TRENCHLESS CONSTRUCTION PROTOCOL

FUEL EFFICIENCY AND REDUCED ASPHALT PRODUCTION

GHG PROTOCOL

PREPARED ACCORDING TO THE REQUIREMENTS OF THE BC EMISSION OFFSETS REGULATION

Prepared on Behalf of:

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1.0 IDENTIFICATION OF THE PROTOCOL DEVELOPER

1.1 TITLE OF THE PROTOCOL

Trenchless Construction Protocol: Fuel Efficiency and Reduced Asphalt Production

1.2 LEAD PROTOCOL DEVELOPER

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2.0 PROTOCOL OVERVIEW

2.1 GOOD PRACTICE GUIDANCE REVIEW

Consultation with existing good practice guidance (GPG) is a key component of drafting carbon offset protocols. Three existing protocols, plus further methodologies and standards from the following jurisdictions were consulted in the drafting of this protocol.

a. Public Transit Offset Protocol - Fuel Efficiency and Efficiency Improvement in Fleets v1.0 prepared by Habitat Carbon Assets and CPS Carbon Project Solutions Inc.
b. BC GHG Quantification Protocol: Fuel Switching From Fossil Fuel-Fired Energy Generation to Less GHG-Intensive Fossil Fuel or Renewable Energy Sources v2.1 Prepared by the Delphi Group and Golder Associates.
c. BC Modal Shift Protocol - FINAL DRAFT – Prepared by the Delphi Group
d. Alberta Offset System
e. Clean Development Mechanism (CDM)
f. WRI/WBCSD GHG Protocol
g. Natural Resources Canada (NRCan) System of Measurement and Reporting for Technologies (SMART)
h. International Organization for Standardization (ISO)
i. The Climate Registry (TCR)
j. Pacific Carbon Trust "Guide to Determining Project Additionality"

2.2 APPLICABILITY

2.2.1 DESCRIPTION OF THE PROJECT TYPE

Trenchless construction can be defined as "a family of construction methods, materials, and equipment used for the installation of new, or replacement or rehabilitation of existing, underground infrastructure with minimal disruption to surface traffic, business, the environment and other activities." Whereas traditional trench construction methods require completely digging up old pipes and/or the paths for new ones, Trenchless Technology allows for the digging of much smaller holes, and inserting/replacing pipes underground between them. Reduction in GHG emissions caused by a reduction in soil disturbance and removal, as well as by lessening the re-paving requirements is to be quantified and credited through use of this Protocol.

Eligibility Criteria –

1. Project utilizes a Trenchless Construction Technology to execute Project Implementations that would otherwise utilize Open Trench Technology.

2. Project may consist of a group of Project Implementations undertaken by an individual entity (company or municipality) within a defined project area.

3. Project may use more than one type of Trenchless Construction Technology to achieve GHG reductions.

4. Project may add further groupings of Project Implementations (jobs) after Project Plan Validation, so long as representative conditions present at Validation continue to apply. Eligibility of added Project Implementations is subject to approval by Verifier.

5. Meets the requirements for offset eligibility as specified in the BC Emission Offset Regulation. Of particular note, emission reductions must:
   i. Result from actions taken on or after November 29, 2007
   ii. Have clearly established ownership
   iii. Be achieved from controlled SSRs, taking into consideration increases in emissions from related SSRs, and,
   iv. Have occurred in BC

With respect to whether or not the primary emission sources considered in this protocol meet the definition of “controlled” as per the BC Emission Offset Regulation, the Regulation indicates that a Controlled SSR “in relation to a proponent, means a greenhouse gas emissions source, sink or reservoir that is controlled, directly or indirectly, by the proponent by legal, financial or any other means”. Please note that throughout this protocol, “controlled, related, and affected” terminology consistent with ISO 14064-2, which views controlled SSRs in a more narrowly defined way, has been used.

Note that this protocol makes specific mention of a range of Trenchless Construction technologies, but that it may be used for development of Projects using other technologies. The use of these technologies must be congruent with the Baseline, Additionality, Sector, Project Type and other offset project-specific rules laid out in this Protocol.

Users of this protocol should clearly describe how their project meets these eligibility requirements in their Offset Project Plan.

2.2.2 DESCRIPTION OF ANY PROJECT-SPECIFIC TECHNOLOGY

Along with the Project-Specific Technology described herein, this Protocol is intended to apply to a range of different Trenchless Construction Technologies. Whether or not an individual project proponent uses the below-described technologies, they are expected to describe their specific technologies and utilize appropriate data when applying the protocol to the preparation of a GHG Project Plan.

Sliplining

Sliplining is completed by installing a smaller, "carrier pipe" into a larger "host pipe," grouting the annular space between the two pipes, and sealing the ends.

Sliplining can be used to stop infiltration and restore structural integrity to an existing pipe. The most common size is 0.20m - 1.5m (8"-60"), but sliplining can occur in any size given appropriate access and a new pipe small or large enough to install.

Pipe bursting

Pipe bursting is a method of pipe renewal where by the existing pipe is broken and pushed into the surrounding ground while a new pipe of equal or larger size is pulled in.

Pipe bursting is suitable when the existing pipe is too small or has partially failed. The upsides that can normally be completed are 2 or 3 pipe sizes. Pipes of up to 1.2m have been burst.

CIPP

CIPP is a jointless, seamless, pipe-within-a-pipe with the capability to rehabilitate pipes ranging in diameter from 0.05 - 2.8 meter (6"-110"). A resin-saturated felt or fiberglass tube made of polyester is inverted or pulled into a damaged pipe. Little to no digging is involved in this trenchless process, making for a more economical, environmentally friendly method than traditional "dig and replace" pipe repair methods. Next, the resin is cured and forms a tight-fitting, and jointless replacement pipe. Service laterals are restored internally with robotically controlled cutting devices

CIPP is suitable when the existing pipe is less than 10% deformed and has sufficient capacity to allow a slight reduction in diameter.

Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is a steerable trenchless method of installing underground pipes, conduits and cables in a shallow arc along a prescribed bore path by using a surface launched drilling rig, with minimal impact on the surrounding area. Directional boring minimizes environmental disruption. . Installation lengths up to 6,500' (2,000m) have been completed, and diameters up to 56" (1,200mm) have been installed but HDD is more suited to smaller diameter pipes. HDD can be accurate enough for sewer lines but only in ideal soils, HDD is generally used to install utilities where grade is not critical.

2.2.3 LIST OF GHG(S) THAT WILL BE REDUCED

Emission of the following GHGs may be reduced:

· Carbon dioxide (CO_2)
· Methane (CH_4)
· Nitrous Oxide (N_2O)

2.2.4 DESCRIPTION OF HOW REAL REDUCTIONS WILL BE ACHIEVED

Utilizing Trenchless Construction Technology allows for more efficient, less disruptive construction episodes than the baseline of Open Trench Construction. By minimizing substrate excavation, transport and replacement, Trenchless Construction Technology reduces the use of heavy equipment and need for filling and repaving. Real reductions in GHG emissions will be achieved primarily through the reduction of diesel combustion emissions relative to what would have* occurred using traditional open cut methods of construction*.

Achievement and appropriate quantification of real emission reductions will be ensured through utilization of the quantification protocol and preparation of subsequent Offset Project Plans in accordance with ISO 14064-2, the BC Emissions Offset Regulation, and other relevant requirements and good practice guidance.

2.2.5 PROTOCOL FLEXIBILITY

The Protocol is intended to have applicability to a wide range of Trenchless Construction Technology projects. To facilitate this, the following flexibility mechanisms are included.

a. **Project-specific emission factors.** Where justified and appropriately documented, project-specific emission factors may be used instead of default factors noted in the protocol. In this case, a project proponent must demonstrate that the emission factors have been developed according to industry standard practice and are appropriate for use in an Offset Project.

b. **Project-specific data quality management approaches.** To account for the wide variety of potential project applications, project-specific data quality management approaches may be used if justified and if they conform to the general requirements stipulated in the protocol.

c. **Baseline approach.** This protocol shall utilize the Performance Standard approach to delineating a baseline. By undertaking a process to build coefficients for a Performance Standard, project proponents will be able to most accurately quantify them emissions that would result from using traditional Open Trench Technology.

   Project proponents may also propose alternate baseline approaches, which would be Validated by an accredited auditor at the time of Project Plan Validation.

d. **Project-specific monitoring approaches.** To account for the wide variety of potential project applications, project-specific monitoring / metering approaches may be used if justified and if they conform to the general requirements stipulated in the protocol. Such project-specific approaches may also include the aggregation of multiple emission sources together where project monitoring treats those emission sources as one larger combined entity (e.g. multiple vehicles using diesel fuel from a single depot or tank, tracked by a single meter).

2.2.6 LIST OF FEDERAL AND PROVINCIAL/TERRITORIAL LEGAL REQUIREMENTS AND CLIMATE CHANGE INCENTIVES

Legal requirements and climate-change incentives may vary depending on the type and location of project proponent for the Project. This protocol addresses only the Renewable Fuel Standard, Greenhouse Gas Reduction Act and the BC Carbon Tax as these will affect all fuel efficiency projects within BC. In addition to these, the proponent must include a description of all legal requirements and climate change incentives that affect their individual project and an explanation of how their effects impact project additionality and/or the quantification methodology. In the absence of further requirements or incentives, the proponent must assert that there are no further requirements or incentives that must be considered.

