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HEALTH, ENVIRONMENT,
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CAYMAN ISLANDS GOVERNMENT

DECCO Consortium

Integrated Solid Waste Management System for the Cayman Islands: Environmental Impact Assessment

Final Draft Terms of Reference

Wood Environment & Infrastructure Solutions UK Limited – April 2021

Report for

Environmental Assessment Board for the Integrated Solid Waste Management System
Sub-committee of the National Conservation Council
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Acronyms and Glossary of Terms

Acronym	Definition
AADT	Annual Average Daily Traffic
AGL	Above ground level
APC	Advanced air pollution control
APCR	Advanced air pollution control residue
BA Processing	Bottom Ash Processing
BAP	Biodiversity Action Plan
BNL	Basic Noise Level
BOD	Biochemical oxygen demand
C&D	Construction and Demolition
CCMI	Central Caribbean Marine Institute
CEA	Cumulative effects assessment
CEM	Continuous emissions monitoring
CFR	Code of Federal Regulations
CH_4	Methane
CIEEM	UK Chartered Institute of Ecology and Environmental Management
CIG	Cayman Islands Government
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon Dioxide
COD	Chemical oxygen demand
COs	Conservation objectives
CPA	Central Planning Authority
CRTN	UK Calculation of Road Traffic Noise
CUC	Caribbean Utility Company
CV	Calorific value
DC	DECCO Consortium (the Proponent)
DEFRA	UK Department for Environment, Food and Rural Affairs
DEH	Department of Environmental Health
DMR	Dry mixed recyclable
DoE	Department of Environment
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	UK Environment Agency
EAB	Environmental Assessment Board
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
ELV	End-of-Life Vehicle
ERF	Energy Recovery Facility
ES	Environmental Statement
FAC	Florida Administrative Code
FDOT	Florida Department of Transportation

GHG	Greenhouse Gas
GLVIA3	Guidelines for Landscape and Visual Impact Assessment
GTLF	George Town landfill
GWDTEs	Groundwater-dependent terrestrial ecosystems
H_2S	Hydrogen Sulfide
HAP	Habitat Action Plans
HDPE	High Density Polyethylene
HGV	Heavy Goods Vehicle
HI	Heavy Industrial
HWRC	Household Waste Recycling Centre
IFC	International Finance Corporation
IOC	Intergovernmental Oceanography Commission
IPCC	Intergovernmental Panel on Climate Change
ISWMS	Integrated Solid Waste Management System
LCRM	Land Contamination Risk Management
LOAEL	Lowest Observable Adverse Effect Level
LoD	Limit of detection
LVIA	Landscape and Visual Impact Assessment
MAGICC	Model for the Assessment of Greenhouse-gas Induced Climate Change
MRF	Material Recycling Facility
NCL	National Conservation Law
NMVOCs	Non-methane volatile organic compounds
NO_2	Nitrogen dioxide
NRA	National Roads Authority
NRCS	The United States Department of Natural Resources Conservation Service
NSR	Noise Sensitive Receptors
NTS	Non-Technical Summary
OBHs	Observation boreholes
PET	Polyethylene Terephthalate
PSDs	Passive sampling devices
RWL	Residual Waste Landfill
SAP	Species Action Plans
SLM	Sound level meters
SO_2	Sulphur dioxide
SWMP	Stormwater Management Plan
ToR	Terms of Reference
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WAC	Water Authority Cayman
WEEE	Waste Electrical and Electronic Equipment
WMF	Waste Management Facility
WTF	Water Treatment Facility
ZoI	Zone of Influence

ZTV	Zone of Theoretical Visibility

1. Introduction

1.1 Overview of the proposed development

1.1.1 These Terms of Reference (ToR) have been prepared collaboratively with the Cayman Islands Government (CIG), the DECCO Consortium and its respective consultants and relate to the proposed development of an Integrated Solid Waste Management System (ISWMS) for the Cayman Islands. The proposed ISWMS is a multi-facility development, including an energy recovery facility (ERF) and supporting non-ERF waste processing, treatment and disposal facilities. Construction and operation of the ISWMS would allow the existing landfills in George Town, Cayman Brac and Little Cayman to be closed and remediated.

1.2 The Proponent

1.2.1 These ToR have been prepared collaboratively on behalf of the DECCO Consortium, which is hereafter referred to as 'the Proponent'.

1.3 Purpose and context of the Terms of Reference

1.3.1 The ToR represent the final stage of refinement of the scope of the Environmental Impact Assessment (EIA) for the proposed development and provide a framework for the preparation of the EIA. They have been developed based on the following documents:

- Request for an EIA Scoping Opinion (GHD; 30 October 2017);
- EIA Scoping Opinion (Environmental Assessment Board (EAB); 27 November 2017);
- Draft Terms of Reference (GHD; 22 March 2018);
- Revised Draft Terms of Reference (GHD; 25 April 2018);
- EAB Comments on Revised Draft Terms of Reference (EAB; 09 May 2018); and
- EAB Comments on Revised Draft Terms of Reference (EAB; 19 October 2019).

1.3.2 As required by the *Directive for Environmental Impact Assessments Section 43, National Conservation Law* (*Extraordinary No. 50/2016*), hereafter referred to as 'The EIA Directive', the ToR will be subject to public consultation which as a minimum, will comprise the following:

- Publication of the draft ToR or a link thereto on the Department of Environment's (DoE's) website for a period of 21 consecutive days;
- Notification of the publication and public meeting in the local press on two separate occasions, within 10 days prior to the publication of the draft ToR;
- A public meeting at a venue to be agreed with the EAB to present the draft ToR. The meeting shall be held at least 7 days prior to the end of the consultation period.

1.3.3 The ToR will be updated to reflect all the relevant comments received during the consultation process.

1.3.4 Notwithstanding the above points, the ToR is also being used as a vehicle to seek to set out and agree on the approach to permitting aspects of the wider ISWMS which are proposed to be excluded from the scope of the EIA. In this context, there are two specific elements of the overall solution which are proposed to sit outside the EIA process, but which remain an integral part of the overall ISWMS. These are:

- The associated developments on the sister islands (Cayman Brac and Little Cayman); and
- Some smaller components of the wider scheme on Grand Cayman, for which separate planning consent will be sought, such that these elements can be delivered in advance of the larger parts of the overall scheme.

1.3.5 Further discussion and details of these parts of the ISWMS are set out in Section 2 of this ToR.

1.4 Structure of Terms of Reference

1.4.1 The remainder of the ToR is structured as follows:

- Chapter 2 provides a description of the ISWMS project; discusses the need for elements of the scheme to sit outside the EIA process; and sets out the need for the scheme and alternatives considered.
- Chapter 3 provides an overview of the legislation and policies that are relevant to the ISWMS project.
- Chapter 4 explains the approach that has been taken to identify the scope of the EIA.
- Chapter 5 set out the proposed scope and methodology for each technical topic where a significant environmental effect is likely to arise as a result of the proposed development.
- Chapter 6 identifies those effects that are scoped out of the EIA and sets out the proposed content of the ES.

1.4.2 The ToR also contains a number of appendices which are referenced throughout the document. Moreover, figures referred to throughout this document can be found at the end of this ToR.

2. The proposed development

2.1 Development description

Context

Each year, approximately 115,000 tons of solid waste is produced in the Cayman Islands, with the overwhelming majority of the material presently being managed by the George Town landfill (GTLF). This landfill capacity is, however, finite and in accordance with the provisions of both the *National Solid Waste Management Strategy for the Cayman Islands* (2016) and *the National Planning Framework (draft for public consultation)* (2018), this ToR has been prepared in relation to the proposed development of a replacement ISWMS for the Cayman Islands.

Site location

2.1.1 The proposed ISWMS site is located to the north of central George Town towards the western coast of Grand Cayman, immediately south-west of the existing GTLF. Access to the site will be via Seymour Drive from the south.

Existing site and surroundings

2.1.2 Overall, the proposed ISWMS development encompasses 17.3 acres of the existing GTLF site for the development of a new Residual Waste Landfill (RWL) and Landfill Gas Facility, together with a 16.8 acre parcel of undeveloped land immediately south-west of this for the remainder of the ISWMS facilities.

2.1.3 The land usage surrounding the ISWMS site is summarised as follows:

- The existing GTLF lies immediately north and east of the proposed ISWMS site. North of this is a tidal drainage channel developed for mosquito control that connects with North Sound to the east. The area immediately north of the drainage channel is mangrove swamp. The Cayman International School and Camana Bay development are located approximately 0.2 miles and 0.5 miles north of the landfill respectively
- The land east of the GTLF is owned by Cayman Water Authority, comprising four large former wastewater treatment lagoons that are still used for sludge storage. South of the lagoons is the current wastewater treatment plant including some buildings and four smaller basins. Some 0.1 to 0.2 miles east of the landfill site is land zoned for industrial use. This is mainly undeveloped or used for open storage. The Department of Environmental Health (DEH) collections depot (comprising several trailers for staff facilities and parking for staff and collection vehicles) is located on approximately 1 acre of land to the east of the wastewater treatment lagoons
- The southern boundary of the proposed ISWMS site is currently mangrove, beyond which is industrial and commercial development. This land is occupied by a variety of businesses, including a concrete batching plant and a concrete block and paver stone manufacturer
- Esterly Tibbetts Highway (the main arterial road to West Bay) lies immediately adjacent to the fence line forming the western boundary of the proposed ISWMS site. The Lakeside residential development is located west of this road. This development comprises 12 three-storey residential apartments with car parking and leisure/landscape areas (including a small lake). The North Mound of the GTLF is visible from the easternmost lakeside buildings

2.1.4 The undeveloped parcel of the ISWMS development (Block 13D Parcel 431) is predominantly zoned Heavy Industrial (HI), which designation includes all of the activities proposed at the ISWMS Site; allowing for power generation, fuel refining and storage, solid waste disposal, recycling, quarrying and mining, mechanical and other forms of manufacture.

2.1.5 This is consistent with the existing zoning designations and activities on the land surrounding the proposed ISWMS development.

Development proposals

Overview

2.1.6 The proposed new ISWMS development consists of various new waste management facilities, all the major components of which will be subject to the EIA process. The development also includes some smaller elements that would not on their own attract the need for an EIA, but will still be considered as part of the overall development in order to assess their 'in-combination' effects with the major components of the ISWMS. In this regard, it is anticipated that the EIA will consider the cumulative effects of **all** aspects of the ISWMS.

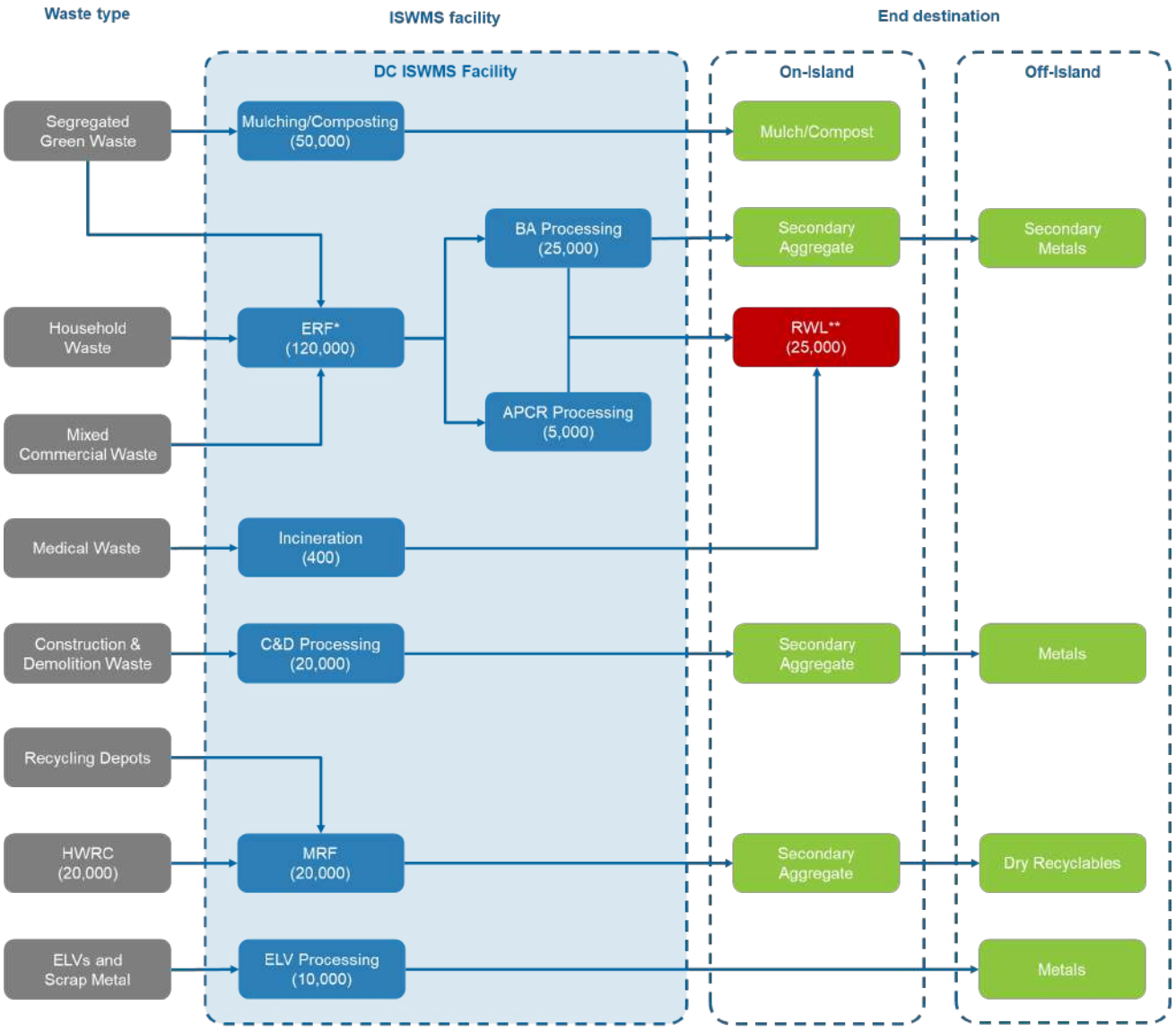
2.1.7 The various components of the new ISWMS are as follows:

- Energy Recovery Facility (subject to EIA)
- Non-Energy Recovery Facilities:
  - Site weighbridges (excluded from EIA)
  - Green Waste Processing Facility (subject to EIA)
  - Construction and Demolition Waste Processing Facility (subject to EIA)
  - Bottom Ash Processing Facility (subject to EIA)
  - Abandoned and End-of-Life / Scrap Metal Processing Facility (subject to EIA)
  - Medical Waste Facility (subject to EIA)
  - Materials Recycling Facility (excluded from EIA)
  - Household Waste Recycling Centre (excluded from EIA)
  - Landfill Gas Facility (subject to EIA)
  - Residual Waste Landfill (subject to EIA)
- Ancillary Facilities:
  - Admin Building (excluded from EIA)
  - Maintenance Building (excluded from EIA)

2.1.8 The design life of the new facilities is 25 years. Whilst a detailed layout of the Site has not been finalised and will be informed by the EIA, a general Site arrangement, detailing the proposed infrastructure is depicted in **Figure 2.1.**

2.1.9 Plate 2.1 indicates how the major waste components by volume will be managed through the ISWMS Facilities and Table 2.1 lists the management options for "specials wastes" that typically will be received in relatively small volumes but will require special attention due to the specific nature of these materials. It is not anticipated that waste will be accepted or processed from cruise ships.

Plate 2.1 Waste (by type) to be managed through the ISWMS Facilities



( ) = maximum annual tonnage.

* Includes allowance for combustible residues from other processing facilities.

** Includes non-recoverable residues from other facilities, plus allowance for potential additional landfilling in later years of contract.

Table 2.1 Waste management options for special wastes

Material type	Disposal options
Tyres	ERF
Auto and marine batteries	Overseas recycling
Household batteries	Overseas recycling
Vegetable oils	Bulked for ERF, overseas recycling
Vehicle oils	Bulked for ERF, overseas recycling
Paints	Re-use, bulked for ERF
Medical waste	Medical Waste Incinerator, ash to RWL
Electronic waste	Re-use, overseas recycling (de-manufacture)
Fluorescent bulbs	Pulverised and overseas recycling
Small animal carcass	ERF
Large animal carcass	RWL
Abattoir waste	ERF
Chemicals	Based on material: ERF, overseas recycling
Pharmaceuticals	Medical Waste Incinerator
Confiscated illegal drugs	Medical Waste Incinerator
Asbestos	RWL
Other	Case by case

2.1.10 Building on the previous work completed to establish the need for the ISWMS, (i.e. National Solid Waste Management Policy Final Report"; "National Solid Waste Management Strategy Final Report"; "Finalized Strategic Outline Business Case – ISWMS for Cayman Islands") the overall design life/ capacity is based on projected waste generation rates and future population. Proposed indicative capacities (where appropriate) for each of the components are outlined in Table 2.2.

Table 2.2 Proposed Facility components and capacities[1]

Facility	Maximum capacity/yr (short ton per annum)[2]	Location	Nominal Operational Date
Energy Recovery Facility	120,000	ISWMS site	July 2024
Site Weighbridges[3]	n/a	ISWMS site	July 2024
Green Waste Facility	50,000	ISWMS site	July 2024
Construction & Demolition Waste Processing Facility	20,000	ISWMS site	July 2024
Bottom Ash Processing Facility	25,000	ISWMS site	July 2024
End of Life Vehicle / Scrap Metal Processing Facility	10,000	ISWMS site	July 2024
Medical Waste Incinerator	400	ISWMS site	July 2024
Materials Recycling Facility[3]	20 000	ISWMS site	July 2024
Household Waste Recycling Centre[3]	20 000	ISWMS site	July 2024
Landfill Gas Facility	600 nm^3/hr	GTLF	January 2022
Residual Waste Landfill	25,,000	GTLF	July 2024
Administration Building[3]	n/a	ISWMS site	July 2024
Maintenance Building[3]	n/a	ISWMS site	July 2024

[1] – Table excludes the Sister Island developments, which are outlined later in this section of the ToR (see paragraphs 2.1.51 to 2.1.63).

[2] – Capacities are approximate and subject to revision resulting from updating waste volumes

[3] – ISWMS Facilities excluded from the EIA – see paragraphs 2.1.49 to 2.1.50 of this ToR.

Energy Recovery Facility

2.1.11 The ERF will be a state-of-the-art controlled combustion (mass burn) facility that will render combustible, non-recyclable waste to an inert ash and reduce the volume of incoming waste by 90%; or about 75% on a tonnage basis. It is anticipated that the ERF will process a maximum of approximately 115,000 tons per year of municipal solid waste (depending on the energy content (calorific value; CV) of the waste being managed). The heat of combustion will be harnessed to produce up to approximately 9.3 megawatts (MW) of electrical power (currently representing approximately 9 percent of the total average electrical power consumption on Grand Cayman) for sale to the Caribbean Utility Company (CUC). Advanced air pollution control (APC) and continuous emissions monitoring (CEM) systems will ensure that ERF emissions are able meet current and future standards and not pose an adverse effect to the environment. Additional environmentally beneficial opportunities to use surplus ERF heat will also be considered.

2.1.12 The capacity of the ERF is determined by the amount of thermal energy that the installed appliances (furnace and boiler) can safely manage. In the case of the ISWMS ERF the capacity is 35.5 MW_{th}. The average annual throughput capacity of the ERF, in tons treated, will be dependent upon the energy content (CV) of the waste, and is anticipated to be between 12.5 and 15.0 tons per hour. The ERF will operate at least 8,000 hours per year. The residence time in the tipping hall bunker is foreseen to be 2-3 days, however, it will be designed to have a normal filling capacity of 5-6 days and an emergency capacity of approximately 10-14 days.

2.1.13 Groundwater sourced, non-contact cooling water for the ERF is anticipated pending an assessment of availability (supply) and potential interference with existing groundwater users in the area. At present, once through, ERF cooling water is envisaged to be returned to the ground. Alternatively, surface water discharge of ERF cooling water may be considered.

2.1.14 Residues from the ERF will comprise bottom ash, fly ash and APC residue (APCR). The bottom ash will be managed via the proposed Bottom Ash Recycling Facility. The treatment of APCR will be by means of a rough terrain concrete mixer truck employed to mix and transfer cement treated APCR to the RWL.

2.1.15 Whilst this ToR relates specifically to the development of a 'single line' ERF with an annual capacity of up to 115,000 tons per annum – sufficient to manage the Cayman Islands' waste management needs for the short and medium term – should long term waste arisings be such that additional capacity is required, it can be confirmed that there is space at the proposed development site to accommodate an additional ERF of similar capacity. This does not form part of the current proposals and would form part of a separate planning submission at the appropriate time, if required.

Green Waste Facility

2.1.16 Green (organic) waste delivered to the ISWMS site will be weighed as it enters the facility and will undergo a pre-treatment shredding process to enable it to achieve a readily compostable state or for immediate use as mulch. If not employed as mulch (or otherwise recovered in the ERF), the shredded green waste will be transferred to the windrow composting area where it will be matured, screened, and tested to meet Florida compost standards for local use.

2.1.17 Windrows are a universally employed, low-technology solution for managing green waste. Green waste will typically be spread over the area in windrows consisting of elongated mounds which will be irrigated naturally (precipitation) and manually (via application of stormwater collected in a stormwater management pond to be constructed at the ISWMS Site with potential contingency use of water generated on site by the ERF process. The windrows are also turned regularly to expedite the composting process.

