, Stern (2006) uses a discount rate of 1.4% compared to a range of between 2.5% and 5% by the US EPA (2013).

**Sensitivity**

To illustrate the sensitivity of estimates to discount rates, discounting $1m at a rate of 1% from the year 2315 back to 2015 results in an equivalent value of $50,000 today. But if the discount rate is 5%, the current value is less than 50 cents (Burtraw and Sterner, 2009).
Arguments for not discounting future values include the ethical consideration of not equally weighting emissions that occur in the future with impacts occurring today. Discounting thus suggests that impacts on future generations are less important than those that occur on present generations. The ‘polluter pays principle’ supports this position by stating that agents causing damages should be accountable for the full extent of the impacts caused.

Consensus is also building for the use of declining discount rates (IPCC, 2014). Literature suggests that if there is a persistent element of uncertainty in the growth rate of the economy, it will result in an effective discount rate that declines over time (RFF, 2012). This approach would yield a higher present value to the long-term impacts of climate change, and thus a higher value for the SCC (Arrow et al., 2014).

For more information on the above, as well as sensitivity analysis for selected parameters, please refer to the full Trucost valuation methodology. This is available on request by emailing info@trucost.com

References


IPCC. (2014) IPCC Fifth Assessment Report. Intergovernmental Panel on Climate Change. Working Group III.


Eutrophication Summary Valuation Methodology

Overview

General Process
Figure 20 summarizes the high-level steps taken to value the impacts of eutrophication. Not all of the possible impacts have been included in the current methodology, such as the loss of fish yields in freshwater and marine ecosystems, and the loss of recreational services in marine ecosystems.

FIGURE 20: GENERAL OVERVIEW OF THE TRUCOST VALUATION PROCESS FOR THE IMPACTS OF EUTROPHICATION

Valuation Methodology Summary

Impact on Human Health

Biophysical Modelling
Water pollution can directly impact human health when unsafe drinking water is consumed. However, water is also treated to prevent the negative impacts of polluted water consumption and this comes
with an economic cost. Therefore, to account for the true impact on human health, it is necessary to look at the economic costs of both safe and unsafe drinking water.

**Unsafe Drinking Water**

Trucost used the data from the EXIOPOL study to calculate the median years of life lost (YLL) per 100,000 males and females within a country due to the consumption of unsafe drinking water. Population data obtained from the World Bank allowed YLL to be made country-specific via adjustments for the demographic breakdown of each nation by gender. The biophysical indicator used for determining YLL was the concentration of nitrates in drinking water.

To calculate the percentage of the national population exposed to unsafe drinking water, Trucost assumed that water was taken directly from freshwater lakes. For this approach, it was necessary to estimate the catchment area from average-sized lakes within each country to determine the proportion of the national population that were most likely to be affected by drinking unsafe water caused by eutrophication. Trucost assumed a three kilometer catchment area for each national average-sized lake. This was selected from a study that found that the majority of the world’s population live within three kilometers of a freshwater source (Kummu et al., 2011). The population density of each country was applied to calculate how many people live in the catchment area.

Finally, the percentage of the population with access to safe drinking water (World Bank Group, 2015) was removed from the calculation so that the valuation was only applied to those who were expected to be reliant on the consumption of unsafe drinking water.

Trucost used YLL as a proxy for DALYs as no information on the years of healthy life lost due to disability (YLD) from consuming eutrophic drinking water could be sourced.

**Safe Drinking Water**

For the proportion of water that is safe to drink, there is an economic cost associated with cleaning the water to a high enough quality. The model used in this approach requires an input of phosphorus yield in a watershed in order to calculate the cost of treating eutrophic water. Information reported by the Nature Conservancy (McDonald & Shemie, 2014) was used to determine the incremental change in phosphorus from an initial sediment yield, which could be used to calculate the biophysical metric.

**Economic Modelling**

**Unsafe Drinking Water**

Once the total YLL (hence DALYs) lost is calculated, several valuation methods can be used to put a monetary value on a DALY, such as the cost of illness, the value of a statistical life (VSL), and the value of a statistical life year (VOLY).

Trucost decided to use the WTP technique utilized in the VOLY method to value DALYs, as it encompasses most aspects relating to illness and expresses the value of a year of life to the wider population. To value DALYs, Trucost used the results of a stated preference study conducted in the context of the New Energy Externalities Development for Sustainability (NEEDS) project (Desaigues et
This is a proactive cost estimate, which takes into account the perceived effects of morbidity. The value of a life year used in this methodology is just in excess of $46,500.