Legal Requirements

BC Energy Plan Renewable Fuel Standard for Diesel

All diesel sold in BC requires a 5% biodiesel fuel content in provincial diesel supplies as of 2010. Since the project scenario is expected to consume less fuel than the baseline scenario, it is conservative to make assumptions that lower the GHG emission factor from fuel combustion. It will therefore be assumed that all fuel that would be consumed in a fuel switch/fuel efficiency project contains a 5% renewable content. Furthermore, instead of including a lifecycle analysis of renewable fuel production, which may or may not occur within BC, it will be conservatively estimated that emissions from renewable fuel production and combustion are zero.

BC Greenhouse Gas Reduction (Cap and Trade) Act

In the future, regulated caps may be imposed under this Act on transportation emissions covered in this protocol, which may cause fuel switch/fuel efficiency transport projects to be ineligible for offset creation at that time.

Climate Change Incentives

BC Carbon Tax

Though not a climate-change incentive, the BC Carbon Tax will act as an incentive to use less GHG intensive modes of transport. Because less fuel is used in the project, the tax creates an incentive for increasing efficiency. The proponent must consider this incentive when determining the impact of financial barriers to the project during baseline selection.

2.2.7 ADDITIONALITY

Project proponents shall consult the most current version of the Pacific Carbon Trust "Guide to Determining Project Additionality" to inform their process for determining Additionality. A full barrier assessment must be performed on the potential baseline scenarios to outline all reasonable options, and the barriers presented them. A comparative assessment of the barriers and discussion of magnitude shall also be undertaken. In order to be considered Additional, the Project Proponent must successfully establish that the Project Case is feasible only through the surmounting of barriers enabled by the fact it is an Offset Project. *thought we are doing this with this protocol??*

2.2.8 LEAKAGE

Project Proponent must evidence that the Project Case provides equivalency of service to the Baseline Case, and does not increase GHG emissions outside the Project Boundary.* does the case that we are moving a lot less dirt/asphalt not do this??*

2.2.9 UNCERTAINTY AND CONSERVATIVENESS

Methodologies developed in this protocol have been developed to minimize uncertainty where possible, and to choose conservative approaches where there is significant uncertainty.

Where more than one approach can be taken in the preparation of an Offset Project Plan, good practice guidance dictates that Project Proponents shall choose conservative approaches to minimize uncertainty and avoid overestimation of emissions reductions.

2.3 GLOSSARY OF TERMS

Affected SSR: A GHG source, sink, or reservoir influenced by a project activity, through changes in market demand or supply for associated product or services, or through physical displacement.

Baseline Case: The particulars of an Open Trench Construction project.

Baseline Machinery: Heavy machinery that would be operated in the Baseline Case.

Baseline Vehicles: Vehicles that would be operated in the Baseline Case.

Biofuel: Typically, any liquid fuel that is derived from biomass.

CO2 equivalent (CO2e): The universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide. It is used to evaluate releasing (or avoiding releasing) different greenhouse gases against a common basis.

Controlled SSR: A GHG source, sink, or reservoir whose operation is under the direction and influence of the proponent through financial, policy, management or other instruments.

Emission factor: A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and absolute GHG emissions.

Fossil fuel: A fuel, with high carbon and hydrogen content, extracted from the Earth and formed from decayed organic material. Examples of common fossil fuels are coal, petroleum, and natural gas.

Fugitive emissions: Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets, etc.

Global warming potential (GWP): A factor describing the radiative forcing impact of one mass-based unit of a given GHG relative to an equivalent unit of carbon dioxide over a given period of time.

Greenhouse gas emission: The release of greenhouse gases to the atmosphere, by a GHG source (e.g. fossil fuel combustion).

Greenhouse gas removal: A removal of greenhouse gases from the atmosphere, by a GHG sink (e.g. growing trees).

Greenhouse gases (GHG): GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO2); methane (CH4); nitrous oxide (N2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF6).

Monitoring: The continuous or periodic assessment and documentation of GHG emissions and removals or other GHG-related data.

Offset Project: An emissions reduction project undertaken for the purpose of generating carbon offsets.

Offset Project Plan: Technical document used to explain how a project meets its relevant protocol and demonstrates all required elements of an Offset Project are present.

Project Case: The particulars of a Trenchless Construction Technology project that utilizes this protocol.

Project Implementations: The term for individual jobs or contracts executed by a construction company or municipality. For example, a company may replace 100 pipes using Trenchless Construction Technology over the course of a year, each of these being a "Project Implementation".

Project Proponent: An organization or group of organizations that create an offset project and submit it for Validation & Verification. Generally will include the asset owner or owners.

Project Machinery: Heavy Machinery to be used in the Project Case.

Project Vehicles: Vehicles that are to be used in the Project Case.

Related SSR: A GHG source, sink, or reservoir that has material or energy flows into, out of, or within the project.

Renewable Energy: Energy from sources that constantly renew themselves or that are regarded as practically inexhaustible. Renewable energy includes, but is not limited to; energy derived from solar, wind, geothermal, hydroelectric, biomass, tidal power, sea currents, and ocean thermal gradients.

Reservoir: A reservoir is defined as a physical unit or component of the biosphere, geosphere or hydrosphere with the capability to store or accumulate a greenhouse gas removed from the atmosphere by a greenhouse gas sink or a greenhouse gas captured from a greenhouse gas source. For example, trees, soil, oil and gas reservoirs and oceans are all reservoirs.

Sink: Any physical unit or process that stores GHGs; usually refers to forests and underground/deep sea reservoirs of CO2.

Source: Any physical unit or process that releases GHG into the atmosphere.

SSR: acronym for sources, sinks and reservoirs.

Trenchless Construction Technology: A family of construction methods, materials, and equipment used for the installation of new, or replacement or rehabilitation of existing, underground infrastructure with minimal disruption to surface traffic, business, the environment and other activities.

World Resources Institute (WRI): WRI is an environmental think tank founded in 1982 based in Washington, D.C. in the United States. WRI is an independent, non-partisan and nonprofit organization with the intention of protecting the Earth and improving people's lives. WRI organizes its work around four key goals: Climate, energy & transport, Governance & access, Markets & enterprise and People & ecosystem.

World Business Council for Sustainable Development (WBCSD): The World Business Council for Sustainable Development (WBCSD) is a CEO-led, global association of some 200 companies dealing exclusively with business and sustainable development. The Council provides a platform for companies to explore sustainable development, share knowledge, experiences and best practices, and to advocate business positions on these issues in a variety of forums, working with governments, non-governmental and intergovernmental organizations

3.0 IDENTIFICATION OF "RELEVANT" GHG SOURCES, SINKS AND RESERVOIRS

3.1 IDENTIFICATION OF PROJECT SSRs

3.1.1 SELECTION OF CRITERIA AND PROCEDURES FOR IDENTIFYING SSRS FOR THE PROJECT

A systematic, lifecycle assessment-based approach should be used to completely and transparently identify relevant SSRs for the project. Such an approach would consider both SSRs directly owned/controlled by the Project Proponent as well as related/affected SSRs upstream and downstream of owned/controlled SSRs, including those that occur on an on-going basis as well as only once. Guidance considered in making this assessment included:

· Annex A of ISO 14064-2
· WRI/WBCSD GHG Protocol
· Canadian Federal Draft Guide for Protocol Developers
· The System of Measurement and Reporting for Technologies (SMART)
· Numerous protocols and project based quantifications prepared for government funding agencies, the Alberta Offset System, etc.

As a result, the following lifecycle assessment-based approach was selected for use in identifying SSRs for the project in this protocol. This procedure draws heavily on procedures developed for preparation of Offset Project Plans based on SMART for projects funded by Natural Resources Canada's Technology Early Action Measures program, which in turn draw upon approaches codified in the ISO 14040 series of lifecycle assessment standards. Please note that the use of a lifecycle assessment-based approach at this stage does not necessarily mean that lifecycle (e.g. upstream, downstream) SSRs will be deemed to be relevant to the quantification – this determination, considering BC Offset System-specific or other relevant criteria, will be made at a later stage in this protocol.

3.1.2 PROCEDURE TO IDENTIFY RELEVANT SSRS FOR THE PROJECT

The following seven-step procedure was used to identify potentially relevant SSRs for projects eligible for quantification using this protocol.

1. Identify the project model based on the processes and activities included in the project.

2. Identification of all SSRs controlled or owned by the Project Proponent relevant to the primary project activities.

3. Identification of all SSRs physically related to the primary project activities, by tracing products, materials and energy inputs/outputs upstream to origins in natural resources and downstream along their life-cycles. For example: electricity production, fossil fuel production, etc.

4. Identification of all SSRs affected by the project through consideration of the economic and social consequences of the project. This is achieved by looking for activities, market effects, and social changes that result from or are associated with the project activity, and documenting the associated GHG emissions.