2.1.18 If necessary, materials in excess of the Green Waste Facility's capacity may also be managed through the ERF. There is a general need for mulch and compost in the Cayman Islands, however, it is noted that mulched and/or composted material could also be used to establish vegetation growth on the remediated/closed GTLF and the RWL.

2.1.19 Notwithstanding this, it is considered that the ERF will have excess capacity during the initial years of operation and that the size of the local market for compost remains uncertain. As such, a phased expansion of the mulching/composting facility operations is proposed, starting at approximately 2,500 short tons in Year 1 of operations and expansion thereafter as required to 100 per cent during the contract period.

End of Life Vehicle and Scrap Metal Processing Facility

2.1.20 End-of-Life Vehicles (ELVs) will be weighed upon entry to the ISWMS Site and all pertinent vehicle details will be logged. The vehicles will be stored prior to processing. ELVs will be stripped of recyclable and/or re-useable components, including removal of residual oils, fuel, refrigerants, and tires which will be processed in the ERF. The remaining ELV carcasses will be crushed and exported to offshore mills for recycling into new materials including steel, non-ferrous metals and plastic.

2.1.21 Other scrap metal such as appliances, metals from the ERF ash, and C&D facilities will be depolluted as required and baled as appropriate before shipment to overseas mills for recycling.

Construction and Demolition Waste Processing Facility

2.1.22 Construction and Demolition (C&D) waste will be subject to a pre-sorting procedure to divert oversized materials and maximize the efficiency of the recycling process. A series of conveyors will pass the waste over magnets and a sorting screen to separate earthen, concrete and cementitious items for aggregate recycling and removal of ferrous and non-ferrous metals. The treatment process will produce clean ferrous and non-ferrous metals and aggregate for use in the construction industry.

2.1.23 Waste will then be loaded into a hopper and fed into a trommel to separate the fines which, subject to environmental and structural properties confirmation, can be used for landfill cover or as general fill. A blower will recover the light combustible waste (e.g., wood) which will be delivered to the ERF to fuel the boiler to produce electricity.

Bottom Ash Processing Facility

2.1.24 Bottom ash will be processed through an advanced processing system whereby the ash will be reduced in size and the ferrous and non-ferrous metals will be recovered. The end product, subject to environmental and structural properties confirmation, will consist of an aggregate for re-use on island in the construction industry, and clean ferrous and non-ferrous metals for offshore export to mills for recycling into new raw metals. Bottom ash maturation and storage areas will be developed at the George Town ISWMS Site to facilitate this process.

2.1.25 Surface water run-off from the bottom ash storage area will be directed to a bottom ash run-off retention lagoon adjacent to the bottom ash maturation area. The collected run-off will be held within the lagoon for subsequent recirculation over the bottom ash within the bottom ash maturation area as part of the weathering process.

Medical Waste Facility

2.1.26 A Medical Waste Facility will be located at the ISWMS site to manage and incinerate pathological and infectious wastes collected from health care facilities and clinics by the DEH. The approximate capacity of the diesel-fired medical waste incinerator will be 8 tons per week.

2.1.27 The Medical Waste Facility may on occasion be employed to destroy such items compatible with the capacities of the unit, such as currency taken out of circulation and confiscated drugs, that are best managed by incineration and where security is readily achieved.

Residual Waste Landfill

2.1.28 The RWL will be an engineered facility with a composite liner, leachate containment, leachate treatment, environmental controls and monitoring compliant with the Florida Administrative Code (FAC) 62-701.400 for Class III landfills. The design life of the ISWMS facilities is 25 years which will

be progressively developed and capped in two phases totalling about 8.2 acres in area and reaching an elevation of approximately 60 feet above sea level.

2.1.29 The RWL capacity will, pending final design, be approximately 350,000 cubic yards and will be developed in 2 phases as per Table 2.3 below. Phase 1 will process up to 120,000 cubic yards per year for the first 13 years and Phase 2 will increase the total volume by 205,000 cubic yards to the ultimate design capacity. Initial inputs will be around 7,000 tons per annum, rising to around 20,000 tons per annum by 2048. Inputs will include up to 5,000 tons per annum of APCR from the ERF, which will require stabilisation through mixing with cement/pozzolan, in a purpose-built mobile mixing truck or similar utility prior to disposal in the RWL. Notwithstanding this, should the need arise i.e. in an emergency situation, the RWL could accept greater quantities of waste material for short durations. For example, should the need arise for the ISWMS to handle hurricane debris at the direction of the CIG, DC will make reasonable endeavours to receive and process the material within the ISWMS facilities (excluding disposal to the RWL) where capacity exists. Further analysis of generated waste from an emergency situation will be assessed during the EIA.

Table 2.3 Development of the RWL

Phase	Area (Acres)	Volume (Cubic Yards)	Life (Years)
Phase 1	4.2	120,000	13
Phase 2	4.0	205,000	12
Total	**8.2**	**325,000**	**25**

Materials Recycling Facility

2.1.30 The Materials Recycling Facility (MRF) will be the main processing facility for the recycling of dry mixed recyclable (DMR) which includes paper, cardboard, plastic bottles (High Density Polyethylene (HDPE) and Polyethylene Terephthalate (PET)), glass, tin and aluminium cans. The MRF is able to process up to 20,000 tons per year of DMR from all three islands but is normally expected to receive up to 1,000 ton per annum. The MRF will consist of a warehouse building, which will be divided into distinct processing areas. This building will be fully enclosed to preserve the state of the recyclables for processing.

2.1.31 Material will arrive into the MRF from the satellite recyclate collection depots in 4 sorted streams: glass bottles and ceramics; mixed paper and cardboard, tin and aluminium cans, and plastic numbers 1 and 2. These materials will be inspected, and major contaminants will be removed prior to processing. DMR will leave the MRF as baled secondary materials ready for export or for re-use in the local construction industry (crushed glass). Residual materials that cannot be recycled will be delivered to the ERF where they will be burned to produce electricity or otherwise disposed of to the RWL.

2.1.32 DMR materials will be largely separated at source but will undergo final separation within the MRF. Trained staff will manually separate cardboard, paper and plastic containers before baling through a hydraulic baler in preparation for export to offshore recycling mills to create new paper, cardboard and plastic products. The DMR materials will be stored in separate areas of the building to prevent cross-contamination of recyclables and ensure a consistently high-quality grade of secondary materials is achieved.

2.1.33 Glass will be treated through a state-of-the-art glass pulveriser. This will reduce the glass to size while simultaneously passing it through a trommel to produce different grades of secondary

recycled product including aggregate for use in construction, sand fines also for use in construction and landscaping and a residual material which will be processed in the ERF.

2.1.34 Metal tins and aluminium cans will be processed through a mechanical sorting system incorporating a magnet to segregate ferrous from non-ferrous metals. This process will produce clean ferrous metals and non-ferrous metals for baling at the MRF and export to offshore aluminium and steel mills for recycling into new raw metals.

Household Waste Recycling Centre

2.1.35 The Household Waste Recycling Centre (HWRC) is where recyclable and non-recyclable household waste will be dropped off by the public via household waste reception bins or a covered re-use centre. The re-use centre will allow the collation of useable items that can be re-purposed such as appliances, kitchen ware, furniture, clothes, bulked paints, books and electronics. The re-use centre building also contains welfare facilities and office space.

The public will be directed to drive along a dedicated one-way roadway system up onto an elevated platform where vehicles can off-load in designated bays and deposit waste into designated containers. Each bay will house a container dedicated to a specific type of material including *inter alia* the following:

- DMR (as noted above);
- Green waste;
- Unsorted Municipal Solid Waste;
- Tyres;
- Household and automotive (and marine) batteries;
- Waste electrical and electronic equipment (WEEE);
- Waste Oils, vegetable and automotive (and marine); and
- Specials wastes such as paints, pharmaceuticals, solvents, etc that are selected for disposal in the ERF or RWL, and in some cases destined for overseas disposal.

2.1.36 The containers will be emptied regularly with the waste materials transferred to the appropriate facility for processing, disposal, or shipment overseas.

Administration and Maintenance Buildings and Site Weighbridge

2.1.37 The proposed ISWMS development will also incorporate the following:

2.1.38 **Administration Building** – a two storey metal cladded, on a steel frame superstructure building of approximately 5500 sf with a wrap-around balcony on the 2nd floor to complement educational and related viewing events. It is generally and open plan building with very few internal walls and a 400 sf (43-person stadium seating format) meeting room on the second floor. The building is adjacent to the main parking lot (32 spaces) for the ISWMS facility.

2.1.39 **Maintenance Building** – this will be for the storage of plant and equipment and for carrying out general maintenance of equipment associated with the ISWMS operation. It is metal cladded on a steel frame superstructure two storey, 6000 sf building, with bathroom, lunchroom, workshop, 2nd storey maintenance products mezzanine and a two-vehicle covered garage area. It is located centrally on the ISWMS for easy access by all areas of the site in need of maintenance services.

2.1.40 **Main Weighbridge and Secondary Weighbridge** – the ISWMS development will include a Main Weighbridge for managing and recording incoming and outgoing traffic, as well as housing security staff managing access to the ISWMS site. The associated weighbridge office comprises a 500 sf metal cladded on steel frame building comprised of an open plan work area, bathroom and other welfare facilities. The ISWMS development will also include a Secondary Weighbridge to record the internal movement of materials between Facilities and the disposal of residual materials to the RWL.

Anticipated Water Demand

2.1.41 The proposed ISWMS development will require the supply and use of water within the ERF and non-ERF facilities.

2.1.42 The provisional project water requirements, including the anticipated source and use, are set out in the following Table 2.4:

Table 2.4 Provisional Project water requirements

Water type	Source	Processing	Demand	Est Quantity m^3/d (US gal/d)	Comments
Potable	Water Authority Cayman	None	Domestic	12.3 (3,250)	Max demand to be establish for design base sizing
Brackish	Boreholes	None	System capacity	54,410 (14,375,880)	
	Borehole water system		ERF cooling	54,050 (14,279,520)	
			Water Treatment Facility (WTF) #1 feed	360 (96,360)	Max inlet flow per capacity diagram
Brackish	Boreholes	Desalination to raw water	Service water	100 (26,420)	Assumed daily demand = storage tank capacity
			Non-ERF	37.9 (10,000)	Composting, vehicle wash, landscaping, dust sup.
			WTF # 2 feed	192 (50,730)	
			Fire water tank	10 (2,640)	1% allowance for leaks
Total raw water demand				340 (89,800)	

Access

2.1.43 The ISWMS site will be accessed along the same route as the current operations: from the South via Seymour Drive.

Proposed site layout

2.1.44 The proposed site for the ISWMS project is on Block 13D Parcel 431, located immediately South of the GTLF and parts of Block 13D Parcels 1 and 287 and parts of Block 13C parcel 1. All parts of the existing GTLF.

Site security and lighting

2.1.45 Security has been addressed on the site by the proposed construction of a 12' high metal chain link perimeter fence. Access to the site is provided via a 24' main gate on the south side of the proposed property. As 90% of the site's activity is done during dawn to dusk lighting is restricted to the main access road (to allow for solid waste deliveries) and building eves.

2.1.46 A lattice of close circuit television cameras will populate the ISWMS site ensuring total coverage.

Proposed working hours

2.1.47 The working hours will vary between the facilities based on the specific work demands and needs. As well as open hours for the public and companies using the facilities. The hours have not been finalised, but the following will be taken into consideration:

- **ERF** – the ERF will be functioning 24/7, with the exception of approx. 10 days of planned annual maintenance periods. On such days it will not be treating waste, but staff will be fully engaged in the maintenance activities, which will likely include additional staff from overseas to facilitate the required maintenance works.
- **MRF, C&D, ELV, Bottom Ash and Green Waste Facilities** – will generally operate normal business hours and "as required". Staff will be shared amongst facilities.
- **Medical Waste Facility** – will be open for the reception of Medical Waste (and Ad Hoc delivers of end-of-life money and seized drugs) for 2-3 morning per week as required.
- **HWRC** – will be open to the public for 48 hrs per week but the hours will include weekends and will be adjusted to accommodate public access.
- **RWL** – will not be open to the public and only to project vehicles on a call-in basis. It will be operational to receive waste from the ERF for approximately 3 afternoon periods per week and as required.
- **Weighbridge** - will operate general "open hours" six days per week.

Employment proposals

2.1.48 The project will tentatively result in the creation of the following full-time positions:

- Senior management – 1
- Management – 5
- Skilled workers – 20
- Non-skilled workers – 38
- **Total for project - 64**

Consenting strategy for the Grand Cayman ISWMS

2.1.49 Table 2.2 above, sets out the timescales for the delivery of the individual components of the ISWMS with the overall development not expected to be fully constructed until 2024.

2.1.50 Regarding the Landfill Gas Facility, it is proposed to seek separate consent (outside the main permission) to allow this facility to be fully constructed in 2021.

Sister Island developments

2.1.51 As previously noted, the ISWMS Facilities located in Grand Cayman will be supported by 'satellite' waste infrastructure located in the two Sister Islands – Cayman Brac and Little Cayman. Details of this infrastructure is set out below:

Cayman Brac

2.1.52 The Cayman Brac facility will consist of a transfer station that will be designed, built, and operated by the CIG as a remote HWRC. The facility will be accessible to the public during established operating hours and will be used for the collection of a range of non-recyclable waste and recyclable materials. The materials collected will either be baled/wrapped, or bulked, palleted/wrapped and then shipped to Grand Cayman where they will be processed at the ISWMS site.

2.1.53 It is anticipated that approximately 2,653 tons of non-recyclable and recyclable waste will be generated in Cayman Brac for subsequent processing in Grand Cayman in 2024, rising to 3,727 tons in 2048. The waste materials will be shipped periodically (assumed at this time to be monthly). The preferred method and frequency of shipping has not been determined by the CIG. However, conceptually, it will involve placement of waste and recyclables into shipping containers at the Cayman Brac ISWMS facility, truck transfer to port, off-loading onto a barge and transfer to port at Grand Cayman at which point the containers will be off-loaded and truck transferred to the George Town ISWMS site. All non-recyclable, non-compostable waste will be baled and wrapped in impermeable plastic such that there are no solid, liquid or gaseous releases, odours or vector-related issues resulting from the storage of these baled materials.

2.1.54 The only materials that will be processed at the Cayman Brac facility will be (i) green waste which will be composted and then used on island as a compost product and (ii) small quantities of glass which will be crushed for use as aggregate. It is anticipated that up to 560 tons per year of green waste will be generated in Cayman Brac for compost processing.

2.1.55 In addition to conventional household waste, the types of materials that the Cayman Brac facility will accept will include:

- Paper, cardboard, boxboard, glass, ceramics, tin and aluminium cans, No. 1 and No. 2 plastics;
- Larger ferrous and non-ferrous metals including derelict vehicles, propane and other empty/unusable gas containing cylinders, white goods including fridges, stoves, etc, large domestic appliances (washing and drying machines, dishwashers, etc.) and small domestic appliances (waste electrical and electronic equipment);
- Medical waste from Faith Hospital;
- Household hazardous waste including paints, thinners, used oil, batteries, fluorescent bulbs, etc; and

- Yard waste including grass, leaf, hedge and tree cuttings and sea grasses are also accepted for composting and these materials will be processed at the Cayman Brac facility via windrow composting.

2.1.56 A hurricane debris storage area will also be developed within the boundary of the existing Cayman Brac landfill. It is intended that any hurricane-related waste that cannot be immediately accommodated by the Cayman Brac facility be temporarily stored in this area. These wastes will be segregated according to waste type and managed based on available processing capacity both in Cayman Brac and Grand Cayman. The precise location of the hurricane debris storage area will be determined in conjunction with the landfill restoration plan that will be developed for the Cayman Brac landfill.

Little Cayman

2.1.57 As in the case of Cayman Brac, the Little Cayman facility will consist of a transfer station that will be designed, built, and operated by the CIG as a remote HWRC. The facility will be accessible to the public during established operating hours and will be used for the collection of a range of non-recyclable waste and recyclable materials. The materials collected will either be baled/wrapped, or bulked, palleted/wrapped and then shipped to Grand Cayman where they will be processed at the George Town ISWMS facility. It is anticipated that approximately 256 tons per year of non-recyclable and recyclable waste will be generated in Little Cayman for subsequent processing in Grand Cayman in 2024, rising to 362 tons in 2048.

2.1.58 The waste materials will be shipped periodically when there is enough volume to fill a cargo vessel (assumed at this time to be quarterly), including contributions from Cayman Brac. The preferred method of shipping has not been determined by the CIG. However, conceptually, it will entail placement of waste and recyclables into shipping containers at the Little Cayman facility, truck transfer to port, off-loading onto a barge and transfer to port at Grand Cayman at which point the containers will be off-loaded and truck transferred to the ISWMS site. All non-recyclable, non-compostable waste will be baled and wrapped in impermeable plastic such that there are no solid, liquid or gaseous releases, odours or vector-related issues resulting from the storage of these baled materials.

2.1.59 The only material that will be processed at the Little Cayman facility will be (i) green waste which will be composted and then used on island as a compost product and (ii) small quantities of glass which will be crushed for use as aggregate. It is anticipated that up to 54 tons per year of green waste will be generated in Little Cayman for compost processing.

2.1.60 In addition to conventional household waste, the types of materials that the Little Cayman facility will accept will include:

- Paper, cardboard, boxboard, glass, ceramics, tin and aluminium cans, No. 1 and No. 2 plastics;
- Larger ferrous and non-ferrous metals including derelict vehicles, propane and other empty/unusable gas containing cylinders, white goods including fridges, stoves, etc, large domestic appliances (washing and drying machines, dishwashers, etc.) and small domestic appliances (waste electrical and electronic equipment);
- Household hazardous waste including paints, thinners, used oil, batteries, fluorescent bulbs, etc; and
- Yard waste including grass, leaf, hedge and tree cuttings and sea grasses are also accepted for composting and these materials will be processed at the Little Cayman facility via windrow composting.

2.1.61 A hurricane debris storage area will be developed within the boundary of the existing Little Cayman Landfill. It is intended that any hurricane-related waste that cannot be immediately accommodated by the Little Cayman facility be temporarily stored in this area. These wastes will be segregated according to waste type and managed based on available capacity both in Little Cayman and Grand Cayman. The precise location of the hurricane debris storage area will be determined in conjunction with the Landfill Restoration Plan that will be developed for the Little Cayman landfill.

Permitting the Sister Island development components

2.1.62 The proposed developments in Cayman Brac and Little Cayman are geographically separated from the proposed ISWMS in Grand Cayman. Indeed, Cayman Brac and Little Cayman are ~95 miles and ~80 miles respectively from Grand Cayman. Additionally, on their own, it is not considered that these small HWRC type developments would attract the need for an EIA. Furthermore, from a planning perspective, development in the sister islands is controlled by separate procedures (Appendix 1 and 2 of the Planning Statement for the Cayman Islands 1977). With these points in mind, it is suggested that the EIA for the ISWMS excludes an assessment of the proposed facilities in Little Cayman and Cayman Brac. Instead, separate planning applications would be made to the CIG, as appropriate, for the two separate developments.

2.1.63 Notwithstanding this suggested approach, it is recognised that the importation of waste from the sister islands to the port at Grand Cayman has the potential to contribute directly to the environmental effects of the main ISWMS site – most notably in the context of transporting material from the port to the facility itself. Such effects will be considered in the EIA and the relevant sections of this ToR reflect this i.e. those section that relate to the assessment of transport, noise and air quality effects. Transport of material from the Sister Islands to the Port will be reviewed and described in the EIA.

2.2 Need and alternatives

2.2.1 As outlined in the documents entitled Strategic Outline Case Integrated Solid Waste Management System (2014), National Solid Waste Management Policy (2015), National Sold Waste Management Strategy for the Cayman Islands (2016) and Integrated Solid Waste Management System for the Cayman Islands – Outline Business Case (2016), the rationale and purpose of the ISWMS is to eliminate the traditional landfill-based waste management approach that has been used in the Cayman Islands for the past several decades and replace it with an integrated waste management philosophy based on the core principles of the international waste hierarchy. The international waste hierarchy, in order of priority, embraces the waste management concepts of reduction, reuse, recycling, and recovery with disposal as the least preferred option.

2.2.2 The need for an ISWMS, as expressed in the above documents, was driven by an urgent recognition by the CIG that the existing solid waste management (landfill) regime is not sustainable, poses a potential threat to the environment and local amenity, and does not make best use of potential resources that could benefit the Cayman Islands. The continued use of aging, non-engineered and over-capacitated landfills on each of the islands was deemed inconsistent with modern and sustainable waste management practices, as reflected in the waste hierarchy, and conflicts with the National Solid Waste Management Policy (2015).

2.2.3 The ISWMS consists of several distinct yet fundamentally integrated waste management components. Each component has been previously assessed and documented by the CIG in relation to their technical and economic merits and comparatively evaluated to arrive at the ideal set of components that will best serve the Cayman Islands now and for the long term.

2.2.4 Based on the above, the need for the undertaking has been established previously by the CIG. Alternatives to the undertaking, including the "do nothing" alternative, and alternative methods of carrying out the undertaking were also previously evaluated, and an outline business case was developed to identify a preferred alternative. As such, the EIA will not readdress the need for the undertaking nor will it assess alternatives to or alternative methods of carrying out the undertaking. However, since the original ISWMS strategy dates back to 2014 the EIA will review the basis for the strategy to ascertain if there have been fundamental changes over time, such as new applicable technologies, that may impact on strategy development.