**Safe Drinking Water**

With increasing sedimentation and nutrient load, the cost of removing sediments increases. A reduction in sedimentation from nutrient pollution by an average of 10% reduces treatment costs by 1.9% (McDonald & Shemie, 2014). This paper presents the relationship between phosphorus yield (tonnes of phosphorus per square kilometer of watershed) and treatment cost. The method was applied to calculate the total cost of water treatment after the unit mass of phosphorus has been applied in the watershed.

**Impact on Ecosystems**

**Biophysical Modelling**

Trucost used the hedonic pricing approach in this methodology to quantify the impact on ecosystems, which estimates the effect of eutrophication on waterfront property prices, as these are significantly affected by water clarity (Gibbs et al., 2002). Secchi depth is the most widely used measure of water clarity, and a link between secchi depth and phosphorus level has been used to quantify the biophysical effect of eutrophication (Downing et al., 2010). This relationship has been investigated as early as the 1970s (see Canfield & Bachman, 1980).

Trucost calculated the increase in phosphorus equivalent concentration, in a national average-sized lake, associated with the use of one kilogram of nitrogen or phosphorus. Trucost calculated the marginal cost of an increase in eutrophication due to excess nutrient loading, changing the state of a lake from oligotrophic to eutrophic. The phosphorus concentration increase was calculated for an average-sized freshwater lake in a country. Using GIS data and the Global Lakes and Wetlands Database (Lehner & Döll, 2004), the median area of a lake, and the average perimeter of a median lake, was calculated for each country.

Trucost then converted the change in excess nutrient concentration into the change in secchi depth, and used the percentage change in secchi depth as the metric for valuation.

**Economic Modelling**

Trucost used data from three studies (Krysel et al., 2003; Gibbs et al, 2002; Michael et al., 1996) in the US, comprising a total of 44 estimates of water frontage price decreases (per foot) due to a one meter reduction in secchi depth, and calculated the median value.

Trucost adjusted the value for each country and calculated the price per waterfront meter. Finally, the value per waterfront meter for each country was applied to the perimeter of the average-sized national lake to establish the hedonic cost of eutrophication at a country-level.

For more information on the above, as well as sensitivity analysis for selected parameters, please refer to the full Trucost valuation methodology. This is available on request by emailing info@trucost.com
References


Downing, J. A., Poole, K., Filstrup, C. T. (2010) Black Hawk Lake Diagnostic/Feasibility Study. Iowa Department of Natural Resources (IDNR) and Iowa State University (ISU). Prepared by the Limnology Laboratory at ISU.


Waste Generation Summary Valuation Methodology

Overview
The collection and disposal of waste degrades the environment and imposes external costs on society. The quantification of the external cost of waste is complex as there are many externalities associated with its disposal including local and global pollution as well as audio and visual nuisances. The prices of these impacts are not directly observable in consumer markets.

Any material can be waste if it is in the wrong place at the wrong time. The natural capital valuation of waste focuses on the conventional definition of waste – solid waste sent to landfill, incineration or recycling. Wastes classed as ‘re-used’ are excluded from the analysis as they are not considered as waste using this definition. The analysis does not value the external cost of waste water and effluent discharged to water. As each waste disposal method has different external costs, Trucost has valued them differently. The figure below summarizes the scope of Trucost’s waste valuation methodology.

FIGURE 21: TRUCOST’S WASTE VALUATION METHODOLOGY SUMMARY

Landfill
Waste sent to landfill has external costs from three main impacts: GHG emissions (specifically methane); leachate (liquid run off that passes into the surrounding area); and disamenity effects of the site (noise, dust, litter, odor, the presence of vermin, visual intrusion and enhanced perceptions of risk). Trucost calculated the quantity of GHG emissions in each year of decomposition in a landfill and applied the Social Cost of Carbon.

Leachate and disamenity valuations were derived based on the quality of waste management in each country, using the percentage of waste collected as a proxy measurement for waste management.
quality. Trucost valued the impacts of basic and sanitary landfills and calculated a weighted average for each country using UN Statistics data on waste disposal routes.

**Incineration**

Waste incineration has external costs from two types of impacts – emissions to air (GHGs, air pollutants, dioxins and heavy metals) and disamenity. Emissions quantities were derived from national incineration emissions limits. GHGs were valued using the social cost of carbon, and air pollution was valued as described in Trucost’s air pollution valuation methodology.