5. Classify SSRs as owned and/or controlled by the project; related to the project, or affected by the project, as defined by ISO 14064-2.

6. Identify the GHG inputs and outputs for each SSR, and identify the parameters required to estimate or measure the GHG emissions.

7. Review all SSRs and material and energy flows to ensure that relevant SSRs have been completely identified.

3.1.3 APPLICATION OF THE PROCEDURE

To assist with applying the procedure, an activity, materials and energy flow diagram was prepared, as shown in Figure 1. Using this model, as well as available good practice guidance including approved CDM and Alberta Offset System GHG protocols / methodologies, and considering the range of likely project technologies, SSRs were identified as per the remaining steps in the procedure. Identified SSRs are illustrated in Figure 2 and described in more detail in Table 1. Note that a particular project may only involve a sub-set of these SSRs, depending on the technology type and other project-specific details.

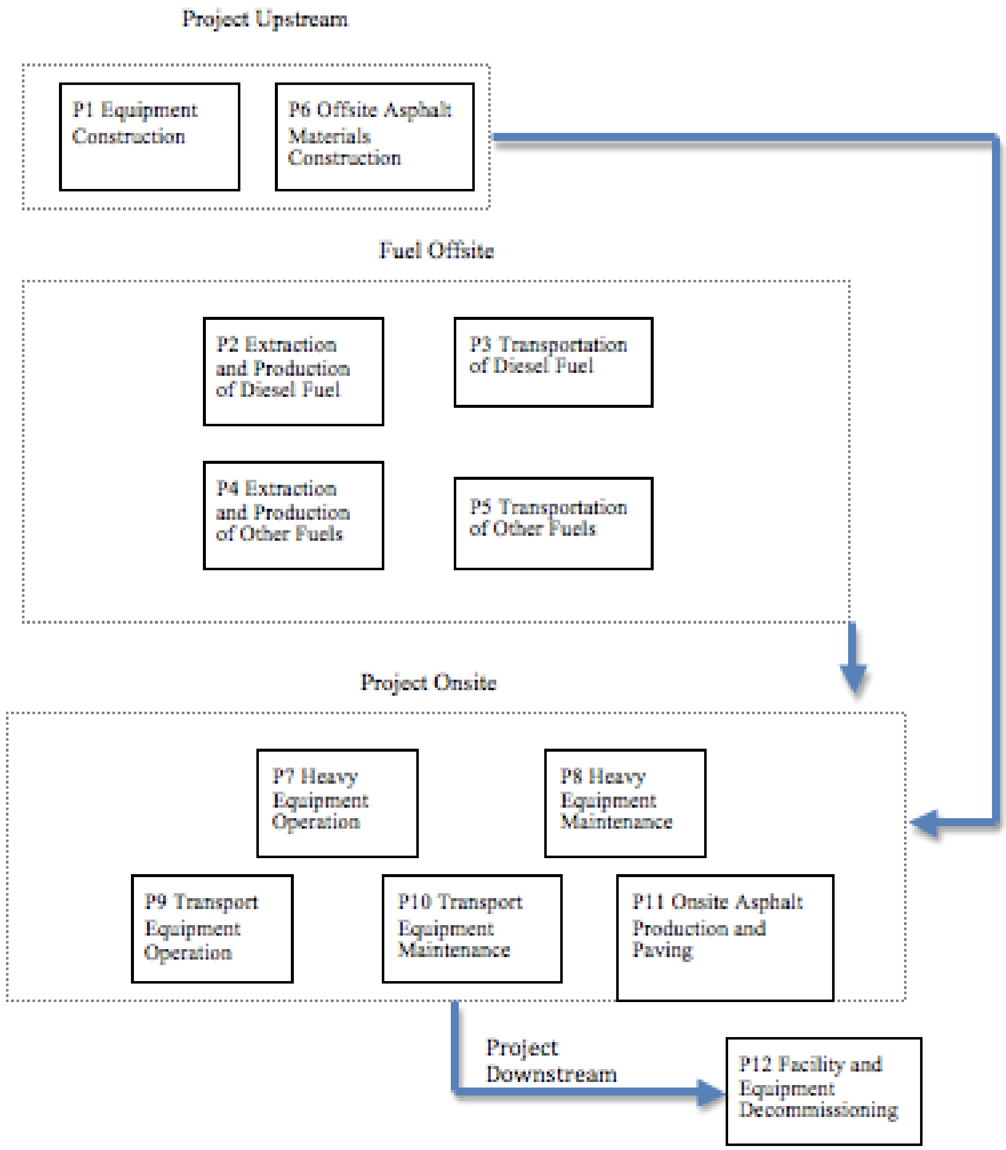

Figure 1. Generic Process Flow Diagram for a Project

Upstream add gravel production. Bigger than asphalt.

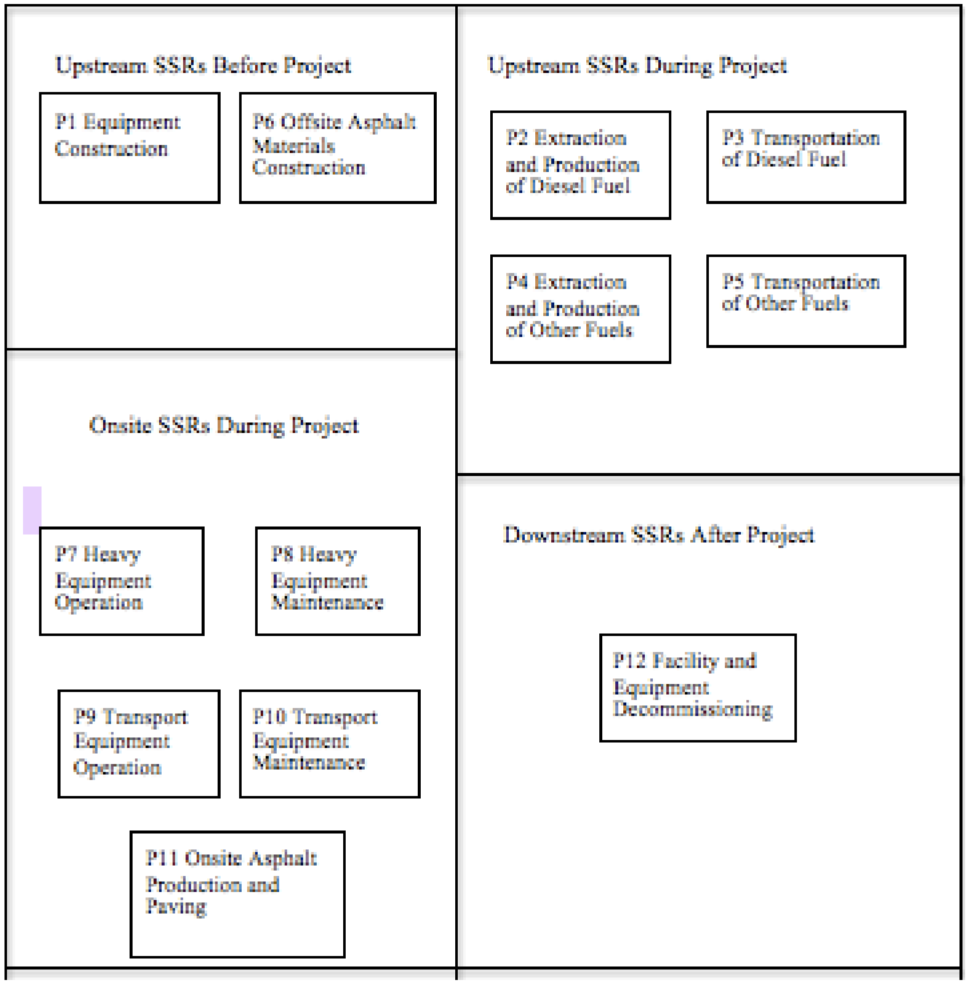

Figure 2.Project SSR Diagram

3.1.4 DESCRIPTION OF PROJECT SSRS

Number	Source, Sink or Reservoir (SSR)	Description	Controlled, Related or Affected
Upstream SSRs			
P1	Equipment Construction	All activities associated with the construction of facilities and equipment that would be required in order to undertake a Trenchless Construction Technology project.	Related
P2	Extraction and Production of Diesel Fuel	All activities associated with the extraction and production of diesel fuel from crude oil or other feedstocks (such as biomass in the case of biodiesel blends).This diesel fuel would be used as fuel for heavy equipment and transportation equipment operation.	Related
P3	Transportation of Diesel Fuel	Transport of diesel fuel from the production facility to the end use location. Transportation may include shipments by truck, pipeline, rail or other mode, with associated GHG emissions.	Related
P4	Extraction and Production of Other Fuels	All activities associated with the extraction and processing of fuels other than diesel	Related
P5	Transportation of Other Fuels	Transport of fuel from the production facility to the end use location. Transportation typically conducted by various means, including truck (e.g. propane) and pipeline (e.g. natural gas).	Related
P6	Offsite Asphalt Materials Production	All asphalt-related materials produced and activities undertaken offsite.	Related
Onsite SSRs			
P7	Heavy Equipment Operation	All activities associated with the operation of Heavy Equipment.	Controlled
P8	Heavy Equipment Maintenance	All activities associated with maintaining Heavy Equipment in operational condition.	Controlled
P9	Transportation Equipment Operation	All activities associated with operation of Transportation Equipment.	Controlled
P10	Transportation Equipment Maintenance	All activities associated with maintaining Transportation Equipment in operational condition.	Controlled
P11	Onsite Asphalt Production and Paving	All asphalt and paving-related materials produced and activities undertaken onsite.	Controlled
Downstream SSRs			
P12	Facility and Equipment Decommissioning	All activities associated with the end-of-life decommissioning, recycling and disposal of equipment that would be required in order to facilitate GHG reductions through adoption of Trenchless Construction Technology that is due to the project.	Related

Table 1. List of Project SSRs

Explanation of SSR Categorization

All SSRs were categorized as controlled, related or affected (C/R/A) based on their relation to the project proponent, where the project proponent is assumed to control all on-site SSRs and upstream and downstream SSRs are assumed to be controlled by others and thus are related to the project. This categorization is to be reviewed by each user of this protocol and adjusted accordingly based on project specific circumstances. However, this categorization does not have any impact on other aspects of this protocol, such as calculation methodologies.