3. Legislation and policy overview

3.1.1 This section sets out the legislative and planning framework that is relevant to the preparation of the ES. The legislation and policy set out in this section will influence the scope of the assessment and is relevant to the determination of the application.

3.2 Legislative context

3.2.1 The need to carry out an EIA and to report the results in an Environmental Statement (ES) is established by the Directive for Environmental Impact Assessments Section 43, National Conservation Law (Extraordinary Gazette No. 50/2016, June 29, 2016) issued in accordance with Sections 3(12)(j) and 43(2)(c) of The National Conservation Law (Supplement No. 1, Extraordinary Gazette, February 5, 2014).

3.2.2 Specifically, Section 41(3) of The National Conservation Law states:

"Every entity shall, in accordance with any guidance notes issued by the Council, consult with Council and take into consideration any views of the Council before taking any action including the grant of any permit or license and the making of any decision or the giving of any undertaking or approval that would or would be likely to have an adverse effect on the environment generally or any natural resource."

3.2.3 Section 43(1) of The National Conservation Law then goes on to state:

"In any consultation pursuant to Section 41(3) or before granting an approval under Section 41(4), the Council may, in its discretion and within such times as it may specify, require an environmental impact assessment to be carried out of the proposed action."

3.2.4 Further, Section 43(2) stipulates that:

"An environmental impact assessment shall –

(a) Assess the proposed action having regard to its direct, indirect and cumulative impact and the need to –

(i) protect and improve public health and social and living conditions;

(ii) preserve natural resources, ecological functions and biological diversity;

(iii) protect and conserve protected areas and conservation areas;

(iv) protect and conserve protected, endemic and migratory species and their habitats; and

(v) avoid any adverse effects of climate change on the quality of the environment;

(b) be carried out by a person approved by Council; and

(c) comply with any directives of the Council and regulations made under this Law."

3.2.5 While Section 43(3) stipulates that:

"All documents relating to an environmental impact assessment shall be available for public inspection and review."

3.2.6 Other relevant legislation specific to environmental topics addressed in the ES are referred to in the relevant technical sections of this ToR.

3.3 Policy context

Planning policy

3.3.1 Planning policy is set out by the Cayman Islands Government Central Planning Authority (CPA). The ES will consider planning policy which is relevant to the proposed development as summarised in the Development Plan 1997 (being the plan for zoning and physical development of the Cayman Islands).

3.3.2 Extant policy in the Development Plan 1997 is also presently under review. In November 2018, the CPA published, for consultation, a new draft National Planning Framework. As this new policy emerges, the ES will, as appropriate, take cognisance of this evolving, new policy.

Waste management policy

3.3.3 Waste management policy for the Cayman Islands is set out in the following key documents:

- National Solid Waste Management Policy for the Cayman Islands (August 2015); and
- National Solid Waste Management Strategy for Cayman Islands (2016); and the associated Integrated Solid Waste Management System for the Cayman Islands – Outline Business Case (2016).

3.3.4 The ES will be prepared in the context of the policy set out in these documents.

Other policy

3.3.5 The ES will also be prepared in accordance with the Institute of Environmental Management and Assessment EIA Quality Mark scheme and resources, (particularly commitments 4, 5 and 6 as relevant). Other policy / standards specific to environmental topics addressed in the ES are referred to in the relevant technical sections of this ToR.

4. Approach to EIA

4.1.1 This ToR identifies the following:

- The people and environmental resources (collectively known as 'receptors') that could be significantly affected by the proposed development; and
- The work required to take forward the assessment of these potentially significant effects.

4.1.2 The preparation of this ToR has been informed by information about the legislative and policy context to the scheme. It has also been informed by the simple rule that, to be significant, an effect must be of sufficient importance that it should influence the process of decision-making about whether or not consent should be granted for the proposed development or an element of it. In this ToR, this is referred to as the 'significance test'.

4.1.3 The conclusion that is made using the significance test is based upon professional judgement, with reference to the project description, and available information about:

- The magnitude and other characteristics of the potential changes that are expected to be caused by the proposed development;
- The sensitivity of receptors to these changes;
- The effects of these changes on relevant receptors; and (where relevant)
- The value of receptors.

4.1.4 If the information that is available at this stage does not enable a robust conclusion to be reached that a potential effect is not likely to be significant, the effect is then taken forward for further assessment.

4.1.5 Subsequent to the issue of this ToR, the scope of the assessment may be progressively refined in response to comments from the determining authority and from consultees, together with environmental information resulting from survey or assessment work carried out in relation to the EIA, and the evolution of the project proposals.

Spatial and temporal scope

4.1.6 Spatial scope is the area over which changes to the environment are predicted to occur as a consequence of the proposed development. In practice, an EIA should focus on those areas where these effects are likely to be significant.

4.1.7 The spatial scope will vary between environmental topics and will therefore be described in each of the topic chapters in the ES. For example, the spatial effects of a development on landscape and visual amenity will likely cover a much greater area to that affected by noise.

4.1.8 The temporal scope of likely significant effects will typically be described in the ES as either:

- Temporary - temporary effects are typically related to a particular activity and will cease when that activity finishes. These activities can nevertheless be either '*short-term*' or '*long-term*; and
- Permanent - these are effects that will remain once the proposed development is completed and will not change.

4.1.9 Effects during the following key stages of a proposed development will generally be considered:

- Construction – the effects may arise from the construction activities themselves, or from the temporary occupation of land. Effects are often of limited duration although there is potential for permanent effects. Where construction activities create permanent change, the effects will continue into the operational period. At present, it is anticipated that the construction period will be over a ~24-33 month period from 2021 to 2024; and
- Operation – effects may be permanent, or they may be temporary, intermittent, or limited to the life of a proposed development until decommissioning (as in the case of wind power developments which gain planning permission for a defined and finite number of years). An assessment of operational effects will be carried out on a reasonable 'worst case' basis. This has been defined as when all components of the ISWMS are operational i.e. commencing mid 2024. As all elements of the proposed ISWMS will not be operating at full capacity in 2024, it is proposed that the assessment will take a conservative approach and assume that all elements will be operating concurrently at peak capacity from the outset for modelling and comparison purposes.

4.2 Overview of assessment methodology

4.2.1 All of the topics discussed in Chapter 5 are based on a common understanding of the nature of the project, as described in Chapter 2.

Identification of baseline conditions

4.2.2 As the various elements of ISWMS project will be built over a period of three years, starting in 2021, and then operated for a minimum period of 25 years, it cannot be assumed that the baseline conditions in the absence of the project would be the same as the current baseline.

4.2.3 To determine the baseline conditions that should be used for the assessment of the potential likely significant effects of the proposed development, it is necessary to define the current baseline conditions and then to decide whether these conditions are likely to change by the 'assessment years' that are selected for the construction, operation or, where appropriate, the decommissioning of the proposed development. If this future baseline is more likely to occur than the current baseline, the future baseline should be used for the assessment of likely significant effects. However, in many cases it will be concluded that the current baseline is just as likely, or even more likely to occur in the assessment years than would be the case with any future baseline conditions. In this case, the current baseline will be used for the assessment.

4.2.4 The current baseline should be determined for each environmental topic by a combination of desk-based research, including consultation with the relevant stakeholders, together with field survey work, in order to identify the current baseline conditions within the 'study area' that is relevant to each environmental topic or to each receptor within a given environmental topic. In this ToR, only desk-based studies have been used to determine the baseline conditions. These should be supplemented by site visits and surveys as necessary.

4.2.5 In its simplest form, the study area is likely to comprise the area of land required for the development. However, it is also likely to include land outside the proposed boundary of the site, especially where the effects of the proposed development are likely to extend beyond such geographical limits to reflect the 'zone of influence' where the proposed development could affect off-site areas. Such a conclusion may be reached if, for example, professional judgement, technical guidance or scientific research.

Overview to approach to significance evaluation methodology

Introduction

4.2.6 One of the requirements of an ES is to set out the conclusions that have been reached about the likely significant environmental effects resulting from the proposed development. Reaching a conclusion about which effects, if any, are likely to be significant is the culmination of an iterative process that involves the following stages:

- Identifying those effects that could be likely to be significant.
- Assessing the effects of the proposed development against the baseline (current or future, as appropriate).
- Concluding whether or not these resultant effects are likely to be significant.

4.2.7 Sections 5.1 to 5.9 describe the proposed approaches that should be used in relation to the stages outlined in the bullet points above, for each of the environmental topics that are considered in this ToR, and to be considered further in the ES.

Mitigation

4.2.8 The assessment of the significance of effects for each technical topic will take into account any inherent mitigation to the proposed ISWMS (i.e. features which form an integral part of the proposed ISWMS, e.g. appropriate lining in the RWL, etc). Additional mitigation measures which are required to avoid, reduce or remedy significant adverse effects will be listed and detailed (e.g. a Stormwater Management Plan). The residual effects which remain significant after the implementation of additional mitigation measures will be identified. It may be that there are no additional mitigation measures required, or that there are no residual effects after mitigation measures are applied.

Significance evaluation

Overview

4.2.9 The receptors that could be significantly affected, and therefore to be taken forward for further detailed assessment, are identified within each topic section. The proposed approach to determine whether the effects on these receptors are significant is to apply a combination of professional judgement and a topic-specific significance evaluation methodology that will draw on the results of the assessment work to be carried out.

4.2.10 In applying this approach to significance evaluation, it will be necessary to ensure that there is consistency between each environmental topic in the level at which effects are considered to be significant. Thus, it is inappropriate for the assessment of one topic to conclude that minor effects are significant, when, for another topic, only comparatively major effects are significant.

4.2.11 In order to achieve the desired level of consistency, the specialist responsible for writing each of the technical chapters should consider the 'significance test' to inform their decision on whether effects are likely to be significant or not, as well as the relevant topic-specific significance evaluation methodology.

4.2.12 The conclusion about significance should be arrived at using professional judgement, with reference to the project description, and available information about the magnitude and other characteristics of the potential changes that are expected to be caused by the proposed

development, receptors' sensitivity to these changes and the effects of these changes on relevant receptors.

4.2.13 Having applied the relevant topic-specific significance evaluation methodology, the topic specialists should check the conclusions against the significance test. If this test results in a different conclusion to that reached through the use of the significance evaluation methodology, a detailed justification should be provided as to why this different conclusion is valid.

Evaluation matrices

4.2.14 Significance evaluation involves combining information about the sensitivity or value of a receptor, and the magnitude and other characteristics of the changes that affect the receptor. The approach to using this information for significance evaluation is outlined below.

Receptor sensitivity of value

4.2.15 The sensitivity or value of a receptor is largely a product of the importance of an asset, as informed by legislation and policy, and as qualified by professional judgement. For example, receptors for landscape, biodiversity or the historic environment may be defined as being of international or national importance. Lower value resources may be designated as being sensitive or important at a county or district level. For each environmental topic, it is necessary to provide a detailed rationale that explains the categories of value/sensitivity have been used and how these have been defined.

4.2.16 The use of a receptor will also play a part in its classification. For example, when considering effects on the amenity of a human population, a receptor used for recreational purposes may be valued more than a place of work as the environmental quality of the recreational receptor is more likely to be an important part of that receptor's use.

Magnitude of change

4.2.17 The magnitude of change affecting a receptor that would result from the development proposals will be identified on a scale from minor alterations or change, up to major changes or the total or substantial loss of the receptor. As with receptor sensitivity and value, a detailed rationale should be provided that explains how the categories of environmental change are defined. For certain topics, the magnitude of change will be related to guidance on levels of acceptability (e.g. for air quality or noise), and be based on numerical parameters, whilst for others it will be a matter of professional judgement to determine the magnitude of change, using descriptive terminology.

Determination of significance

4.2.18 The determination of significance is derived with reference to information about the nature of the development, the receptors that could be significantly affected and their sensitivity or value, together with the magnitudes of change that are likely to occur.

4.2.19 Other than for environmental topics for which significance evaluation does not involve the use of matrices, sensitivity/value and the characteristics of environmental changes can be combined using a matrix (see Table 4.1). In addition, professional judgement is applied because, for certain environmental topics, the lines between the sensitivities or magnitudes of change may not be clearly defined and the resulting assessment conclusions may need clarifying.

4.2.20 Variations to this approach, which may be applicable to specific environmental topics, will be detailed in the relevant 'Assessment methodology' sub-section contained in each environmental topic section.

4.2.21 Definitions of how the categories that are used in the matrix are derived for each topic are also set out in each environmental topic sections, along with the relevant explanation and descriptions of receptor sensitivity, magnitude of change and levels of effect that are considered significant in terms of the EIA Directive.

4.2.22 Within the matrix that is used in most significance evaluation exercises, reference is made to:

- Major effects, which will always be determined as being significant;
- Moderate effects that are likely to be significant, although there may be circumstances where such effects are considered 'not significant' based on specific scenarios and professional judgement.
- Minor or negligible effects, which will always be determined as 'not significant'.

Table 4.1 Significance evaluation matrix

		Magnitude of change				
		Very high	**High**	**Medium**	**Low**	**Very low**
Sensitivity	**Very high**	Major (Significant)	Major (Significant)	Major (Significant)	Major (Significant)	Moderate (Possibly significant)
	High	Major (Significant)	Major (Significant)	Major (Significant)	Moderate (Possibly significant)	Minor (Not significant)
	Medium	Major (Significant)	Major (Significant)	Moderate (Possibly significant)	Minor (Not significant)	Negligible (Not significant)
	Low	Major (Significant)	Moderate (Possibly significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)
	Very Low	Moderate (Possibly significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)	Negligible (Not significant)

Note: Significant effects are those identified as 'Major'. 'Moderate' effects have the potential to be significant, and indeed they would normally be deemed to be significant. However, there may be some exceptions, depending on the environmental topic and the application of professional judgment.

4.3 Assessment of cumulative effects

Introduction

4.3.1 Paragraph 5 of Schedule 2 of the EIA Directive refers to the need to consider cumulative effects.

4.3.2 There are two types of cumulative effects assessment (CEA) which should be considered in the EIA, as set out below.

Inter-project effects

4.3.3 For each environmental topic to be considered in the EIA, an assessment should be undertaken of how the environmental effects resulting from the proposed ISWMS development could combine

with similar topic-related effects generated by other committed[1] or proposed developments that affect a common receptor. To do this, it is important to first identify, which other developments are relevant for cumulative environmental topic assessments.

4.3.4 At this stage, schemes which are considered to be proximate to the proposed ISWMS and of a scale which will require an assessment of cumulative effects are:

- The Planned Area Development for Camana Bay; and
- The proposed Cruise Berthing Facility.

4.3.5 However, the traffic and transport assessment of cumulative effects should not include these schemes in the baseline conditions.

Inter-related effects

4.3.6 The second type of CEA involves assessing whether any of the individual environmental topic effects resulting from the proposed development could combine to create effects that are greater than the sum of the individual effects on a given receptor.

4.3.7 The first step is to identify the environmental topics that have common receptors, and then to consider whether the topic effects on any common receptors are likely to combine. The most likely types of receptors that could fall into this category are those pertaining to the amenity of the relevant human population. For example, the occupants of a residential property in close proximity to the proposed development might be subject to adverse effects in terms of noise, vibration, air quality, traffic, as well as with regard to visual amenity, or any combination thereof, each of which, when assessed individually, is not significant in EIA terms, but when assessed in combination the combined effects are judged to be significant.

4.3.8 Because this combined assessment involves different environmental topic assessments that cannot robustly be combined, the outcome of this CEA will be reliant on the application of professional judgement from, potentially, several different technical specialists.

4.4 Non-technical summary

4.4.1 A Non-Technical Summary (NTS) will be prepared, in accordance with the EIA Directive (the Directive for Environmental Impact Assessments Section 43, National Conservation Law (Extraordinary No. 50/2016). The NTS will be a concise document that provides a description of the EIA process and findings in a manner that is easily understood to a member of the public. The NTS will be supported by figures, maps, tables and photographs and include in plain terms:

- A description of the development,
- An outline of the main alternatives studied by the applicant,
- A description of the aspects of the environment likely to be significantly affected by the development,
- The basis for the evaluation of impact significance, and
- A description of the likely significant effects of the environment.

[1] Developments which have planning consent, but which have yet to be constructed.

4.5 Other matters

4.5.1 The ES will contain a list of abbreviations or a glossary. The ES will also embed the figures within the main text so that it is easy for the reader to review and refer to the figures.

4.6 EIA technical team

4.6.1 The EIA technical team consists of members of the DECCO Consortium including Gutteridge Haskins and Davey Limited (GHD), APEC Consultants, Dart Enterprises Cayman, DECCO and specialist subconsultants. GHD and APEC Consultants employ a number of professional, accredited specialists including environmental planners, biologist/ecologists, hydrogeologists, solid waste engineers, air and acoustic engineers and surface water engineers. The EIA technical team has been approved by the EAB.

4.7 Stakeholder consultation

4.7.1 The ISWMS project is an inherently public project that will engage the residents of the Cayman Islands in a new and innovative approach to solid waste management for many years. To be successful, implementation of the ISWMS requires a commitment to open dialogue and a mutually inclusive communications campaign with multiple stakeholders. This has been demonstrated initially by the community engagement work already undertaken by the CIG to establish the ISWMS core policies, which has helped ensure an early dialogue around the need for non-landfill-based waste management alternatives. The Proponent acknowledges the work that has been undertaken to date by the CIG, which has begun to lay the foundations for a broader communications plan for ISWMS implementation.

4.7.2 As per the Directive for Environmental Impact Assessments, there are two points of mandatory public consultation that occur during an EIA:

- Draft ToR review and comment; and
- Draft Environmental Statement (ES) review and comment.

4.7.3 Pending initial review and comment by the EAB, the Draft ToR will be released to the public to ensure that it addresses the likely significant issues of importance. Prior to such review, the following procedures will be incorporated:

- Publication of the Draft ToR or a link thereto on the DoE's website for a period of 21 consecutive days;
- Notification of the publication and public meeting on each of the three islands in the local press on two separate occasions, within 10 days prior to the publication of the Draft ToR; and
- Public meetings at venues to be agreed with the EAB to present the Draft ToR. The meetings will be held at least 7 days prior to the end of the consultation period.

4.7.4 Comments on the published Draft ToR will be submitted in writing to the EAB c/o the DoE via email post or hand delivery to offices of the DoE. Comments from the Council on the Draft ToR will also be received at this time. The EAB will work with the Proponent to ensure that all relevant comments are reflected in the Final ToR, and the Proponent shall provide a written response to the consultation comments. All responses will be appended to the Final ToR. Once the ToR has been finalized by the EAB and the Proponent, inclusive of the relevant concerns of the public and Council, the EIA may commence.

4.7.5 Consultation on the ES will be undertaken upon completion of the Draft ES in order to consider representations by the public or key stakeholder groups with valid concerns associated with the ES. This consultation will include as a minimum:

- Publication of the Draft ES or a link thereto on the DoE's website for a period of 21 consecutive days.
- Notification of the publication and public meeting on each of the three islands in the local press on two separate occasions within 10 days prior to the publication of the Draft ES.
- Public meetings at venues to be agreed with the EAB to present the Draft ES. The meetings will be held at least 7 days prior to the end of the consultation period.

4.7.6 The Proponent will respond to and address as appropriate representations received during the consultation on the Draft ES. These representations and responses will be appended to the Final ES.

5. Potential Environmental Effects

The following sub-sections describe the following:

- which environmental effects will be assessed as part of the EIA;
- the likely affected receptors;
- the methodology for undertaking the proposed assessments;
- the applicable standards or guidance relevant to each assessment; and
- the significance evaluation methodology to be used in the assessments (to be read in conjunction with that outlined in section 4.2).

5.1 Marine ecology

Introduction

5.1.1 This section of the ToR acts as a guide to the formulation of the EIA of the proposed development with respect to marine ecology. The section should be read in conjunction with the development description provided in Chapter 2: The proposed development and with respect to relevant parts of Section 5.2: Terrestrial ecology, Section 5.3: Hydrology and Hydrogeology and Section 5.9: Socio-economics, where common receptors and effect pathways have been considered and where there is an overlap or relationship between the assessment of effects. For instance, water quality will be assessed in the hydrology chapter and the indirect effects of changes in water quality on marine ecology will be assessed in the marine ecology chapter. Effects of changes in marine ecology on commercial fisheries will be assessed in the Socio-economics chapter of the ES. Further, noting that as defined by the National Conservation Law (2013) marine areas include any terrestrial or wetland area forming part of the same ecological system.

5.1.2 In the Marine Ecology assessment, receptors are referred to as ecological features, to accord with the Chartered Institute of Ecology and Environmental Management (CIEEM 2018) "*Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine*". The term ecological feature is defined in the guidance as pertaining to habitats, species and ecosystems.

5.1.3 Taking account of relevant conservation legislation this section of the ToR will set out the scope and methodology employed to assess the potential impacts on marine ecological features to complete to complete a full EIA to an appropriate standard and eventual ES for the proposed development.

Applicable standards and technical guidance

5.1.4 As for the wider EIA, the marine ecological assessment will need to follow the process outlined in the Directive for EIAs (2016) issued in accordance with The National Conservation Law (2013). In addition, the following legislation and guidance is applicable to marine ecology.

Legislation

- Cayman Island National Trust Law (2010 Revision) - To manage and conserve natural and cultural beauty and wealth of Cayman Islands including submarine areas.