The cost of dioxin and heavy metal emissions was derived from the 2009 EXIOPOL study “Waste Management Externalities in EU25”. Energy recovery conversion factors and grid electricity conversion factors are used to account for avoided GHG emissions from energy recovery.

**References**


Water Consumption Summary Valuation Methodology

Overview

General Process
Figure 22 summarizes the overall approach used to value water consumption. The first shaded box indicates the steps taken to quantify the environmental impact of water consumption, while the second indicates the steps taken to value these impacts.

FIGURE 22: GENERAL OVERVIEW OF TRUCOST’S VALUATION PROCESS FOR WATER CONSUMPTION
Valuation Methodology Summary

Impact on Human Health

**Biophysical Modelling**
The quantification methodology for human health impacts due to water consumption was developed using an estimate of the disability adjusted life years (DALY) lost per unit of water consumed as reported in Eco-indicator 99 (Goedkoop & Spriensma, 2000). The impacts due to lack of water for irrigation and lack of domestic water are both quantified in ‘DALYs per cubic meter’ of water abstracted.

**Lack of Water for Irrigation**
In order to quantify human health impacts associated with malnutrition as a result of lack of water for irrigation, Trucost uses the methodology developed by Pfister (2011). This parameter is country-specific and depends on several variables such as water stress, share of total water withdrawals used for agricultural purposes, human development, and per-capita water requirement to prevent malnutrition.

**Lack of Domestic Water**
For the quantification of human health impacts due to the spread of diseases, country-specific factors were sourced from Motoshita et al. (2010). This model is based on a multiple regression analysis and covers health impacts related to the incidence of diarrhea and three intestinal nematode infections: ascariasis, trichuriasis, and hookworm disease.

**Economic Modelling**
Once the quantity of DALYs lost is calculated, several valuation methods can be used to put a monetary value on a DALY, such as the cost of illness, the value of a statistical life (VSL), and the value of a statistical life year (VOLY).

Trucost decided to use the WTP technique utilized in the VOLY method to value DALYs, as it encompasses most aspects relating to illness and expresses the value of a year of life to the wider population. To value DALYs, Trucost used the results of a stated preference study conducted in the context of the New Energy Externalities Development for Sustainability (NEEDS) project (Desaigues et al., 2006; 2011). This is a proactive cost estimate, which takes into account the perceived effects of morbidity. The value of a life year used in this methodology is just in excess of $46,500.
Impact on Ecosystems

**Biophysical Modelling**

Impacts of water consumption on ecosystems were measured based on net primary productivity (NPP). NPP, which is the rate of new biomass production (by plants) that is available for consumption, is used by Trucost as a measure of how well an ecosystem is functioning. NPP was considered here as a proxy to measure impacts on ecosystems, as it is closely related to the vulnerability of vascular plant species (Pfister, 2011). Furthermore, vascular plants are primary products in the food chain and are therefore essential for the healthy functioning of an ecosystem (Ibid). In addition, it is assumed that damage to vascular plants is representative of damage to all fauna and flora species in an ecosystem (Delft, 2010).

The objective of biophysical modelling is to determine the fraction of NPP which is limited only by water availability, and thus captures the vulnerability of an ecosystem to water deficiencies. However, as the effects of water consumption on ecosystems depend on local water availability, NPP is adjusted to take into account the prevailing water scarcity. Thus, the metric is expressed as the percentage of one square meter that will be affected by the consumption of one cubic meter of water in a year.

**Economic Modelling**

Trucost’s approach to valuing a change in NPP due to water abstraction follows a four-step process, as displayed in Figure 23 below. The underlying approach calculates NPP before and after water consumption, and links those to the ecosystem service value (ESV) before and after water consumption. This allowed for quantifying the loss of ESV due to water abstraction.

![Figure 23: Steps for calculating the value of ecosystem services linked directly to biodiversity](image)

Trucost first calculated the average NPP for each country in its database, based on the average NPP per ecosystem type (Costanza et al., 2007) and the ecosystem split per country (Olson et al., 2004). Species richness is based on the International Union for Conservation of Nature (IUCN) Red List, which provides at a country-level, the number of fauna and flora species, as well as their conservation status (IUCN, 2015).