3.2 DETERMINING THE BASELINE SCENARIO

In order to calculate the net emission reductions and/or removal enhancements that have resulted from a particular project undertaking, it is necessary to first estimate the quantity of emissions that would have occurred had the project not been implemented. To quantify these emissions, it is necessary to identify and select a baseline scenario representing what would have most likely occurred in the absence of the project.

3.2.1 SELECTION OF CRITERIA AND PROCEDURES FOR DETERMINING THE BASELINE SCENARIO

Various approaches exist to both identifying and assessing potential baseline scenarios and identifying and justifying the final baseline scenario selected. Good practice guidance reviewed in this regard included:

· Pacific Carbon Trust Guide to Determining Project Additionality
· WRI/WBCSD GHG Protocol
· Federal Draft Guide for Protocol Developers
· The Alberta Offset System
· Annex A of ISO 14064-2

3.2.2 PROCEDURE TO IDENTIFY RELEVANT SSRS FOR THE BASELINE

Identification of relevant SSRs in this protocol is based on the requirements and good practice guidance found in ISO 14064-2 (e.g. requirements specified in Section 5.4) for cases where specific criteria are not provided. The types of baseline scenarios that must be considered according to the draft Federal Guide for Protocol Developers are described below:

Historic Benchmark: Typically site-specific and can be constructed to reflect reductions in a base period (such as the average emissions of previous years). This approach assumes that past trends in emissions and/or carbon stock changes will continue into the future.

Performance Standard: Assumes the typical emissions profile for the industry or sector is a reasonable representation of the baseline. An assessment of comparable activities within a given industry or sector is necessary.

Comparison-based: Actual measurements of parameters from a control group (such as a plot of forested land, space heating natural gas consumption per square metre, etc.) to compare with the project. Emissions or removals from the control group are monitored throughout the project and compared with the emissions from the project site to determine the incremental reductions from the project. Such a control group can be used with more than one project.

Projection-based: Projections of reductions in the future can use a variety of techniques, from simple straight-line growth assumptions to complex models. Forward-looking projections can be specified in terms of a set of constant parameters or can vary over time according to pre-defined procedures.

Pre-registered: Baselines that are already approved for use in similar Offset System Quantification Protocols (OSQP) in the Offset System.

Other (if appropriate): Protocol Developers may have other approaches for developing a baseline. Direct measurement of project input and output could be considered in this category.

Normalized Baseline (if appropriate): Where it is clear that a jurisdiction has taken regulatory or other steps to protect the environment that are significantly in advance of what is happening in most other jurisdictions, Environment Canada may establish a normalized baseline (this would be announced on the Offset System website). In these cases, Protocol Developers will only need to state that they are using this type of baseline. If a normalized baseline has not been established by Environment Canada (or other appropriate regulatory body) for a project type that is subject to clear differences between jurisdictions, the Protocol Developer can propose one.

3.2.3 APPLICATION OF THE PROCEDURE

The suitability of each potential baseline scenario was evaluated for Trenchless Construction Technology projects, as documented in Table 2, considering the positive and negative aspects of each approach.

Baseline Approach	**Discussion of Suitability**
Historic Benchmark	A historic benchmark approach to baseline quantification will be difficult or impossible to quantify because Project Proponents and those in the Open Trench/Trenchless construction industries do not typically monitor the baseline SSRs of their activities. Some companies undertake both Open Trench and Trenchless Construction projects, but many specialize in one or the other, negating the ability for a Trenchless-only company to quantify a historical baseline.

	In addition, using a historical benchmark baseline approach would obligate project proponents to make their own determination of benchmark figures. This is undesirable for both unnecessary repetition of effort, as well as consistency of quantification between one proponent's projects and another's.
Performance Standard	The creation and utilization of a performance standard is the most suitable of baseline approaches for use in a Trenchless Construction Technology offset project. It provides the most achievable route to: 1. Provide consistent baseline data for equivalent Project Cases across different potential Project Proponents. 2. Allow Project Proponents who do not undertake Open Trench Technology projects to quantify a baseline. 3. Lower costs and effort to quantify a baseline. 4. Arrive at accurate figures for baseline coefficients that utilize large data sets and more rigorous quantification procedures than could be expected of an individual Project Proponent. This protocol shall utilize the performance standard baseline approach unless otherwise selected and justified by the Project Proponent.
Comparison Based	Operations of the Project Proponent during the Trenchless Construction project would be compared to the activities of other similar Open Trench projects (i.e. a control group). This approach is not optimal for use in this protocol, because it will give results with a much higher level of uncertainty than the use of a rigorously quantified performance standard.
Projection Based	This approach is unlikely to be feasible for use in baseline quantification for this project type. Each Project Implementation is different, and many Project Proponents will not have sufficient data to quantify and project baselines into the future.
Pre-Registered	Not applicable
Other	Not applicable
Normalized Baseline	Not applicable

Table 2: Potential Baseline Evaluation

Baseline Approach

This protocol shall utilize the Performance Standard approach to delineating a baseline. There is insufficient standardized data available on effort, transport and removals of material for Open Trench Technology projects. By executing a process to build coefficients for a Performance Standard, project proponents will be able to most accurately quantify the emissions that would result from using traditional Open Trench Technology. Though this approach requires a significant amount of data gathering and conglomeration, it will provide the most accurate tool for quantifying a baseline.

3.3 IDENTIFICATION OF BASELINE SSRS

As per ISO14064-2 requirements baseline SSRs were identified using the same criteria and procedures as for identification of project SSRs. No additional criteria were used. An activity and materials & energy flow diagram was prepared for a generic baseline scenario, as illustrated in Figure 3. Utilizing the same step-wise procedure that was outlined in Section 3.1.2, relevant SSRs for the baseline were then identified, as illustrated in Figure 3 and described in more detail in Table 3.