- Cayman Islands (Territorial Sea) Order, 1989 - it defines the baseline from which the breadth of the territorial sea is measured.
- Marine Conservation (Marine Parks) Regulations (2021 Revision) - determining restrictions on specified areas, designating marine protected areas.
- National Conservation Law (2013) – to promote and secure biological diversity and the sustainable use of natural resources.
- Wastewater Collection and Treatment (Amendment) Law, 2017.
- Cayman Islands are included in the UK's ratification of the following international agreements relevant to the marine environment and the proposed development:
  - Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention);
  - Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) - Protocol on Specially Protected Areas and Wildlife;
  - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).
- Water Authority Act (2018 Revision) – if the discharge of cooling water into the marine environment is required a permit will need to be obtained. At this point in time no direct discharge of cooling water into the marine environment will occur.

Guidance

5.1.5 The following guidance and local plans will be used in the determination of effects:

- Cayman Islands National Biodiversity Action Plan 2009 - preservation of key habitats, through Habitat Action Plans (HAPs) and preservation of key individual species, through Species Action Plans (SAPs) with a view to ensuring that full consideration of the value of an ecologically sound environment be taken into consideration in all decisions pertaining to the future of the country. Nineteen Habitat Action Plans and thirty Species Action Plans were developed out of the BAP process.
- UK Chartered Institute of Ecology and Environmental Management (CIEEM) current (2018) best-practice approaches for Ecological Impact Assessment (EcIA).

Baseline conditions

5.1.6 The purpose of baseline studies is to determine and describe the environmental conditions against which any changes, in particular those associated with the proposed development, can be measured, predicted or assessed. To support this ToR, baseline information is presented which will be further developed in the EIA, particularly following consultation with local environmental organisations.

Data gathering methodology

5.1.7 To present the baseline conditions of the marine environment a Study area of the North Sound as well as wider coastal waters, from mean high water mark on Grand Cayman out to 12 nautical miles, has been established, however linked inland habitats are also considered (detailed in Section 5.2 Terrestrial Ecology).

5.1.8 A web-based search to establish the baseline of the marine environment was undertaken with reference to the following sources:

- National Biodiversity Action Plan 2009;
- UK Overseas Territories and Crown Dependencies: 2011 Biodiversity snapshot;
- Web-based aerial imagery;
- Species Conservation Plan for Mangroves National Conservation Law, section 17;
- Marine Studies carried out by the Department for Environment e.g. 2016 Wetlands leaflet;
- Biodiversity research carried out by the Cayman Island National Trust;
- Survey undertaken in 2010/2011 M. A. Roessler and Associates of the marine ecology adjacent to the proposed development;
- Scientific literature, e.g. Morgan, G.S. 1994. Mammals of the Cayman Islands. In: The Cayman Islands: natural history and biogeography, ed. by M.A. Brunt & J.E. Davies, 435–463. Dordrecht, Kluwer Academic Publishers.

Current baseline

5.1.9 The three Cayman Islands are flat, low-lying limestone islands with extensive offshore reef systems and mostly surrounded by fringing reefs and mangroves enclosing shallow, sand and seagrass filled lagoons. Associated with these habitats is a high diversity of marine species, including several molluscs and crustaceans providing commercially significant species. Baseline studies of the oceanography and biology of the shallow marine environments of Grand Cayman have been carried out by the Cayman Island Government's Department of Environment.

Habitats

5.1.10 The Cayman Island National Biodiversity Action Plan was published in 2009 and as part of this a detailed habitat mapping assessment of the Cayman Islands was conducted. This included coastal communities which were classified according to vegetation. Marine habitats are divided into the open sea, coral reef, lagoons, seagrass beds, dredged seabeds and artificial installations. Coastal habitats are divided into maritime cliffs, sandy beach and cobble, mangroves, invasive coastal plants and coastal shrubland. Marine habitats adjacent to the proposed development comprise the fringing mangrove and seagrass beds of the North sound. The proposed development on Grand Cayman is located within 750 m (2460 ft) of the North Sound which in this location comprises fringing red mangroves, which in parts are within the Mangrove Buffer Zone, and seagrass beds.

5.1.11 The hydrology of the site is further described in Section 5.4, which describes the drainage into the North Sound and also the water quality. A survey of the embayment where the dyke that runs adjacent to development discharges to the North Sound was observed by snorkelling in June 2011. Surveys revealed dense growth of turtle grass (*Thallasia testudinum*) with moderate epiphyte growth that reached three quarters of the way up the dyke.

Species

5.1.12 Given the transportation of waste associated with the proposed development, wider appreciation of mobile species is required. Marine mammal species occurring within the Cayman Islands are largely transient in the offshore environment, rarely coming close to shore. Exceptions may include species of beaked whales whose local range may be restricted to deep foraging water such as the Cayman trench. Marine mammal sighting schemes in the Cayman Islands have led to the reporting of the

presence of a number of marine mammals, for example the bottlenose dolphin *Tursiops truncatus* and spotted dolphin *Stenella frontalis*. According to the Volunteer Observer Sighting Scheme, two small species of whale, short-finned pilot *Globicephala macrorhynchus* and beaked whales *Mesoplodon* spp, are more regularly seen further offshore, around various submarine banks. Further the sperm whale *Physeter catadon* (cetacean of global conservation concern) (Morgan, 1994), Blainville's beaked whale (*Mesoplodon densirostris*) and killer whale (*Orcinus orca*) have been recorded and it is probable that other marine mammal species occur in Cayman waters.

5.1.13 Three sea turtle species have been reported to occur in the waters of the Cayman Islands, namely the green turtle *Chelonia mydas*, loggerhead *Caretta caretta* and hawksbill sea turtle *Eretmochelys imbricata*.

5.1.14 A variety of other pelagic species, such as sharks and rays are reported in the waters of the Cayman Islands as a result of both deep and shallow water environments. Pelagic species include the Tiger Shark (*Gladeocerdo cuvier*), Great Hammerhead Shark (*Sphyma mokarran*), Oceanic White Tip Shark (*Carcharhinus longimanus*) and the Silky Shark (*Carcharhinus falciformis*). In addition, some shark species reside in Cayman all year around and inhabit coastal waters, these include the Nurse Shark (*Ginglymostoma cirratum*), Lemon Shark (*Negaprion brevirostris*), Caribbean Reef Shark (*Carcharhinus perezi*) and Blacktip Shark (*Carcharhinus limbatus*).

5.1.15 The Cayman Islands is home to a number of Nassau grouper (*Epinephelus striatus*) spawning sites.

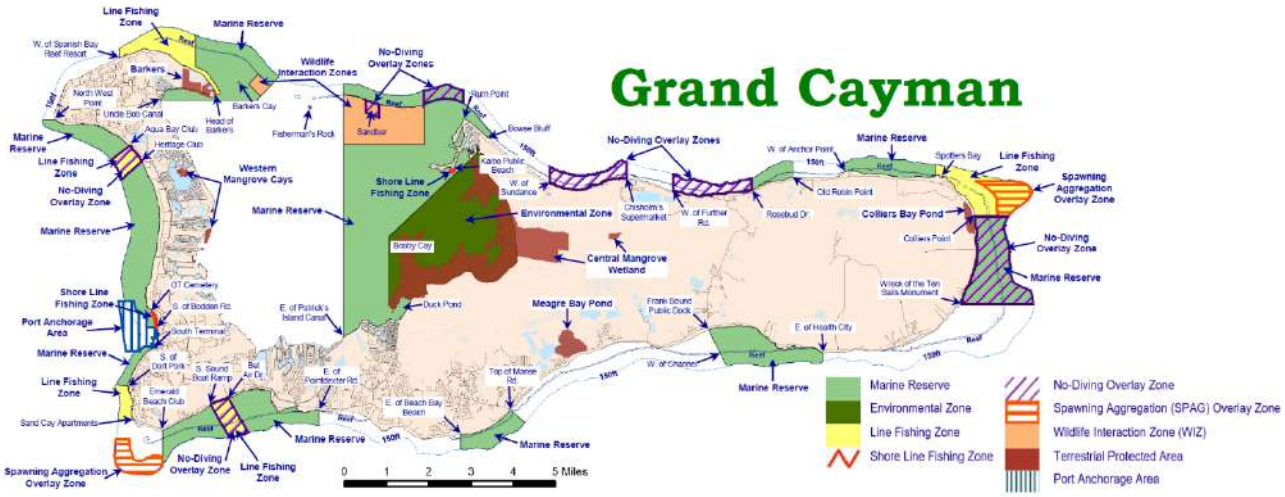
Protected areas

5.1.16 The Cayman Islands has a network of marine protected areas as shown in Plate 5.1 below for Grand Cayman. These areas are regulated under the *National Conservation (Marine Parks) Regulation, 2021* which was Gazetted on March 12, 2021. There are seven categories of marine parks:

- *Marine Reserve Zone:* which prohibits the removal of any specimen and the anchoring of any vessel unless the requirements under *Section 5(2) and 5(3)* can be met;
- *Environmental zone*: in which prohibited activities include the removal of any form of marine life, the use of anchors, entry into the water and exceeding a speed of five knots;
- *Wildlife Interaction Zone*: in which engagement of wildlife interaction in accordance with any orders, guidance notes or directives issued by the Council is allowed but the anchoring of vessels is forbidden, except in certain circumstances;
- *Line Fishing Zone:* in which the removal of fry and sprat are permitted but anchoring is forbidden, except in certain circumstances;
- *Shore Line Fishing Zone*: in which the removal of certain species of fish are permitted;
- *No*-Diving Overlay Zone: in which scuba diving is not permitted unless authorized by the Council to do so or under other circumstances listed in the regulation;
- *Spawning aggregation overlay Zone*: in which the removal of any specimen, anchoring of vehicles and entering into the water is prohibited during the period beginning 1st December and ending 30th April.

5.1.17 There are also wildlife interaction zones and designated grouper spawning areas where certain activities are prohibited. The enhanced network being implemented will also consist of marine reserves which replaces the marine park zone and replenishment zone terminology. The closest protected area to the proposed development is the Marine Reserve to the west coast along Seven Mile Beach. The North Sound to the west also contains Replenishment and Environmental zones.

Plate 5.1 Network of marine protected areas in Grand Cayman



Future baseline

5.1.18 As shown in Plate 5.1 there are currently existing marine protection areas which should be considered when determining the effects of the proposed development.

5.1.19 Local long-range implications of climate change remain largely unknown but elevated sea temperatures are reportedly resulting in increases in major coral bleaching episodes and subsequent rise in coral disease and mortality in the Cayman Islands. Further, sea level rise may overwhelm the mangroves' ability to lay down peat at the same rate, resulting in extensive drowning and die-off. Major storms and hurricanes have also resulted in substantial impacts on the shallow and fringing reef and mangrove environments and any increase in the frequency or intensity of such events as predicted as a result of climate change may impact the future baseline.

5.1.20 While the effects of climate change are likely to change the habitats and species distributions around the Cayman Island marine environments, it is difficult to accurately determine the future baseline in relation to the lifetime of the proposed development and it is therefore considered appropriate to use the current baseline for the purpose of this assessment.; however, continuation of the depletion of coral reef and mangrove habitats in particular are expected.

Consultation

5.1.21 Community engagement work has already been undertaken by the CIG to establish the ISWMS core policies, and this has helped ensure an early dialogue around the need for non-landfill-based waste management alternatives.

5.1.22 The Proponent submitted an EIA Request for Scoping Opinion to the DoE in October 2017, and the EAB responded in November 2017 with its EIA Scoping Opinion, summarising the potentially significant environmental effects of the project that will need to be addressed, as well as additional information requirements that the EAB deemed necessary to prepare an ES.

5.1.23 No additional consultation, beyond that carried out with the DoE in relation to the draft ToR, in relation to marine ecology has been undertaken at this stage; however, future EIA consultation should include but not be limited to the following organisation:

- DoE;
- National Trust for the Cayman Islands;

- Central Caribbean Marine Institute (CCMI);
- Shark Conservation Cayman and other conservation groups.

5.1.24 Consultation will be used to obtain further baseline information which will then be used to determine if any specific marine surveys will be required to establish a robust baseline for the EIA of the proposed development. Consultation will also gather information on potential areas of concerns and allow discussions around mitigation should this be required.

Scope of the assessment

5.1.25 The scope of the assessment will be based on the activity-change-effect (on feature) conceptual model, where potential effects arising from the proposed development are identified, as are potential feature and pathways linking the two. If there is no pathway (direct or indirect) by which a feature can be exposed to the effects of an activity, there will be no significant effects on that feature. Pathways may be direct (e.g. removal of habitat) or indirect (e.g. changes in water quality affecting a coastal habitat which, in turn, affects food availability for other species).

Potential features

5.1.26 The first stage of the ecological assessment is to decide which ecological features (habitats, species, ecosystem and their functions/processes) have the potential to be significantly affected.

5.1.27 During the EIA a Zone of Influence (ZoI) will be established by considering the pathway of effects to features in the Study area; however, given the activities associated with the proposed development and the hydrology of the site the ZoI is likely to comprise the receiving waters, and contained marine habitat and species, of the North Sound in addition to the marine transportation routes between the Islands. The ZoI for effects will be established for all activities that will lead to environmental change and the marine ecological features within this zone will be identified as features. For this, interaction with the hydrology assessment in particular is important given the potential pathway of effects through surface and groundwater.

5.1.28 Features have been initially identified below, however these will be further refined during the EIA upon receipt of more detailed information of the activities associated with the construction, operation and decommissioning of the development. This will include consideration of if there are species protected under Schedule 1 Part 1 and 2 of the National Conservation Law (NCL) that could be affected by the development.

- Mangroves and seagrass beds of the North Sound.
- Migratory and highly mobile animals such as turtles (e.g. hawksbill, green and loggerhead turtle), groupers, conch, lobster and other marine mammals and fish.

5.1.29 Once the features have been identified their value at a project scale will be assigned. This will be based on the conservation status of the species/ habitat and their ecological importance as highlighted in Table 5.1 below.

Table 5.1 Importance of the proposed development for ecological features

Geographic context of importance	Example / Description
International	1. Sites of international Importance e.g., Ramsar Conservation Wetland of International importance 2. Internationally endangered species e.g., Species under the Endangered species Act, marine mammal protection act

Geographic context of importance	Example / Description
National	1. A nationally designated site including marine parks, environmental zones and replenishment zones 2. Species protected under Schedule 1 Part 1 and 2 of the NCL 3. Species and habitats listed in the National Biodiversity Action Plan.
Local	1. Protected species that based on their extent, population size, quality etc. are determined to be at a lesser level of importance than the geographic contexts above. 2. Common and widespread semi-natural habitats occurring within the study area in proportions greater than may be expected in the local context. 3. Common and widespread native species occurring within the study area in numbers greater than may be expected in the local context.
Negligible	1. Common and widespread semi-natural habitats and species that do not occur in levels elevated above those of the surrounding area. 2. Areas of heavily modified or managed land uses (e.g., hard standing used for car parking, as roads etc.)

Likely significant effects

5.1.30 Given the proximity of the proposed development and the pathway of potential effects through surface and ground water contamination, leading to a change to the water quality, potential effects on habitats and species in the receiving marine environment (the North Sound) are identified. Ecological effects of changes in water quality may include, for example:

- reduction in dissolved oxygen concentrations due to organic loading, potentially affecting fish in particular;
- inputs of toxic contaminants potentially affecting a wide variety of marine life;
- inputs of inorganic nutrients causing excess plant growth and a reduction in diversity of sea grasses and marine algae (eutrophication); and
- the discharging of cooling water into the surface water.

5.1.31 Baled waste and contained wastes and recyclables will be shipped periodically by CIG by barge (between monthly to quarterly) from the Sister Islands to Grand Cayman for treatment and bulking at the main ISWMS site. The barge would deliver to the main dock on Grand Cayman. Therefore, movement of waste to and from the proposed ISWMS may disturb migratory and highly mobile marine animals e.g., hawksbill, green and loggerhead turtle, groupers, marine mammals and sharks, thus this potential effect is identified. In addition to this, the effects of potential risks associated with the movement of waste will also need to be considered, such as the potential for grounding of barges.

5.1.32 The likely significant marine ecology effects that have been taken forward for assessment are summarised in Table 5.2.

Table 5.2 Likely significant marine ecology effects

Activity (leading to environmental change)	Effect	Feature
Land preparation e.g., earthworks, excavation (during construction)	Migration of contaminates through surface water/storm water and groundwater movements	North Sound habitats and species including fringing mangroves and seagrass beds
Waste processing (during operation)	Migration of contaminates through surface water/storm water and groundwater movements	North Sound habitats and species including fringing mangroves and seagrass beds
Vessel movements (during operation)	Disturbance	Migratory and highly mobile marine animals e.g., hawksbill, green and loggerhead turtle, groupers, marine mammals and sharks

5.1.33 The effects scoped out from further assessment are:

- Coral reef – coral reefs are located to the west of the development at a distance of around 1.2 km (4000 ft) and there is no pathway of effects through drainage. The North Sound coral reef is over 7 km away and indirect effects through changes to water quality are not expected at this distance.

Assessment methodology

5.1.34 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in section 4.2. However, whilst this approach has informed the approach that will be used in this Marine Ecology assessment, it is necessary to set out how this methodology will be applied, and adapted as appropriate, to address the specific needs of this Marine Ecology assessment. This assessment methodology follows CIEEM (2018) guidance as set out below, noting that a matrix approach is not recommended or therefore used for marine ecology.

5.1.35 CIEEM (2018) defines a significant effect as one "*that either supports or undermines biodiversity conservation objectives for 'important ecological features' or for biodiversity in general*".

5.1.36 When considering potentially significant effects on ecological features, whether these be adverse or beneficial, the following characteristics of environmental change will be taken into account[2]:

- Extent – the spatial or geographical area over which the environmental change may occur;
- Magnitude – the size, amount, intensity or volume of the environmental change;
- Duration – the length of time over which the environmental change may occur;
- Frequency – the number of times the environmental change may occur;
- Timing – the periods of the day/year etc. during which an environmental change may occur;
- Reversibility – whether the environmental change can be reversed through restoration actions.

Although the characteristics described above are all important in assessing effects by using information about the way in which habitats and species are likely to be affected, a scale for the magnitude of the

[2] The definitions of the characteristics of environmental change are based on the descriptions provided in CIEEM 2018.

environmental change, as a result of the Proposed Development, has been described in Table 5.3 to provide an understanding of the relative change from the baseline position, be that adverse or beneficial changes.

Table 5.3 Guidelines for the assessment of the scale of magnitude

Scale of change	Criteria and resultant effect
High	The change permanently (or over the long-term) affects the conservation status of a habitat/species, reducing or increasing the ability to sustain the habitat or the population level of the species within a given geographic area. Relative to the wider habitat resource/species population, a large area of habitat or large proportion of the wider species population is affected. For protected sites, integrity is compromised. There may be a change in the level of importance of the feature in the context of the project.
Medium	The change permanently (or over the long term) affects the conservation status of a habitat/species reducing or increasing the ability to sustain the habitat or the population level of the species within a given geographic area. Relative to the wider habitat resource/species population, a small-medium area of habitat or small-medium proportion of the wider species population is affected. There may be a change in the level of importance of this feature in the context of the project.
Low	The quality or extent of protected sites or habitats or the sizes of species' populations, experience some small-scale reduction or increase. These changes are likely to be within the range of natural variability and they are not expected to result in any permanent change in the conservation status of the species/habitat or integrity of the protected site. The change is unlikely to modify the evaluation of the feature in terms of its importance.
Very Low	Although there may be some effects on individuals or parts of a habitat area or protected site, the quality or extent of sites and habitats, or the size of species populations, means that they would experience little or no change. Any changes are also likely to be within the range of natural variability and there would be no short-term or long-term change to conservation status of habitats/species features or the integrity of designated sites.
Negligible	A change, the level of which is so low, that it is not discernible on designated sites or habitats or the size of species' populations, or changes that balance each other out over the lifespan of a project and result in a neutral position.

5.1.37 Adverse effects will be assessed as being significant if the favourable conservation status of an ecological feature would be lost as a result of the Proposed Development. Beneficial effects will be assessed as those where a resulting change from baseline improves the quality of the environment. For a beneficial effect to be considered significant, the conservation status will need to positively increase in line with a magnitude of change of "high" as described in Table 5.3 above.

5.1.38 Conservation status is defined as follows (as per CIEEM 2018):

- "*For habitats, conservation status is determined by the sum of the influences acting on the habitat that may affect its extent, structure and functions as well as its distribution and typical species within a given geographical area;*
- *For species, conservation status is determined by the sum of influences acting on the species concerned that may affect its abundance and distribution within a given geographical area*".

5.1.39 The decision as to whether the conservation status of an ecological feature would alter will be made using professional judgement, drawing upon the information produced through the baseline characterisation and assessment of how each feature is likely to be affected by the Proposed Development.

5.1.40 A similar procedure will be used where protected sites may be affected by the Proposed Development, except that the focus is on the effects on the integrity of each site; defined as:

- "*The coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified*".

5.1.41 The assessment of effects on integrity will draw upon the assessment of effects on the conservation status of the features for which the site has been designated. Where these features are not clearly defined, professional judgement will be used to identify the interest features.

5.1.42 In summary, a final conclusion for each potentially significant effect will be given, whether it is Significant or Not Significant. The assessment methodology of significance will take into account the nature of the environmental change, the sensitivity of the feature, the resulting effect and its likely scale, with consideration given to the change's extent, magnitude, duration, frequency, timing and reversibility as appropriate.

