

# **Sustainable Development Evaluation of Road Infrastructure Programmes and Projects**

## **Section 3**

### **A sustainability assessment process for road-building and other development in Ireland**

Leyden, K., Healy, D., Douthwaite, R., Lumley, I., Gibbons, M., Murray, A., Farrell, K., Guckian, B., Johnston, P.

June 2007



The Foundation for the Economics of Sustainability

Cad a dhéanfaimid feasta gan adhmaid? Tá deireadh na gcoillte ar lár  
'What will we do in the future without wood? The end of the forests has come'

## **ACKNOWLEDGEMENTS**

This report has been prepared as part of the *Environmental Research Technological Development and Innovation Programme* under the *Productive Sector Operational Programme 2000-2006*. The programme is financed by the Irish Government under the *National Development Plan 2000-2006*. It is administered on behalf of the Department of the Environment and Local Government by the Environmental Protection Agency which has the statutory function of co-ordinating and promoting environmental research.

## **DISCLAIMER**

Although every effort has been made to ensure the accuracy of the material contained in this publication, complete accuracy cannot be guaranteed. Neither the **Environmental Protection Agency** nor the author(s) accept any responsibility whatsoever for loss or damage occasioned or claimed to have been occasioned, in part or in full, as a consequence of any person, acting, or refraining from acting, as a result of a matter contained in this publication. All or part of this publication may be reproduced without further permission, provided the source is acknowledged.

## **SOCIO ECONOMICS**

The Socio Economics Section of the Environmental RTDI Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in this area. The reports in this series are intended as contributions to the necessary debate on Socio Economics and the environment.

## ***Abstract***

In this section we propose a sustainability assessment process. To oversee the sustainability assessment process, we recommend the creation of a new office, housed in the EPA, called the **Office of Sustainability Assessment**. We wish to emphasise that we are not proposing a separate strand of assessment in addition to Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), but rather an overall structure within which they would be included. We believe our proposal would not require any changes to existing EU legislation on SEA and EIA, but could of course serve as a model for a revision of existing SEA and EIA processes.

In this document we primarily use roads as an example of how the sustainability assessment process would function. However, we believe that the model can be used for all forms of transportation-planning and other projects also; examples of the latter are land-use planning and development.

## Table of Contents

List of Tables .....	6
1 What is sustainability .....	7
1.1 Why does Ireland need sustainability assessment?.....	7
1.2 The Sustainability Assessment Process: An Overview .....	9
1.3 Sustainability Assessment: Thinking About Policy First.....	11
1.3.1 Establishing the real aim .....	11
1.3.2 Looking for conflicts between objectives .....	12
1.4 Stage 1 Sustainability Assessment: The Programme Stage .....	13
1.4.1 The Four Capitals Approach to Sustainability .....	14
1.4.2 Strong and weak sustainability .....	16
1.4.3 Getting More Specific: How Do we Make Sustainability Assessments at the Programme Stage? .....	17
1.5 Stage 2 Sustainability Assessment: The Project Stage .....	19
1.5.1 How do we assure that the Sustainability Assessments at the Project Level are Accurate?.....	19
1.5.2 An Example of how the Sustainability Assessment Process might progress early on, prior to development of accurate forecasts for all indicators .....	20
1.6 Stage 3 Sustainability Assessment: The Post Decision Stage .....	22
1.7 Measuring Sustainability: The Indicators.....	22
2 Air and Climate (Example of Natural Capital with effects on Human Capital) .....	23
2.1 Criterion 1: Predicted emissions of Greenhouse gases – specifically CO <sub>2</sub> .....	23
2.2 Criterion 2: Emissions of long range pollutants, NO <sub>x</sub> and SO <sub>x</sub> .....	24
2.3 Criterion 3: Predicted ambient levels of particulates and NO <sub>x</sub> .....	24
2.4 Potential Criterion 4 – Heavy metals impact on Health .....	25
3 Social Capital and Community Effects .....	25
3.1 Background.....	25
3.2 Social Effects: Measuring Social Capital.....	27
3.3 Community Effects: Measuring Walkability (Example of Physical Capital).....	27
3.4 Community Effects: Human Health (Example of Human Capital) .....	29
4 Biodiversity (Example of Natural Capital).....	30
4.1 EEA Assessment .....	30
5 Archaeological and Architectural Heritage (Example of Human, Social and Physical Capital).....	32
5.1 Assessing the Impact on the Visual Amenity and Heritage Value of Known Archaeology .....	33
5.1.1 Visual Amenity and Heritage Value.....	33
5.2 Assessing the Mitigation Value of the Information Gathering Phase .....	34
5.3 Pre-Fieldwork Research .....	34
5.4 Field work, monitoring and preservation by record.....	36
5.5 Knowledge Creation.....	37
5.5.1 Publication.....	38
5.5.2 Storage and Curatorial Issues .....	38
5.6 Downstream Impacts .....	38
5.7 Sustainability Assessment.....	39
6 Economics (Example of Physical and Human Capital .....	40
6.1 Will some groups benefit disproportionately? .....	41
6.2 Will the competitive position of some firms be improved at the expense of others? .....	42
6.3 Is it possible to correct for the effect on property values?.....	42
6.4 Baseline Indicators.....	43
7 Transport Policy Impact (Example of all Capitals).....	43
8 Water Quality (Example of Natural Capital with effects on Human Capital) .....	44
9 Traffic Modelling (Affects Physical and Social Capital) .....	45

9.1	Modelling software .....	45
9.2	Assessment of model predictions in current schemes .....	46
9.3	Infrastructure assumptions as inputs to traffic models .....	46
9.4	Economic stress testing.....	46
10	Spatial Planning (Affects all Four Capitals).....	47
Appendix 1	Sustainability Assessment Flowchart .....	48
Appendix 2	A short survey that has been used by Robert Putnam and his colleagues to measure social capital in various communities in the U.S. ....	51
Appendix 3	A series of survey items that could be used to assess perceived subjective walkability. These items were developed by James Sallis of San Diego State University and the Robert Wood Johnson Foundation.....	61
Appendix 4	References (see also Section 1 and Section 2 reports).....	68

## ***List of Figures***

Figure 1. Integrated flow chart of the entire Sustainability Assessment Process.....	48
Figure 2. Role of the Office of Sustainability Assessment in Environmental Impact Assessment. ....	49
Figure 3. Inputs to and Outputs from the Office of Sustainability Assessment.....	50

## ***List of Tables***

Table 1-1 A simple programme matrix for use by planners to assess overall net increase in the total four-capital stock as a result of the programme they are developing .....	18
Table 3-1 Walkability Index, Frank et al (Journal of the American Planning Association, Vol.72, No. 1, Winter 2006) .....	29

# **1 What is sustainability**

In 1987, the United Nations' World Commission on Environment and Development, also known as the Bruntland Commission, released a report entitled *Our Common Future*. The primary purpose of the report was to begin a dialogue on ways to balance the need for economic development with the need to protect the environment. Bruntland concluded that countries should aim for economic activity that "...meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, 8).

Bruntland and the subsequent literature on sustainability recognizes that if a development is not to undermine future generations' ability to meet their needs it must take into account rather more than economics and the natural environment. Healthy people and thriving communities, cultures and societies are an essential part of any sustainable future. We therefore need to ask: what effects do the decisions we make today have on our quality of life *over time* and on that of future generations? We need to think long term so that we do not jeopardize our common future.

## **1.1 Why does Ireland need sustainability assessment?**

There is a growing recognition that decisions based on achieving long-term sustainability make good economic sense. "Green" building designs that emphasize energy efficiency reduce costs to businesses and government. Countries that offer a range of transport options to their citizens are far less vulnerable to oil price shocks than countries that are highly dependent on car-use, and this in turn creates a more stable economic and political environment which is good for business and democratic governance.

The costs of allowing unsustainable forms of development are already beginning to affect consumers and governments. In Florida (USA), where hurricanes have become more frequent, insurance companies are declining to cover some home-owners, and are doubling or tripling their rates to those they do take on to make up the costs of climate change. The State of Florida has had to step in to provide and subsidize the cost of homeowners insurance. According to the New York Times:

*Abandoned by insurers with cold feet and empty pockets, homeowners are increasingly turning to the Citizens Property Insurance Corporation, the state-created insurer of last resort, which by law must charge more than private insurers to be non-competitive. Citizens has picked up 150,000 homeowner policies in Florida since June 2005, said Rocky*

*Scott, a spokesman, and expects to add another 320,000 by the end of the summer.*

*Last year, hurricane claims put Citizens \$1.73 billion in the red. The Legislature bailed out the company with \$715 million from the state surplus. Homeowners are picking up the remaining tab through assessments to their policies, which in some cases are twice as expensive as last year's. (New York Times, June 29, 2006)*

Businesses too, even some oil companies, have begun to realize that climate change is upon us and must be planned for accordingly. Again, according to the New York Times:

*"Climate will shape our business", said Chris Mottershead, and advisor on climate policy to the chief executive of BP, Lord Browne. Some of the largest oil companies, including BP, Shell, and Chevron, are already planning multibillion-dollar investments in energy sources that emit little or no carbon, like wind and solar power, biofuels or hydrogen from renewable sources. (New York Times, June 30, 2006).*

Sensing the new direction, investors have already begun favouring companies which seem more sustainable because they are less likely to be materially affected by future regulations on pollution, energy cost increases or by law suits. Investors want to know which companies are most likely to be adaptable to change and/or are part of the solution to climate change issues instead of being part of the problem. For example, USA Today states:

*In February, a London-based investor coalition called the Carbon Disclosure Project sent its fourth annual request for information on greenhouse-gas emissions to 1800 of the largest publicly traded companies in the world. A total of 211 institutional investors with a collective \$31 trillion under management signed the letter up from the 35 investors representing \$4.5 trillion worth of capital who signed the first report. Among the US signatories: Merrill Lynch, Franklin Templeton, Dreyfus, State Street Global Advisors, New York State and City Employees Pension Funds, and the State treasurers of Maine, Vermont and Oregon. (USA Today, June 1, 2006)*

Markets for green technologies and products are expanding rapidly. Countries that encourage the adoption of these products and processes, and thus provide a good location for the companies producing them, whether domestic or foreign, will find that they benefit from this important growth market. This is a market, which could become very important if, as a result of restrictions on energy use, existing sectors of the economy begin to decline. Ireland benefited a lot from embracing the last new wave of technologies – Information and Communications Technologies (ICT). It needs to position itself to take advantage of the next one, namely the technologies required to move to a low carbon world.

Of course, a greater degree of sustainability also is good for the environment, public health (and unhealthy populations cost money and are a drag on the economy) and quality of life. Sustainability policies too are important because the public and certain business sectors expect cleaner, healthier environments in which to live and work. Any perceived, immediate costs will be quickly outweighed by long-term benefits.

## **1.2 The Sustainability Assessment Process: An Overview**

Therefore, transport should be planned, used, and monitored with sustainability in mind. This means that planners should seek to reduce greenhouse gas emissions (and certainly not increase them) and make sure that nothing is done to jeopardize human health and quality of life. Road-building decisions under these criteria have to be considered and evaluated not in isolation, but along with decisions about public transport and community design and planning features that enable walking and cycling for transport, leisure and daily activities such as shopping.

It is important to note that the idea of an Office of Sustainability Assessment is not entirely novel. The Netherlands, for example, has an Environmental Assessment Agency<sup>1</sup> which focuses, in part, on sustainability assessment:

*The Netherlands Environmental Assessment Agency (MNP in Dutch) functions as the interface between science, policy and politics, producing independent assessments on the quality of the environment for people, plants and animals to advise national and international policy makers. Each year, the Netherlands Environmental Assessment Agency establishes a work programme for the coming year in consultation with the Ministry for Public Health, Spatial Planning and the Environment and the Ministry of Agriculture, Nature and Food Quality (VROM and LNV, respectively in Dutch).*

*We provide independent integrated assessments on topics such as sustainable development, energy and climate change, biodiversity, transport, land use and air quality. The MNP acts as the interface between science and policy.*

The Netherlands Environmental Assessment Agency has created an inventory of existing assessment tools—called *Sustainability-A-Test*—which can be used to assess sustainability on many levels. According to their website:

*The word 'tools' refers to all kinds of methods, analytical approaches, procedures and frameworks that can be used for the assessment of policy. Examples of tools are cost-benefit analysis tools, participatory tools, scenario tools, multi-criteria tools and models<sup>2</sup>.*

---

<sup>1</sup> See: <http://www.mnp.nl/en/index.html>

<sup>2</sup> See <http://ivm5.ivm.vu.nl/sat/>

In order to visualize our proposed Irish Sustainability Assessment Process, a few definitions are necessary. We envision the Sustainability Assessment process to be overseen by a new **Office of Sustainability Assessment**. This Office of Sustainability Assessment would have a role to play at the policy, programme, and project stages. It would also continually monitor the consequences of various project decisions—past and present—on an on-going basis; for example, the effects of roads, built over the past ten years, on the sustainability of the surrounding local area, the region and Ireland as a whole would be assessed regularly. The same would hold true for new projects. This monitoring would provide important empirical data that could be used to inform future decisions and, perhaps, provide reasons to re-assess and take corrective action on old decisions.

The Office of Sustainability Assessment would be involved in the following stages of every major project (See the organizational flow chart in Appendix 1):

- **The Policy Stage:** setting out the overall objectives and a general understanding of how they can be achieved.
- **The Programme Stage:** listing all projects. Ideally, these should reflect policy and be presented in a coherent way. In the area of transport, we usually think about programmes as networks that link together transport options/modes.
- **The Project Stage:** the assessment and construction of a proposed new road (or new railway or port, etc).
- **The Post-Decision Stage:** the monitoring of roads (or other transport decisions) for their effects on sustainability over time.

Once fully developed, we propose that Sustainability Assessments be used:

1. To assess whether a road (or particular transport option) should be built in the first place; i.e., whether a road is a sustainable policy option for a particular route. This we label as **Stage 1 Sustainability Assessment: the Programme Stage**, and would be carried out when plans and programmes such as the National Development Plan or County Development Plans were being drawn up.
2. To evaluate the effects that a particular road proposal would have on local communities, individuals, and the environment along the proposed route, once a road or other project was selected for inclusion in the National Development Plan or a County Development Plan. This more thorough assessment we call the **Stage 2 Sustainability Assessment: the Project Stage**.
3. To monitor, scientifically, a road's effects on sustainability over time once it is built. This monitoring process we label as **Stage 3 Sustainability Assessment: the Post Decision Stage**. The effects of older transport decisions should also be monitored. In some cases,

this may prove that a current transport option is in need of remediation or corrective action.

Measures or reliable and valid indicators will be used at all three stages of the Sustainability Assessment. These measures will be discussed in their own sections below (See 1.7 Measuring Sustainability: The Indicators).

In addition to these measures it is important that the Sustainability Assessment process also:

1. Strives to be an open, inclusive process that actively encourages public participation and consultation.
2. Contributes to capacity-building within strategic organisations for sustainability thinking.
3. Recognizes that hired consultants must be fully independent professionals, and should be held accountable for the quality of their reports. Consideration should be given to creating a licensing procedure that would frequently review a consultant's qualifications and the accuracy of their reports. Consultants must be properly qualified for the area of the Sustainability Assessment which they will be asked to examine. The current EIA/EIS process relies too readily on Engineers. This bias needs to be addressed where appropriate.
4. Recognizes that decisions to build roads cannot be made in a vacuum. Land-use planning and public transport planning must accompany road decisions. For example, car-oriented housing estates that minimize walking and cycling and which lack viable public transport create more demand for road use. Therefore, road-building authorities and hired consultants must take into account the nature or character of land-use that lies (or will lie) adjacent to a proposed road.