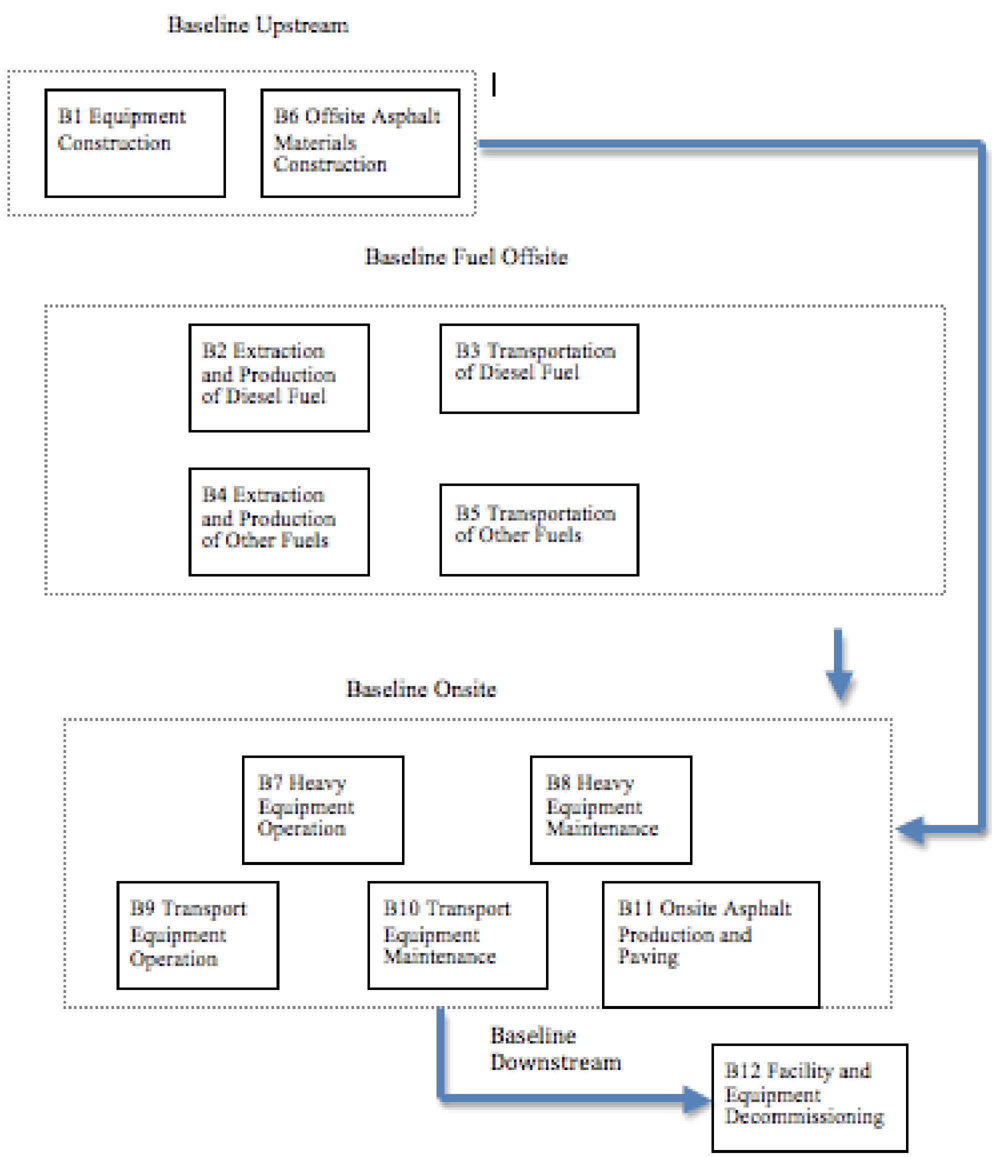

Figure 3: Generic process flow diagram for the baseline.

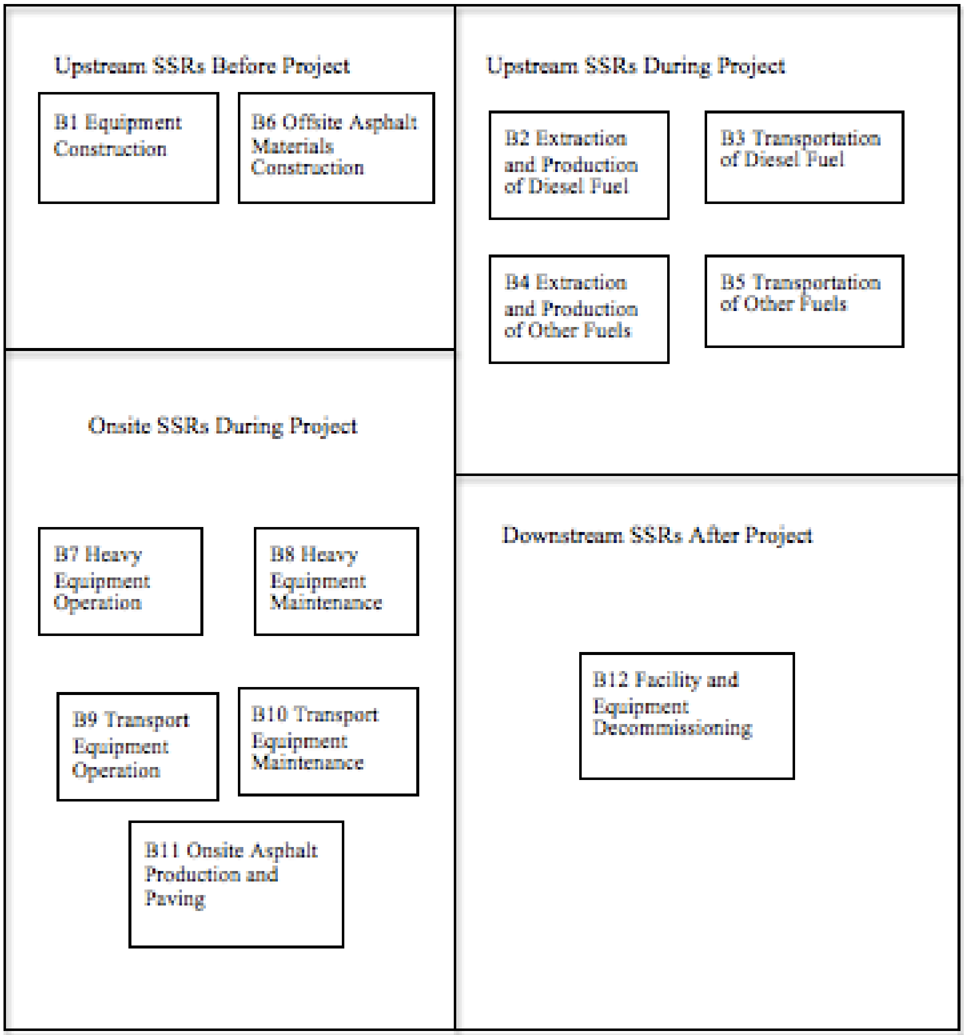

Figure 4: Baseline SSR Diagram

3.3.1 DESCRIPTION OF BASELINE SSRs

Number	Source, Sink or Reservoir (SSR)	Description	Controlled, Related or Affected
Upstream SSRs			
B1	Equipment Construction	All activities associated with the construction of facilities and equipment that would be required in order to undertake a Trenchless Construction Technology project.	Related
B2	Extraction and Production of Diesel Fuel	All activities associated with the extraction and production of diesel fuel from crude oil or other feedstocks (such as biomass in the case of biodiesel blends). This diesel fuel would be used as fuel for heavy equipment and transportation equipment operation.	Related
B3	Transportation of Diesel Fuel	Transport of diesel fuel from the production facility to the end use location. Transportation may include shipments by truck, pipeline, rail or other mode, with associated GHG emissions.	Related
B4	Extraction and Production of Other Fuels	All activities associated with the extraction and processing of fuels other than diesel	Related
B5	Transportation of Other Fuels	Transport of fuel from the production facility to the end use location. Transportation typically conducted by various means, including truck (e.g. propane) and pipeline (e.g. natural gas).	Related
B6	Offsite Asphalt Materials Production	All asphalt-related materials produced and activities undertaken offsite.	Related
Onsite SSRs			
B7	Heavy Equipment Operation	All activities associated with the operation of Heavy Equipment.	Controlled
B8	Heavy Equipment Maintenance	All activities associated with maintaining Heavy Equipment in operational condition.	Controlled
B9	Transportation Equipment Operation	All activities associated with operation of Transportation Equipment.	Controlled
B10	Transportation Equipment Maintenance	All activities associated with maintaining Transportation Equipment in operational condition.	Controlled
B11	Onsite Asphalt Production and Paving	All asphalt and paving-related materials produced and activities undertaken onsite.	Controlled
Downstream SSRs			
B12	Facility and Equipment Decommissioning	All activities associated with the end-of-life decommissioning, recycling and disposal of facilities and equipment that would be required in order to facilitate GHG reductions through adoption of Trenchless Construction Technology that is due to the project.	Related

Table 3. List of Baseline SSRs

Explanation of SSR Categorization
All SSRs were categorized as controlled, related or affected (C/R/A) based on their relation to the project proponent and based on how similar SSRs were categorized in the project case, where the project proponent is assumed to control all on-site SSRs in the project and analogous SSRs in the baseline, whereas upstream and downstream SSRs are assumed to be controlled by others, and thus are related to the project. This categorization is to be reviewed by each user of this protocol and adjusted accordingly based on project-specific circumstances. However, this categorization does not have any impact on other aspects of this protocol, such as calculation methodologies.

3.4 COMPARE PROJECT AND BASELINE SSRS

This section includes the following methodological components:
· Compare project SSRs to baseline SSRs (as per section 5.5 c) of ISO 14064-2
· Identify a final list of relevant project and baseline SSRs
· Select relevant SSRs for either monitoring or estimating GHG emissions and removals

3.4.1 SELECTION OF CRITERIA AND PROCEDURES

While no specific criteria or procedures are required for comparison of project and baseline SSRs according to ISO 14064-2 requirements, criteria and procedures are required to both identify the final set of relevant SSRs as well as to determine whether emissions and removals from each relevant SSR should be monitored or estimated.

With regards to identifying a final set of relevant SSRs, the criteria and procedures identified in ISO 14064-2, the draft Federal Guide for Protocol Developers, and BC-specific offset rules for assessing the relevance of SSRs were considered to be the most relevant and current, and were thus used to identify and compare a final set of relevant project and baseline SSRs from the preliminary lists of SSRs presented above. ISO 14064-2 provides common good practice guidance (in Figure A.2 included within the standard) used to compare and select relevant GHG SSRs for monitoring and estimating. Additionally, since one-time-only emission sources, such as those associated with construction of project equipment and end-of-life decommissioning, are typically not material to overall GHG emission reduction calculations, these emission sources have not been considered relevant in this protocol. This approach is consistent with the draft Federal Guide for Protocol Developers. However, Project Proponents may propose specific one-time-only emission sources that must be quantified, where there is potential for associated emissions to be material to the emission reduction calculation. Finally, BC offset-specific requirements related to emission reductions and removal enhancements occurring within British Columbia were also respected.