5.2 Terrestrial ecology

Introduction

5.2.1 This section of the ToR acts a guide to the formulation of the EIA for the Proposed Development with respect to terrestrial ecology. This section should be read in conjunction with Section 2. The proposed development and with respect to relevant parts of Section 5.1: Marine Ecology, Section 5.3: Hydrology, Section 5.5: Landscape & Visual, Section 5.6 Air Quality and Section 5.7 Noise Vibration and where common receptors have been considered and where there is an overlap or relationship between the assessments of effects.

5.2.2 In the Terrestrial Ecology assessment, receptors are referred to as ecological features, to accord with the Chartered Institute of Ecology and Environmental Management (CIEEM 2018) "*Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine*". The term ecological feature is defined in the guidance as pertaining to habitats, species and ecosystems.

5.2.3 Taking account of relevant biodiversity conservation legislation this section of the ToR sets out the scope and methodology required to assess the potential impacts on terrestrial ecological features to complete a full EIA to an appropriate standard and eventual ES for the proposed development.

Applicable standards and technical guidance

5.2.4 For the wider EIA, the terrestrial ecological assessment will need to follow the process outlined in the Directive for EIAs (2016) issued in accordance with The National Conservation Law (2013). In addition, the following legislation and guidance is applicable to terrestrial ecology.

Legislation

- Animals Law (2013 Revision) – Includes details of protected animals and animal sanctuaries. There are a limited number of species listed under this legislation (two species of iguana and non-domestic, non-game bird species). This list is greatly expanded under the National Conservation Law (2013 Revision) which lists plant species, as well as mammals and invertebrates.
- National Trust Law (2010 Revision) - To manage and conserve natural and cultural beauty and wealth of Cayman Islands.

- Development and Planning Act (2021) – Mandates a Development Plan for the Cayman Islands. This plan has little in the way of ecological protection but the law itself includes provision for tree preservation orders and mangrove buffers
- Development and Planning regulations (2021)
- Development and Planning (Amendment) Regulations (2021)
- The Mangrove Conservation Plan – offers protection to mangroves
- Wastewater Collection and Treatment (Amendment) Law, 2017.
- Water Authority Act (2018 Revision)

5.2.5 The Cayman Islands are also included in the UK's ratification of the following international agreements relevant to the terrestrial environment:

- Convention on Biological Diversity;
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Guidance

5.2.6 The following guidance and local plans will be used in the determination of effects:

- Cayman Islands National Biodiversity Action Plan 2009, which sets out requirements for the preservation of key habitats, through Habitat Action Plans (HAPs) and preservation of key individual species, through Species Action Plans (SAPs) with a view to ensuring that full consideration of the value of an ecologically sound environment be taken into consideration in all decisions pertaining to the future of the country. Nineteen Habitat Action Plans and 30 Species Action Plans were developed through the BAP process.
- UK Chartered Institute of Ecology and Environmental Management (CIEEM) current best-practice approaches for Ecological Impact Assessment (EcIA).

Baseline conditions

5.2.7 The purpose of baseline studies is to determine and describe the environmental conditions against which any changes, in particular those associated with the proposed development, can be measured, predicted or assessed. To support this ToR baseline information is presented which will be further developed in the EIA, particularly following consultation with local environmental organisations using field surveys as appropriate.

Data gathering methodology

5.2.8 The desk study search area for internationally designated sites (Ramsar), including sites that have been proposed[3] for future designation, was 12 km radius to allow for the fact effects on these

[3] In this case these are sites not necessarily proposed to the government but are potential sites that have been identified as meriting Ramsar designation by the Review of Existing and potential Ramsar sites in the UK Overseas Territories and Crown Dependencies (UK Overseas Territories Conservation Forum 2005)

would be felt over greater distances. Nationally designated sites, habitats and species will be considered up to 2 km from the proposed development – see **Figure 5.1: Study area for ecology**.

5.2.9 A web-based search to establish the baseline of the terrestrial environment was undertaken with reference to the following sources:

- UK Overseas Territories and Crown Dependencies: 2011 Biodiversity snapshot;
- Web-based aerial imagery; and
- Site photographs.

Limitations

5.2.10 Detailed baseline data for the proposed development site and surrounding area informed by field survey are not available. Up-to-date information on the location of existing Cayman Islands National Trust owned sites were not found; therefore, this assessment has been informed by data collated in 2013 and online information on the DoE's Terrestrial Protected Area Nominations consulted on between May and August 2018. As part of the EIA process more information will be obtained through consultation with local environmental bodies (including the DoE and National Trust) to make sure all relevant protected sites, habitats and species are considered, and that lack of desk study data is not a limitation.

Current baseline

5.2.11 Within the defined desk study search radius there are two proposed Ramsar sites, details of which are provided in Table 5.4. These are illustrated on **Figure 5.2: Environmental context plan.**

Table 5.4 Internationally designated sites for biodiversity conservation within 12 km of the site

Name	Status	Approximate distance and direction from proposed development site	Description
Central Mangrove Wetland, Little Sound, Ponds and associated Marine Zones	Proposed Ramsar site	4.5 km east	A 98% pristine mangrove wetland covering ca.30% of the area of Grand Cayman. It supports important habitats, marine invertebrates and internationally important populations of migratory birds.
Barkers Wetland	Proposed Ramsar site	7.5 km north	One of the largest areas of undeveloped land on the western peninsula of Grand Cayman, it is a continuum from coral reef to coastal forest and mangrove. The wetland supports breeding and migratory birds as well as important invertebrates and endemic fish.

5.2.12 There are two categories of nationally designated sites found within the study area, data for which is held by the DoE:

- Protected areas; and
- Mangrove buffer zones.

5.2.13 Further information including justification for designation and boundaries should be obtained from consultation with the DoE (see below).

5.2.14 The site itself consists of areas of mangrove, filled land, poorly vegetated land and bare ground. The southern part of the site comprises an area of mangrove. The remainder of the site is a combination of bare ground, landfilled ground and sporadic buildings with little or no vegetative cover.

5.2.15 The site lies within a landscape which is mostly heavily developed, and construction has occurred close by on all sides. Immediately north of the site lies GTLF – indeed, the north-western part of the proposed ISWMS site is formed of part of the landfilled area. To the west is the Esterly Tibbetts Highway and a small area of mangrove, and to the northeast is the Cayman Islands wastewater treatment plant. Immediately south and east of the site is an industrial area comprising bare land, open air storage of plant and equipment and a series of (generally) low rise industrial buildings.

Future baseline

5.2.16 Determining a future baseline draws upon information about the likely future use and management of the site in the absence of development, known population trends (for species), climate change and any other proposed developments (consented or otherwise) that may act cumulatively with the proposed development to affect ecological features.

5.2.17 In the absence of the proposed development it is likely that in the areas of the site which are not directly affected by ongoing industrial activities, vegetation will continue to grow and re-establish. However, as the development is proposed to commence in the near future (i.e. less than 5 years) it is unlikely this process will have progressed notably. Land use/management is currently anticipated to remain largely unchanged in the absence of development and it is, therefore, considered appropriate to use the current baseline for the purpose of this assessment.

Consultation

5.2.18 Community engagement work has already been undertaken by the Cayman Islands Government (CIG) to establish the ISWMS core policies, and this has helped ensure an early dialogue around the need for non-landfill based waste management alternatives.

5.2.19 The Proponent submitted an EIA Request for Scoping Opinion to the DoE in October 2017, and the EAB responded in November 2017 with its EIA Scoping Opinion, summarising the potentially significant environmental effects of the project that will need to be addressed, as well as additional information requirements that the EAB deemed necessary to prepare an ES.

5.2.20 No additional consultation, beyond that carried out with the DoE in relation to the draft ToR, has been undertaken in relation to terrestrial ecology at this stage; however, during the EIA process consultation should include, but not be limited to, the following organisations:

- DoE;
- National Trust for the Cayman Islands;
- National Conservation Council; and
- Birdlife international.

5.2.21 Consultation will be used to obtain further baseline information which will then be used to determine if any specific ecological surveys will be required to establish a robust baseline for the EIA of the proposed development. Consultation will also gather potential areas of concerns and allow discussions around mitigation should this be required.

Scope of the assessment

Potential receptors

5.2.22 For the terrestrial ecology assessment the first stage in determining the scope of the assessment is to identify which ecological features identified through the desk study (see Paragraphs 5.2.11 to 5.2.15) are 'important'[4] in the context of the Proposed Development. Following CIEEM (2018) guidance, the importance of ecological features is first determined with reference to Cayman Island legislation and then with regard to the extent of habitat or size of population that may be affected by the Proposed Development.

5.2.23 Receptors have been initially identified as follows, however, these will be further refined during the EIA upon more detailed information of the activities associated with the construction, operation and decommissioning of the development:

- Proposed Ramsar sites (see Table 5.4);
- Nationally designated sites;
- Mangrove (including that immediately west of the site);
- Migratory and wetland bird which are qualifying species for Ramsar sites;
- Notable (e.g. BAP) habitats;
- Notable (e.g. BAP) species; and
- Protected animal species (likely to include bat species and invertebrates).

5.2.24 Once the receptors have been identified their value at a project scale will be assigned. This will be based on the conservation status of the species or habitat and their ecological importance, as highlighted in Table 5.5.

Table 5.5 Level of importance (on a geographical scale) of ecological features pertinent to the Proposed Development

Geographic context of importance	Example/description
International	3. Sites of international Importance e.g., Ramsar Conservation Wetland of International Importance 4. Internationally endangered species e.g., Species on the IUCN red list 5. Species endemic to the Cayman Islands
National	4. A nationally designated site including National Trust parks 5. Species and habitats listed in the National Biodiversity Action Plan.

[4] Importance relates to the quality and extent of designated sites and habitats, habitat/species rarity and its rate of decline. Ecological features that are not considered to be important are those that are sufficiently widespread, unthreatened and resilient, and with populations that will remain viable and sustainable irrespective of the Proposed Development.

Geographic context of importance	Example/description
Local	4. Protected species that, based on their extent, population size, quality etc., are determined to be at a lesser level of importance than the geographic contexts above. 5. Common and widespread semi-natural habitats occurring within the study area in proportions greater than may be expected in the local context. 6. Common and widespread native species occurring within the study area in numbers greater than may be expected in the local context.
Negligible	3. Common and widespread semi-natural habitats and species that do not occur in levels elevated above those of the surrounding area. 4. Areas of heavily modified or managed land uses (e.g., hard standing used for car parking, as roads etc.)

Spatial scope

5.2.25 Key to establishing which environmental changes may result in likely significant effects is the determination of a ZoI for each important ecological feature identified. ZoIs differ depending on the type of environmental change (i.e., the change from the existing baseline) as a result of the Proposed Development and the ecological feature being considered.

5.2.26 The most straightforward ZoI to define is the area affected by land-take and direct land-cover changes associated with the Proposed Development. This ZoI is the same for all affected ecological features. Others will be discussed with the authors of other chapters, for example the ZoI for effects dues to changes in air quality will be determined following the modelling of the spread of the plume of emissions from the proposed development.

Likely significant effects

5.2.27 The likely significant terrestrial ecology effects that have been taken forward for assessment are summarised in Table 5.6.

Table 5.6 Likely significant terrestrial ecology effects

Activity	Effect	Feature
Land take (during construction)	Loss of habitat that provides foraging and sheltering habitat for fauna	Protected and notable habitats and species around the site
Land preparation e.g., earthworks, excavation (during construction)	Killing or injury of animals	Protected and notable species using the site
Land preparation e.g., earthworks, excavation (during construction)	Airborne dust creation	Protected and notable habitats and species around the site
Land preparation e.g., earthworks, excavation (during construction)	Noise/light/visual disturbance including from movement of construction workers disturbing sensitive fauna	Wetland/migratory birds potentially on habitat functionally linked to the proposed Ramsar sites; Protected and notable species around the site
Land preparation e.g., earthworks, excavation (during construction)	Migration of contaminates from surface water/storm water and groundwater movements	Aquatic/riparian invertebrates, wetland/migratory birds using fringing mangroves and seagrass beds. Fringing

Activity	Effect	Feature
		mangroves and seagrass beds themselves will be dealt in the Marine Ecology Chapter.
Waste processing (during operation)	Migration of contaminates from surface water/storm water and groundwater movements	Aquatic/riparian invertebrates, wetland/migratory birds using fringing mangroves and seagrass beds. Fringing mangroves and seagrass beds themselves will be dealt in the Marine Ecology Chapter.
Combustion of waste (during operation)	Deposition of contaminants on sensitive habitats or species	Designated sites, protected and notable habitats and species within range of the emissions from the plant
Uncontrolled vehicular movement (during operation)	Vehicle strikes on animals causing injury or death	Protected and notable species around the site.
Lighting (during operation)	Disturbance of animals	Protected and notable species around the site;
Noise (during operation)	Disturbance of animals	Wetland/migratory birds potentially on habitat functionally linked to the proposed Ramsar sites; Protected and notable species around the site

Assessment methodology

5.2.28 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in section 4.2. However, while this has informed the approach taken in the Terrestrial Ecology assessment, it has been necessary to refine how the methodology has been applied and adapted to address the specific needs of this topic. The Terrestrial Ecology assessment methodology includes elements of CIEEM (2018) guidance to help provide the rational for defining importance and reduce the reliance on professional judgement.

5.2.29 When considering the overall magnitude of potentially significant effects on ecological features, whether these be adverse or beneficial, the following characteristics of environmental change will be taken into account[5]:

- Extent – the spatial or geographical area over which the environmental change may occur;
- Magnitude – the size, amount, intensity or volume of the environmental change;
- Duration – the length of time over which the environmental change may occur;
- Frequency – the number of times the environmental change may occur;
- Timing – the periods of the day/year etc. during which an environmental change may occur; and
- Reversibility – whether the environmental change can be reversed through restoration actions.

[5] The definitions of the characteristics of environmental change are based on the descriptions provided in CIEEM 2018.

Although the characteristics described are all important in assessing effects by using information about the way in which habitats and species are likely to be affected, a scale for the magnitude of the environmental change, as a result of the Proposed Development, has been described in Table 5.7 below to provide an understanding of the relative change from the baseline position, be that adverse or beneficial changes.

Table 5.7 Guidelines for the assessment of the scale of magnitude

Scale of change	Criteria and resultant effect
High	The change permanently (or over the long-term) affects the conservation status of a habitat/species, reducing or increasing the ability to sustain the habitat or the population level of the species within a given geographic area. Relative to the wider habitat resource/species population, a large area of habitat or large proportion of the wider species population is affected. For protected sites, integrity is compromised. There may be a change in the level of importance of the receptor in the context of the project.
Medium	The change permanently (or over the long term) affects the conservation status of a habitat/species reducing or increasing the ability to sustain the habitat or the population level of the species within a given geographic area. Relative to the wider habitat resource/species population, a small-medium area of habitat or small-medium proportion of the wider species population is affected. There may be a change in the level of importance of this receptor in the context of the project.
Low	The quality or extent of protected sites or habitats or the sizes of species' populations, experience some small-scale reduction or increase. These changes are likely to be within the range of natural variability and they are not expected to result in any permanent change in the conservation status of the species/habitat or integrity of the protected site. The change is unlikely to modify the evaluation of the receptor in terms of its importance.
Very Low	Although there may be some effects on individuals or parts of a habitat area or protected site, the quality or extent of sites and habitats, or the size of species populations, means that they would experience little or no change. Any changes are also likely to be within the range of natural variability and there would be no short-term or long-term change to conservation status of habitats/species receptors or the integrity of designated sites.
Negligible	A change, the level of which is so low, that it is not discernible on designated sites or habitats or the size of species' populations, or changes that balance each other out over the lifespan of a project and result in a neutral position.

5.2.30 Where protected sites may be affected by the Proposed Development, the focus is on the effects on the integrity of each site; defined as:

- "*The coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified*".

5.2.31 The assessment of effects on integrity draws upon the assessment of effects on the conservation status of the features for which the site has been designated. Where these features are not clearly defined, it is necessary to use professional judgement to identify the interest features.

5.2.32 Details on assessing the sensitivity of habitats are given in section 5.2.24 and Table 5.5.

5.3 Hydrology (including flood risk) and hydrogeology

Introduction

5.3.1 This section of the ToR acts as a guide to the formulation of the EIA of the proposed development with respect to hydrology (including flood risk) and hydrogeology. The section should be read in conjunction with the development description provided in Chapter 2: The proposed development and with respect to relevant parts of Section 5.1: Marine Ecology, Section 5.2: Terrestrial Ecology and Section 5.4: Land Quality, where common receptors have been considered and where there is an overlap or relationship between the assessment of effects.

Applicable standards and technical guidance

5.3.2 As for the wider EIA, the hydrology and hydrogeology element of the assessment will need to follow the process outlined in the Directive for EIAs (2016) issued in accordance with The National Conservation Law (2013) and will take into account the Water Authority Act (2018 Revision) which states in section 19 that groundwater vests in the name of the Crown and appoints the Water Authority Cayman (WAC) as the custodian of groundwater in the name of, and on behalf of, the Crown.

5.3.3 There are no specific standards for water quality in the Cayman Islands. Therefore, consultation with the Department of Environment (DoE), WAC and DEH will be required to determine the applicable standards that should be adopted for this part of the assessment. The assessment should also consider international standards such as the UK's and Canada's Environmental Quality Standards. The Environmental, Health and Safety Guidelines, General EHS Guidelines: Environment (International Finance Corporation (IFC), 2007). Wastewater and ambient water quality provide supplementary international guidance on water quality.

5.3.4 The assessment of stormwater effects will need to include reference to the Stormwater Management (National Roads Authority (NRA)) Guidelines Levels (2008), the United States Department of Natural Resources Conservation Service (NRCS) National Engineering Handbook, and the Florida Department of Transportation (FDOT) Drainage Manual (February 2012) and associated FDOT Hand books. Also relevant is the Florida Administrative Code Rule Chapter 62-777 Contaminant Cleanup Target Levels.

5.3.5 The standards to be used for the new RWL within the boundaries of the existing GTLF include the Resource Conservation and Recovery Act (Sub-Title D – Non Hazardous Rules, Sub-Title C – Hazardous Rules) and the United States Environmental Protection Agency (USEPA) Code of Federal Regulations Title 40 (Part 60 – Standards for Performance for Municipal Solid Waste Landfills, Part 258 – Criteria for Municipal Solid Waste Landfills, Part 264 – Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, Part 265 – Interim). The Florida Administrative Code for Class III Landfills is also of relevance.

5.3.6 The proposed development will be subject to water abstraction license and wastewater discharge permits issued by WAC under the Water Authority Act (2018 Revision).

5.3.7 The CIG has directed that the construction and operation of the proposed facilities on the Sister Islands will be managed by the DEH, and so will lie outside the scope of this EIA. Furthermore, with respect to the landfill closures on each of the three islands, it is understood that such activities will be subject to risk-based assessments that will be conducted outside the EIA.

Baseline conditions

Data gathering methodology

5.3.8 To assist in the formulation of the hydrology and hydrogeology assessment within the EIA, relevant desk study data for hydrology, flood risk and hydrogeology for a defined Study Area have been gathered during the production of this ToR. The Study Area is focussed on the proposed development and a 2 km buffer area immediately beyond the site boundary, on the basis that the majority of the potential effects on the water environment are unlikely to occur beyond this Study Area. Nevertheless, data for a wider area beyond this have also been collected as appropriate, such as abstractions, discharges and conservation sites.

5.3.9 The data gathering methodology has been restricted to a desk study based on a range of online and published material listed in Table 5.8.

5.3.10 The hydrology and hydrogeology baseline is also inter-related with, and uses information from, other sections of this ToR, as referenced earlier.

5.3.11 During the formulation of the EIA, other data will be collected as appropriate, including that within existing literature and also any ongoing and additional field monitoring of water levels, quality and flow, and to incorporate such data in a more definitive description of the baseline environment. Such a description will include the presentation of a conceptual model (with schematic sections) summarising key attributes of the baseline water environment in the vicinity of the proposed development.

Limitations

5.3.12 Detailed baseline data for the proposed development site and surrounding area informed by site visit surveys are not available. Furthermore, no delineated floodplain mapping exists for the Cayman Islands. As part of the EIA process more information will be acquired through a site visit survey, a detailed topographic survey and consultation with local environmental bodies, in order to identify local flooding issues and the presence and condition of any local flood defences.

Table 5.8 Sources of desk study information for hydrology (including, flood risk) and hydrogeology

Source	Data / Information
Aerial photography (Bing maps and Google maps) Online topographic map (http://en-gb.topographic-map.com/places/George-Town-133291)	Topography and features
Previous environmental reports for the Cayman Islands: • CIG, 1992. Environmental Assessment of Grand Cayman Sanitary Landfill, Grand Cayman Island, B.W.I. • WAC, 2001. Investigation of Groundwater Quality at Grand Cayman Wastewater Treatment Plant 1999-2001. • Jones, B., 1994. 2. The Geology of the Cayman Islands. In M. A. Brunt and J. E. Davies (eds). The Cayman Islands: Natural History and Biogeography, (pp. 13-49) Kluwer Academic Publishers, Netherlands. • Bugg, S.F. and Lloyd, J. W., 1976. A Study of Freshwater Lens Configuration in the Cayman Islands using Resistivity Methods. Quarterly Journal of Engineering Geology (QJEG). V. 9, p. 291-302. • Amec Foster Wheeler (now Wood), 2016. Landfill Site Environmental Review. Task 2: Environmental Investigations Interpretative Report. • Cayman Islands National Emergency Website (http://www.caymanprepared.ky/portal/page/portal/hmchome/resources/brochures/196853%20Past%20Hurricanes.pdf). Accessed 2 April 2019. • Cardno ENTRIX, 2013. Grand Cayman Waste Management Facility Draft Environmental Statement. • Mott MacDonald, 2013. Cruise Berthing Terminal for Cayman Islands. Final EIA Terms of Reference. • Novelo-Casanova, D.A. and Suarez, G, (2010). Natural and man-made hazards in the Cayman Islands. Natural Hazards. November 2010. (55), pp.441–466. Springer Science.	Climate, geology, hydrogeology, hydrology, and flood risk
National Climate Change Committee, 2011. Achieving a Low Carbon Climate-Resilient Economy: Cayman Islands' Climate Change Policy. Report produced for presentation to the Cabinet of the Cayman Islands.	Climate change
Previous environmental reports for the Cayman Islands: • Amec Foster Wheeler (now Wood), 2016. Landfill Site Environmental Review. Task 2: Environmental Investigations Interpretative Report. • WAC, 2001. Investigation of Groundwater Quality at Grand Cayman Wastewater Treatment Plant 1999-2001.	Water abstractions and discharges

Current baseline

Topography

5.3.13 The land surrounding the proposed development site is mainly flat and low-lying. Online topographic mapping (http://en-gb.topographic-map.com/places/George-Town-133291) indicates that the site elevation ranges approximately between approximately 7 and 20 ft (2.0m and 7.0 m) above mean sea level.