### **1.3 Sustainability Assessment: Thinking About Policy First**

#### **1.3.1 Establishing the real aim**

The first step in balancing our own needs with those of future generations is to be clear about what our own needs are. We need to set policy objectives that are clear, and which guide programmes and projects. We also need to think deeply about the consequences of choosing one policy over another. The Department of Transport's *Operational Programme for Transport*, for example, aims to allow vehicles to achieve an average speed between urban areas of 80 kph. This forces planners to concentrate on road building, when other solutions might be more appropriate. Before setting such a policy, we should be asking: "Why do people and goods need to move between urban areas? And "might it not be better for those people and goods, which do need to

travel, to be moved in some other way?" Such questions might have caused the inter-urban road programme to be reconsidered.

### **1.3.2 Looking for conflicts between objectives**

Every government has aims and policies in many areas besides those for transport. Indeed, it should be recognised that the demand for transport is a secondary, derived demand, which arises because people use the transport system largely in the course of doing other things. Very few people dispatch goods or travel themselves simply because it gives them pleasure. Government departments or individuals developing transport policies therefore need to consider the broader context. If particular transport policies prevent some other government or EU policy from being achieved, those transport policies might have to be abandoned or changed. At the very least, policymakers should endeavour to judge whether the specific needs that their proposed policy aims to fulfil, outweigh the reduction in other types of needs, which reduction would result from implementing the policy. Not only is such an approach commonsense, it is EU policy. For example, the *Sixth Environment Action Programme of the European Community 2002-2012*<sup>3</sup> stipulates that "*integration of environmental concerns into other policies must be deepened*" in order to move towards sustainable development; the so-called "**Cardiff Process**".

The process of integrating policies with each other should recognise that there are certain paramount needs, which, if infringed by a suggested transport policy, should be an absolute bar to the policy being developed further. The Cardiff Process suggests that these include the need for the world to have a stable climate regime, and the need for people not to have anything done to them or their environment, which would damage their health. In detail, the principles of the Cardiff Process are considered as follows:

1. **A stable climate regime:** The threat of a climate catastrophe is widely considered so great that any transport policy, which would lead to an increase in greenhouse gas emissions, should not go ahead, however effective it might be at meeting genuine, specific, pressing needs. This is because if the world's emissions are not reduced significantly over the next few decades, the damage expected in Ireland by rising temperatures and more energetic weather systems will almost certainly far outweigh any possible gains as a result of such a transport policy. It could be argued that this policy should be flexible in that it should allow a government to decide that it will allow emissions to increase as a result of a policy but reduce them somewhere else to compensate. However, many people might feel that such a trade-off is proper only when a country is already producing well below its share of the total amount of emissions which the world's greenhouse gas

---

<sup>3</sup> <http://ec.europa.eu/environment/newprg/index.htm>

sinks can safely handle; i.e. whether a country has an option for trade-offs depends in part on how responsible it has been to date.

- 2. No damage to human health.** An insistence on this principle would mean that no policy would be adopted if it damaged human health by causing an overall increase in noise, accidents or harmful emissions, tended to reduce social ties or led to people taking less exercise and therefore becoming obese. According to this principle, Government should never intentionally harm the health of its citizens or their communities. Strict adherence to this principle would rule out the adoption of policies leading to any increases in relative or absolute poverty; such increases have been shown by Richard Wilkinson and others to have a very harmful effect on the health of the groups losing out. Overall, however, this principle is probably less stringent than the climate requirement because, if policymakers find any aspect of a proposal to be harmful to health, they may be able to find ways to compensate so that there is no overall health-loss.

These two principles do not currently guide transport decisions in Ireland. We recommend that they be adopted and be used to screen government policies—existing and new—and that policymakers should reject any ideas that would increase emissions or damage health. Whatever principles are adopted to shape policy for any national development plan, they should be clearly stated and well thought through.

There certainly needs to be more integration between policies. If the transport aspects of the 2000-2006 National Development Plan had been subjected to an integrated analysis, it would have necessitated an exploration of whether developing a road system that encouraged the greater use of private cars was compatible with the goal of reducing social exclusion since certain groups—the young, the elderly, the poor and the disabled—cannot be expected to own and drive vehicles. Similarly, the planners would have had to produce evidence to show that better road links with, Dublin for example, would lead to more activity in the regions rather than a concentration of activity in the capital. They would also have been required to attempt to show that the road projects they had put into the plan were better than any other form of capital investment in achieving whatever primary goals they had in mind when aiming to reduce regional disparities.

## **1.4 Stage 1 Sustainability Assessment: The Programme Stage**

If a broad-brush policy can pass the test of basic principles (outlined above), and those responsible for it are confident that it should meet real needs whilst not conflicting with other key national or regional objectives, it should

be developed as a specific programme. We recommend this be done using the four capitals procedure we explain in the next paragraph. A programme should only proceed to the project assessment stage if it is entirely clear that the gains will outweigh the losses using this four capitals approach.

### **1.4.1 The Four Capitals Approach to Sustainability**

When we talk about sustainability, one may ask the question what are we trying to sustain. The answer, surely, is the flow of benefits which not only allow human life to go on but which make it a pleasant and rewarding experience. In other words, we want to sustain, and if possible improve, the quality of human life. And what determines the quality of life? In responses to surveys, people have said that the following *thirteen* factors are important elements, although the list is not complete:

1. The quantity of goods and services produced and consumed.
2. The strength of one's family, home and community ties.
3. The quality of the environment people enjoy, including space, energy, natural resources and plant and animal species.
4. How fairly—or unfairly—the available income is distributed.
5. The fraction of time available for leisure.
6. How easy it is to get a job. Supporting oneself by one's own work is one of the essential aspects of existence and the absence of a possibility of doing so means in all probability a considerable loss of welfare.
7. The safety of the future. Humankind derives part of the meaning of existence from the company of others. These include in any case one's children and grandchildren. The prospect of a safer future is therefore a normal human need, and the dimming of this prospect has a negative effect on welfare.
8. How healthy people are.
9. The level of cultural activity, the standard of education and the ease of access to it.
10. The quality of the housing available.
11. The chance to develop a satisfactory religious or spiritual life.
12. How good or bad working conditions are.
13. Being able to participate in decision-making on key areas which affect life.

It is important to note that only the first of these factors can be measured in monetary terms. The rest are essentially non-monetary. That is why developing indicators to track the other factors is so important, and why, in this analysis, we do not try to express everything in monetary terms.

All thirteen factors listed above can be regarded as the products of, or related to, *four* forms of capital which together provide a continuous flow of benefits supporting and enriching human life. The four types of capital are defined below:

- **Social capital:** Social and community *interactions and networks* that inspire trust and reciprocity among citizens. These interactions typically occur between neighbours, family members, friends, or within various community or professional groups/organizations. High levels of social capital have been linked to better health, the proper functioning of democracy, the prevention of crime, enhanced economic development, and the socialization of well-adjusted children and teenagers. Possible measures include scientific public opinion surveys of communities assessing levels of social capital. These surveys could be conducted before and after a road (or transport scheme) was built to assess the road's impact on social capital. Survey questions would focus on: levels of trust, reciprocity, social engagement with others, involvement in the community, volunteering efforts, various forms of political and community engagement, the willingness of respondents to become involved and address problems in their community, one's connection to one's community, religion, television-usage, car-dependency, fear of crime, and commuting times. Actual valid and reliable survey questions are provided in this document and its appendices.
- **Human capital:** The capabilities or capacities that *reside in individuals* and allow them to work to accomplish other goals (ESDI, Sustainability Report: [www.sustreport.org](http://www.sustreport.org)). Measures would include education levels, literacy levels, technological sophistication, health (as measured by surveys and use of medical services), access to quality healthcare services, income distribution, poverty levels, household debt, savings-rate, retirement-income and support, the availability and quality of childcare services and various cultural measures (e.g., knowledge of other countries, history the arts, etc).
- **Physical capital:** The source of the benefits we get from *what we produce* or make. Concepts include the quantity and quality of our housing, roads, factories, machines, public transport system, communication systems, cultural and sport amenities, parks, public squares & green spaces, architecture, walking and cycling pathways/lanes, schools, etc. (Physical Capital is sometimes referred to as Produced Capital).
- **Natural capital:** The endowment represented by *the natural world*. This takes in not only natural resources—fisheries, forests, minerals, soils etc.—but also nature's services such as climate-regulation and pollutant-disposal. The immense benefits humans derive from natural beauty are also the product of this form of capital. Concepts to be measured might include levels of air and water pollution, fertile soils, forested areas, wetlands, fishing stocks, biodiversity, handling of waste, and the sustainability of the food and energy production process.

The idea of using the **Four Capitals** to assess sustainability was popularised by the World Bank after it was introduced to them by Paul Ekins<sup>i</sup>. It is based on the idea that if the capital stock per head of the human population is diminished, the flow of benefits the stock can provide to each person is diminished too. This unavoidably leaves the next generation worse off. A continuing reduction in each generation's benefits cannot be sustainable as, at some point, it would fall below the level required for survival. On the other hand, if the total *per capita* value of the four types of capital handed on to each generation is no less than the previous generation received, sustainability ought to be assured.

One major question to be answered by those using this approach is whether—and, if so, to what extent—it is permissible to run down one type of capital if another capital stock is simultaneously being built up. For example, is it all right to reduce natural capital by consuming fossil fuels and causing pollution if human capital as represented by improvements in renewable energy technologies is simultaneously being built up? There is no hard and fast answer to this type of problem and careful judgement is required on a case-by-case basis. However, most people would probably accept that there are limits below which each type of capital should not be reduced whatever the gains in other areas. After all, there is no point in, say, improving the transport infrastructure, if, simultaneously, the social fabric is breaking down catastrophically. Ismail Serageldin's World Bank paper<sup>ii</sup> on the Four Capitals approach accepts that there are absolute limits that must be observed.

#### **1.4.2 Strong and weak sustainability**

In addition to discussing the absolute lower limits of the four capitals, Serageldin<sup>iii</sup> divided possible attitudes to increases in capital in some areas and losses in others into *four* categories: "weak sustainability", "sensible sustainability", "strong sustainability", and "absurdly strong sustainability."

1. **Weak sustainability** is not concerned with the level of the individual indicators, just the overall sum of the Four Capitals handed on to the next generation. Losses in any area can be made up by gains in any another.
2. **Sensible sustainability** is primarily concerned with maintaining the total stock of capital handed on but pays some attention to the parts which are assumed to be substitutable up to a point. Since that point is not known, they should be treated prudently. For example, oil may be depleted so long as the receipts are invested in renewable energy production.
3. **Strong sustainability** requires maintaining all the capitals in good condition, as well as the total capital stock. One type of capital cannot be substituted for another, and there is only limited substitutability even within the same capital type. For example, the loss of forest in one

place should be replaced by the addition of a similar type of forest elsewhere, not the restoration of some other biotype.

4. **Absurdly strong sustainability** would maintain all parts completely intact and never deplete anything. Only the "over-mature" portion of a timber stand or other stock of renewable resources could be harvested, and oil and other non-renewable resources could not be used at all.

### **1.4.3 Getting More Specific: How Do we Make Sustainability Assessments at the Programme Stage?**

The final section of this part of the report, namely section “**1.7 Measuring Sustainability: The Indicators**”, proposes a variety of specific indicators that can be used to assess Sustainability, and which measure aspects of the Four Capitals outlined above. In advance of that discussion, we describe the Sustainability Assessment at the Programme stage (in this subsection), and at the Project stage (in the next subsection).

At the Stage 1 Sustainability Assessment: Programme stage, a limited number of these measures would be used *to make a general assessment* as to whether a list of projects were sound and should go on to the specific project stage. The project stage would require an examination of a longer list of specific indicators and how they are expected to be affected at a specific localized location.

We have prepared the following matrix for *programme planners* to use to assess whether there might be an overall net increase in the total four-capital stock as a result of the programme they are developing – see Table 1-1. Each major aspect of the programme should be tested with its own matrix, and alternative courses should be tested, one against another. For example, a transport need could be met, conceivably, in two or three ways. If each were tested, the matrix should enable the planners to state which option seemed to be superior from a sustainability perspective. In this way, various forms of transport options could be simultaneously assessed for sustainability. If the differences are not clear-cut, however, it might be necessary to explore the options in more detail in the second assessment phase (at the project level).

	<b>construction</b>	<b>0-5 years</b>	<b>6-15 years</b>	<b>16-50 years</b>
	Nat Soc Hum Phys	Nat Soc Hum Phys	Nat Soc Hum Phys	Nat Soc Hum Phys
Local				
Regional				
National				
World				

**Table 1-1 A simple programme matrix for use by planners to assess overall net increase in the total four-capital stock as a result of the programme they are developing**

### **How would this work at the Programme Stage?**

The Department of Transport would establish indicators as criteria with advice from the Office of Sustainability Assessment, such as the indicators we outline in **1.7 Measuring Sustainability: The Indicators**, which measure the four capitals. For the Programme Stage this would be a limited number of general indicators. These indicators, measuring each of the four capitals, would be given numerical values, and summed (for each capital); these numbers being placed into one of five categories<sup>4</sup>. These categories, indicating assessments of how each capital would be affected by a proposed programme scheme, would be converted into an easily understood five-colour “impact scheme” with the colours red, yellow, white, light green and dark green indicating differing levels of impact on the capital as follows:

- **Red:** if any capital is expected to decline seriously in a period for a particular location, that square is coloured red.
- **Yellow:** a moderate decline is indicated by yellow
- **White:** no change is left white,
- **Green:** a small gain is indicated by light green
- **Dark Green:** a large gain is indicated by dark green.

Obviously, the quantity of dark greens should outweigh the reds, and the local or regional gains should not be at the expense of national or international declines, such as may occur if shifting developments from one place from another. An assessment would be carried out for each of the various ways of achieving the programme's real goal; for e.g.: road versus rail; and its sustainability assessed. This assessment would be carried out in consultation both with other Government Departments and Agencies, and with the public.

Clearly, the programme stage Sustainability Assessment process is general. However, putting programmes through this matrix checklist will force people to

<sup>4</sup> We provide a clearer example of this in 1.5 Stage 2 Sustainability Assessment: The Project Stage

think in detail about the full implications of what is being proposed. The process goes some way towards ensuring that the EPA's definition of sustainable development comes about: "*development which occurs within the general carrying capacity of the environment and any net negative effects of which are balanced against development gains*". In particular, it will mean that planners have to weigh losses in one form of capital against gains in another without recourse to a monetary evaluation.