With regards to selecting relevant SSRs for monitoring vs. estimating, the cost/benefit criteria and procedures described in ISO 14064-2 Annex A, Figure A.2 are considered to be a generally accepted approach, and were used.

3.4.2 PROCEDURES FOR SELECTING FINAL LIST OF RELEVANT SSRS AND SELECTING SSRS FOR MONITORING OR ESTIMATING

Selecting Final List of Relevant SSRs

In performing a final assessment of relevance for project and baseline SSRs, the following criteria were used:

· **No change between project and baseline**: if there were no apparent changes in emissions between the project and baseline for an equivalent SSR, then the SSR was excluded from further consideration since it would have no bearing on overall project emission reductions. (as per ISO 14064-2 Figure A.2 No. 6)

· **Emissions greater for baseline than project**: if estimated emissions for a baseline SSR were greater than for an equivalent project SSR, or if there was no equivalent project SSR, then the SSR was considered for exclusion (equivalent to estimating emissions at zero) as it would be conservative to do so. This decision would be made based on a cost-benefit analysis (e.g., it would be excluded where effort required to quantify the emissions were considered prohibitive given the size or uncertainty of the SSRs in question).

· **Emission Reductions and Removal Enhancements from SSRs within BC**: where emissions are greater for the baseline than the project for SSRs located outside BC, these SSRs must be excluded as the BC Emissions Offset Regulation only permits emission reductions and removal enhancements to be counted from SSRs within BC.

· **One-Time-Only Upstream or Downstream SSRs**: all one-time-only SSRs that occur either before or after the project, such as construction of project and baseline equipment, end-of-life decommissioning of equipment, etc., are excluded from consideration.

Selecting Relevant SSRs for Monitoring or Estimating

For each relevant SSRs, consideration was given with respect to whether or not an SSR could be monitored cost-effectively (e.g. do the potential benefits of monitoring, such as enhanced accuracy and possibly increased potential for emission reductions, out-weigh any increased costs associated with monitoring rather than estimating). Where estimating was selected, justification for the decision based on cost-benefit criteria is provided.

3.4.3 APPLICATION OF THE PROCEDURES

In applying the procedures described above, all project and baseline SSRs were entered into Table 4, with similar SSRs for the project and baseline entered on the same row. Each SSR was identified as either controlled, related or affected, and then a decision was made regarding 1) is the SSR relevant to the quantification, and 2) if so, should associated emissions and removals be monitored or estimated.

Where an SSR was deemed to be not relevant and/or selected for estimating, supporting justification is provided. No justification is needed for relevant SSRs selected for monitoring.

SSR	BASELINE Controlled Related or Affected	PROJECT Controlled Related or Affected	Relevant	Monitored or Estimated	Justification
P1/B1 Equipment Construction	Related	Related	Not Relevant	n/a	This SSR is a one-time-only upstream SSR and thus excluded from consideration.
P2/B2 Extraction and Production of Diesel Fuel	Related	Related	Not Relevant	n/a	Process emissions are likely to take place out of BC. The emissions from this SSR are greater in the Baseline Case than the Project Case, as the project results in a reduction in diesel use. Therefore, this emission source is conservatively excluded from further consideration.
P3/B3 Transportation of Diesel Fuel	Related	Related	Not Relevant	n/a	The emissions from this SSR are greater in the Baseline Case than the Project Case, as the project results in a reduction in diesel use. Therefore, this emission source is conservatively excluded from further consideration.
P4/B4 Extraction and Production of Other Fuels	Related	Related	Not Relevant	n/a	The emissions from this SSR are greater in the Baseline Case than the Project Case, as the project results in a reduction in diesel use. Therefore, this emission source is conservatively excluded from further consideration.
P5/B5 Transportation of Other Fuels	Related	Related	Not Relevant	n/a	The emissions from this SSR are greater in the Baseline Case than the Project Case, as the project results in a reduction in diesel use. Therefore, this emission source is conservatively excluded from further consideration.

P6/B6 Offsite Asphalt Materials Production	Related	Related	Not Relevant	n/a	The emissions from this SSR are greater in the Baseline Case than the Project Case, as the project results in a reduction in diesel use. Therefore, this emission source is conservatively excluded from further consideration.
P7/B7 Heavy Equipment Operation	Controlled	Controlled	Relevant	Monitored	Differences between Project and Baseline case of this SSR are controlled by the project and are key to the emissions reductions resulting from this project.
P8/B8 Heavy Equipment Maintenance	Controlled	Controlled	Not Relevant	n/a	This SSR is difficult to assess, and differences between Project and Baseline are likely to be negligible.
P9/B9 Transportation Equipment Operation	Controlled	Controlled	Relevant	Monitored	Differences between Project and Baseline case of this SSR are controlled by the project and are key to the emissions reductions resulting from this project.
P10/B10 Transportation Equipment Maintenance	Controlled	Controlled	Not Relevant	n/a	This SSR is difficult to assess, and differences between Project and Baseline are likely to be negligible
P11/B11 Onsite Asphalt Production and Paving	Controlled	Controlled	Relevant	Monitored	Differences between Project and Baseline case of this SSR are controlled by the project and are key to the emissions reductions resulting from this project.
P12/B12 Facility and Equipment Decommissioning	Related	Related	Not Relevant	n/a	This Baseline SSR is expected to be equal or greater than its counterpart Project SSR, and occur outside the project boundary. It has been conservatively excluded from quantification.

- Need to look at this table in more detail*

Table 4. Identification of Relevant SSRs

4.0 QUANTIFICATION OF GHG EMISSIONS AND EMISSION REDUCTIONS

4.1 QUANTIFICATION OF PROJECT AND BASELINE EMISSIONS

4.1.1 QUANTIFICATION METHODOLOGIES

For each “relevant” SSR identified in Table 4, a calculation method is provided and justified for quantifying associated GHG emissions in the following section. A typical, universally accepted emission factor-based equation has been used for most SSRs to calculate emissions, as follows:

Equation 1: $T_{ij} = EF_{ij} * AL_i * CF$

Where:
Tij is the total emissions of GHG j (e.g. tonnes of CO_2, tonnes of CH_4, etc.) for SSR i;
EFij is the emission factor for GHG j and SSR i [e.g. tonne CO_2/(activity or input/output)]; and
ALi is the quantity of input/output or “activity level” for SSR i (e.g. volume of fuel combusted, distance traveled, electricity generated, etc.).

CF is a conversion factor to be used when the units of the activity level do not match those of the emission factor. Where both the activity level and emission factor are expressed in the same units, CF would be set to 1. In most cases, emissions will be calculated using this equation or a variation of this equation.

Following calculation of individual GHGs, total GHG emissions in units of tonnes of CO_2e would then be calculated using the following generalized, universally accepted equation:

Equation 2: $T_i = \Sigma[T_{ij} * GWP_j]$ ***for all relevant j’s***

Where:
Ti is the total emissions in units of tonnes CO_2e for SSR i; and
GWPj is the global warming potential for GHG j.

Below, equations and parameters are provided and justified for each relevant SSR for the project and baseline.

Onsite SSRs During Operation

Various approaches are available for calculating vehicle/machinery-related emissions, ranging from approaches based on detailed fuel consumption data (most accurate), to calculations based on vehicle/machine-specific fuel consumption factors and vehicle/machine-specific operational data. These approaches are outlined in various sources, including the TCR General Reporting Protocol and CDM methodology AM0036. Given the sensitivity of vehicle/machinery emissions to various operational, vehicle, and operator-specific factors, quantification of emissions for this SSR must be based on either monitored fuel consumption data by Project / Baseline Vehicles or project-specific fuel consumption factors and distance data (to calculate fuel consumption) for Project / Baseline Vehicles.

Due to the increased accuracy and availability of quality data monitoring sources the approach outlined in this protocol will be utilizing monitored project-specific fuel consumption data for Project / Baseline vehicles.

B7/P7 – Heavy Equipment Operation

This emission source is related to the direct combustion of diesel/gasoline fuel during the operation of vehicles and machinery by construction bodies. Emissions associated with this SSR are calculated using Equation 3, which is standard practice for calculating fuel emissions.

Equation 3: $T = EF * FC * RFT_{k,adj}$
Where,
T is the total emissions of GHGs (expressed as CO_2e)
EF is the transportation emission factor per liter (e.g. kg CO_2e / L)
FC is the total diesel/gasoline fuel consumed by Heavy Equipment during crediting period (L)
RFTk,adj is the renewable fuel content adjustment factor. This factor is equal to the percent of nonrenewable fuel in the diesel fuel (taken as 95% in 2010 - see Section 2.2.6)

Determining the emission factor
Given the range of reasonable, low uncertainty fossil fuel combustion emission factors available for standard combustion fuels (e.g. gasoline, diesel, etc.), an average emission factor from a recognized source such as the BC or National Inventory Reports may be used so long as the emission factor selected is appropriate for the vehicle type used, and separate emission factors for CO_2, CH_4, and N_2O are available. Where different types of vehicles are used associated emission calculations must be performed separately for each vehicle type.