Trucost then tested the strength of the relationship between NPP and species richness to assess whether a significant correlation exists. Trucost used this relationship to calculate the pre- and post-change in average NPP for each country in its dataset based on species richness.

In order to calculate the post-change NPP, Trucost used the NPP limited by water availability to estimate the change in NPP that is attributable to water consumption. By using the percentage of NPP affected by water availability, the NPP remaining after water consumption was determined.
A monetary value for the provisioning, regulating and cultural services by terrestrial ecosystem type was first calculated based on the analysis of De Groot et al. (2012). De Groot et al calculate the minimum, maximum, median, average and standard deviation for each service provided by key terrestrial ecosystems.

Finally, Trucost calculated the percentage difference between pre- and post-water consumption ESV at a country level. Trucost applied this percentage to the average value of one square meter of natural ecosystem in a given region to align with the results of the biophysical modelling.

For more information on the above, as well as sensitivity analysis for selected parameters, please refer to the full Trucost valuation methodology. This is available on request by emailing info@trucost.com

References


IUCN. (2015) Table 6a - Number of animal species in each IUCN Red List Category by country. Table 6b - Number of plant species in each IUCN Red List Category by country. [Online] Available from: http://www.iucnredlist.org/about/summary-statistics [Accessed on: 06.06.15]


Pfister, S. (2011) Environmental evaluation of freshwater consumption within the framework of life cycle assessment. DISS. ETH NO. 19490. ETH ZURICH.
Estimating Environmental Impacts: An Introduction to Trucost’s Environmentally Extended Input-Output (EEIO) Model

Overview

Environmental impacts attributable to a business are calculated by Trucost using environmental intensities expressed as emissions or resource use per unit of revenue. These are calculated by obtaining emissions or resource data by sector, and using this data in conjunction with financial data to create environmental intensities. The intensities are applied to financial information gained from ‘make and use’ tables provided by the United States Bureau of Economic Analysis to enable Trucost to calculate the environmental impacts of a company’s supply chain. Trucost has adapted these tables so that it can calculate the operational and supply chain emissions or resource use of 531 business sectors.

Trucost has been collecting environmental data since 2000, and is able to test this model against many years of data on quantitative environmental disclosures from thousands of companies, which Trucost engage with annually. The table below outlines the key methodological steps in this process as well as giving some examples at each of these stages.

TABLE 19: STEPS TAKEN IN TRUCOST’S ESTIMATION OF ENVIRONMENTAL IMPACTS

<table>
<thead>
<tr>
<th>METHODOLOGICAL STEPS</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of the sector(s) of interest from a list of 531 sectors</td>
<td>Soybean farming; natural gas extraction; coal power generation; industrial gas manufacturing</td>
</tr>
<tr>
<td>Definition of the functional unit to be used</td>
<td>1 tonne of soybeans; 1 million cubic feet of natural gas; 1000 MWh; US$1 million revenue</td>
</tr>
<tr>
<td>Calculation of environmental intensities</td>
<td>The environmental intensities are calculated in terms of metric tons, cubic meters, or square meters per unit of revenue. Data is utilized from a wide array of supra-national, international, national, and industry bodies across a wide range of sectors and geographies. Impacts are calculated in one of seven categories including:</td>
</tr>
<tr>
<td></td>
<td>– Greenhouse gas emissions</td>
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<tr>
<td></td>
<td>– Air pollutants</td>
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<tr>
<td></td>
<td>– Land pollutants</td>
</tr>
<tr>
<td></td>
<td>– Water pollutants</td>
</tr>
<tr>
<td></td>
<td>– Waste production</td>
</tr>
<tr>
<td></td>
<td>– Water consumption</td>
</tr>
<tr>
<td></td>
<td>– Land use</td>
</tr>
<tr>
<td>Modelling of operational environmental impacts</td>
<td>These are calculated using country-specific or global average factors.</td>
</tr>
<tr>
<td>Modelling of supply chain environmental impacts</td>
<td>By adapting ‘make and use’ tables from the United States Bureau of Economic Analysis, Trucost estimates the environmental impacts of sectors within supply chains by applying environmental intensities to the flows of monetary transactions. The US economy is therefore used as the benchmark for national economies around the world.</td>
</tr>
</tbody>
</table>
Outputs

Over 100 quantified environmental impacts are classified into the categories listed above, which enables:
- Identification of the countries or regions generating the greatest absolute and relative environmental impacts
- Identification of the most material environmental impacts for each country or region
- Comparison of operational versus supply chain impacts