## **1.5 Stage 2 Sustainability Assessment: The Project Stage**

If and when a road project is selected for inclusion in a programme such as a roads programme under the National Development Plan or a County Development Plan, a more thorough **Stage 2 Sustainability Assessment: The Project Stage** should be used to evaluate the likely effects that a particular proposed road will have on local communities, individuals, and the environment along the proposed route. At this stage the Office of Sustainability Assessment would again draw upon our suggested list of indicators (and others) to assess a particular project. Unlike the Programme stage, the indicators used for the project stage would be comprehensive and would examine specifically the effect of a project (for e.g.: a road) on the local area and the communities contained therein. This list of indicators would supplement and in some cases replace the measures considered in the current Environmental Impact Statement (EIS). Like the EIS, public and private consultation would be sought along with the assessments of the Office of Sustainability Assessment. However, as outlined above, serious efforts would be made to involve the public and to employ qualified, licensed, independent consultants with expertise and credentials in their specific areas. The oft-charged tendency to hire consultants, whose primary duty is to confirm pre-ordained government decisions, would be avoided. Moreover, consultants who provided poor assessments or assessments that did not hold true over time could lose their license to consult on government projects. Consultants would be expected to be experts and would be held accountable for their professed expertise.

### **1.5.1 How do we assure that the Sustainability Assessments at the Project Level are Accurate?**

The short answer is through time and experience. In the beginning, the Office of Sustainability Assessment will have to rely upon qualified experts and public consultation to utilize the long list of approved indicators and make educated predictions about the effect of a proposed project on a local area. However, over time, the Office of Sustainability Assessment will be able to acquire empirically grounded predictors based upon its monitoring of the effects of existing roads (or transport schemes). This is why the monitoring

process (or post-decision assessment) process is so critically important. Such monitoring over time will produce real data and real predictions that are reliable and valid for each of the four capitals. Of course, with some indicators the forecasting is already available (e.g., the production of air pollutants from roads). To facilitate the creation of these forecasts, the Office of Sustainability Assessment will also hire scientists to examine the scholarly research on the measurement and forecast of the four capitals in other countries and across disciplines. This empirically-based information will also be used to help provide forecasts concerning the effects of various schemes on sustainability.

### ***1.5.2 An Example of how the Sustainability Assessment Process might progress early on, prior to development of accurate forecasts for all indicators***

If a programme promises a four-capital gain, the next step is to look at the individual projects within it to ensure that the gains are maximised and the losses minimised. As we note in **1.7 Measuring Sustainability: The Indicators** (below), each researcher in our team was asked to recommend indicators that could be used to assess how a particular project might affect the future flow of benefits from his or her area of concern. Most of the indicators which the specialists recommended fitted easily into one or more of the four capital types.

The question then would be how to weigh up the capital losses shown by some indicators against the gains shown by others. How do you balance, say, an improvement in childhood dental health (a human capital gain) against a drop in the butterfly population (a natural capital loss)? There is no objective way in which these can be compared. However, we will be able to measure each capital and make forecasts about it in due time. The ultimate decision about trade-offs (or whether they should be allowed at all) is a matter to be decided by the public and its government.

Ultimately, planners assessing sustainability will have to make judgements. Early on, that is, prior to reliable forecasts being available, we propose that these judgements be applied as follows. Suppose we have 20 indicators tracking the level of human capital. The Office of Sustainability Assessment team would discuss the relative importance of each indicator and decide what weight to assign to each one, so that the total weighting added up to 100. Thus, although the average per-indicator weighting would be 5, one indicator might be assigned a value of only 2, while another might get a score of 20. We suggest that this weighting process should be carried out on a project by project basis as some indicators might be particularly crucial in some areas and, if they were already low, a further decline might matter more than a similar decline would in an area in which the indicator was high. Indeed, it might be that the baseline level of one indicator was so low already that any further decline would be disastrous. More generally, we expect that those planning projects will look at the weightings assigned to the indicators for the

areas through which their roads will pass and take great pains to minimise the effects on those with the highest weightings. This is exactly the response we would want.

After the weights had been assigned, the net gains and net losses for each of the indicators would be multiplied by their respective weightings and summed, to show whether there would be an overall gain or loss in flow of benefits from each type of capital as a result of the project during the various phases of the project's life. If some types of capital showed gains and others losses, they would then have to form the basis for a judgment on whether the gains were great enough to outweigh the losses thus allowing the project to proceed.

Apart from the assembly of the baseline data, this process would be somewhat subjective in the early phases of the Sustainability Process. As indicated, with time and monitoring and analysis, accurate forecasts and consequences would be developed, thereby removing much of the subjectivity from the process. In many ways we would be moving towards a better understanding of Sustainability overtime, all the while cautiously considering, estimating, forecasting, and debating issues of sustainability here and now.

Early on—during the here and now period—it is quite possible to imagine a different set of assessors having a different set of values and deriving quite different expectations about whether the project was likely to lead to an overall sustainability gain or not. It would not be a bad thing if this happened because it would mean that the two or more views would have to be debated and the reasons for the diverging views established before the project could proceed. The key is, especially early on, that *there actually is* a set or team of assessors for each of the different capitals.

Very probably, a limited range of indicators would be affected. Altering the project so that it paid more attention to these might mean that both sides could agree that the project made an overall contribution to sustainability.

The debate on the assumptions and values underlying the assessment should not be confined to “experts”. We would like the general public to be able to explore the likely effects of the project too by various means and in various forums. For example, we recommend that the graphs showing the baseline data for each indicator, and the specialists' projections on how that indicator might be affected by the project, be made available on internet. These should be presented in a way that allows a visitor to the website to make his or her own projections and then to assign their own weightings to these so that they can see what effect they have on the project's sustainability. We believe that this would be a much more open and transparent approach than, say, attempting to assign cash values to the gains and losses and then presenting those as hard, objective economic gains which have been derived scientifically and which only experts can discuss. In a democracy, people should be able to participate in the making of decisions which affect their and their children's futures. This is a way in which they can do so.

## **1.6 Stage 3 Sustainability Assessment: The Post Decision Stage**

We propose that once a road or transport project is built, its sustainability should be monitored over time using scientifically attained measures. This monitoring will include the effects the road or transport project has had on subsequent land-use planning decisions because the mode of transportation chosen affects the character of land-use that follows. In **1.7 Measuring Sustainability: The Indicators** below we lay out the type of indicators that should be monitored over time. As noted above, this monitoring process should take place for both newly approved roads and public transport options *and* also those in place or which have been built or improved over the last ten years or more. Including these older systems in the monitoring process is critical because they enable the collection and analysis of comparative data on the effects of road and transport decisions at different stages of maturity. For example, this would allow us now to improve our ability to forecast how roads, which are new, or five or ten or twenty years old, will affect sustainability in the future. Longitudinal and cross-sectional data, collected systematically and rigorously analyzed, will go a long way to reducing the subjective guesswork from assessing the effects a road will have on sustainability measures over time.

Of course, there is plenty of exiting empirical research and time-proven models on the effects of roads (or transport) on air, noise, water, likely transit-use, induced traffic, and a host of other indicators that are part of our four capitals approach. We reference some of this information in our indicators section (below). In addition to other responsibilities, our proposed Office of Sustainability Assessment should be in charge of collecting these models and research across disciplines (and across countries) so that is could be readily applied to the sustainability assessment process.

The EPA's current work in assessing the **State of the Environment** on a national basis and their planned work on County State of the Environment reports means that they are the logical existing Agency to house this Office of Sustainability Assessment.

## **1.7 Measuring Sustainability: The Indicators**

In the remainder of this section of the document, we examine possible indicators or measures that could be used for our proposed Sustainability Assessment. *Each researcher on the team was asked to recommend measures that could be used to assess key concepts in their particular area of concern. Most of these recommended measures easily tap into one or more of the four capitals presented above.*

Our recommendation is that, with consultation with stakeholders, these measures be refined and measured nationally and locally and utilized to assess programmes and specific projects. These measures should also be used in the post-decision stage to monitor the four capitals over time.

The indicators suggested below are only initial suggestions for their own fields. They are not intended to be complete. As such, they need to be fully developed by teams of experts and additionally revised by an interdisciplinary team. There are no suggestions in a few significant areas such as noise, visual amenity and landscape and loss of agricultural land. However, we felt it was important to give examples in order to explain the methodology which we are proposing and also to document potential indicators whose importance became clear to us during the research. Other work on indicators has been done by EEA with their TERM indicators<sup>5</sup> and through Action 350 of COST<sup>6</sup>.

## ***2 Air and Climate (Example of Natural Capital with effects on Human Capital)***

The following criteria are recommended for inclusion under the heading Air and Climate in the matrix for project selection during Sustainability Assessment of transport plans and programmes (Stage 1 Sustainability Assessment). These criteria would also be used in Stages 2 and 3.

### ***2.1 Criterion1: Predicted emissions of Greenhouse gases – specifically CO<sub>2</sub>***

**Target for comparison:** required reduction in emissions to meet UNFCCC goal of *"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"*<sup>iv</sup>.

The calculation of estimated changes in emissions from changes in trip numbers and distances as measured by traffic engineers and predicted by traffic modellers is comparatively straightforward. It relies on emissions factors for the various categories of vehicles using or predicted to use the road network following the investment.

The more difficult but no less important element is to ensure that the calculations reliably predict and assess changes in trip numbers and lengths resulting from:

---

<sup>5</sup> [http://reports.eea.europa.eu/eea\\_report\\_2006\\_3/en](http://reports.eea.europa.eu/eea_report_2006_3/en)

<sup>6</sup> <http://www.cost.esf.org/index.php?id=418>

1. trip reassignment
2. modal split changes
3. new trips/suppressed demand
4. changed trip lengths/chaining
5. consequential development/land use changes, associated minor roads and resultant trips

These factors will need to be included in the traffic calculations carried out at the project selection stage in order to get reliable calculations of impacts on GHG emissions.

Note that at EIA stage and in retrospective studies, one can include assessment of changes in emissions due to changes in trip speeds, congestion, queuing etc. However, it might not be practical to do this prior to the design of the road. One possible way to deal with this would be to use a schematic design in the modelling exercise. For the assessment of projects other than road construction projects, where, obviously, the existing road design is known, it would be possible to include these elements.

## **2.2 Criterion 2: Emissions of long range pollutants, NO<sub>x</sub> and SO<sub>x</sub>**

**Target for comparison:** National Emissions Ceilings Directive<sup>v</sup>.

The effects of transport investments on emissions of long range acidifying pollutants can be calculated using effectively the same methods as emissions of CO<sub>2</sub>. Effectively the same considerations apply.

## **2.3 Criterion 3: Predicted ambient levels of particulates and NO<sub>x</sub>**

It is recommended that as part of the Sustainability Assessment of transport investment proposals, calculations be carried out for any potential transport investment to estimate the overall change in population exposure. This should then be expressed in terms of health impacts using established epidemiological relationships.

The NRA's Draft "*Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes*"<sup>vi</sup> recommends that calculations of the overall change in exposure at residential properties be made at route corridor selection stage.

The essence of this recommendation is that estimates be made of the number of locations at which people will be exposed to changed levels of pollution as a result of the scheme in question, an estimate of the numbers of people involved and an estimate of the extent of the change in exposure which is likely.

This data should then be used to generate health risk assessment data, relying on established epidemiological data. Epidemiological relationships exist showing associations between particulate pollution and health effects. These relationships are highly consistent over time and location and are used by the WHO in official studies and advice<sup>vii</sup>.

## ***2.4 Potential Criterion 4 – Heavy metals impact on Health***

A similar process of assessing potential human health impacts could in theory be carried out for heavy metals such as lead, zinc, copper, chromium and cadmium originating from transport installations, which find their way into humans by air or water. However, the level of knowledge of their release and dispersion into the environment from roads may not be sufficient at the moment to enable meaningful estimates to be made.

# ***3 Social Capital and Community Effects***

## ***3.1 Background***

The current EIA process fails to assess adequately or accurately a road's likely or actual impact on social interaction and communities. This is discussed in depth in the "Section 1" report of this research project. Part of the problem is that the current EIS criteria views social and community effects too narrowly. This is an unfortunate oversight that clearly needs to be remedied.

Part of the problem may also be that engineers and most planners may not always recognize how their decisions affect social interactions or communities. A decision to build a motorway, for example, creates pressures to convert farm land into housing estates or retail outlets. Recent evidence suggests that when this development occurs in Ireland it tends to follow a car-oriented form of development similar to what is currently found in suburbs in the U.S. Much of Ireland's new growth around motorways is largely designed using American style Euclidian Zoning. Euclidean zoning's main characteristic is the segregation or separation of uses. Shops, schools and other amenities tend to be separated from residential zones and are often best accessed by car. Car use is typically a requirement due to distances and the lack of

connectivity between housing estates. Zoning regulations or planning guidelines “often favour disconnected cul-de-sac street designs over more connected grid networks” (Frank et al, 2006). In such places, children are typically driven to school, and all shopping or the enjoyment of amenities is car-dependent.

Car-oriented development that encourages or enables one-off housing or suburban estates that require long commutes to work and to shop have been found to create many unintended consequences. One consequence is that people walk or cycle less and thus are more likely to be overweight. “A survey of 10,898 people in Atlanta, Georgia (Frank, Anderson & Schmid, 2004) showed that each additional hour spent in a car was associated with a 6% increase in the odds of being obese, while each additional kilometre walked per day was associated with a 4.8% reduction in the odds of being obese” (Frank et al., 2006). A recent article published in the *Journal of the American Planning Association* made the following conclusions based on empirical examination of communities in Washington State in the US:

*The literature shows single-use, low density land development and disconnected street networks to be positively associated with auto dependence and negatively associated with walking and transit use. These factors in turn appear to affect health by influencing physical activity, obesity, and emissions of air pollutants. We evaluated the association between a single index of walkability that incorporated land use mix, street connectivity, net residential density, and retail floor area ratios, with health-related outcomes in King County, Washington. We found a 5% increase in walkability to be associated with a per capita 32.1% increase in time spent in physical active travel, a 0.23-point reduction in body mass index, 6.5% fewer vehicle miles travelled. 5.6% fewer grams of oxides of nitrogen (NOx) emitted, and 5.5% fewer grams of volatile organic compounds (VOC) emitted. These results connect development patterns with factors that affect prevalent chronic diseases. (Frank et al., 2006). Emphasis added.*

The point, of course is that there are empirically documented relationships between community design and transport options and that these in turn have consequences for human health and pollution. Road-building, public transport and community planning cannot be divorced from each other; they must be planned simultaneously with an eye toward providing citizens with a range of viable transport options that include walking or cycling.

Having established the important linkage between road-building and land-use community planning, it is important to specify what social and community indicators should be measured for our Sustainability Assessment. We divide these below into two main categories: *social effects* and *community effects*. The community effects section is further subdivided into effects on community walkability and human health.

### **3.2 Social Effects: Measuring Social Capital**

Social Capital is defined as social networks and interactions that inspire trust and reciprocity among citizens<sup>viii</sup>. Persons who are socially engaged with others and actively involved in their communities tend to be healthier physically and mentally<sup>ix, x, xi, xii, xiii, xiv, xv, xvi, xvii, xviii, xix, xx</sup>. In addition, higher levels of social capital have been linked to the proper functioning of democracy, the prevention of crime, enhanced economic development, and the socialization of well-adjusted children and teenagers. These interactions typically occur between neighbours, family members, friends, or within various community or professional groups/organizations. Leyden has demonstrated that there may be important linkages between community design and social capital<sup>xxi</sup>.

The best way to measure social capital is through random-sample scientific public opinion surveys. These surveys could be conducted before and after a road was built to assess the road's impact on social capital in communities that are adjacent to the road. Survey questions would focus on: levels of trust (in others and public officials), reciprocity, social engagement with others, involvement in the community, volunteering efforts, various forms of political and community engagement, the willingness of respondents to become involved and address problems in their community, one's connection to their community, religion, television usage, fear of crime, and commuting times.