Determining the total fuel consumed
Three different approaches exist for determining the fuel consumed by an onsite vehicle/machine. Where available and appropriate, the most accurate approach of using monitored fuel consumption data for each vehicle/machine affected by the project should be used. In the absence of accurate monitored fuel consumption for each vehicle/machine the total fuel consumed by all onsite project vehicles/machines can be monitored as a whole (e.g. data from site refueling vehicles).

For baseline data, to account for variability in the depth and difficulty of the trench, fuel consumption per day and productivity data (meters per day) from 12 months of open trench projects should be recorded based on 4 levels of depth and 4 levels of difficulty.

These depth and difficulty levels must be decided upon by the construction body, and must encapsulate all of the projects they would encounter for open trench and trenchless constructions. The criteria for each level must be outlined and followed by the construction body to create a matrix of average project fuel consumption and productivity data. Fuel consumption data will be required to come from sources outlined above and will need to be divided by the project duration to calculate average daily fuel consumption, and productivity data will be calculated by dividing the total trench length (in meters) by the project duration to calculate the projects average meters per day productivity. This data will be used to identify suitable fuel consumption and project duration data to be used as the baseline for future trenchless construction projects by dividing the length of the trench by the productivity and multiplying the resulting number of days by the average daily fuel consumption figure.

The above data collection and analysis will form the basis of generating the performance standard for British Columbia Trenchless Technology projects, and will be required to be validated during Project Plan Validation. Figure 5 is an illustration of the matrix described above:

	Difficulty Grade 1	**Difficulty Grade 2**	**Difficulty Grade 3**	**Difficulty Grade 4**
Depth Range 1	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day
Depth Range 2	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day
Depth Range 3	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day
Depth Range 4	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day	Average Productivity and Fuel Consumption per day
	Difficulty Grade 1	**Difficulty Grade 2**	**Difficulty Grade 3**	**Difficulty Grade 4**

	Criteria	Criteria	Criteria	Criteria

Figure 5: Baseline Productivity and Fuel Consumption Matrix

Transportation SSRs During Operation

Various approaches are available for calculating transportation-related emissions, ranging from approaches based on detailed fuel consumption data (most accurate), to calculations based on vehicle-specific fuel economy data and route-specific distance data. These approaches are outlined in various sources, including the TCR General Reporting Protocol and CDM methodology AM0036. Given the sensitivity of transportation emissions to various route, vehicle, and driver-specific factors, and that a particular project would likely not involve a range of different transportation routes that on average might approximate the emissions profile of generic emissions factor approach, quantification of emissions for this SSR must be based on either monitored fuel consumption data by Project / Baseline Vehicles or project-specific fuel economy and distance data (to calculate fuel consumption) for Project / Baseline Vehicles.

Due to the fluctuations that occur between project transportation routes, the approach outlined in this protocol will be utilizing project-specific fuel efficiency and distance data (to calculate fuel consumption) for Project / Baseline vehicles.

B9/P9 – Transportation Equipment Operation

This emission source is related to the direct combustion of diesel/gasoline fuel during the operation of diesel/gasoline vehicles by construction bodies. Emissions associated with this SSR are calculated using Equation 4, which is standard practice for calculating transportation emissions.

If monitored fuel consumption data is to be used for the calculation of emissions from Transportation Equipment operation, then Equation 3 should be used.

Equation 4: $T = EF * VKT * CF * RFT_{k,adj}$
Where,
T is the total emissions of GHGs (expressed as CO_2e)
EF is the transportation emission factor per liter (e.g. kg CO_2e / L)
VKT is the Vehicle Kilometers Travelled (VKT) by Transportation Equipment (km)
CF is the diesel fuel consumed per VKT (L per km)
$RFT_{k,adj}$ is the renewable fuel content adjustment factor. This factor is equal to the percent of nonrenewable fuel in the diesel fuel (taken as 95% in 2010 - see Section 2.2.6)

Determining the emission factor
Given the range of reasonable, low uncertainty fossil fuel combustion emission factors available for standard mobile combustion fuels (e.g. gasoline, diesel, etc.), an average emission factor from a recognized source such as the BC or National Inventory Reports may be used so long as the emission factor selected is appropriate for the vehicle type used, and separate emission factors for CO_2, CH_4, and N_2O are available. Where different types of vehicles are used associated emission calculations must be performed

separately for each vehicle type.

Determining the activity level
Where available and appropriate, the most accurate approach of using monitored vehicle kilometers travelled on the actual route(s) affected by the project should be used.

For Baseline Vehicles, to account for increased transportation requirements, the VKT will be calculated using Equation 5.

Equation 5: VKT = ((V *(1+ LF) / LC)* D
Where,
VKT is the total vehicle kilometers traveled (km)
V is the total volume of material moved for open trench construction (m3)
LF is the Load Factor for the type of material moved (%)
LC is the load capacity of the vehicle used to move materials (m3)
D is the roundtrip distance from the project site to the dumpsite for materials (km)

Determining volume of material
The volume of material to be moved is calculated based on the length, depth and width of the trench necessary for construction. This calculation is required to be completed based on standard industry practices; the following Figure 6 outlines how to measure the depth and width of the trench:

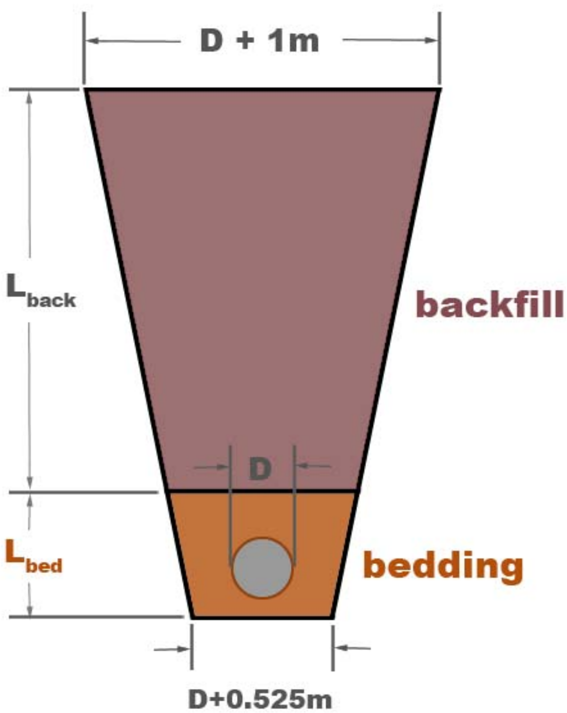

Figure 6: Trench Depth and Width Measurements

Determining load factor

The load factor describes how much a certain material will expand once it has been removed from the ground. Load factors to be used in this protocol must be specific to the type of materials being moved by the project, and must come from a government report or peer reviewed study.

Determining load capacity
Two different approaches are acceptable for determining the load capacity of a vehicle. The first approach is to use the vehicle manufacturer's safe load capacity information. The second approach is to use the average actual load capacity from a specific vehicle, as measured and averaged over 25 loads by that vehicle.

Determining roundtrip distance
The acceptable approach to determining the roundtrip distance is to record the roundtrip distance from the construction site to the dumpsite on for at least 10 trips and averaging this distance. Distance data must be recorded for each individual trip, not the total distance.

Determining the consumption factor
Three different approaches exist for determining the consumption factor of a vehicle. Where available and appropriate, the most accurate approach of using monitored fuel efficiency data for transport vehicles on the actual route(s) affected by the project should be used. In the absence of accurate monitored fuel efficiency data and for baseline data, to account for any route variability, transport vehicle fuel efficiency data for the most recent 1 year historic period should be used to determine the average transport vehicle fuel efficiency figure, which will be used during the quantification period in question.

P11/B11 Onsite Asphalt Production and Paving

Equation 6: $T = AT * AEF$
Where,
T is the total tonnes of CO_2e emitted (tCO_2e)
AT is the total tonnes of asphalt used (t Asphalt)
AEF is the Onsite Asphalt Emissions Factor (tCO_2e/t Asphalt)

Determining the total tonnes of asphalt
Two different approaches exist for determining the total tonnes of asphalt used. Where available and appropriate, the most accurate approach of using monitored asphalt production figures (tonnes) should be used. In the absence of accurate monitored asphalt production figures, the total tonnes of asphalt used should be estimated based on the surface area, required thickness of asphalt, and a standard asphalt composition factors.

Determining the Onsite Asphalt Emissions Factor
Project Proponents shall select an Onsite Asphalt Emissions Factor for use in quantifying eligible emissions reductions from the reduction in Asphalt use in the Project Case. This emissions factor may be arrived at through any process a Project Proponent chooses, but must be Validated at the time of Project Plan Validation. Depending on quality of data available a Project Proponent, calculations based on actual project emissions are the

preferred route to determining this SSR. Keep in mind that only onsite, in-BC emissions are to be included in this figure. Helpful information on this topic can be sought from the approved Alberta Offset Protocol “QUANTIFICATION PROTOCOL FOR THE SUBSTITUTION OF BITUMEN BINDER IN HOT MIX ASPHALT PRODUCTION AND USAGE, October 2009, v1.0” as well as the Canadian Association of Petroleum Producers.