Climate

5.3.14 Meteorological conditions for Grand Cayman are summarised in Table 5.9. (Cardno ENTRIX, 2013). Average monthly rainfall in Grand Cayman varies from just under 1 inch (25 mm) per month, to over 20 inches (508 mm) per month. Average annual rainfall varies significantly, depending on individual storm events. The long term annual average rainfall is 64.3 inches (1.63 m).

5.3.15 The Cayman Islands experience a tropical marine climate, including warm, rainy summers from May to October, with average temperatures approximately 80 to 85°F. The peak average monthly temperature in July at 83.9°F. Winters are only slightly cooler on average, from November to April, with the lowest average monthly temperatures in February at 77.2°F. The heaviest rains typically occur in October. Tropical low-pressure systems affect Grand Cayman during the summer months, including tropical waves, depressions, tropical storms, and hurricanes (with sustained winds at times exceeding speeds of 74 mph (119 kmph)). Hurricanes that periodically impact on the island typically range from Category I through Category V on the Saffir Simpson scale. The hurricane season in the region is June 1 to November 30. During the winter, 'Nor'wester' storms can bring cooler temperatures and strong northwest winds to the Cayman Islands.

Table 5.9 Meteorological summary for Grand Cayman

Month	Average Rainfall (inches)[a]	Average Wind Speed (mph)[b]	Average Wind Direction[c]	Average Temperature (°F)
January	1.68	11.3	ENE	77.3
February	2.88	9.6	ENE	77.2
March	7.42	9.9	ENE	78.4
April	20.36	10.2	ENE	80.0
May	3.56	8.6	E	81.7
June	1.69	8.9	E	83.3
July	11.51	8.8	E	83.9
August	5.35	8.4	E	83.6
September	3.85	6.7	E	83.1
October	0.71	9.8	ENE	81.8
November	1.97	11.4	ENE	80.7
December	3.36	9.7	ENE	78.7

Notes: Data sources:
a. CIG National Weather Service 30-year average for George Town, Grand Cayman Island.
b. CIG National Weather Service 21-year average for George Town, Grand Cayman Island.
c. CIG www.caymanislands-guide/weather/wind

Geology

5.3.16 The geology in the vicinity of the proposed development is described in CIG (1992), WAC (2001) and Jones (1994) and summarised in Table 5.10.

5.3.17 The Cayman Islands are outcrops of the Cayman Ridge, an undersea mountain range within a tectonically active area. The islands are located on a separate fault block that has been elevated above the general level of the Cayman Ridge. The islands have a granodiorite base, with a cap of basalt and some 1,300 m of Tertiary carbonates – limestones and dolostones. The Tertiary Period geological succession consists of the Pleistocene Ironshore Formation unconformably overlying the Bluff Group. In many areas of the Grand Cayman, including the proposed development site, the bedrock is covered by peat that has formed in the low-lying wetland areas covering vast tracts of land, and imported fill.

5.3.18 The Ironshore Formation comprises soft to hard coralline limestones interspersed with hard lenses, coral ledge and pockets of calcareous sand. The underlying Bluff Group consists of the Pedro Castle Formation, Cayman Formation and Brac Formation. The Cayman Formation exhibits a number of prominent features including joints, fractures, and (primarily in-filled) sinkholes and solution cavities, and is divided into the upper 'cap rock'(5.5 to 65 ft (1.7 to 19.8 m) below ground level (bgl)) and the lower part of the Cayman Formation that extends to depths below 250 ft (76 m) deep. The 'cap rock' is formed of hard dolostones that have low porosities and low permeabilities, and the lower unit of the Cayman Formation is formed of relatively friable dolostones with high porosities and high permeabilities.

Table 5.10 Geology summary for the Cayman Islands

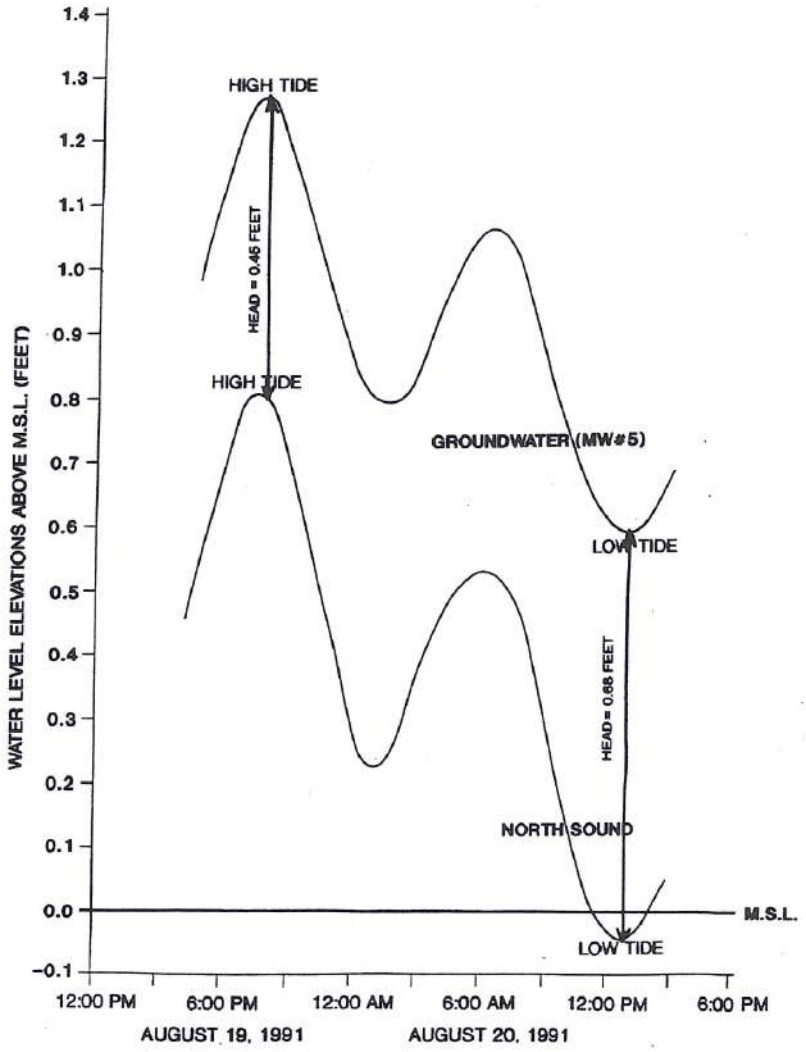
Period	Series	Formation	Elevation (ft/m above mean sea level)	Thickness (ft / m)
Made ground	Made ground	Imported fill	+1.5 to +4.0 ft +0.45 to +1.2 m	2.5 ft/ 0.75 m
Quaternary	Holocene	Peat (swamp deposits)	0 to +1.5 ft 0 to +0.45 m	1.5 ft/ 0.45 m (4-10 ft/ 1.2-3.0 m below wastewater treatment lagoons to the west of the proposed development)
Quaternary	Pleistocene	Ironshore Formation (calcareous marl)	0 to -3.0 ft 0 to -0.9 m	3.0 ft/ 0.9 m
Quaternary	Pleistocene	Ironshore Formation (very soft friable limestone)	-3.0 to -7.5 ft -0.9 to -2.3 m	4.5 ft/ 1.4 m
Quaternary	Pleistocene	Ironshore Formation (soft friable limestone and marl bands)	-7.5 to -25 ft -2.3 to -7.6 m	17.5ft/ 5.3 m
Tertiary	Pliocene	Bluff Group- Pedro Castle Formation (hard dolomite and limestone)	-25 to -45 ft -7.6 to -13.7 m	20ft/ 6.1 m
Tertiary	Miocene	Bluff Group- Cayman Formation (dolostone)	-45 to >-300 ft -13.7 to >-91.4 m	>250ft/ >76 m
Tertiary	Oligocene	Bluff Group- Brac Formation (limestone and sucrosic dolostone)	>-300 ft >-91.4 m	-

Notes: Based on information reported in CIG (1992), WAC (2001) and Jones (1992). Thickness of Brac Formation not reported.

Hydrogeology

5.3.19 Groundwater below the proposed development in George Town is tidally influenced with a hydraulic gradient to the east towards the North Sound (CIG, 1992). Groundwater level monitoring in observation boreholes (OBHs) located around the GTLF in relation to tidal cycles has been assessed in CIG (1992). An OBH within the central part of the landfill was shown to have a head difference of between 0.45 ft (0.14 m) and 0.68 ft (0.2 m) (mean 0.56 ft (0.17 m)) above the corresponding tidal level in North Sound, with the groundwater levels exhibiting a tidal lag (Plate 5.2). The amplitude of tidal fluctuations in North Sound were 1.2 times that at the OBH. Assuming a net mean hydraulic head of 0.56 ft (0.17 m) and an average distance from a central point in the landfill to North South of 3000 feet (914 m) and using an aquifer permeability of 0.00188 ft (0.00057 m) per minute (constant head permeability test measurement) and a porosity of 15%, the groundwater flow rate is calculated in CIG (1992) to be 12 ft (3.6 m) per day. Groundwater monitoring undertaken more recently by Amec Foster Wheeler (2015) at 10 boreholes near the landfill, on the western edge of the proposed development, show groundwater levels ranging between 1.87 ft (0.57 m) and 11.4 ft (3.47 m) bgl and subject to tidal variation (0.59 to 0.62 ft (0.18 to 0.19 m) over a 24 h period). Additional data collected as part of the proposed groundwater monitoring programme should be used to confirm and augment the published groundwater baseline data (paragraph 5.3.49).

Plate 5.2 Net hydraulic head difference between groundwater levels at OBH within the central part of GTLF and water levels in the North Sound (from CIG, 1992)



5.3.20 Due to the generally poor quality (high salinity) of groundwater and lack of significant freshwater resources on Grand Cayman, potable water is supplied from desalinisation plants (treatment by reverse osmosis). Although freshwater lenses are present in several isolated areas of Grand Cayman (Bugg and Lloyd, 1976), these are not used as a primary source of drinking water for the Island. The proposed development site is not in close proximity to any major freshwater lenses.

5.3.21 Groundwater quality monitoring undertaken at a number of OBHs around the landfill site and reported in CIG (1992) shows evidence of leachate contamination of groundwater on the eastern boundary of the landfill, with elevated ammoniacal nitrogen (up to 400 mg/l and above the Florida Clean-up Standard for poor yield/low quality groundwater of 28 mg/l), metals (lead, iron and chromium) and hydrocarbons (benzene, toluene, ethylbenzene and chlorobenzene). Further groundwater monitoring undertaken during 2006 to 2015 and reported in full in Amec Foster Wheeler (2016) also show impact by landfill leachate, with elevated ammonia, hydrocarbons, chemical oxygen demand (COD), biochemical oxygen demand (BOD) and orthophosphate. The data are summarised in Table 5.11 for selected substances.

Table 5.11 Groundwater quality summary near the proposed development site

Substance	Unit	Groundwater Monitoring Data		
		Min	Mean	Max
General Chemistry				
Ammonia	mg/l	0.1	22.3	270
Orthophosphate	mg/l	0.051	0.3	1.2
COD	mg/l	18	524	2,100
pH	-	7.1	7.4	7.7
Specific Conductance	µmhos/cm	2,300	12,915	25,000
BOD	mg/l	3.8	67.9	1,800
Hydrocarbons				
Diesel Range Organics [C10-C28]	mg/l	0.1	2.8	18
Gasoline Range Organics (GRO)-C6-C10	mg/l	<0.05	<0.05	<0.05

Notes: Groundwater monitoring data collected during 2006 to 2015 and reported in full in Amec Foster Wheeler (2016).

5.3.22 There are no known groundwater abstractions in the immediate vicinity of the proposed development site. The closest groundwater abstractions are as follows (Amec Foster Wheeler (2016) and WAC (2001):

- WAC operates two reverse osmosis plants at its Red Gate Road Water Works for potable water supply. The works are located approximately 1.0 miles (1.6 km) southeast of the proposed development. The plants take saline groundwater from feed water wells cased to 100 ft (30 m) depth bgl, open zone from 100 ft (30 m) – 150 ft (45 m) or 160 ft (48 m) bgl. Brine disposal wells on the same site are cased to 210 ft bgl, with an open zone from 210 ft – 300 ft (63 m–90 m);
- Caribbean Utilities Company (CUC) abstract groundwater for cooling purposes at its site off North Sound Road/Sparky's Drive approximately 0.7 miles (1.1 km) southeast of the proposed development site; and
- Groundwater abstraction for geothermal cooling purposes is undertaken by various other developments including Fosters warehouses (1.2 miles or 2.0 km northwest of the site) and the Owen Roberts International Airport (1.5 miles or 2.5 km south of the site), with the expectation of further future projects.

Hydrology

5.3.23 The porous nature of the limestone bedrock and the flat topography of the Grand Cayman results in a lack rivers or streams across the island. Mosquito control channels transverse the local area and discharge into North Sound approximately 740 ft (225 m) east of the proposed development site. The closest channel ('northern channel') runs west to east along the northern boundary of the proposed development. The northern channel is fringed with mangroves and is culverted below

Esterly Tibbetts Highway to the west of the site. Other channels are present around the GTLF to the west of the site and discharge into the 'northern channel'.

5.3.24 Water level in the channels and the North Sound fluctuate with the tide. The tidal variation in the North Sound recorded by CIG (1992) was in the order of 0.8 ft (0.24 m). Data from an Intergovernmental Oceanography Commission (IOC) sea level monitoring station at George Town (http://www.ioc-sealevelmonitoring.org/station.php) indicates the tidal variation in North Sound at the time of water sampling on 14 April 2015 was approximately 1 ft (0.3 m). The depth of the canals is such that they will be in hydraulic conductivity with groundwater.

5.3.25 Surface water quality in the 'northern channel' and the North Sound near the proposed development site has been monitored by DEH between 2006 and 2013 and by Amec Foster Wheeler in 2015. The data are provided in full in Amec Foster Wheeler (2016) and summarised in Table 5.12 for selected substances. The data shows that the 'northern channel' is impacted by leachate from GTLF and is a source of ammonia, orthophosphate, BOD and COD into the North Sound. However, there is a relatively rapid dilution/dispersion of the northern ditch discharge in North Sound. DoE/WAC has undertaken marine water quality monitoring and these data sets will also be reviewed and referenced in the EIA.

5.3.26 The northern and landfill ditches have no recreational use. The North Sound is used for diving and wildlife interaction, and these activities suggest that the quality of water in the Sound is good.

Table 5.12 Surface water quality summary near the proposed development site

Substance	Unit	Northern Channel			North Sound		
		Min	Mean	Max	Min	Mean	Max
Ammonia	mg/l	0.32	4.26	13	0.51	0.81	1.1
Orthophosphate	mg/l	0.03	0.13	0.44	<0.015	0.039	0.052
COD	mg/l	23	1,902	11,000	200	200	200
pH	-	7.34	7.56	8.25	n.m.	n.m.	n.m.
Specific Conductance	umhos/cm	15,000	52,000	130,000	n.m.	n.m.	n.m.
BOD	mg/l	2.5	11	36	<2.0	-	3
Diesel Range Organics [C10-C28]	mg/l	0.046	0.119	0.33	-	-	0.048
GRO-C6-C10	mg/l	<0.047	-	-	n.m.	n.m.	n.m.

Notes: Monitoring data for the northern channel and North Sound collected during 2006 to 2013 and 2015 and reported in full in Amec Foster Wheeler (2016); n.m. not measured.

Flood risk

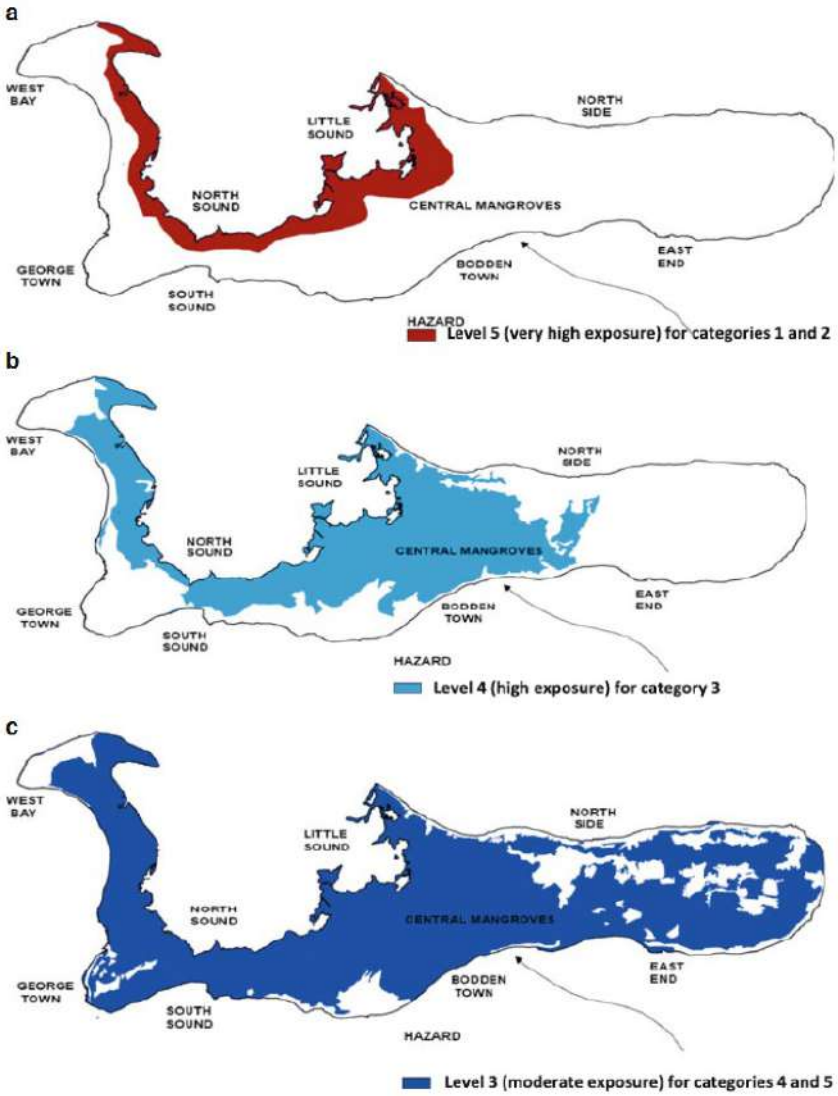
5.3.27 Surface water flooding, which occurs when the intensity of rainfall is greater than the local drainage and infiltration capacity causing water to flow overland, is a potential hazard following heavy rainfall events. Typically, heavy rain in the Cayman Islands only takes place for a few hours, occasionally affecting some low-lying areas in the islands with moderate flooding at worst. This is due to the island's surface mostly comprising limestone outcrop or very thin and porous limestone soils that encourage rapid infiltration of water. However, if a tropical depression settles over the

island, it can rain over several days with surface water flooding causing severe problems (Novelo-Casanova and Suarez, 2010).

5.3.28 The Cayman Islands has experienced 74 tropical storms and hurricanes over 156 years (1852-2008), with nine major storms (Category three or higher). Major storms have devastating socio-economic impacts. For example, in September 2004, Hurricane Ivan caused sustained winds of up to 155 mph (249 km/h), producing storm surges of 9.8 ft (3 m) and wave heights of greater than 26 ft (7.9 m) that flooded large coastal areas and deposited large amounts of sediment onshore (Cayman Islands National Emergency Website http://www.caymanprepared.ky/portal/page/portal/hmchome/resources/brochures/196853%20Past%20Hurricanes.pdf, undated).

5.3.29 No delineated floodplain mapping exists for the Cayman Islands. However, the proposed development site, like much of Grand Cayman, is low-lying which indicates that tidal flooding and hurricane/tropical storm-associated flooding are significant potential hazards. Novelo-Casanova and Suarez (2010) delineated flood zones resulting from hurricanes according to hurricane categories on the Saffir-Simpson Scale (Plate 5.3). This shows that the proposed development site is within an area of very high exposure to hurricanes and associated flooding and storm surge. Storm surges combined with wave action are responsible for much of the damage usually caused by hurricanes, especially in large, low-lying coastal settlements. In addition to causing flooding and damage to coastal structures, storm surges may also cause flooding further inland through the blockage of the outfalls of drainage systems.