Attached is a short survey that has been used by Robert Putnam and his colleagues to measure social capital in various communities in the U.S. (See Appendix 2). Most of the items noted above are measured via the questions provided. Some of the questions—especially those focusing on race and ethnic relations—may or may not be relevant here. Of course, some of the questions provided in Appendix 2 would have to be updated slightly for the Irish context (See Leyden, 2003). Together these questions could be used to assess community social capital in local communities (and nationally) over time. Use of this survey could enable researchers and consultants to assess the effects of a road on social capital in adjacent communities or areas with one-off housing. Moreover, these findings could be compared to social capital levels in existing villages and urban areas where no new roads have been built recently. By comparing communities across locations and over time conclusions could be drawn on the effects that road-building and land-use planning decisions have on social capital in Ireland.

### **3.3 Community Effects: Measuring Walkability (Example of Physical Capital)**

The existing EIA/EIS process examines a road's impact on Journey Lengths, Amenity and Quality of Life and Community Severance. The problems with measuring and assessing these items are discussed in the Social and

Community Effects portion of the “Section 1” report of this Transport research project. Suffice it to say that Ireland could do far better at measuring a road’s likely community effects.

One way to do this is to measure a community's walkability, and to ask whether a road enhances residents’ ability to travel on foot or cycle. Over the last 5 years, there is a growing realization in the US that walkable communities are healthier places; physically, mentally, and socially. This holds especially true for those who do not drive such as children and the elderly.

The costs of planning and building walkable communities with a village or urban feel are more than offset by the cost saving in health related illnesses. In the US, physical inactivity has an enormous cost. The projected annual cost ranges from \$24 to \$57 billion for physical inactivity alone<sup>xxii, xxiii</sup>. Inactivity significantly impacts weight control, worker productivity, premature disease, and premature death.

It is our contention that Sustainability Assessments should include indicators of neighbourhood or community walkability. There are two basic ways to measure this concept: subjectively and/or objectively. The subjective methodology uses scientific public opinion surveys and asks residents a range of questions designed to measure their perceptions of walkability. After all, they are the ones that do the walking. So-called objective measures focus on measures that are commonly found in maps, or official statistics concerning residential densities, retail locations, etc. In both instances researchers attempt to measure the “three D’s”: density (e.g., population density, employment density), diversity of land usage (or land use mix), and design (e.g. availability of footpaths and pedestrian crossings, cycle and pedestrian amenities, street pattern, streetscape)<sup>xxiv</sup>. Other elements include measures that affect the pleasantness of the journey or perceived safety such as street lighting, traffic speed, trash and litter, boarded up homes and businesses. Communities that are mixed-use (where residents can walk to shops and other amenities), feel safe, and which provide proper footpaths and facilitate walking generally are thought to be more walkable.

**Appendix 3** illustrates a series of survey items that could be used to assess perceived subjective walkability. These items were developed by James Sallis of San Diego State University and the Robert Wood Johnson Foundation. Additional surveys designed to assess neighbourhood walkability have been developed by Ainsworth, et al. and Brownson, et al<sup>xxv</sup>. All of these surveys allow respondents to assess measures such as density, land-use diversity and access, aesthetics, and safety among others.

Objective measures rely on existing governmental records to assess walkability. Research conducted by Robert Cervero of University of California, Berkeley and Lawrence Frank of the University of British Columbia best illustrates this methodology. Examples of the kind of measures typically used are replicated below in Table 3-1.

Using the Sustainability Assessment process, road schemes would not be built if they negatively affected walkability of adjacent communities. Moreover, community walkability would be measured before and going forward (over time) if and when a road scheme was to be built. Awareness of walkability as a key component of the Sustainability Assessment process would push road making authorities to work more closely with public transport and planning authorities to enhance, not diminish, walkability over time. As with all aspects of the Sustainability Assessment, long term monitoring would be required.

Measure	Definition
Net residential density	Residential units divided by acres in residential use
Street connectivity	Intersections per square kilometre
Land use mix	$A/(\ln(N))$ (see note)
Retail floor area ratio (FAR)	Retail building floor area (sq. ft.) divided by retail land area (sq. ft.)

**Note:** Land use mix =  $A/(\ln(N))$  where

- $A = (b1/a)*\ln(b1/a) + (b2/a)*\ln(b2/a) + (b3/a)*\ln(b3/a) + (b4/a)*\ln(b4/a) + (b5/a)*\ln(b5/a) + (b6/a)*\ln(b6/a)$
- a = total square feet of land for a six and uses present in buffer
- b1 = square ft. of building floor area in education uses
- b2 = square ft. of building floor area in entertainment uses
- b3 = square ft. of building floor area in single-family residential units
- b4 = square ft. of building floor area in multifamily residential units
- b5 = square ft. of building floor area in retail uses
- b6 = square ft. of building floor area in office uses
- N = number of six land uses with FAR>0

**Table 3-1 Walkability Index, Frank et al (Journal of the American Planning Association, Vol.72, No. 1, Winter 2006)**

### **3.4 Community Effects: Human Health (Example of Human Capital)**

The way authorities decide to design and build transport systems and communities affects human health. As noted above, car-dependent designs not only produce greenhouse gases and other pollutants but affect human health in other ways, such as reducing opportunities to be physically active or engaged with others in their communities.

Elements of neighbourhood or community design have been shown to be significant in explaining active travel (decisions to walk or cycle) and active recreation when residents have access to land use mix, density, access to parks and trails and certain street patterns. Active travel and recreation are also related to levels of perceived comfort for pedestrians and cyclists in the neighbourhood (e.g. presence of sidewalks, cycle paths, ease of use of pedestrian crossings, and the speed of traffic)<sup>xxvi, xxvii, xxviii, xxix, xxx, xxxi, xxxii, xxxiii, xxxiv, xxxv, xxxvi, xxxvii, xxxviii, xxxix, xl, xli, xlii, xliii, xliv</sup>. Some community designs enhance or enable physical activity and others do not.

Our Team feels it is imperative that a Sustainability Assessment consider the effects that road projects have on human health and that these measures are monitored on an on-going basis (perhaps yearly). Human health should be monitored before and after a road is built in adjacent communities. We recommend that health in these communities be monitored with surveys similar to the Behavioural Risk Factors Surveillance System (BRFSS) in the United States. This survey is quite comprehensive and uses measures that have been demonstrated to be reliable and valid measures of human health. A copy of the complete BRFSS 2005 survey (conducted by the Center for Disease Control and Prevention) may be obtained from <http://www.cdc.gov/brfss/questionnaires/index.htm>.

## **4 Biodiversity (Example of Natural Capital)**

Biodiversity is defined in the Convention on Biological Diversity (CBD) as *“the variability among living organisms from all sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of eco-systems”*.

Article 6 of the Convention requests that each party *“develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity...”* and that they *“integrate as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.”* The Conference of the Parties has provided additional guidance for the elaboration of such strategy.

Under this it is proposed to develop a system of *indicators* based on a species and ecosystems approach, as a means towards monitoring and assessment, as well as pressures and threats. Research on this system is carried out by the **European Environmental Agency** and its Network:

*“Examples of indicators at local level could be decline of a species, use of pesticides or change in pesticide use. Examples of indicators at Community level could be percentage of threatened species per known species, **fragmentation of habitats by linear transport infrastructure** or sites designated under NATURA 2000”.*

### **4.1 EEA Assessment**

Indicators used for biodiversity Assessment

- Designated areas
- *Exposure of ecosystems to acidification, eutrophication and ozone*

- Species diversity, asking the question ‘what is the state and trend of biodiversity?’

The ‘state and trends in Biodiversity’ are assessed on an EU level as follows:

Butterfly and bird species occurring in different habitat types across Europe show population changes (declines) of between -2% and -37% since the early 1970s. Similar trends can be observed in the land-cover change for related habitats between 1990 and 2000, especially for heaths and scrubs as well as mires, bogs and fens, which are specific wetland habitats; more specifically trends in birds and butterfly populations. The indicator links population trends of species belonging to these two groups (birds and butterflies) to the trends in extent of different habitat-types deriving from land cover change analysis 1990-2000.

The assessment is based on 295 butterfly species and 47 bird species linked to *five* different habitat types across several European countries. Results vary among species/habitats groups, but it is striking that both birds and butterflies, linked to different habitat types, show a decline in all habitats examined.

The area of woodland and forest habitats has increased by 1% since 1990, which in absolute terms is about 500,000 hectares. However, the species linked to the woodland and forest habitats have declined. (With regard to threatened or protected species, the question that needs to be addressed is what measures are taken to conserve or restore biodiversity?)

Therefore, in short, the three key indicators for biodiversity that could be measured are:

1. Fragmentation of habitats by linear transport infrastructure
2. Sites designated under NATURA 2000 and NHAs (natural heritage areas)
3. Exposure of ecosystems to acidification, eutrophication and ozone
4. State/condition and trends in Biodiversity, using, for example, butterfly, freshwater invertebrates, and bird species linked to a range of different habitat types relevant to the landscape types that the road is going through.

As for how much each of these are being measured currently, we summarise as follows:

1. Habitat fragmentation is not being measured
2. Sites designated under NATURA 2000 and NHAs (natural heritage areas) are well measured and documented
3. Acidification and eutrophication is measured to a reasonable extent by various agencies, required under the Water Framework Directive (WFD).
4. Research is being carried out towards establishing a long-term monitoring programme to document the current status and future trends in terrestrial and aquatic bio-diversity within the intensively-

farmed Irish landscape, although there is no systematic measurement of biodiversity status and trends in relation to the major habitat types likely to be affected by the development of transport infrastructure (e.g. wetlands, marginal land, rivers, woods, semi-natural grasslands, bog and heath, etc)

Water pollution is being measured, relatively adequately as a beginning, as a result of our requirements under the WFD.

Our recommendation is to establish a wide ranging monitoring of biodiversity health in the full range of Irish Habitat types using a set of appropriate key indicator species, such as butterflies, selected other invertebrates, and birds.

## ***5 Archaeological and Architectural Heritage (Example of Human, Social and Physical Capital)***

Unlike many of the other categories of impact discussed in this report, the impact on sustainability of archaeological impacts is inherently difficult to assess in numerical terms. Taking a Four Capitals approach, archaeological and architectural remains, and the information potentially contained within them, might be imagined as a finite source of Human Capital and Physical Capital, which also serves, to a lesser extent, as a source of Social Capital (when this information is adequately communicated to the wider community). Whereas other elements assessed as part of a sustainability assessment, such as Biodiversity, exist independently of the assessment process itself, much of the Human, Physical and Social Capital involved in archaeological and architectural assessment is actually created during the assessment.

As such, sustainability assessment of archaeological impacts must focus very closely on the production of Environmental Impact Assessments, related archaeological reports and the resulting publications. The extent of the archaeological impact is directly related to the quality of the resulting information. If a previously unidentified site is destroyed by a road scheme and the resulting information is lost due to a lack of excavation or the resulting excavation report remains unpublished, then the impact has been severe and unsustainable. If, on the other hand, the site is thoroughly excavated and the results published in a timely fashion then the result may be a net gain in Human Capital.

As discussed in the “Section 1” report of this project, National Road Schemes affect the Archaeological and Architectural Heritage principally by their impact on surviving remains, both known and unknown. The principal difficulty with any prior assessment of archaeological impacts on National Road Schemes is the fact that the vast majority of the surviving archaeology remains invisible and undiscovered until it is detected by geophysical survey or trial trenching in the final stages of pre-construction survey work. By contrast, assessment can be made of the impact on both buildings of architectural importance and on

vernacular architecture, which have a much higher visibility in the written record and are far more easily identified by survey work in the early stages of the planning process.

Due to the difficulties involved in effectively avoiding archaeological impacts, the process of sustainability assessment on National Road Schemes must focus on the effectiveness of mitigation measures rather than on specific impacts, most of which are inherently unpredictable. When discussed in terms of Human, Physical and Social Capital, archaeological remains are principally valuable as sources of visual amenity (when upstanding and visible), as an aid in creating a sense of “place” or “heritage” (not open to measurement but universally agreed to be a significant factor in social cohesion and quality of life) and as a source of information and knowledge about conditions in the past.

## ***5.1 Assessing the Impact on the Visual Amenity and Heritage Value of Known Archaeology***

Impacts on the first two factors can be effectively assessed prior to road construction. Visual amenity can be affected by interference with the intervisibility of surviving monuments and the effect of road construction on existing archaeological and historical landscapes made up of related features. In some cases, such as planned demesne landscapes, the precise outlines of historical landscapes can be determined with a degree of precision. In other cases, particularly where a series of multi-period landscapes interact with and overlay one another (as across much of Ireland), the process inevitably will be more subjective and require a multi-disciplinary process of research and consultation in advance of the assessment (see below). Once the landscapes themselves have been identified however the impact of road construction on them can be assessed with a degree of accuracy.

### ***5.1.1 Visual Amenity and Heritage Value***

Criteria for the impact on the surviving monuments and landscapes include:

1. The Impact on the intervisibility of known archaeological monuments (identified during the research process), both as a result of the road itself and of later development resulting from construction. The effectiveness of mitigation measures, both to conceal the road itself and to minimise the resulting light pollution and noise pollution can be effectively assessed. Regulations based on the **Carrowmore** judgement, requiring planners to take the effect on the setting of monuments into account during the development process can be put in

place as part of the Road Planning Process and their effectiveness can also be easily assessed.

2. Impacts on archaeological and historical landscapes can also be assessed, although more subjectively. Crucial questions to be answered during the assessment include.
  - a. Will the development divide crucial elements of the landscape from the whole?
  - b. If so, to what degree? i.e.: will the area be bisected or will the impact restricted to a small portion of the landscape? Will related ancillary roads and developments result in the complete destruction of the landscape as an integrated entity? If so can this be effectively mitigated against by regulation?
  - c. To what degree will the surviving physical links (field walls, linear earthworks, boundaries etc) between different elements of the landscape be affected?
  - d. To what degree will the adverse effects on the landscapes be mitigated by excavation, survey and other research techniques related to the development? Will the knowledge gain resulting from this research process compensate for the damage to the integrity of the existing landscape? (see below)

The destruction of archaeological remains as a result of National Road Schemes is principally mitigated against by the process of information gathering and knowledge creation. Although they are of course intimately connected, for the purposes of sustainability assessment, the two categories—information gathering and knowledge creation—can usefully be considered separately.

## ***5.2 Assessing the Mitigation Value of the Information Gathering Phase***

The information gathered as a result of pre-development research is contained in the completed in the Environmental Impact Assessment and in related reports. Discussion of several individual EIAs, consultation with professionals and academics involved in the EIA process and analysis of the NRA's "*Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes*" in the "Section 1" report of this research, identified several weaknesses with the information gathering process as presently practiced.