Environmental Intensities

Each of the 531 sectors have average environmental intensities associated with their operation, expressed in terms of emissions or resource use per dollar of output. These are calculated for over 100 impacts which are derived from a wide array of data sources highlighted in Table 20. Trucost tests this data against the many thousands of disclosures it collects from companies during its annual engagement program. Where available, Trucost applies country-specific factors, otherwise global average factors are used, which are weighted by production value. When using country-specific environmental intensities in conjunction with ‘make and use’ tables from the Bureau of Economic Analysis, this is referred to as hybridization. This approach allows Trucost to take into account regional differences in the emissions profiles of different sectors. Table 20 below provides some typical sources of data that Trucost uses to calculate environmental intensities.

<table>
<thead>
<tr>
<th>DATA CATEGORY</th>
<th>EXAMPLE SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector production quantities and prices</td>
<td>- Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td></td>
<td>- International Energy Agency (IEA)</td>
</tr>
<tr>
<td></td>
<td>- United States Energy Information Agency (EIA)</td>
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<td></td>
<td>- United States Geological Survey (USGS)</td>
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<tr>
<td></td>
<td>- Mining Congress</td>
</tr>
<tr>
<td></td>
<td>- FactSet</td>
</tr>
<tr>
<td>Resource use – Energy, water, and land</td>
<td>- Industry and academic reports</td>
</tr>
<tr>
<td></td>
<td>- AQUASTAT</td>
</tr>
<tr>
<td></td>
<td>- Water Footprint Organization</td>
</tr>
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<td></td>
<td>- United States Department of Energy (DOE)</td>
</tr>
<tr>
<td></td>
<td>- Eurostat</td>
</tr>
<tr>
<td></td>
<td>- Company annual reports, Security and Exchange Commission (SEC) filings</td>
</tr>
<tr>
<td></td>
<td>- Direct disclosures</td>
</tr>
<tr>
<td>Emissions – greenhouse gases, air pollutants, land pollutants, and water pollutants</td>
<td>- IPCC</td>
</tr>
<tr>
<td></td>
<td>- Agrifootprint and Ecoinvent life-cycle analysis (LCA) databases</td>
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<td></td>
<td>- Toxic Release Inventories</td>
</tr>
<tr>
<td></td>
<td>- Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td></td>
<td>- United States Energy Information Agency (EIA)</td>
</tr>
<tr>
<td></td>
<td>- Direct disclosures</td>
</tr>
</tbody>
</table>
Supply Chain
Supply chain impacts are calculated from ‘make and use’ tables published by the United States Department of Commerce, Bureau of Economic Analysis. The Bureau of Economic Analysis compiles data from a wide range of sources including its Economic Census (conducted every five years) and annual surveys for specific industries including the agriculture, mining, manufacturing, wholesale trade, retail trade, transportation, communications, utilities, finance, insurance and real estate. Data is collated and homogenized so that each industry’s inputs reflect, as far as possible, a unique set of inputs for around 426 industries.

Input-output (IO) tables are created detailing the ratio of expenditure from one sector with every other sector of the economy, termed “intermediate demands”. It is largely due to this level of detail that Trucost has chosen to use the US economy as a proxy for the world economy as a starting point for the creation of its supply chain model. Additionally, the US economy has the advantage of being highly diversified, so major commodities can be included.

However, some sectors which are important from an environmental perspective, such as power generation, are highly aggregated, and the Bureau of Economic Analysis has insufficient detail on many sectors within the agricultural industry. In these cases, Trucost has disaggregated the IO tables proportionally. For example, power generation is represented by seven separate sectors within the Trucost model. Trucost has further extended the supply chain model to create entries for an additional 80 sectors. Finally, the supply chain model is refined by using disclosures made directly to Trucost from over 6,000 companies, which are collected through an annual engagement program.

Multi-Region IO Modelling
Input-output modelling assumes generic flows through sectors, as described in the supply chain model above. Alternative approaches include using multi-regional IO modelling, or a hybrid approach as used by Trucost.

Applying environmental intensities to multi-regional IO models, which adjusts for trade between regions, enables the estimation of environmental impacts of sectors more accurately. However, Trucost recommends adopting a hybridized approach to adjust for regional variations in environmental impacts as described above. This is because single-region IO models have greater granularity: Trucost’s IO model includes 531 sectors, whereas multi-regional IO models usually include 80 sectors.
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