Plate 5.3 Level of exposure to due to flooding from hurricanes: a) Hurricane categories 1 and 2, b) Hurricane category 3, c) Hurricane categories 4 and 5. The arrow indicates the direction of approach of the hurricane (from Novelo-Casanova and Suarez (2010))



Protected areas

5.3.30 The closest proposed international designated (proposed Ramsar) sites are located approximately 4.5 km (2.75 miles) to the east (Central Mangrove Wetland, Little Sound, Ponds and associated Marine Zones) and 7.5 km (4.75 miles) to the north (Barkers Wetland) of the proposed development site. The Central Mangrove Wetland, Little Sound, Ponds and associated Marine Zones comprise pristine mangrove wetlands supporting important habitats, marine invertebrates and internationally important populations of migratory birds. Barkers Wetland is a continuum from coral reef to coastal forest and mangrove supporting endangered marine and terrestrial reptiles, breeding and migratory birds as well as important invertebrates and endemic fish.

5.3.31 The Cayman Islands has a network of marine protected areas. There are three categories of marine parks for Grand Cayman:

- *Environmental zone*: in which prohibited activities include the removal of any form of marine life, the use of anchors, entry into the water and exceeding a speed of five knots;

- *Replenishment zone*: where the removal of conch and lobster is prohibited, and fishing methods restricted; and
- *Marine park zone*: in which marine life is protected and anchoring forbidden, except in certain circumstances.

5.3.32 The closest marine protected area to the proposed development site is the Marine Reserve on the west coast which comprises the Seven Mile Beach. The North Sound to the east of the site also contains marine protected areas (Replenishment and Environmental zones). The closest nationally important terrestrial areas to the proposed development site include the Mangrove Buffer Zone near the west coast and three Terrestrial Protected Areas between 1.4 km (0.9 miles) and 2.5 km (1.5 miles) to the north.

Future baseline

5.3.33 Land use and climate change could affect the Study Area in the future. In particular, the conditions at the proposed development will be affected by the likely influence of climate change, which could affect the amount, intensity and duration of rainfall, temperature and evapotranspiration, occurrence of extreme weather (hurricanes) and amount and rate of sea level rise.

5.3.34 Estimates of future sea-level rise within the Caribbean in the Model for the Assessment of Greenhouse-gas Induced Climate Change (MAGICC) indicates an increase of 12 cm (0.4 ft) to 80 cm (2.6 ft) in sea levels by 2100 from a 1990 baseline. This range encompasses the conservative estimates by the Intergovernmental Panel on Climate Change (IPCC) for global sea-level rise and represents a rise of approximately 0.14 cm to 0.91 cm (0.05 inch to 0.35 inch) per year. The Cayman Islands are amongst those islands showing regional variation in rainfall projections, with a decrease of between 10 and 50 mm in annual rainfall totals predicted between 2011 and 2099 (National Climate Change Committee, 2011). This could change the hydrological characteristics of the proposed development site and wider catchment areas over time.

Consultation

5.3.35 Community engagement work has already been undertaken by the CIG to establish the ISWMS core policies, and this has helped ensure an early dialogue around the need for non-landfill-based waste management alternatives.

5.3.36 The Proponent submitted a Request for an EIA Scoping Opinion to the DoE in October 2017, and the EAB responded in November 2017 with its EIA Scoping Opinion, summarising the potentially significant environmental effects of the project that will need to be addressed, as well as additional information requirements that the EAB deemed necessary to prepare an ES. Key elements of this Opinion are presented later.

Scope of the assessment

Potential receptors

5.3.37 The main potential water and flood risk receptors that could be affected by the proposed development are summarised in Table 5.13. It is important to note that this chapter examines potential changes of the proposed development on the water environment supporting designated conservation sites and any potential undesignated groundwater-dependent terrestrial ecosystems (GWDTEs), not the habitats themselves, which are considered in Sections 5.1 and 5.2. During the formulation of the EIA, other receptors will be identified as appropriate.

Table 5.13 Potential hydrology (including flood risk) and hydrogeology receptors

Receptor	Location
Water Environment	
Ironshore Formation aquifer (limestone and marl bands up to 7.6 m thick)	Beneath the proposed development site (0 to -25 ft / 0 to -7.6 m below mean sea level)
Bluff Group aquifer (Pedro Castle Formation aquifer, Cayman Formation and Brac Formation; dolomite, limestone and dolostone)	Beneath the proposed development site (<-25 ft /-7.6 m below mean sea level)
North Sound (contains Replenishment and Environmental Zone which are marine protected areas)	2,460 ft (750 m) north-east of the site
Water Use	
Groundwater abstraction for potable water supply following desalination at WAC's Red Gate Road Water Works (reverse osmosis plants)	0.9 miles (1.4 km) east of the proposed development site
Groundwater abstraction for geothermal cooling purposes at the CUC electrical power generation facility	0.6 miles (1.0 km) north east of the proposed development site
Groundwater abstraction for geothermal cooling purposes undertaken by various other developments including Fosters warehouses and the Owen Roberts International Airport, with expectation of further future projects	1.2 miles (2.0 km) northwest (Fosters warehouse) and south (Airport) of the proposed development site
Humans, properties and infrastructure within areas prone to flooding	
Site infrastructure, staff and visitors	Proposed development site
Surrounding land infrastructure, users and visitors	Surrounding land

Likely significant effects

5.3.38 The likely significant hydrology (including flood risk) and hydrogeology effects that are recommended for assessment are summarised in Table 5.14. During the formulation of the EIA, other likely significant effects will be identified as appropriate.

Table 5.14 Likely significant hydrology (including flood risk) and hydrogeology effects

Activity	Effect	Receptor
Construction phase - dewatering associated with the excavation of the foundations for infrastructure	Localised and temporary decline in groundwater levels and baseflows, deterioration in groundwater quality via induced saline intrusion	Aquifers Mosquito control canals North Sound Groundwater abstractions
Construction phase – temporary storage/stockpiling of materials	Change surface water drainage patterns and locally increase flood risk	Site infrastructure, staff and visitors
Construction and operation phases - soil compaction and introduction of areas of hardstanding	Reduce infiltration recharge and groundwater levels and baseflows	Aquifers Mosquito control canals North Sound Groundwater abstractions
	Increase surface water runoff and sediment-loading	Mosquito control canals North Sound
	Increase surface water runoff and flood risk	Surrounding land infrastructure, users and visitors
Operation phase - groundwater abstraction for site potable water supply (for domestic consumption and sanitary purposes) and non-potable supply for ERF cooling, compost irrigation and general site maintenance)	Localised decline in groundwater levels and baseflows, further deterioration in groundwater quality via induced saline intrusion	Aquifers Mosquito control canals North Sound Groundwater abstractions
Operation- disposal of wastewater generated at the site (including sanitary effluent, facility wash water, Composting Area runoff and non-contact ERF cooling water) assumed to be to ground	Deterioration in groundwater and baseflow quality	Aquifers Mosquito control canals North Sound Groundwater abstractions
Operation and decommissioning (disposal of landfill leachate from the RWL)	Deterioration in groundwater and baseflow quality	Aquifers Mosquito control canals North Sound Groundwater abstractions
All phases (construction, operation and decommissioning) - potentially polluting site activities	Release of pollutants directly (e.g., spillages) or indirectly (via surface water runoff) leading to deterioration in surface water and groundwater quality	Aquifers Mosquito control canals North Sound Groundwater abstractions
All phases (construction, operation and decommissioning)- tidal flooding, surface water flooding and extreme weather and climate change-induced flood events	Multiple effects e.g., sediment-loading release of pollutants, flooding, mobilisation of contaminants off-site by flood water	Aquifers Mosquito control canals North Sound Groundwater abstractions Site infrastructure, staff and visitors

Assessment methodology

Overall approach

5.3.39 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in section 4.2. However, whilst this approach has informed the hydrology (including flood risk) and hydrogeology assessment methodology, some adaptions are required to address the specific needs of the water assessment, and these are described below.

5.3.40 The significance of the effects resulting from the proposed development is primarily determined by the value of a given water feature and the magnitude of change. In terms of the hydrology and hydrogeology, the key types of effects relate to water quantity (level and flow), and quality. However, depending on the effects on surface water flows, there may also be effects on immediate and downstream morphology and sediment dynamics and flood risk[6].

5.3.41 The method and criteria recommended to be used to determine value, magnitude of change, and the significance of the effects, is described in this section. The description has deliberately not been constrained by the limited set of receptors and activities identified in Tables 5.13 and 5.14 respectively, so as to allow the method and criteria to be suitable for use with any additional receptors and activities identified by the Proponent.

5.3.42 The value of hydrological and hydrogeological water features scoped into the assessment is normally related to the importance of the surface water or groundwater feature. Table 5.15 provides a summary of the criteria recommended for use in the valuation of water features and introduces the concept of receptor type (groups of receptors whose value is assessed using the same criteria). The criteria are semi-quantitative and therefore professional judgement will need to be applied to the assessment.

5.3.43 The magnitude of change on water receptors is independent of the value of the receptor, and its assessment (both potential, taking into account any inherent (integral) mitigation to the proposed ISWMS, and residual, after the implementation of additional mitigation measures) is semi-quantitative and also relies in part on professional judgement. Table 5.16 provides examples of how various levels of change can be determined with respect to water features.

Table 5.15 Summary of value of hydrology (including flood risk) and hydrogeology receptors

Value	Criteria	Receptor type*	Examples
High	Features with a high yield, quality or rarity with little potential for substitution	Aquatic environment	Conditions supporting a site with an international conservation designation, where the designation is based specifically on aquatic features. High status (quantity and/or quality) watercourse, also any associated upstream unclassified watercourse. Principal aquifer (high permeability, able to support water supply and/or watercourse baseflow on a strategic scale).
	Water use supporting human health and economic activity at a regional scale	Water use	Regionally important public surface water or groundwater supply (and associated catchment) or permitted discharge.
	Features with a high vulnerability to flooding	Flood risk	Land use type considered as 'Essential Infrastructure' (i.e., critical national infrastructure, such as essential transport and utility infrastructure) and 'Highly Vulnerable' (e.g. police/ambulance stations that are required to operate during flooding, mobile homes intended for permanent residential use).

[6] As noted earlier, effects on water-dependent habitats themselves, rather than simply the water conditions that support these sites, are addressed in Section 5.1 and 5.2.

Value	Criteria	Receptor type*	Examples
Medium	Features with a medium yield, quality or rarity, with a limited potential for substitution	Aquatic environment	Conditions supporting a site with a national conservation designation, where the designation is based specifically on aquatic features. Good status (quantity and/or quality) watercourse, also any associated upstream unclassified watercourse. Secondary aquifer (permeable, able to support water supply and/or watercourse baseflow on a local scale).
	Water use supporting human health and economic activity at a local scale	Water use	Local public surface water and groundwater supply (and associated catchment) or permitted discharge. Licensed non-public surface water and groundwater supply abstraction (and associated groundwater catchment) which is relatively large relative to available resource, or where raw water quality is a critical issue, e.g., industrial process water, or permitted discharge.
	Features with a medium vulnerability to flooding	Flood risk	Land use type considered as 'More Vulnerable' (e.g., most types of residential development, hostels and hotels, landfill and waste management facilities).
Low	Features with a low yield, quality or rarity, with some potential for substitution	Aquatic environment	Conditions supporting a site with a local conservation designation, where the designation is based specifically on aquatic features, or an undesignated but highly/moderately water-dependent ecosystem. Lower status (quantity and/or quality) watercourse, also any associated upstream unclassified watercourse. Secondary aquifer (lower permeability, limited yield).
	Water use supporting human health and economic activity at household/individual business scale	Water use	Licensed non-public surface water and groundwater supply abstraction (and associated catchment), which is small relative to available resource, or where raw water quality is not critical, e.g., cooling water, spray irrigation, mineral washing or permitted discharge. Unlicensed potable surface water and groundwater abstraction (and associated catchment) e.g., private domestic water supply, well, spring or permitted discharge.
	Features with a low vulnerability to flooding	Flood risk	Land use type considered as 'Less Vulnerable' (e.g., most types of business premises).
Very Low	Commonplace features with very low yield or quality with good potential for substitution	Aquatic environment	Conditions supporting an undesignated and low water-dependent ecosystem. Unclassified watercourse. Non-aquifer (low permeability, minimal yield)
	Water use does not support human health, and of only limited economic benefit	Water use	Unlicensed non-potable surface water and groundwater abstraction (and associated catchment) e.g., livestock supply.

Value	Criteria	Receptor type*	Examples
	Features that are resilient to flooding	Flood risk	Land use type considered as 'Water-compatible use' (e.g., appropriately designed flood control infrastructure; water transmission infrastructure).

Notes:
*Receptor types map onto receptors such as those identified in Table 5.13 as follows:

- Aquatic environment – aquifers, watercourses, conditions supporting GWDTEs and designated conservation sites
- Water use – springs, abstractions
- Flood risk – humans, properties and infrastructure.

Table 5.16 Summary of hydrology (including flood risk) and hydrogeology magnitude of change

Magnitude	Criteria	Receptor type	Example
High	Results in major change to feature, of sufficient magnitude to affect its use/integrity.	Aquatic environment	Deterioration in river flow regime, morphology or water quality, leading to sustained, permanent or long-term breach of relevant conservation objectives (COs) or non-temporary downgrading (deterioration) of watercourse status (quantity and/or quality) or dependent receptors. Deterioration in groundwater levels, flows or water quality, leading to non-temporary downgrading of status (quantity and/or quality) of aquifer or dependent receptors.
		Water use	Complete or severely reduced water availability and/or quality, compromising the ability of water users to abstract.
		Flood risk	Change in flood risk resulting in potential loss of life or major damage to property or infrastructure.
Medium	Results in noticeable change to feature, of sufficient magnitude to affect its use/integrity in some circumstances.	Aquatic environment	Deterioration in river flow regime, morphology or water quality, leading to periodic, short-term and reversible breaches of relevant COs, or potential temporary downgrading of watercourse status (quantity and/or quality) or dependent receptors. Deterioration in groundwater levels, flows or water quality, leading to potential temporary downgrading of status (quantity and/or quality) of aquifer or dependent receptors.
		Water use	Moderate reduction in water availability and/or quality, which may compromise the ability of the water user to abstract on a temporary basis or for limited periods, with no longer-term impact on the purpose for which the water is used.
		Flood risk	Change in flood risk resulting in potential for moderate damage to property or infrastructure.
Low	Results in minor change to feature, with insufficient magnitude to affect its use/integrity in most circumstances.	Aquatic environment	Slight change in river flow regime, morphology or water quality, but remaining generally within COs, and with no short-term or permanent change to watercourse status (quantity and/or quality) or dependent receptors. Slight deterioration in groundwater levels, flows or water quality, but with no short-term or permanent downgrading of status (quantity and/or quality) of aquifer or dependent receptors.
		Water use	Minor reduction in water availability and/or quality, but unlikely to affect the ability of a water user to abstract.
		Flood risk	Change in flood risk resulting in potential for minor damage to property or infrastructure.

Magnitude	Criteria	Receptor type	Example
Very Low	Results in little change to feature, with insufficient magnitude to affect its use/integrity	Aquatic environment	Very slight change in river flow regime or water quality, and no consequences in terms of COs or watercourse status (quantity and/or quality) or dependent receptors. Very slight change in groundwater levels or quality, and no consequences in terms of status (quantity and/or quality) of aquifer or dependent receptors.
		Water use	Very slight change in water availability or quality and no change in ability of the water user to exercise licensed rights or continue with small private abstraction.
		Flood risk	Increased frequency of flood flows, but which does not pose an increased risk to property or infrastructure.

5.3.44 The Directive for EIAs requires that a final judgement is made about whether the effects (both potential and residual) are likely to be significant. The significance of water-related effects is derived by considering both the value of the feature and the magnitude of change. In this assessment, it is recommended that effects are assessed as being significant or not significant as per the matrix in Table 5.17, with *'Major'* effects taken to be *'Significant'* and, likewise, '*Moderate*' effects in most cases (and where they are not considered to be not significant, the rationale for this will be provided). Significance can be *'Beneficial'*, *'Adverse'* or *'Neutral'*.

Table 5.17 Significance evaluation matrix relating to the water environment

		Magnitude of change			
		High	**Medium**	**Low**	**Very Low**
Value	**High**	Major (Significant)	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)
	Medium	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)
	Low	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)
	Very Low	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)	Negligible (Not significant)

Note: 'Significant' effects are those identified as 'Major'. 'Moderate' effects would normally be deemed to be 'significant'. However, there may be some exceptions, depending on the environmental topic and the application of professional judgment.

5.3.45 The residual effects which remain *'Significant'* after the implementation of additional mitigation measures will need to be identified. It may be that there are no additional mitigation measures required, or that there are no residual effects after mitigation measures are applied.

5.3.46 It is important to recognise that *'Significant'* effects on receptors in the water environment does not necessarily mean that the same outcomes would occur in respect of the same receptors that may also be ecology receptors. Indeed, because of the different value and magnitude criteria used by the two assessments, it is possible that effects assessed as *'Not significant'* in one environmental topic assessment, e.g., the water environment, can still sit alongside effects assessed as *'Significant'* in another environmental topic assessment, e.g., ecology, and vice-versa.

Anticipated supporting work

5.3.47 It is considered that further studies in support of the EIA will be required if '*Significant*' residual effects are to be avoided. Some initial recommendations as to the scope of this work and additional mitigation are provided below, and these will be refined and added to as appropriate. Additional mitigation measures which are required to avoid, reduce or remedy '*Significant*' potential adverse effects will need to be listed and detailed.

Water quality

5.3.48 Various activities at the proposed development site have the potential to release contaminants that may impact water resources. Potential sources include the following: Composting Area, RWL, ERF Bottom Ash Storage, APCR Storage, potential geothermal cooling and wastewater and leachate treatment and disposal. Due to the karst geology of the Cayman Islands and the absence of shallow low permeability confining zones, contaminants released from the site have the potential to migrate into the underlying aquifers.

5.3.49 A Stormwater Management Plan (SWMP, further described below) should be developed for the site and incorporate mitigation measures, as appropriate, to address any potential water quality impacts from contaminated surface water runoff. Contaminated runoff should be segregated from uncontaminated runoff. Best practice pollution prevention techniques should be followed to minimise release of contaminants during construction, operation and decommissioning of the site.

5.3.50 The RWL should be engineered using a low permeability basal barrier and cap in accordance with the standards previously identified. Leachate from the RWL should be collected and treated prior to disposal. Groundwater monitoring wells should be installed around the perimeter of the RWL and proposed development site and monitored for groundwater quality and levels. The data should be used to confirm and augment the published groundwater baseline data discussed previously. The boreholes should be retained for the purpose of long-term monitoring of any potential impacts on water quality from the RWL and the wider site.

5.3.51 Wastewater will be generated at the site including sanitary effluent, ISWMS facility washwater and non-contact ERF cooling water. Wastewater disposal options will need to be assessed. Any discharges from the site to ground/surface water must meet applicable water quality discharge criteria as previously identified and will be subject to wastewater discharge permits issued by WAC under the Water Authority Act (2018 Revision). WAC will be consulted to provide information on existing large-scale discharges within the study area for consideration in the EIA. Depending on the anticipated temperature differential between abstraction and disposal, a site-specific hydrogeological study will be required by WAC. A review of the methodology to complete this work will be reviewed with the EAB in advance of commencing the study.

Water availability

5.3.52 The proposed development will require potable water supply for domestic consumption and sanitary purposes and non-potable water for ERF cooling, compost application and general site maintenance purposes. Water supply sources for the site will need to be assessed, including mains potable water supply and deep groundwater abstraction (non-potable water supply subject to on-site treatment).

5.3.53 In the event that groundwater is used for water supply at the site, a water resources assessment will need to be undertaken to evaluate the availability of groundwater for abstraction and potential effects on local groundwater abstractions. WAC will be consulted to provide information on existing groundwater abstractions within the study area. Groundwater abstraction will be subject to a license issued by WAC. Depending on the anticipated abstraction volume, a site-specific

hydrogeological study will be required by WAC. A review of the methodology to complete this work will be reviewed with the EAB in advance of commencing the study.

Flood risk

5.3.54 A Flood Risk Assessment (FRA) will need to be undertaken for the proposed development site to demonstrate how flood risk to the development and any potential to increase flood risk to third parties due to the proposed development will be managed over the site's lifetime, taking appropriate account of climate change. An assessment of the potential sources of flood risk to the site should be undertaken and the need for mitigation measures assessed.

5.3.55 The assessment of flood risk should follow a source-pathway-receptor led approach. For the avoidance of doubt, sources comprise the origin of flood waters, such as direct rainfall, the sea, sewers or artificial sources. The pathways provide the means by which the source of flood risk can impact receptors, whilst a specific combination of sources and pathways is referred to as a flood mechanism. Receptors comprise those persons or assets that could be vulnerable to the flood mechanisms identified.

5.3.56 A visit to the site and surrounding area should be undertaken to confirm the local topography, identify key hydrological features (such as runoff pathways), key drainage assets (e.g., gully, grates and pipes) and localised vulnerable receptors.

5.3.57 Review of desk-based baseline information indicates that the key flood mechanisms at the proposed development are tidal flooding and surface water flooding which are exacerbated by hurricane-related storm surge and tropical rainfall events. In the absence of delineated floodplain mapping for the Cayman Islands, flood/hydraulic modelling may be required for the assessment. A detailed topographic survey and consultation with local emergency planning, development planning and environmental bodies should be undertaken in order to identify local flooding issues and the presence and condition of any local flood defences.