## ***5.3 Pre-Fieldwork Research***

Useful Criteria for the assessment of the pre-field work research include:

1. **The use of available cartographic and historic information:** Have all available sources been consulted in the compilation of the EIA? The availability of these will vary widely depending on the geographical location involved but at a minimum will involve the cartographic sources listed in the Hayes Catalogue in the National Library, the available materials in the Ordnance Survey Memoirs, published maps and archives, materials in the National Museum's archives and other official sources listed in the NRA's guidelines, the available secondary literature including articles in local histories historical journals, memoirs etc and other sources identified during the consultation process. It will never be possible fully to exhaust all potentially available sources of information but the mere process of assessing the historical/cartographic research section of the EIA should help to clarify and improve the methods involved.
2. **The consultation process:** Have all potentially interested parties been consulted early in the process (i.e. prior to the selection of the preferred route by road planners) and has the information gained as a result of consultation been integrated with information from other sources? The consultation process should not only include the statutory consultees but also University Departments, the Discovery Programme, individuals who have published historical or archaeological works on the area in question, land owners, local archaeological and historical societies, folklore and place-name experts with an interest in the area as well as the County Archaeologists and their staff. As with the assessment of historical and cartographic sources, the process of consultation will never succeed in gathering all of the information potentially available but the results attained can be markedly improved over present practice and the process of assessment will help to identify further weaknesses.
3. **The necessary expertise:** Did the team involved in the EIA have the necessary expertise to assess the area through which the proposed routes are to run? i.e. if demesne landscapes, areas of significant industrial archaeological sensitivity or areas with special archaeological issues such as wetlands are present in the study area, did the team contain personnel with experience in these fields? If not then was this deficiency remedied during the consultation process?
4. **Deficiencies in the available information:** Were weaknesses and "blank areas" in the evidence identified during the research process? When no cartographic or documentary evidence was available for certain areas, or structures are known to have been present but cannot now be precisely located, has an effort been made to rectify this by the use of other sources or has an absence of material simply been assumed?
5. **Cooperation with the architectural heritage assessment team:** The "Section 1" report identified failures in consultation between the archaeological and architectural heritage teams as a critical area leading to a loss of potential information. Has cooperation between the two teams been documented and areas of overlap or mutual concern, i.e. possible earlier phases of architecturally significant buildings or the

incorporation of archaeological monuments or earlier landscapes into demesne features been adequately addressed?

6. **The use of modern survey techniques:** Given the ubiquity of buried archaeology on road routes the use of geophysical survey techniques, lidar, aerial survey, aerial photographic archives and other procedures should be considered as standard procedure and used in all cases where they might be useful. The assessment process should determine whether or not this has been the case and where a potential source (such as the Air Corp's vertical coverage from the 1950s) has been neglected it should identify the reasons for this deficiency.
7. **The identification of archaeological and historical landscapes:** It is rarely possible to precisely delineate archaeological or historical landscapes, and recent efforts funded by the Heritage Council to give them a precise definition have proved indecisive. Nevertheless, given the importance of such landscapes for assessing the impact of Road Schemes on the Heritage Value and Visual Amenity of known monuments as well as the importance of setting and interrelationships for effective knowledge creation (see below), identifying such landscapes and the relationships between them should play a central role in the consultation and pre-fieldwork research phases of the EIA process.
8. **Areas of potential archaeological interest:** Have areas of potential archaeological interest been identified? While the present NRA Guidelines and standard Archaeological assessments are adequate in addressing such areas of archaeological interest as wetlands (particularly where this is mandated by official bodies) other potential areas of archaeological interest are regularly given only a cursory treatment. As part of pre-fieldwork research and consultation every effort should be made to identify portions of the study area where archaeological material is likely to be encountered. Information gathered from other sources, notably the NMI files and the Architectural Heritage team, should be integrated into this effort and the resulting lists should be used to advise the monitoring and excavation teams.

#### ***5.4 Field work, monitoring and preservation by record***

The following criteria should be used in assessing the fieldwork component:

1. **Inspection and Recording of identified sites:** Have all sites, identified during pre-fieldwork research, been adequately inspected and recorded? Some archaeological monuments, vernacular buildings and linear boundaries inevitably will be destroyed during road construction. If these have been adequately recorded then the archaeological impact may still be sustainable. Monuments should be surveyed and excavated in order to identify their precise extent and derive the maximum benefit from their destruction. Vernacular buildings and linear boundaries also should be surveyed thoroughly and

recorded, both to identify any earlier phases of use on the site and to preserve as much information as possible about an irreplaceable heritage resource.

2. **Identification of unlocated sites:** Have unlocated but previously identified sites been identified during fieldwork or archaeological monitoring? Aerial photographic, geophysical and documentary research often identifies crop-marks, other anomalous features and historically present but at present unlocated sites (it is virtually impossible to completely destroy an archaeological site) along projected routes. Archaeological fieldwork prior to construction and monitoring and excavation work should endeavour to resolve outstanding questions relating to these prior to road construction.
3. **Experience of archaeological personnel:** Do the personnel assigned to fieldwork have sufficient experience to identify correctly the archaeological material they are likely to encounter during their time in the field? During consultation in preparation for the “Section 1” report of this research, the issue of inexperienced personnel being assigned to monitor soil-stripping and do field inspections prior to work commencing was mentioned repeatedly. Assessment of field experience-needs should draw upon information gathered during the research for sections 7 and 8 above. The lack of Mesolithic material encountered during archaeological monitoring has been noted in the “Section 2” report and may be related both to a lack of experience with Mesolithic material on the part of monitoring staff and to the tendency of pre-fieldwork research to ignore the Mesolithic in the assessment of areas of archaeological interest. Valuable information is certainly being lost as a result.

## **5.5 Knowledge Creation**

Consultation during the preparation of this report and the influential “2020 Archaeology: Knowledge Creation through Partnership” report have identified knowledge creation and dissemination as crucial bottlenecks in Irish archaeology. Vast quantities of information have been produced in the form of excavation reports, archaeological surveys, and geophysical and other technical reports but there has been a persistent failure to convert this into usable knowledge by timely publication. The information contained in technical and excavation reports rapidly loses value after the initial report is complete as archaeological teams are broken up and move on to other projects. Simultaneously the large volume of excavated material accumulated during development-led archaeological excavations is putting an unsustainable level of strain on the curatorial capabilities of the National Museum and rendering it difficult or impossible to display or store material in an appropriate or usable way.

At a strategic level, **Archaeological Sustainability Assessment** should focus on the incorporation of knowledge-creation strategies into the Road Planning Process. The following criteria are significant.

### **5.5.1 Publication**

1. Have financial and logistical guarantees of publication been incorporated into the proposed mitigation measures? Regardless of the quality of excavation or fieldwork, preservation by record or excavation is valueless unless the resulting information is made available in published form. Publication must be incorporated into the Assessment process as a compulsory mitigation measure and rigorously enforced by the relevant authorities. This will necessitate financial provision being made for the archaeologists and specialists involved and publication deadlines being incorporated into the contracts of the companies involved, rather than being left as an afterthought as appears to be the case at present.
2. Is the data accumulated as a result of earlier research in the form of Environmental Impact Statements, archaeological reports etc available to the public? The information contained in EIAs and their related documentation represents a valuable source, both for the specific archaeological information and also for the resulting insight into developing archaeological techniques. Ideally the EIA process should be one of continuous improvement based on lessons learned and insights gained during the research process. At present EIAs can be quite difficult to acquire but they could easily be made available online in PDF format. The resulting accumulation of archaeological information would be an invaluable resource for other scholars.

### **5.5.2 Storage and Curatorial Issues**

Has provision been made for the adequate storage and (where appropriate) display of material resulting from archaeological monitoring and excavation-work relating to the road scheme? A road programme which produces bodies of material and artefacts which overwhelm the curatorial capabilities of the state bodies assigned to deal with such material is not sustainable even in the short term. The cost of analysis, storage and display of artefacts discovered on National Road Schemes needs to be incorporated into sustainability assessment in order to make provision for what will otherwise be an unforeseen but wide-ranging negative impact on the whole of Irish archaeology.

### **5.6 Downstream Impacts**

Have potential downstream impacts on archaeological material been adequately addressed? In addition to direct impacts caused by construction work, road schemes can have a wide range of downstream effects on buried

archaeology by altering the soil environment, increasing the level of vibration or atmospheric pollution in the area etc. These effects need to be assessed by the archaeological team performing the initial Environmental Impact Assessment in cooperation with other teams working in separate fields. The impact on, for example, buried biological deposits due to alterations in the level of soil moisture, are not address under the system as practised at present but represent a serious, if unquantifiable, impact on the archaeological heritage.

## **5.7 Sustainability Assessment**

To recap, regrettably assessing the impact of road schemes on the archaeological and architectural heritage does not lend itself to a series of readily quantifiable indicators.

The following criteria are recommended for use under the heading **Archaeological and Architectural Heritage** in the matrix for project-selection during Sustainability Assessment. The criteria used in such an assessment resolve themselves into a series of questions:

- Has the impact on the intervisibility of known archaeological monuments been effectively mitigated against? (Y/N)
- Has the impact on identified archaeological, architectural and historical landscapes (both immediate and longer term) been adequately assessed and mitigated against? (Y/N)
- Has all available cartographic, historic and aerial photographic evidence been consulted? (Y/N)
- Have all potentially interested parties been consulted? (Y/N)
- Has the necessary expertise been made available to effectively deal with archaeological, historical and architectural issues likely to arise during construction? (Y/N)
- Have deficiencies in the available information been identified and compensated for? (Y/N)
- Has effective cooperation between the architectural and archaeological heritage assessment teams been established? (Y/N)
- Have all appropriate technological survey techniques been deployed? (Y/N)
- Have areas of potential archaeological interest been identified? (Y/N)
- Have all sites identified during pre-fieldwork research been adequately inspected and recorded? (Y/N)
- Has provision been made for the identification of unlocated but previously identified sites? (Y/N)
- Have adequately experienced personnel been assigned to fieldwork and monitoring work? (Y/N)
- Have arrangements been made to guarantee timely publication of excavation results? (Y/N)

- Have technical and archaeological reports been made available for use by other scholars? (Y/N)
- Has provision (financial and physical) been made for the storage and display of archaeological material? (Y/N)
- Have potential downstream impacts been adequately addressed, and has provision been made for monitoring these impacts? (Y/N)

Road projects which fail to adequately address the issues raised by the questions above should be considered unsustainable from an archaeological point of view. Many cannot be answered with any sense of finality but the process of trying to answer them and the creation of the appropriate mechanisms for consultation and discussion related to them should lead to an improved understanding of the Heritage issues involved in individual road projects and hence to a more sustainable approach. We recommend that it be recognised that the EIA process as currently practised does not adequately address any of the issues raised and that as a result the actual archaeological and architectural impact of National Road Schemes is being radically under-assessed.

## **6 Economics (Example of Physical and Human Capital)**

The key question to ask about the economic sustainability of any project is

*“Just how robust is the stream of benefits that this project will produce? What is the risk that the benefits will be reduced by changed circumstances in the future while the costs involved in keeping the project running will not be reduced by the same extent with the result that costs outweigh benefits and society is not prepared to accept the loss and decides to close it down?”*

In the case of a road, its maintenance costs plus the purchase and running costs of the vehicles, together with any other costs connected with road transport, might become so high that the road gets little use, becomes potholed and is gradually abandoned. This might seem an unlikely scenario but roads have become impassable as a result of rock falls, and have been abandoned in parts of the Ukraine since the collapse of the Soviet Union. In the Irish case, very few motor vehicles used the roads during World War 2, and the effects of oil scarcity or a collapse of the world economy could mean that the nation no longer needed today's roads to the current extent. It might find that it could not spare the resources to maintain the network at its present size and in the present state of repair. Other, less energy intensive, transport modes such as rail and water might be given priority.

We therefore suggest that the test of a road project's sustainability has to be that it does not rely on a projected increase in road usage to show major benefits. Instead, it should show savings in today's terms. It should be a more

efficient, lower cost way of doing what we already do. And a key component of that lower cost should be a lower level of energy use.

At present, as was noted in an earlier section of this report, the main benefits considered by those planning road projects are the projected time savings to road users. However, we pointed out that, if these time-savings are realised, the effective cost of using the road system falls, and people can be expected to travel more frequently. The number of truck movements will also rise. Both will increase energy use. In order to prevent a new road having this effect, road pricing should be imposed to capture for the public the benefits of any time-saving. Charges should be adjusted to ensure that the overall volume of traffic does not grow and increase energy use above its current level.

The energy used annually by the vehicles on a road does not capture the full extent of the energy requirement. It omits the energy required to build the road itself, and that used to manufacture the vehicles and provide all the other aspects of a transport system. The capital cost of these items is a good proxy for their energy content and for the amount of energy required each year to maintain and replace them. In general, because of entropy, the lower the total capital required by a transport system per unit moved, the more sustainable it is. In the policy development stage of a transport project, therefore, an attempt should be made to assess the total capital cost to the nation of each possibility and to select whichever is lowest for the desired level of transport activity.

Another important question is: Who will benefit from the new road? Ideally, since this is a public project, the benefits should be shared equally. But will they go disproportionately to the better-off? Will the improvements benefit larger firms at the expense of smaller ones? Will some landowners reap windfall property gains while others see losses? We will look at these questions in turn.

### ***6.1 Will some groups benefit disproportionately?***

It may be that some groups, the better-off, perhaps, travel more by road than their poorer counterparts and would therefore benefit more from a new road's construction, especially as they would be less affected by the user-charges since they would represent a smaller proportion of their incomes. Indeed, it might be that the user-charges would make the social background of the road users more skewed than it is at present. If road projects are not to widen the gap between rich and poor, remedial measures might have to be taken to prevent it happening. This could be, say, the provision of better or cheaper coach services financed from the user charges, a development which would allow more people to benefit from the road and, possibly, lowering overall energy use. Other groups whose position must not be disadvantaged by the new road are the old, the sick, the young and those who cannot drive.

## ***6.2 Will the competitive position of some firms be improved at the expense of others?***

The road will almost certainly change shopping and distribution patterns. The spending on it could amount, in effect, to a subsidy for certain types of business. There needs to be a debate about whether the commercial changes the road could bring are in the public interest – do the people in the area served by the road want international chain stores to expand at the expense of their village shops? If they do, fine. If not, something must be done to level the playing field.

## ***6.3 Is it possible to correct for the effect on property values?***

The construction of a road will affect property values, or more correctly, site values, in the areas around it. Some owners will see their sites rise in value because of better accessibility, although the extent of this effect will be more limited than at present because an overall increase in road use will be prevented by adjusting road-use prices. Other owners will see their valuations fall because of increased traffic noise while still others will gain because the existing roads beside their properties will have become quieter.

Site valuations represent the market's assessment of the capital value of the stream of benefits that comes from owning a particular property. While a road project does not have to show a net increase in site valuations to go ahead, if it shows a loss, there needs to be an offsetting rise in some other stream of benefits—such as the energy saving—to justify the project. Note that cost of the land taken to build the road represents a capital loss. It is the capital value of the stream of benefits that the land was yielding in its present use or could yield in the future if planning permission were given for a change of use. The annual figure to which this capital value converts has to be deducted from the increased level of benefits generated by the road to show there is a net gain.

Provision needs to be made in the project budget for compensating site owners whose values fall, and imposing a betterment levy on those whose values rise. This is not only important from a fairness perspective. It also ensures that the project does not increase disparities of wealth, with the knock-on health effects that would cause.

Only experience will teach politicians and planners the best ways of counteracting the socially- and economically-divisive effects of a new road. They will learn a lot from surveys of road users carried out both before the road is built and then at regular intervals for some time afterwards.

## **6.4 Baseline Indicators**

There are a number of baseline indicators:

1. Volume of traffic using the existing road network
2. Survey to establish the journeys being made over the network, the time being taken and the incomes of the road users
3. Estimate the total amount of energy being used by the vehicles using the existing network, including that used in maintaining the road and the manufacture and maintenance of the vehicles.
4. Site values of properties in areas likely to be significantly affected by the proposed road.