4.1.2 DATA MONITORING – PRIMARY PROCEDURES

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
Onsite SSRs During operation						
P7/B7 Heavy Equipment Operation						
	Fuel Consumed (FC)	liter (l)	Measured	Manual checking of fuel tank levels, combined with invoices for fuel delivery.	Daily	Fuel usage will be measured daily from the project diesel storage tanks. The process for measurement is straightforward, and strong controls over project data and property can be achieved by frequent monitoring.
	Emissions Factor (EF)	$tCO2/l$	Estimated	Emissions factor for Diesel will be taken from most recent BC or National Inventory Reports.	Annually	BC or National Inventory Reports compile pertinent emissions factors data for diesel consumption. Annual frequency is appropriate due to small or negligible changes to the emissions factor figure.
	Diesel (5% biodiesel) emission factor	$t/CO2e/L$	Calculated from Fuel Properties	Based on fuel density and percentage carbon by mass as determined	Periodic fuel samples sent for analysis. Supplier	Fuel purchased from trusted supplier so regular analysis not required

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
				by laboratory analysis of fuel samples	complies with fuel specifications and can supply analysis data	
P9/B9 Transportation Equipment Operation						
	Fuel consumed per VKT (CF)	L/km	Measured	Calculate this consumption factor using a statistically significant sampling of km travelled vs. fuel used by each type of transport vehicle and relevant parameter.	Annually	Consumption factor is unlikely to change per vehicle type over the course of a year.
	Vehicle Kilometers Travelled (VKT)	km	Measured	Measurement of Transportation Equipment odometer readings	Daily	Odometers should be read daily, to ensure travel related to other projects is not included.
	Transportation emission factor (EF)	t CO2e / L	Estimated	From published Canadian data	Annually	BC or National Inventory Reports compile pertinent emissions factors data for diesel consumption. Annual frequency is appropriate due to small or negligible changes

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
						to the emissions factor figure
P11/B11 Onsite Asphalt Production and Paving						
	Asphalt Used	Tonnes	Measured	Mass of asphalt utilized by product shall be directly measured at project site.	Monthly	Quantities of aggregate and binder shipped and used can be measured on a less frequent basis due to the fact that these raw materials may be retained onsite.
	Onsite Asphalt Emissions Factor (AEF)	tCO2e/t	Measured	Measure emissions related to Asphalt production. Project Proponents are to select and defend use of an Onsite Asphalt Emissions Factor. This factor must be Validated as part of a Project Plan.	Annually	Project Proponents shall measure and defend an Onsite Asphalt Emissions Factor and the methods used to reach it. Annual updates are appropriate once this emissions factor has been selected and Validated.

- **We need to add the gravel use as well.**

Table 5: Data Monitoring – Primary Procedures

- 4.1.3 DATA MONITORING – CONTINGENCY PROCEDURES

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
Onsite SSRs During operation						
P7/B7 Heavy Equipment Operation						
	Fuel Consumed (FC)	liter (l)	Estimated	Utilize hourly/daily fuel consumption factors for heavy equipment used onsite to estimate diesel-related CO2e emissions.	Daily	Standardized fuel consumption rates will give a broad understanding of emissions from Heavy Equipment Operation. It may be advisable to use this method for both the Project and the Baseline to avoid any bias in listed fuel efficiencies being higher than actual.
	Emissions Factor (EF)	tCO2/l	Estimated	Emissions factor for Diesel will be taken from most senior (applicable to sector and region) competent body.	Annually	Project Proponents shall select the emissions factor most likely to reflect reality from the best available data. Annual frequency matches usual release of standardized data.
	Diesel (5%	t/CO2e/L	Estimated	Based on Provincial	Annually	Provincial or Federal

HABITAT CARBON ASSETS

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
	biodiesel) emission factor		Fuel Properties	requirements for maximum biofuel percentage.		requirements for maximum biofuel percentages can be assumed to be correct. Choice of maximum allowable biodiesel fuel percentage is conservative, and will guard against overestimation of emissions reductions benefit..
P9/B9 Transportatio n Equipment Operation						
	Fuel consumed per VKT (CF)	L/km	Measured	Utilize hourly/daily fuel consumption factors for transport equipment used, to estimate diesel-related CO2e emissions.	Annually	Standardized fuel consumption rates will give a broad understanding of emissions from Transport Equipment Operation. It may be advisable to use this method for both the Project and the Baseline to avoid any bias in listed fuel efficiencies being higher than actual..
	Vehicle Kilometers Travelled (VKT)	km	Estimated	Utilize map or computer mapping service to estimate distance travelled by transport equipment.	Daily	Accurate mapping of transportation routes combined with the number of trips taken is likely to give reasonable accurate measure

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
				Multiply this by average number of loads per day.		of VKT.
	Transportation emission factor (EF)	t CO2e / L	Estimated	Utilize most pertinent non-Canadian data source to determine tCO2e/L	Annually	If Canadian data for tCO2e/L of diesel is unavailable, other sources of this data will also be very accurate, given that this emissions factor is relatively constant due to the chemistry of diesel and air. Annual frequency is appropriate due to small or negligible changes to the emissions factor figure
P11/B11 Onsite Asphalt Production and Paving						
	Asphalt Used	Tonnes	Estimated	In the absence of accurate monitored asphalt production figures, the total tonnes of asphalt used should be estimated based on the surface area, required thickness of	Monthly	Accurate estimations of Asphalt laid can be gained by assessing an existing area covered with the material (road or lot).

Project / Baseline SSR	Parameter	Units of Measure	Measured / Estimated	Method	Frequency of Measure	Justification of method and monitoring frequency
				asphalt, and a standard asphalt composition factors		
	Onsite Asphalt Emissions Factor (AEF)	tCO_2e/t	Estimated	Select a regionally and project appropriate emissions factor from published data. Project Proponents are to select and defend use of an Onsite Asphalt Emissions Factor. This factor must be Validated as part of a Project Plan.	Annually	Project Proponents shall estimate and defend an Onsite Asphalt Emissions Factor and the methods used to reach it. Annual updates are appropriate once this emissions factor has been selected and Validated.

Table 6: Data Monitoring – Contingency Procedures

4.1.4 SUMMARY OF EQUATIONS

The calculation methodologies above serve to complete the following three equations for calculating the annual emission reductions from the comparison of the baseline and project conditions. Note however that the annual emissions reductions and the actual offset credits that can be generated are not necessarily equal. The section below elaborates further upon this distinction.

Equation 7: Emissions Reductions = Emissions Baseline **–** Emissions Project

Equation 8: Emissions Baseline = Emissions Heavy Equipment Operation + Emissions Transportation Equipment Operation + Emissions Onsite Asphalt Production and Paving

Equation 9: Emissions Project = Emissions Heavy Equipment Operation + Emissions Transportation Equipment Operation + Emissions Onsite Asphalt Production and Paving

Where,

Emissions Heavy Equipment Operation = Emissions under SSRs B7/P7

Emissions Transportation Equipment Operation= Emissions under SSRs B9/P9

Emissions Onsite Asphalt Production and Paving= Emissions under SSRs B11/P11

Net emissions reductions are therefore reported as positive values and net emissions increases are reported as negative values.

5.0 DATA QUALITY MANAGEMENT

Without rigorous and auditable data, Offset Projects cannot be issued the offsets for which they would otherwise be eligible. Data tracking systems and procedures are expected to vary considerably between different Project Proponents depending on factors such as organizational size, statutory reporting requirements, vehicles and machinery used, fuels used, efficiency improvements undertaken etc. Specific data quality management procedures will not be prescribed in this protocol. Project Proponents must select data quality management procedures that are sufficient to pass final verification.

It is suggested that Project Proponents demonstrate in their Offset Project Plan that their data quality management activities include the following procedures:

1. Data collection, analysis, and quality management processes are clearly documented and made available to all staff with a role in the processes.

2. Staff responsible for data collection, analysis, and quality management are clearly documented, and responsibilities are clearly communicated to relevant staff.

3. Appropriate staff training is conducted based on designated responsibilities.

4. A data management system is established, preferably involving the use of a protected electronic database to store and perform basic calculations on monitored data, and to ensure data integrity and security. If an electronic database is not available, an alternative secure and authenticated hardcopy data management system could/should be implemented.

5. · Data collection records are maintained for seven years, either electronically or in hard-copy, that identify for each data set collected:
    - Fiscal year to which the data pertains;
    - Date and time the data was recorded or modified; and
    - Identity of staff member recording or modifying the data

6. A data back-up system is in place to ensure that, in the event of a computer failure, fire, etc., project data will not be lost.

7. Some form of periodic data assessment / error-checking is performed, possibly on a sub-set of the collected data.

8. An internal data quality assurance system is in place to periodically:
    - Confirm that data quality procedures are being followed; and
    - Identify, correct, and record where data quality procedures have not been followed.

9. A competent staff member should be made responsible for the data quality management system, and required to sign-off on data quality on a periodic basis.