## **7 Transport Policy Impact (Example of all Capitals)**

As noted earlier in this report, roads planning cannot operate in a vacuum. Policy research in the “Sections 1” and “Sections 2” reports of the study showed the negative consequences of a non-evidence-based, mono-modal transport planning regime, which, overwhelmingly and unsustainably favoured the road mode.

Sustainability Assessment as brought to bear on transport policy requires a dramatic shift in mindset and a conscious and directed move away from reliance on single-mode planning. This in turn requires significant and ongoing cultural change in local authorities and in the wider transportation planning field.

The success of a newly sustainable, responsible and holistic transport policy can be measured using the indicators outlined earlier across the different areas identified.

However the following *additional* indicators should also be incorporated, viz.:

- Km of new<sup>7</sup> heavy and light rail routes built, as proportion of total *road* network km
- Km of road re-purposed as public transport-, pedestrian- and cycle-only “Greenways”, as proportion of total road network km
- Km of road-building avoided or curtailed
- Km of cycleway or pedestrian routes built, as proportion of total *road* network km
- Number of road projects deleted

---

<sup>7</sup> “Greenfield” construction, or line re-openings; renewal of existing routes not applicable

- Number of bicycles sold
- Reductions in new car and HGV sales
- Reductions in total vehicle km generated per annum
- Reductions in total number of cars and HGVs, using 2006 as base year
- Increase of rate of conversion to sustainable non-road transportation per annum using above indicator data measured over time

It should also be noted that the measures, used to date, in transport projects have focussed almost entirely on *delivery* (Indecon, 2005). That is an insufficient approach as it omits any consideration of effects or consequences. Measures should also reflect targeted reductions in transport demand over time, acknowledging the fact that growth in demand for motorised transportation is a form of inflation and is undesirable given its cumulative impact on the environment (even where sustainable motorised modes are used). In the list above, concrete measures such as reductions in new car sales, in total vehicle km generated annually, and in the total number of vehicles on the roads, are designed with this in mind.

Sustainability Assessment of projects further embeds full and meaningful public participation, avoiding prescribed outcomes as detailed in the transport policy research in the “Section 1” report of this research. Genuine public input guarantees a broad range of views, leading to suggestions and ideas representative of and related to, all modes of transport, not just roads. This broad approach ensures balance, and outcomes that are owned, and indeed *created* by, communities.

A balanced approach with meaningful public participation will further facilitate the true and genuine consideration of alternatives, under the Sustainable Assessment methodology. One of the most serious problems uncovered in the “Section 1” research on transport policy was the restriction of the meaning of alternatives, as embodied in the EU Directive on EIA, to just mean *alternative routes* for road schemes, rather than alternatives *to* the road scheme – a critical distinction. This distorted meaning, mutually reinforced the mono-modal transport planning regime also explored in both the “Section 1” and “Section 2” research.

Finally, a focus on both balance and sustainability also will minimise naturally the impact of projects on the Four Capitals. In effect, what is involved here is the creation of a positive and self-improving decision-making ecology, within the current system.

## **8 Water Quality (Example of Natural Capital with effects on Human Capital)**

The likely and actual effects a road (or other transport scheme) has on water quality must also be assessed as part of a Sustainability Assessment process. Roads produce significant level of pollutants that are damaging to water.

Similar to the assessment of Air quality impacts, we recommend that a serious effort be made to assess the impacts that existing road schemes have had on water and to use this empirical data to inform future road scheme decisions. Existing scientific research, of course, would further inform this effort.

Part of the problem with water is that current law deals primarily with water flows (to prevent flooding and pooling). While this effort successfully removes water from the road way, very little is done to predict, investigate or monitor the effects of this water drainage (or run-off) on groundwater, streams or lakes. Of course, once water is affected it may also have profound effects on the health of plants, animals, fish and human beings.

Our Team recommends that:

1. Serious scientific research be conducted on how current road schemes are affecting water quality. This information should be used to inform decision on future road schemes.
2. A protocol be developed to set limits to the amount of pollutants which a road can produce. Pollutants over these limits must be remediated.
3. The NRA develops predictive indicators that will enable them to accurately assess how traffic densities affect water quality.
4. Groundwater pollutants be measured and reported, and that rates and flow of pollutants into streams, rivers and lakes be monitored. Pathways of these pollutants, and their effects on groundwater and soil should be investigated and monitored.
5. It be recognized that the current system design to remove water from roadways does not adequately address issues of water pollution caused by roads and its effects.

## **9 Traffic Modelling (Affects Physical and Social Capital)**

### **9.1 Modelling software**

As discussed in the “Section 1” report, traffic modelling in Ireland is in need of a general overhaul. Our team recommends that the NRA and other appropriate authorities invest in and/or develop leading edge *micro-simulation* modelling software. The micro-simulation approach still allows planners to extract more conventional aggregated quantities, such as the fraction of travellers who chose public transport for example, but also allows the generation of detailed data on air and noise pollution. One such example is the US DoT TRANSIMS suite developed to fulfil requirements of the **Clean Air Act**, the **Transportation Equity Act for the 21st Century** and other

regulations [TEA21]. It is now in wide-spread use in the USA. It has also been used in studies in Switzerland, to model the entire transport network of 5 million travellers [Raney1, Raney2, and Nagel3]. Such a suite could be adapted for use in Ireland. Given that the number of travellers is significantly smaller, the hardware investment for the high performance computing cluster necessary to run such a model would be relatively modest.

Additional modelling software should be employed for predicting pedestrian and cycling movements on and in the vicinity of proposed schemes. Such movements are invariably related to land-use and community design features.

## **9.2 Assessment of model predictions in current schemes**

We recommend that there be a comprehensive retrospective evaluation of current road schemes and to what degree they met or failed to meet their predicted traffic predictions. Understanding what went right and what went wrong with previous predictions is the first step toward refining models to improve future predictions.

## **9.3 Infrastructure assumptions as inputs to traffic models**

The current practice in Ireland whereby all transport infrastructure, and timescales for its implementation—as defined in the DTO’s and other policy documents—are used as inputs into traffic models is flawed. The reasons for this view are outlined in the “Section 1” report.

We recommend a proper empirical analysis of past policy implementation to determine a “rate of advancement of policy initiatives” in an Irish context. From this, one could derive a *likely-case scenario* for public transport and other infrastructural initiatives. Although such an approach is far from perfect, we suggest that it is still considerably better than the current practice of using the aspirational best-case scenario.

## **9.4 Economic stress testing**

We recommend that traffic predictions be made for different economic forecasts. These would enable the economic benefits of a proposed scheme to be “stress-tested” using various “sensitivity indicators”.

## ***10 Spatial Planning (Affects all Four Capitals)***

It is important to note again that decisions to build roads affect the nature of land development and human settlement patterns. As a start, we recommend indicators that measure:

1. Changes in the number of one-off houses associated with a road scheme.
2. Changes in the number of housing estates associated with a road scheme
3. The number of residents living in either #1 or #2 above, who work and shop locally as opposed to at distant sites.

Further spatial planning indicators should also be developed.

# Appendix 1 Sustainability Assessment Flowcharts

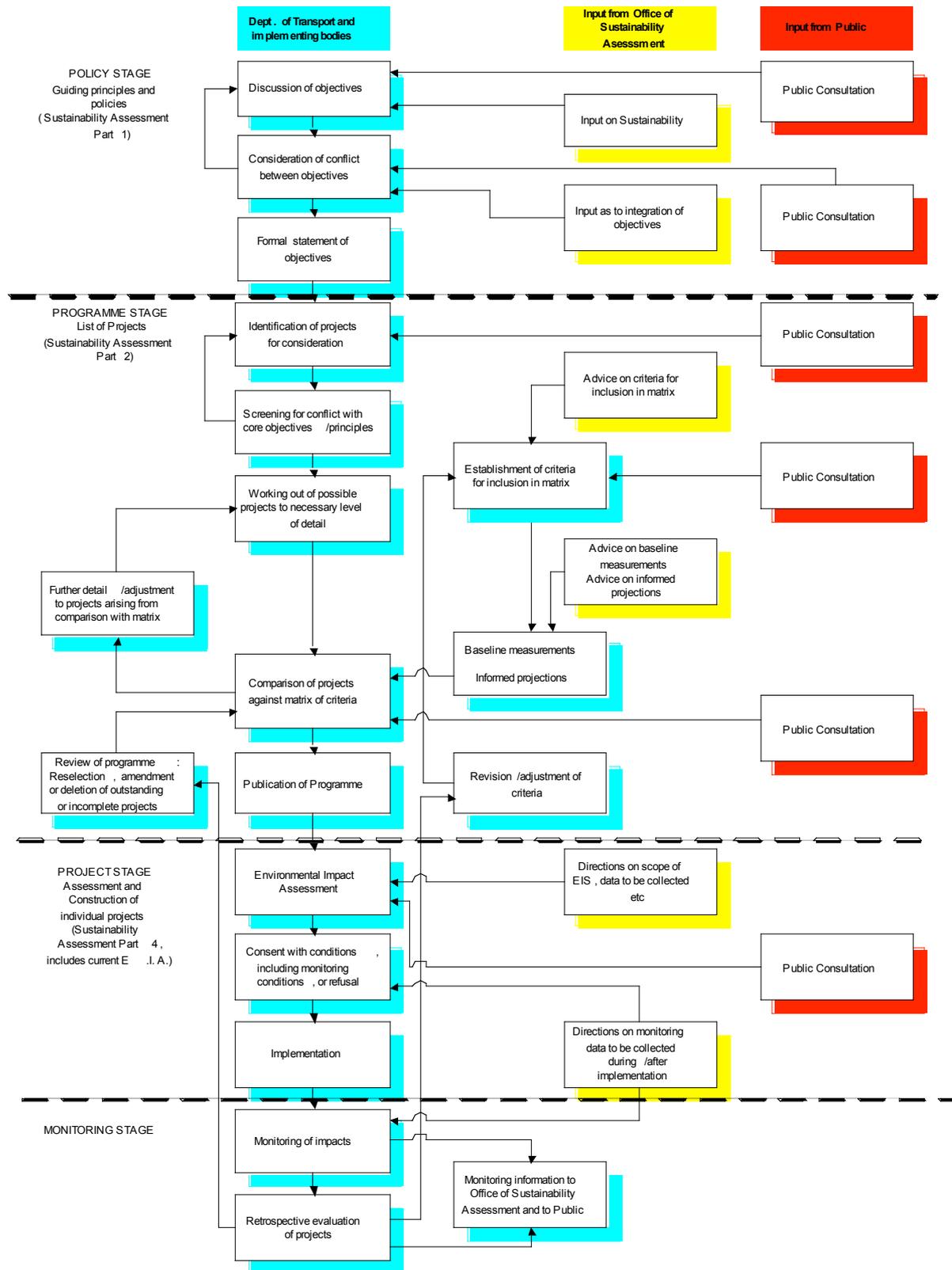
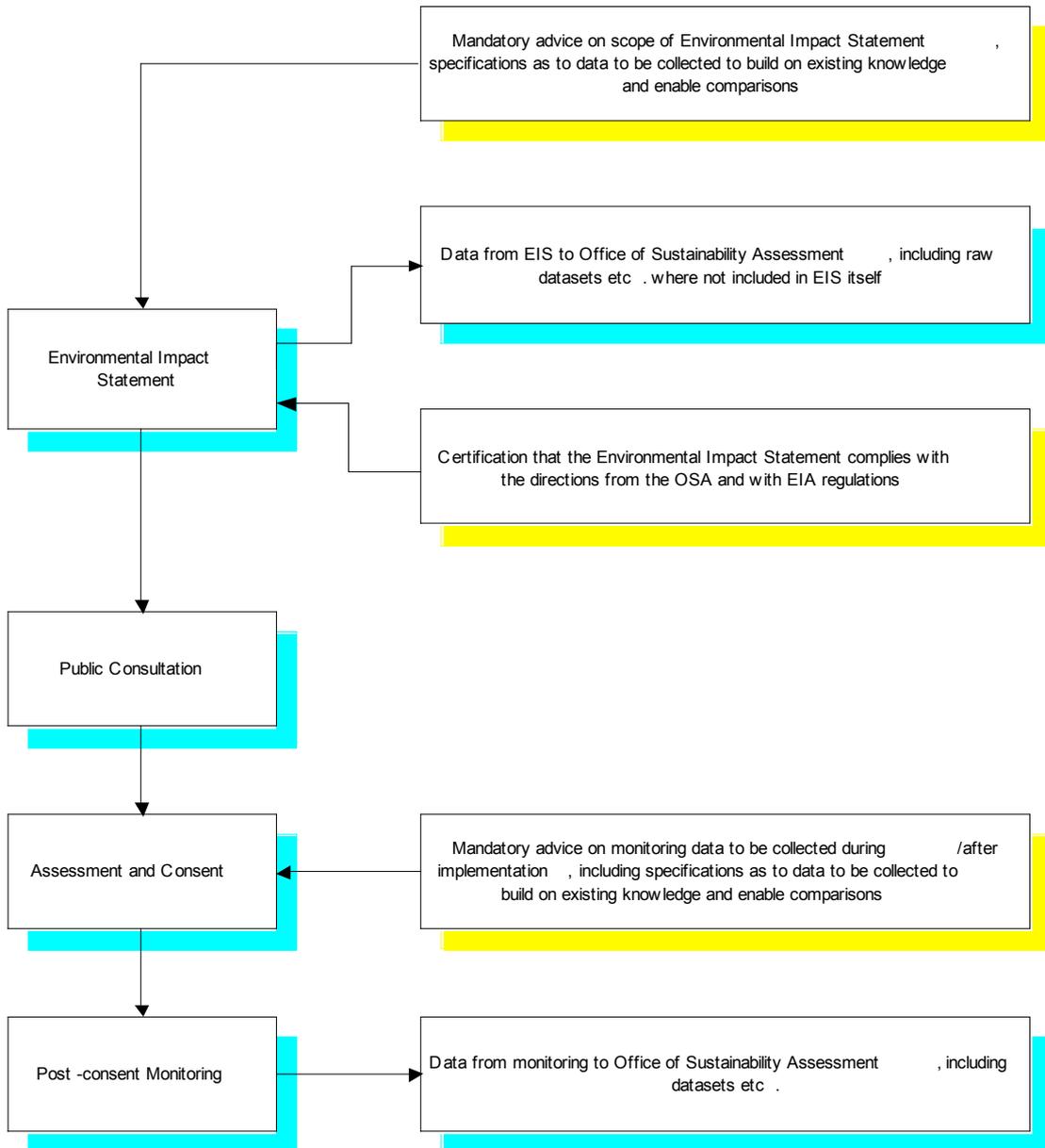
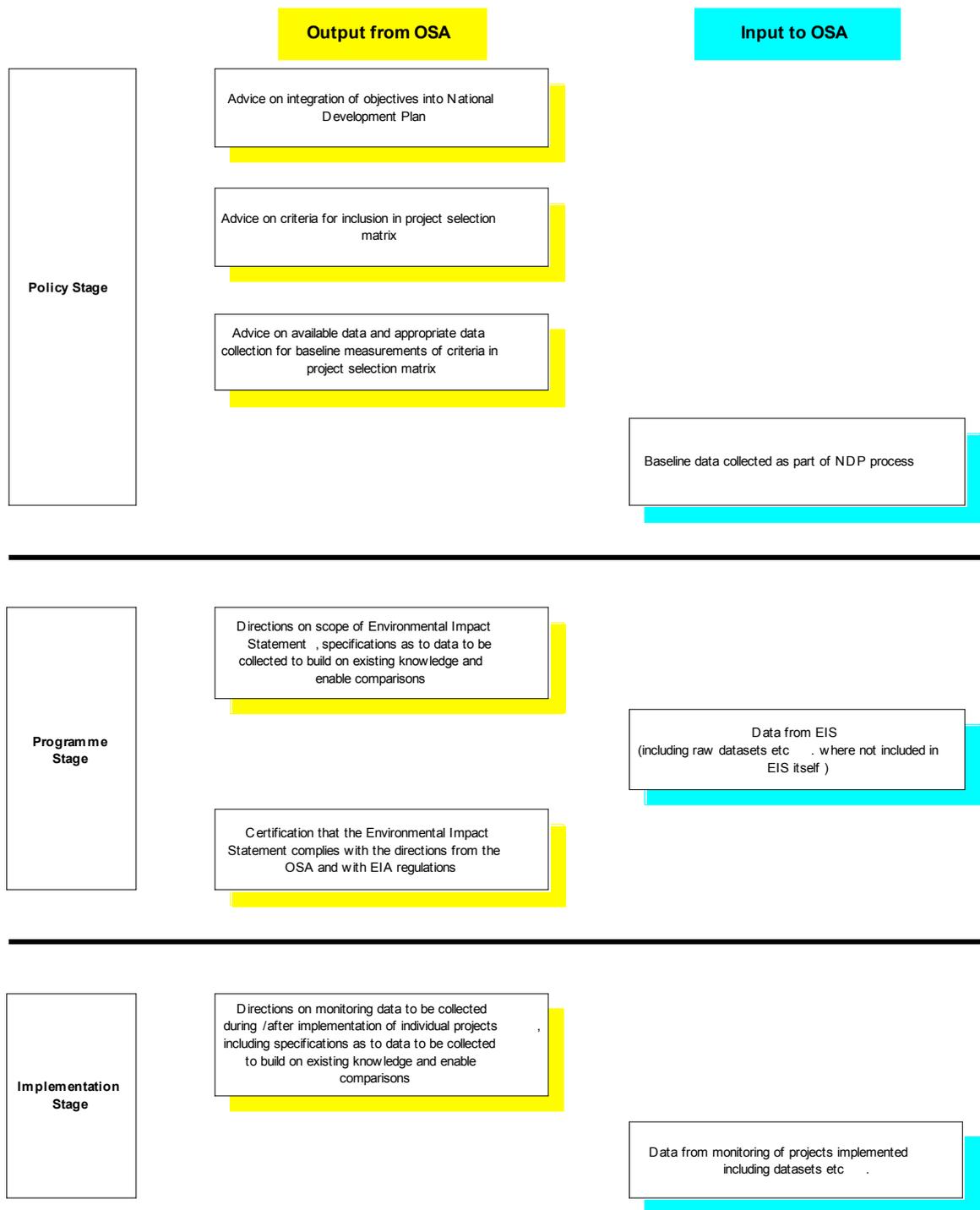


Figure 1. Integrated flow chart of the entire Sustainability Assessment Process.



**Figure 2. Role of the Office of Sustainability Assessment in Environmental Impact Assessment.**



**Figure 3. Inputs to, and Outputs from, the Office of Sustainability Assessment.**

## ***Appendix 2 A short survey that has been used by Robert Putnam and his colleagues to measure social capital in various communities in the U.S.***

### **Social Capital Community Benchmark Survey short form**

**(September 2002 draft. Release 1.0)**

**Saguaro Seminar: Civic Engagement in America Project at the John F. Kennedy School of Government at Harvard University on the Social Capital Community Benchmark Survey (SCCBS).**

### **Questions in Social Capital Community Benchmark Survey short form**

#### **Notes:**

Our estimate is that this about 7.5 minutes of starred questions (including 2.5 minutes of demographics). The optional questions would add 5 minutes to the survey length.

#### **Proposed questions:**

Hello, I'm \_\_\_\_\_ calling from \_\_\_\_\_. We are conducting an important survey about life in communities across America including yours.

[GENDER: INTERVIEWER: RECORD R's GENDER

(IF NECESSARY SAY: I am recording that you are a male/female.)

<GENDER>

1 Male

2 Female

\*1 We'd like to ask you some questions about how you view other people, groups and institutions.

Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?

<TRUST>

1 People can be trusted

2 You can't be too careful

3 (VOLUNTEERED) Depends

8 Don't Know

9 Refused

\*2 Next, we'd like to know how much you trust different groups of people. First, think about (GROUP). Generally speaking, would you say that you can trust them a lot, some, only a little, or not at all?

\*2A People in your neighborhood

(CLARIFY IF NECESSARY: How about in general?)

<TRNEI>

1 Trust them a lot

2 Trust them some

3 Trust them only a little

4 Trust them not at all

5 (VOLUNTEERED) Does not apply

8 Don't Know

9 Refused

2B (How about) The police in your local community (would you say that you can trust them a lot, some, only a little, or not at all?)

<TRCOP>

1 Trust them a lot

2 Trust them some

3 Trust them only a little

4 Trust them not at all

5 (VOLUNTEERED) Does not apply  
8 Don't Know  
9 Refused

2C People who work in the stores where you shop  
<TRSHOP>

1 Trust them a lot  
2 Trust them some  
3 Trust them only a little  
4 Trust them not at all  
5 (VOLUNTEERED) Does not apply  
8 Don't Know  
9 Refused

\*2D (How about) White people?

<TRWHT>  
1 Trust them a lot  
2 Trust them some  
3 Trust them only a little  
4 Trust them not at all  
5 (VOLUNTEERED) Does not apply  
8 Don't Know  
9 Refused

\*2E (How about) African Americans or Blacks?

<TRBLK>  
1 Trust them a lot  
2 Trust them some  
3 Trust them only a little  
4 Trust them not at all  
5 (VOLUNTEERED) Does not apply  
8 Don't Know  
9 Refused

\*2F (How about) Hispanics or Latinos?

<TRHISP>  
1 Trust them a lot  
2 Trust them some  
3 Trust them only a little  
4 Trust them not at all  
5 (VOLUNTEERED) Does not apply  
8 Don't Know  
9 Refused

3 My next questions are about public affairs. How interested are you in politics and national affairs? Are you very interested, somewhat interested, only slightly interested, or not at all interested?

<POLINT>  
1 Very interested  
2 Somewhat interested  
3 Only slightly interested  
4 Not at all interested  
8 Don't know  
9 Refused

\*4 Are you currently registered to vote

<REGVOTE>  
1 Yes

- 2 No
- 3 (VOLUNTEERED) Not eligible to vote
- 8 Don't know
- 9 Refused

5A How much of the time do you think you can trust the NATIONAL government to do what is right – just about always, most of the time, only some of the time, or hardly ever?

- <TGNAT>
- 1 Just about always
  - 2 Most of the time
  - 3 Some of the time
  - 4 Hardly ever
  - 8 Don't know
  - 9 Refused

5B How about your LOCAL government? How much of the time do you think you can trust the LOCAL government to do what is right? (Would you say just about always, most of the time, only some of the time, or hardly ever?)

- <TGLOC>
- 1 Just about always
  - 2 Most of the time
  - 3 Some of the time
  - 4 Hardly ever
  - 8 Don't know
  - 9 Refused

5C Thinking POLITICALLY AND SOCIALLY, how would you describe your own general outlook--as being very conservative, moderately conservative, middle-of-the-road, moderately liberal or very liberal?

- <IDEO>
- 1 Very conservative
  - 2 Moderately conservative
  - 3 Middle-of-the-road
  - 4 Moderately liberal
  - 5 Very Liberal
  - 6 (VOLUNTEERED) Something else
  - 8 Don't know
  - 9 Refused

6 Now I'm going to ask you how many times you've done certain things in the past 12 months, if at all. For all of these, I want you just to give me your best guess, and don't worry that you might be off a little. About how many times in the past 12 months have you (ACTIVITY):

RANDOMIZE A-J

Note: for all questions 6A-6J, interviewer probes for an actual number and if respondent can not provide an actual number, the interviewer follows up with:

Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that? (IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

6A (How many times in the past twelve months have you) Worked on a community project?

<CPROJECT>  
VALID RANGE 0 to 53

- 98 Don't Know
- 99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on

average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

< PROJCT >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

6B (How many times in the past twelve months have you) Donated blood?

<CBLOOD>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

< BLOOD >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6C (How many times in the past twelve months have you) Attended any public meeting in which there was discussion of town or school affairs?

<CPUBMEET>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

< PUBMEET >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

- 4 2-4 times
- 5 5-9 times
- 6 about once a month on average
- 7 twice a month
- 8 about once a week on average
- 9 more than once a week
- 98 Don't Know
- 99 Refused

6D (How many times in the past twelve months have you) Attended a political meeting or rally?

<CRALLY>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

< RALLY >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6E (How many times in the past twelve months have you) Attended any club or organizational meeting (not including meetings for work)?

<CORGMTG>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

< ORGMTG >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6F (How many times in the past twelve months have you) had friends over to your home?

<CFRDVIS>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

<FRDVIS>

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6G (How many times in the past twelve months have you) been in the home of a friend of a different race or had them in your home?

<CFRDRAC>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

<FRDRAC >

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6H (How many times in the past twelve months have you) been in the home of someone of a different neighborhood or had them in your home?

<CFRDXNEI>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

<FRDXNEI>

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6I (How many times in the past twelve months have you) been in the home of someone you consider to be a community leader or had one in your home?

<CLDRHOM>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

<LDRHOM>

1 never did this

2 once

3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)

4 2-4 times

5 5-9 times

6 about once a month on average

7 twice a month

8 about once a week on average

9 more than once a week

98 Don't Know

99 Refused

\*6J (How many times in the past twelve months have you) volunteered?

<CVOLTIM>

VALID RANGE 0 to 53

98 Don't Know

99 Refused

(IF RESPONDENT IS UNABLE TO ANSWER, PROBE:) Would you say you never did this, did it once, a few times, about once a month on average, twice a month, about once a week on average, or more often than that?

(IF RESPONDENT ANSWERS "A FEW TIMES", PROBE WITH:) Would that be closer to 2-4 times or 5-9 times?

<VOLTIM >

1 never did this

- 2 once
- 3 a few times (ENTER ONLY IF FIGURE CANNOT BE CLARIFIED)
- 4 2-4 times
- 5 5-9 times
- 6 about once a month on average
- 7 twice a month
- 8 about once a week on average
- 9 more than once a week
- 98 Don't Know
- 99 Refused

7 In the past twelve months, have you served as an officer or served on a committee of any local club or organization?

<OFFICER>

- 1 Yes
- 2 No
- 8 Don't know
- 9 Refused

\*8 Not including weddings and funerals, how often do you attend religious services? (IF NECESSARY PROBE WITH CATEGORIES) (Every week (or more often)/Almost every week/Once or twice a month/A few times per year/Less often than that/Don't know/Refused)

<RELATEND>

- 1 Every week (or more often)
- 2 Almost every week
- 3 Once or twice a month
- 4 A few times per year
- 5 Less often than that
- 6 Never
- 8 Don't know
- 9 Refused

9 People and families contribute money, property or other assets for a wide variety of charitable purposes. During the past 12 months, approximately how much money did you and the other family members in your household contribute to all secular causes and all religious causes, including your local religious congregation

(IF NECESSARY: By contribution, I mean a voluntary contribution with no intention of making a profit or obtaining goods or services for yourself.)

(IF NECESSARY: REPEAT ASSURANCES OF CONFIDENTIALITY)

<GIVE>

- 1 None
- 2 Less than \$100
- 3 \$100 to less than \$500
- 4 \$500 to less than \$1000
- 5 \$1000 to less than \$5000
- 6 More than \$5000
- 8 Don't know
- 9 Refused

\*10 All things considered, would you say you are very happy, happy, not very happy, or not happy at all?

<HAPPY>

- 1 Very happy
- 2 Happy
- 3 Not very Happy
- 4 Not happy at all
- 8 Don't Know
- 9 Refused

12 Please tell me for the following statement whether you agree strongly, agree somewhat, disagree somewhat, or disagree strongly. Television is my primary form of entertainment

<TVONE>

- 1 Agree strongly
- 2 Agree somewhat
- 3 (VOLUNTEERED) Neither/depends
- 4 Disagree somewhat
- 5 Disagree strongly
- 8 Don't know
- 9 Refused

\*13 Our last questions are used to ensure that our sample for this survey accurately reflects the population as a whole. First, we'd like to know if you are working now, temporarily laid off, or if you are unemployed, retired, permanently disabled, a homemaker, a student, or what? (INTERVIEWER: IF MULTIPLE RESPONSES ARE GIVEN, ENTER THE ONE WITH THE LOWEST CODE NUMBER.)

\*16 Do you consider yourself Hispanic or Latino?

<HISPAN>

- 1 Yes
- 2 No SKIP TO 17
- 8 Don't know SKIP TO 17
- 9 Refused SKIP TO 17

\*16A Would you say your background is Mexican, Puerto Rican, Cuban, or something else?

<HISPNAT>

- 1 Mexican
- 2 Puerto Rican
- 3 Cuban
- 4 Other
- 8 Don't know
- 9 Refused

\*16B Do you consider yourself to be White or Black?

<HISPRACE>

- 1 White
- 2 Black
- 3 Other
- 8 Don't Know
- 9 Refused

ALL SKIP TO 18

\*17 Do you consider yourself to be White, Black or African American, Asian or Pacific Islander, Native American, or some other race?

<RACE>

- 1 White SKIP TO 18
- 2 African American or Black SKIP TO 18
- 3 Asian or Pacific Islander SKIP TO 17B
- 4 Alaskan Native/Native American SKIP TO 18
- 5 Other
- 8 Don't know SKIP TO 18
- 9 Refused SKIP TO 18

\*17A Specify:

<RACEO> [STRING] SKIP TO 18

\*17B Would you say your background is Chinese, Korean, Japanese, Filipino, or something else?

<ASNNAT>

- 1 Chinese
- 2 Korean
- 3 Japanese
- 4 Filipino
- 5 Asian Indian
- 6 Vietnamese

- 7 Cambodian
- 8 Other
- 98 Don't know
- 99 Refused

\*18 Are you an American citizen?

<CITIZ>

- 1 Yes
- 2 No
- 8 Don't know
- 9 Refused

**SEVERAL QUESTIONS REMOVED TO FIT APPENDIX PAGE LIMIT**

**Appendix 3 A series of survey items that could be used to assess perceived subjective walkability. These items were developed by James Sallis of San Diego State University and the Robert Wood Johnson Foundation.**

ID # \_\_\_\_\_

SOURCE: Dr. James Sallis, San Diego State University and the Robert Wood Johnson Foundation. See: [www.drjamessallis.sdsu.edu](http://www.drjamessallis.sdsu.edu)

We would like to find out more information about the way that you perceive or think about your neighborhood. Please answer the following questions about your neighborhood and yourself.



**D. Types of residences in your neighborhood**

Please circle the answer that best applies to you and your neighborhood.

1. How common are detached single-family residences in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

2. How common are townhouses or row houses of 1-3 stories in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

3. How common are apartments or condos 1-3 stories in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

4. How common are apartments or condos 4-6 stories in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

5. How common are apartments or condos 7-12 stories in your immediate neighborhood?

1	2	3	4	5
None	A few	Some	Most	All

6. How common are apartments or condos more than 13 stories in your immediate neighborhood?

- 1                      2                      3                      4                      5  
None                  A few                  Some                  Most                  All



### E. Stores, facilities, and other things in your neighborhood

About how long would it take to get from your home to the nearest businesses or facilities listed below if you walked to them? Please put only one check mark (✓) for each business or facility.

	1-5 min	6-10 min	11-20 min	20-30 min	30+ min	don't know
<b>example: gas station</b>	1.____	2.____	3. <input checked="" type="checkbox"/>	4.____	5.____	8.____
1. convenience/small grocery store	1.____	2.____	3.____	4.____	5.____	8.____
2. supermarket	1.____	2.____	3.____	4.____	5.____	8.____
3. hardware store	1.____	2.____	3.____	4.____	5.____	8.____
4. fruit/vegetable market	1.____	2.____	3.____	4.____	5.____	8.____
5. laundry/dry cleaners	1.____	2.____	3.____	4.____	5.____	8.____
6. clothing store	1.____	2.____	3.____	4.____	5.____	8.____
7. post office	1.____	2.____	3.____	4.____	5.____	8.____
8. library	1.____	2.____	3.____	4.____	5.____	8.____
9. elementary school	1.____	2.____	3.____	4.____	5.____	8.____
10. other schools	1.____	2.____	3.____	4.____	5.____	8.____
11. book store	1.____	2.____	3.____	4.____	5.____	8.____
12. fast food restaurant	1.____	2.____	3.____	4.____	5.____	8.____
13. coffee place	1.____	2.____	3.____	4.____	5.____	8.____
14. bank/credit union	1.____	2.____	3.____	4.____	5.____	8.____
15. non-fast food restaurant	1.____	2.____	3.____	4.____	5.____	8.____
16. video store	1.____	2.____	3.____	4.____	5.____	8.____
17. pharmacy/drug store	1.____	2.____	3.____	4.____	5.____	8.____
18. salon/barber shop	1.____	2.____	3.____	4.____	5.____	8.____
19. your job or school [check here _____ if not applicable]	1.____	2.____	3.____	4.____	5.____	8.____

	1-5 min	6-10 min	11-20 min	20-30 min	30+ min	don't know
20. bus or train stop	1.____	2.____	3.____	4.____	5.____	8.____
21. park	1.____	2.____	3.____	4.____	5.____	8.____
22. recreation center	1.____	2.____	3.____	4.____	5.____	8.____
23. gym or fitness facility	1.____	2.____	3.____	4.____	5.____	8.____



## F. Access to services

Please circle the answer that best applies to you and your neighborhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

1. Stores are within easy walking distance of my home.
 

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree
2. Parking is difficult in local shopping areas.
 

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree
3. There are many places to go within easy walking distance of my home.
 

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree
4. It is easy to walk to a transit stop (bus, train) from my home.
 

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree
5. The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.
 

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree
6. There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers).
 

1	2	3	4
---	---	---	---

strongly  
strongly  
disagree

somewhat  
disagree

somewhat  
agree

agree



### G. Streets in my neighborhood

Please circle the answer that best applies to you and your neighborhood.

1. The streets in my neighborhood do not have many cul-de-sacs (dead-end streets).

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

2. The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

3. There are many alternative routes for getting from place to place in my neighborhood. (I don't have to go the same way every time.)

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree



You're making great progress.....keep it up!



### H. Places for walking and cycling

Please circle the answer that best applies to you and your neighborhood.

1. There are sidewalks on most of the streets in my neighborhood.

1	2	3	4
strongly	somewhat	somewhat	
strongly			

disagree

disagree

agree

agree

2. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.

1

strongly  
disagree

2

somewhat  
disagree

3

somewhat  
agree

4

strongly  
agree

3. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.

1

strongly  
strongly  
disagree

2

somewhat  
disagree

3

somewhat  
agree

4

agree



## I. Neighborhood surroundings

Please circle the answer that best applies to you and your neighborhood.

1. There are trees along the streets in my neighborhood.

1

strongly  
strongly  
disagree

2

somewhat  
disagree

3

somewhat  
agree

4

agree

2. There are many interesting things to look at while walking in my neighborhood.

1

strongly  
strongly  
disagree

2

somewhat  
disagree

3

somewhat  
agree

4

agree

3. There are many attractive natural sights in my neighborhood (such as landscaping, views).

1

strongly  
strongly  
disagree

2

somewhat  
disagree

3

somewhat  
agree

4

agree

4. There are attractive buildings/homes in my neighborhood.

1

strongly  
strongly  
disagree

2

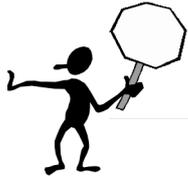
somewhat  
disagree

3

somewhat  
agree

4

agree



## J. Neighborhood safety

Please circle the answer that best applies to you and your neighborhood.

1. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

2. The speed of traffic on most nearby streets is usually slow (30 mph or less).

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

3. Most drivers exceed the posted speed limits while driving in my neighborhood.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

4. My neighborhood streets are well lit at night.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

5. Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

6. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

7. There is a high crime rate in my neighborhood.

1	2	3	4
---	---	---	---

strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

8. The crime rate in my neighborhood makes it unsafe to go on walks during the day.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

9. The crime rate in my neighborhood makes it unsafe to go on walks at night.

1	2	3	4
strongly	somewhat	somewhat	
strongly			
disagree	disagree	agree	agree

## **Appendix 4 References (see also Section 1 and Section 2 reports)**

---

<sup>i</sup> See Sustainability and the Wealth of Nations: First Steps in an Ongoing Journey, by Ismail Serageldin, the vice president for Environmentally Sustainable Development at the World Bank. (Environmentally Sustainable Development Studies and Monographs Series, No. 5, Washington, DC, 1996). Serageldin does not give any sources for the approach but it first appeared in Paul Ekin's book *Wealth Beyond Measure: An Atlas of the New Economics*, (Gaia Books, London, 1992). *'I presented [the idea] at a seminar which included World Bank people and, I think, Serageldin, at the Bank that I did to promote the book. The next thing I know it appears in all the World Bank stuff authored by Munasinghe and Serageldin et al. Well, you know what they say about imitation being the sincerest form of flattery. It appears that the promotional tour was a success!'* Ekins wrote. (Feb 1999). For a more recent treatment of the idea by Ekins see 'Sustainable Wealth Creation at the Local Level in an Age of Globalisation' *Regional Studies*, Vol. 32.9, pp. 863-871, 1998.

<sup>ii</sup> See above.

<sup>iii</sup> Serageldin, Ismail, & Andrew Steer. 1994. Epilogue: expanding the capital stock. In: Serageldin, Ismail, & Andrew Steer (eds). 1994. *Making development sustainable: from concepts to action*. Environmentally Sustainable Development Occasional Papers 2. The World Bank, Washington, DC.

<sup>iv</sup> United Nations Framework Convention on Climate Change, Article 2.

<sup>v</sup> Directive 2001/81/EC Directive 2001/81/EC on National Emission Ceilings for certain pollutants

<sup>vi</sup> Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes Consultation Draft, National Roads Authority, undated (believed to be 2006)

<sup>vii</sup> WHO, 1999, *Guidelines for Air Quality*, Geneva

Dockery, D.W. et al. An association between air pollution and mortality in six U.S. cities. *N Engl J Med*; **329** (24):1753-9 (1993).

Jarett M, et al. Spatial analysis of air pollution and mortality in Los Angeles. *Epidemiology*, 16; 727-736 (2005).

---

Krewski D. et al. Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality. *Health Effects Institute Special Report, July 2000.*

<sup>viii</sup> Putnam RD. *Bowling Alone: The Collapse and Revival of American Community.* New York: [Simon & Schuster](#), 2000

<sup>ix</sup> Kaplan, GA. Social contacts and ischaemic heart disease. *Annals of Clinical Research* 1988. 20:131-136.

<sup>x</sup> House, JS, Landis, KR, Umberson, D. Social relationships and health. *Science.* 1988. 241:540-545.

<sup>xi</sup> Berkman, LF. The role of social relations in health promotion. *Psychosomatic Medicine.* 1995. 57:245-254.

<sup>xii</sup> Berkman, LF, Syme, SL. Social networks, host resistance and mortality: a nine year follow-up of alameda county residents. *Am J Epidemiol.* 1979. 109:186-204.

<sup>xiii</sup> House, JS, Robbins, Metzger, H. The association of social relationships and activities with mortality: prospective evidence from the Tecumseh community health study. *Am J Epidemiol.* 1982; 116:123-140.

<sup>xiv</sup> Seeman, TE, Kaplan GA, Knudsen, L., Cohen, R, Guralnik J. Social networks ties and mortality among the elderly in the alameda county study. *Am J of Epidemiol.* 1987; 126:714-723.

<sup>xv</sup> Kawachi, I, Kennedy BP, Glass R. Social capital and self-rated health: a contextual analysis. 1999. 89:1187-1193.

<sup>xvi</sup> Kawachi, I Social capital and community effects on population and individual health. In *Socioeconomic status and health in industrial nations*, Adler, NE, Marmot, M McEwen, BS, Stewart, J eds. *Ann N Y Acad Sci* 1999; 896:120-130.

<sup>xvii</sup> Yen IH, Kaplan, GA. Neighborhood social environment and risk of death: multilevel evidence from the alameda county study. *Am J of Epidemiol.* 1999; 149:898-907.

<sup>xviii</sup> Berkman LF, Glass T, Brissette, I, Seeman, TE. From social integration to health: Durkheim in the new millennium. *Social Science and Medicine.* 2000 51:843-857.

<sup>xix</sup> Kawachi I, Berkman LF. Social ties and mental health. *J Urban Health.* 2001; 78:458-67.

<sup>xx</sup> Brummett, BH, Barefoot, JC, Siegler, IC, et al. Characteristics of socially isolated patients with coronary artery disease who are at elevated risk for mortality. *Psychosomatic Medicine.* 2001;63: 267-272.

- 
- <sup>xxi</sup> Leyden KM. Social capital and the built environment: the importance of walkable neighborhoods. *American Journal of Public Health*. 2003; 93(9):1546-51.
- <sup>xxii</sup> The Surgeon General's Call to action to prevent and decrease obesity [Rockville, MD]: US Department of Health and Human Services, Public Health Service, Office of the Surgeon General; 2001.
- <sup>xxiii</sup> Pratt M, Macera C, Wang G. Higher direct medical costs associated with physical inactivity. *Physician and Sportsmedicine*. 2000;28:10, 63-70.
- <sup>xxiv</sup> Cervero, R. and K. Kockelman (1997). "Travel Demand and the 3Ds: Density, Diversity and Design." Transportation Research Part D 2(3): 199-219.
- <sup>xxv</sup> Brownson RC, Chang JJ, Eyster AA, Ainsworth BE, Kirtland KA, Saelens BE, Sallis JF. Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires. *American Journal of Public Health*. 2004; 94(3):473-83.
- <sup>xxvi</sup> Frank, L. D. and G. Pivo (1994). "Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit and Walking." Transportation Research Record 1466: 44-52.
- <sup>xxvii</sup> Cervero, R. (1996). "Mixed land-uses and commuting: evidence from the american housing survey." Transportation Research Part A 30(5): 361-377.
- <sup>xxviii</sup> Kockelman, K. (1997). "Travel Behavior as Function of Accessibility, Land Use Mixing, and Land Use Balance." Transportation Research Record 1607: 116-125.
- <sup>xxix</sup> Brownson, R. C., E. A. Baker, R. A. Housemann, L. K. Brennan and S. J. Bacak (2001). "Environmental and policy determinants of physical activity in the United States." Am J Public Health 91(12): 1995-2003.
- <sup>xxx</sup> Troped, P. J., R. P. Saunders, R. R. Pate, B. Reininger, J. R. Ureda, et al. (2001). "Associations between self-reported and objective physical environmental factors and use of a community rail-trail." Prev Med 32(2): 191-200.
- <sup>xxxi</sup> Berrigan, D. and R. P. Troiano (2002). "The association between urban form and physical activity in U.S. adults." American Journal of Preventive Medicine 23(2, Supplement 1): 74-79.
- <sup>xxxii</sup> Craig, C. L., R. C. Brownson, S. E. Cragg and A. L. Dunn (2002). "Exploring the effect of the environment on physical activity: a study examining walking to work." Am J Prev Med 23(2 Suppl): 36-43.
- <sup>xxxiii</sup> Boureaudhuij, I. D., J. F. Sallis and B. Saelens (2003). "Environmental correlates of physical activity in a sample of Belgian adults." American Journal of Health Promotion 18(1): 83-92.

---

<sup>xxxiv</sup> Cervero, R. and M. Duncan (2003). "Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay area." American Journal of Public Health 93(9): 1478-1483.

<sup>xxxv</sup> Giles-Corti, B. and R. J. Donovan (2003). "Relative influences of individual, social environmental, and physical environmental correlates of walking." Am J Public Health 93(9): 1583-9.

<sup>xxxvi</sup> King, W. C., J. S. Brach, S. Belle, R. Killingsworth, M. Fenton, et al. (2003). "The relationship between convenience of destinations and walking levels in older women." Am J Health Promot 18(1): 74-82.

<sup>xxxvii</sup> Saelens, B. E., J. F. Sallis, J. B. Black and D. Chen (2003). "Neighborhood-based differences in physical activity: an environment scale evaluation." Am J Public Health 93(9): 1552-8.

<sup>xxxviii</sup> Carnegie, M. A., A. Bauman, A. L. Marshall, M. Mohsin, V. Westley-Wise, et al. (2002). "Perceptions of the physical environment, stage of change for physical activity, and walking among Australian adults." Res Q Exerc Sport 73(2): 146-55.

<sup>xxxix</sup> Frank, L. D., T. L. Schmid, J. F. Sallis, J. Chapman and B. E. Saelens (2005). "Linking objectively measured physical activity with objectively measured urban form Findings from SMARTRAQ." Am J Prev Med 28(2 Suppl 2): 117-25.

<sup>xi</sup> Giles-Corti, B., M. H. Broomhall, M. Knuiman, C. Collins, K. Douglas, et al. (2005). "Increasing walking How important is distance to, attractiveness, and size of public open space?" Am J Prev Med 28(2 Suppl 2): 169-76.

<sup>xii</sup> Sharpe, P. A., M. L. Granner, B. Hutto and B. E. Ainsworth (2004). "Association of environmental factors to meeting physical activity recommendations in two South Carolina counties." Am J Health Promot 18(3): 251-7.

<sup>xiii</sup> Humpel, N., N. Owen, E. Leslie, A. L. Marshall, A. E. Bauman, et al. (2004). "Associations of location and perceived environmental attributes with walking in neighborhoods." Am J Health Promot 18(3): 239-42.

<sup>xiiii</sup> Hoehner, C. M., L. K. Brennan Ramirez, M. B. Elliott, S. L. Handy and R. C. Brownson (2005). "Perceived and objective environmental measures and physical activity among urban adults." Am J Prev Med 28(2 Suppl 2): 105-16.

<sup>xliv</sup> Humpel, N., N. Owen and E. Leslie (2002). "Environmental factors associated with adults' participation in physical activity: a review." Am J Prev Med 22(3): 188-99.