5.3.58 Mitigation measures are likely to include guidance on the siting of temporary stockpiles, measures to ensure safety of site workers (e.g., evacuation plans) and appropriate raising of finished floor level of sensitive infrastructure.

Storm water management plan

5.3.59 A SWMP will need to be developed for the proposed development site to demonstrate that the site is able to operate effectively during intense rainfall events and it will not increase flood risk to surrounding properties or infrastructure. Specifically, the SWMP will need to address the following issues:

- Identification of an appropriate location to discharge storm water from the site;
- A review of the recommended design rainfall intensity, using available local rainfall data and taking into account climate change to ensure it is adequately conservative for this development;
- Design of drainage infrastructure with adequate capacity to safely convey the design rainfall intensity and minimise potential flood and water quality impacts;
- Provision of safe overland storm water flow routes to minimise potential flood and water quality (mobilisation of contaminants by flood waters) impacts during design exceedance events;
- Design of mitigation measures to ensure the adequate attenuation of storm water prior to discharge;

- Design of mitigation measures to maintain good water quality in the discharged water; and
- Identification, together with any necessary mitigation measures, of existing drainage infrastructure or overland flow routes which may be affected by the proposed development.

5.3.60 Detailed consideration should be given to ensure that the storm water drainage system, including discharge points, is resilient to the effect of climate change. Key impacts are likely to include an increase in both the design rainfall rate and the sea level at the discharge point. Appropriate climate change uplift factors should be used to define key drainage design parameters.

5.4 Land quality (geo-environmental and geotechnical effects)

Introduction

5.4.1 This section of the ToR acts as a guide to the formulation of the EIA of the proposed development at George Town with respect to land quality, i.e., geo-environmental and geotechnical effects.

5.4.2 The section should be read in conjunction with the development description provided in Chapter 2: The proposed development and with respect to relevant parts of Section 5.3: Hydrology (including flood risk) and hydrogeology, where common receptors have been considered and where there is an overlap or relationship between the assessment of effects.

Applicable standards and technical guidance

5.4.3 As for the wider EIA, the land quality element of the assessment will need to follow the process outlined in the Directive for EIAs (2016) issued in accordance with The National Conservation Law (2014).

5.4.4 A tiered approach to assessing risks from land (and water) contamination is set out in the UK Department for Environment, Food and Rural Affairs (DEFRA) and UK Environment Agency (EA) publication *Land Contamination: Risk Management (LCRM)*. If possible, the land contamination risk assessment should be signed off by a Suitably Qualified Person (SQP) under the National Quality Mark Scheme (NQMS) for land contamination management.

5.4.5 Ground investigation(s) should be carried out in accordance with British Standard BS5930:2015 *Code of practice for ground investigations* or equivalent US ASTM standards. BS5930:2015 deals with the investigation of sites to assess their suitability for construction and to identify the characteristics of a site that affect the design and construction of the project. It also considers related issues including the environment and the security of adjacent land and property. BS5930:2015 is compliant with BS EN 1997-1 and BS EN 1997-2 *Eurocode 7: Geotechnical design* and related test standards.

5.4.6 Investigations of ground gases and vapours should be undertaken in accordance with BS 8576:2013 *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*, which provides guidance on the monitoring and sampling of ground gases including VOCs and permanent gases such as carbon dioxide, methane and oxygen. BS 8576:2013 is intended to be used in conjunction with BS 10175 *Investigation of potentially contaminated sites - Code of Practice*.

5.4.7 The Florida Administrative Code (FAC) contaminant clean up target levels can be used for screening soils quality data as part of a quantitative assessment of the risks to human health receptors from land contamination. The FAC levels are those which are considered most directly relevant to the Cayman Islands considering geography, climate and given that the FAC levels also consider marine surface water criteria which is an important factor for the islands.

5.4.8 As part of any ground investigation, sample collection, preservation, holding times, field testing and analytical laboratory accreditation should be carried out in accordance with United States Environmental Protection Agency (USEPA) guidance and be compared to Code of Federal Regulations (CFR) Title 40 Part 258 – *Criteria for Municipal Solid Waste Landfills* and FAC Chapter 62-701 *Solid Waste Management Facilities*.

5.4.9 The proposed RWL within the boundaries of the existing GTLF Site is included within the scope of the EIA and therefore this ToR. The standards to be used for the new RWL include the Resource Conservation and Recovery Act (Sub-Title D – Non Hazardous Rules, Sub-Title C – Hazardous Rules) and the USEPA CFR Title 40 (Part 60 – Standards for Performance for Municipal Solid Waste Landfills, Part 258 – Criteria for Municipal Solid Waste Landfills, Part 264 – Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, Part 265 – Interim).

5.4.10 With respect to landfill closures on each of the three islands, it is understood that such activities will be subject to risk-based assessments that will be conducted outside the scope of the EIA.

Baseline conditions

Data gathering methodology

5.4.11 To assist in the formulation of the eventual EIA, relevant desk study data for land quality for a defined Study Area have been gathered during the production of this ToR. The Study Area is focussed on the proposed ISWMS development in George Town and includes the proposed RWL within the nearby GTLF Site. Data have been collected where available and as appropriate, such as investigation data from the GTLF.

5.4.12 The appraisal has involved the collection and interpretation of a range of data and information from published material. The data collected, and other sources of information, are listed in Table 5.18.

Table 5.18 Sources of desk study information for land quality

Source	Data
Aerial photography (Bing maps and Google maps) Online topographic map (http://en-gb.topographic-map.com/places/George-Town-133291)	Topography and features
Previous environmental reports for the Cayman Islands: • Cayman Islands Government (CIG), 1992. Environmental Assessment of Grand Cayman Sanitary Landfill, Grand Cayman Island, B.W.I. • Jones, B., 2013. Appendix I-6 (Proposed WMF General Geological Setting) of the ES for Grand Cayman Waste Management Facility (pp. 1406-1431) • Amec Foster Wheeler (now Wood), 2016. Landfill Site Environmental Review. Task 2: Environmental Investigations Interpretative Report • Cardno ENTRIX, 2013. Grand Cayman Waste Management Facility Draft Environmental Statement • Mott MacDonald, 2013. Cruise Berthing Terminal for Cayman Islands. Final EIA Terms of Reference.	Geology and ground conditions
Previous environmental reports for the Cayman Islands: • Amec Foster Wheeler (now Wood), 2015. Landfill Site Environmental Review. Task 1: Environmental Investigations and Risk Assessments • Amec Foster Wheeler (now Wood), 2016. Landfill Site Environmental Review. Task 2: Environmental Investigations Interpretative Report	Land quality including ground gases

5.4.13 The land quality baseline is also inter-related with, and uses information from, other sections of this ToR, particularly Section 5.3 Hydrology (including flood risk) and hydrogeology.

5.4.14 During the formulation of the EIA, other data will be collected as appropriate, including that within existing literature as well as site-specific geo-environmental and geotechnical data from site investigation(s). Any such data will be incorporated into the EIA to provide a more definitive description of the baseline environment.

5.4.15 Such a description will include the presentation of a conceptual model (with schematic sections) summarising key attributes of the baseline geo-environmental and geotechnical conditions near the George Town ISWMS site and RWL that together comprises the proposed development.

Current baseline

Topography

5.4.16 The land surrounding the proposed development site is mainly flat and low lying and where developed is formed from reclamation of former mangrove swamp. Online topographic mapping (http://en-gb.topographic-map.com/places/George-Town-133291) indicates that the site elevation ranges approximately between 7 and 20 ft above mean sea level.

Geology – made ground

5.4.17 Made ground is thicker at the proposed ISWMS site compared to other areas of Grand Cayman as noted above.

5.4.18 Made ground at the GTLF Site is described in Wood (2015). The site of the proposed RWL is within the boundary of the GTLF. and has been used to stockpile mostly metals and end of life vehicles since Hurricane Ivan. A pond that was created by extraction of cover material for the GTLF was filled with hurricane Ivan debris. This approximate 5 acre area is outside of the area proposed for the RWL. In addition, there is a small (approx. 1 acre) geomembrane lined and capped area in the eastern part of the GTLF, within the footprint of the proposed RWL. Site staff stated that this

contains ash from burning of timber waste arising from Hurricane Ivan. The ash is reported to have arsenic content arising from insecticides originally used to treat the timber. No construction records were made available for this area but there are some marker posts indicating its position on the ground. The EIA will consider how to incorporate the containment cell into the RWL design as part of the baseline assessment.

Geology - natural

5.4.19 The geology of the Cayman Islands is described in CIG (1992) and Jones (1994) and is summarised in Table 5.19.

5.4.20 The Cayman Islands are outcrops of the Cayman Ridge, an undersea mountain range within a tectonically active area. The islands are located on a separate fault block that has been elevated above the general level of the Cayman Ridge. The islands have a granodiorite base, followed by a cap of basalt and covered by about 1,300 m of Tertiary carbonates (limestones and dolostones). The Tertiary Period geological succession consists of the Bluff Group which is overlain unconformably by the Pleistocene Ironshore Formation. In many areas of the Grand Cayman, including the proposed development site, the bedrock is covered by peat that has formed in the low-lying wetland areas covering vast tracts of land.

5.4.21 The Ironshore Formation are soft to hard coralline limestones interspersed with hard lenses, coral ledge and pockets of calcareous sand. The underlying Bluff Group consists of the Brac Formation, Cayman Formation and Pedro Castle Formation. The Cayman Formation comprises a number of prominent features including joints, fractures, and (primarily in-filled) sinkholes and solution cavities and is divided into the upper "cap rock" (5.5 to 65 ft below ground level) and the lower part of the Cayman Formation that extends to depths below 250 ft deep. The "cap rock" is formed of hard dolostones that have low porosities and low permeabilities, and the lower unit of the Cayman Formation is formed of relatively friable dolostones with high porosities and high permeabilities.

Table 5.19 Geology summary for the Cayman Islands (after CIG 1992 and Jones 2013)

Period	Series	Formation	Elevation (ft/m above mean sea level)	Thickness (ft / m)
Made ground	Made ground	Imported fill	+1.5 to +4.0 ft +0.45 to +1.2 m	2.5 ft/ 0.75 m
Quaternary	Holocene	Peat (swamp deposits)	0 to +1.5 ft 0 to +0.45 m	1.5 ft/ 0.45 m (4-10 ft/ 1.2-3.0 m below wastewater treatment lagoons to the west of the proposed development)
Quaternary	Pleistocene	Ironshore Formation (calcareous marl)	0 to -3.0 ft 0 to -0.9 m	3.0 ft/ 0.9 m
Quaternary	Pleistocene	Ironshore Formation (very soft friable limestone)	-3.0 to -7.5 ft -0.9 to -2.3 m	4.5 ft/ 1.4 m
Quaternary	Pleistocene	Ironshore Formation (soft friable limestone and marl bands)	-7.5 to -25 ft -2.3 to -7.6 m	17.5ft/ 5.3 m
Tertiary	Pliocene	Bluff Group- Pedro Castle Formation (hard dolomite and limestone)	-25 to -45 ft -7.6 to -13.7 m	20ft/ 6.1 m
Tertiary	Miocene	Bluff Group- Cayman Formation (dolostone)	-45 to >-300 ft -13.7 to >-91.4 m	>250ft/ >76 m
Tertiary	Oligocene	Bluff Group- Brac Formation (limestone and sucrosic dolostone)	>-300 ft >-91.4 m	-

Notes: Based on information reported in CIG (1992), WAC (2001) and Jones (2013). Thickness of Brac Formation not reported.

Mineral reserves

5.4.22 As previously stated, the land surrounding the proposed development site is mainly flat and low-lying and where developed is formed from reclamation of former mangrove swamp. There is no readily available information on the extent and quality of mineral reserves in the Cayman Islands but given the reclaimed nature of the land it is unlikely that the proposed development site presents a significant mineral reserve.

Geotechnical

5.4.23 There is no known geotechnical information specific to the proposed development site. Geotechnical baseline information for the previously proposed waste management facility (WMF) near Bodden Town on Grand Cayman is provided in a geotechnical investigation report produced by APEC that is included as an appendix within Cardno ENTRIX (2013).

Regional tectonics and seismic activity

5.4.24 Regional tectonics and seismic activity for the Cayman Islands is described in Mott McDonald (2013) and is provided in the following sections.

5.4.25 The Cayman Islands sit in an active seismic zone on a transformational plate boundary between the North American and Caribbean tectonic plates known as the Oriente Fracture Zone. The active fault line runs along the south-east coast of Cuba to an area just west of Cayman, roughly following the

northern edge of the Cayman Trough. The region surrounding the Cayman Islands has a high earthquake hazard rating and there have been a number of powerful earthquakes recorded along the Oriente Fracture Zone. Higher magnitude earthquakes are limited to a magnitude of 7 on the Richter scale, although it is not unusual for minor tremors to be recorded. In December 2004 Grand Cayman experienced an earthquake of 6.8 in magnitude. Despite the magnitude, this event did not cause significant damage to critical infrastructure, homes or businesses.

5.4.26 Tsunamis are also a significant risk for the Cayman Islands. The main sources of tsunamis in the Caribbean are earthquakes (generated at the boundaries of the Caribbean Plate or within the Plate), submarine landslides, volcanoes, and large earthquakes which occur far away and generate a large tsunami which reaches the Caribbean. In the past 500 years, there have been 10 confirmed earthquake generated tsunamis in the Caribbean Basin, which killed an estimated 350 people in total. Tsunamis can devastate coastlines, causing widespread property damage and loss of life. The tsunami risk to the Caribbean is however uncertain. The movement of the Oriente Fracture Zone is typically transcurrent, which creates horizontal stress. Vertical stress is the usually the mechanism for tsunami generation.

Soil quality and ground gases

5.4.27 There is no known information on soil quality or ground gases specific to the proposed ISWMS site. Baseline information is however available for the GTLF Site from the investigation report produced by Amec Foster Wheeler (now Wood), 2016 and is provided in the following sections.

5.4.28 The CIG Department of Environmental Health (DEH) has carried out some sampling of soils from the banks of perimeter canals near the GTLF Site. Samples were collected above the normal water level adjacent to some of the surface water sample locations and from surface soils adjacent to some of the perimeter monitoring boreholes around the GTLF site. Forty datasets are available for the period 2011-2013. Data were screened against the Florida soil clean-up standards for both:

- Direct exposure for commercial/industrial use; and
- Leachability based on groundwater of low yield/poor quality (assessment criteria are available for a limited number of metals).

5.4.29 Based on the results of the screening, metal concentrations are below the assessment criteria except for arsenic which exceeded the Florida direct exposure clean-up criteria of 12 mg/kg at three locations with a maximum concentration of 60 mg/kg. It is noted the Florida clean-up standard for arsenic is exceptionally low when compared to UK assessment criteria for the same commercial/industrial use scenario (which is 640 mg/kg). Concentrations of up to 40 mg/kg are typical of background in the UK for naturally occurring soils, but this is expected to be less for the limestone derived soils on the Cayman Islands. Another potential source of soil arsenic is from the past burning of treated timber.

5.4.30 No metal values exceed the leachability criteria for groundwater of low yield/poor quality but exceed the criteria for leachability for marine surface water. Polychlorinated biphenyl (PCB) test results (30 No) for soils were all below the laboratory limit of detection (LoD). Pesticide suite test results (11 No) are also less than LoD apart from 3 No compounds, which are present at concentrations well below assessment standards for direct exposure or leachability to groundwater of poor quality.

5.4.31 Seventeen samples of surface soil were collected by Wood from across the Hurricane Ivan fill area of GTLF Site for asbestos analysis in 2015. No asbestos was detected in any of the samples.

5.4.32 Gas monitoring and sampling was undertaken by Wood from gas probes (GP1 to GP6) which were installed within the GTLF Site in April 2015. The data shows methane and carbon dioxide concentrations indicative of landfill gas (~50-60% methane and ~25-45% carbon dioxide) with no

or little (~2% or less) oxygen in all probes except GP1, located in the north-east of the site adjacent to a haul road. GP1 showed much lower concentrations of methane (1.8% v/v) and carbon dioxide (1.5% v/v) and oxygen around atmospheric concentration (21.5% v/v).

5.4.33 The gas analysis suite consisted of bulk gas constituents (C1-C4 hydrocarbons, carbon dioxide, nitrogen, oxygen, hydrogen and helium) as well as hydrogen sulphide, carbon monoxide and non-methane volatile organic compounds (NMVOCs). Concentrations of bulk landfill gas (methane, carbon dioxide, oxygen and nitrogen) are largely consistent with the pre-sampling field data, although the concentrations of methane and carbon dioxide detected in GP1 and the laboratory analysis are substantially higher than the field results, whereas the oxygen concentration is lower.

5.4.34 The low/below LoD hydrogen concentrations recorded are typical of a landfill in the long methanogenic stage of landfill gas generation.

5.4.35 The hydrogen sulphide concentrations recorded are typical of those usually measured in landfills, although the result from GP3 is around two orders of magnitude higher than the other results. It is possible that the higher concentration recorded in GP3 is attributable to sulphate-based wastes (typically gypsum) landfilled within the vicinity of the probe.

5.4.36 Regarding the NMVOCs, those detected above the relevant LoD are all typical trace components within landfill gas. Some of the trace compounds detected, such as carbon disulphide, toluene and xylene, as well as hydrogen sulphide, are odorous components of landfill gas.

Future baseline

5.4.37 The ground conditions at the proposed development will likely be affected by future site development and operation (e.g., the attendant risks of ground contamination and ground instability caused by construction works and operation) and may be affected by hazards related to seismic activity, such as earthquakes and tsunamis. With regard to these hazards, there will be appropriate raising of finished floor level of sensitive infrastructure.

Consultation

5.4.38 Community engagement work has already been undertaken by the CIG to establish the ISWMS core policies and this has helped ensure an early dialogue around the need for non-landfill-based waste management alternatives.

5.4.39 The Proponent submitted an EIA Request for Scoping Opinion to the DoE in October 2017, and the EAB responded in November 2017 with its EIA Scoping Opinion, summarising the potentially significant environmental effects of the project that will need to be addressed, as well as additional information requirements that the EAB deemed necessary to prepare an ES. Key elements of this opinion are presented later.

Scope of the assessment

Potential receptors

5.4.40 The main potential land quality receptors that could be affected by the proposed development are summarised in Table 5.20.

5.4.41 During the formulation of the EIA other receptors will be identified as appropriate.

Table 5.20 Potential land quality receptors

Receptor	Location
Site staff, construction workers and visitors (human health)	Proposed development site
ISWMS infrastructure	Proposed development site
Surrounding land users (human health) e.g. residential, commercial/industrial, schools*	Surrounding land

* Some surrounding land users may be too far away for there to be any relevant potential contaminant linkages.

Likely significant effects

5.4.42 The likely significant land quality effects that are recommended for assessment are summarised in Table 5.21.

5.4.43 During the formulation of the EIA, other likely significant effects will be identified as appropriate.

Table 5.21 Likely significant land quality effects

Activity	Effect	Receptor
All phases (construction, operation and decommissioning) - site activities	Contaminants already present in the subsurface associated with historical impact from nearby sites (such as ground gases and vapours from GTLF Site and Cayman Water treatment facility) may present adverse risks to human health and infrastructure.	Site staff, construction workers and visitors (human health) ISWMS infrastructure
All phases (construction, operation and decommissioning) - site activities	Karst features in subsurface such as sinkholes and caves that are unable to adequately support the proposed development lead to geotechnical instability.	Site staff, construction workers and visitors (human health) ISWMS infrastructure
All phases (construction, operation and decommissioning) - the various components of the proposed development have the potential release pollutants to ground.	Release of pollutants directly (e.g., spillages) or indirectly (via surface water runoff) to ground, leading to land contamination. Potential sources of effect include the following: • Mulching/Composting Area; • RWL • ERF Bottom Ash Storage; • Fly Ash disposal; • Potential geothermal cooling; • Surface water management; and • Wastewater and leachate treatment and disposal.	Site staff, construction workers and visitors (human health) ISWMS Infrastructure Surrounding land users (human health)
All phases (construction, operation and decommissioning) - seismic/tectonic events	The Cayman Islands sits in an active seismic zone. Earthquakes and tsunamis are significant potential hazards.	Site staff, construction workers and visitors (human health) ISWMS infrastructure

Assessment methodology

Generic approach

5.4.44 The generic project-wide approach to the assessment methodology is set out in Chapter 4. Whilst this approach has informed the approach that has been used in this land quality assessment, it is necessary to set out how this methodology should be applied, and adapted as appropriate, to address the specific needs of the land quality assessment.

Land contamination

5.4.45 Desk studies and subsequent investigations of the proposed ISWMS Site and RWL should be undertaken to define site-specific baseline soil, bedrock and ground gas/vapour conditions.

5.4.46 The criteria used to assess the sensitivity of the land quality receptors are presented in Table 5.22. This table is specifically for assessing the sensitivity of the geology and ground conditions receptors and complements the generic tables presented in Chapter 4.

Table 5.22 Sensitivity of land quality receptors

Activity	Example Receptor Definition
High	The environmental parameter is fragile, and an effect is likely to leave it in an altered state from which recovery would be difficult or impossible.
Medium	The parameter has a degree of adaptability and resilience and is likely to cope with the changes caused by an effect, although there may be some residual modification as a result.
Low	The parameter is adaptable and is resilient to change.

5.4.47 The sensitivity of human health receptors should generally be considered as high although it can be less sensitive with, for example, health and safety controls in industrial areas. The sensitivity of other receptors could be based on, for example, Construction Industry Research and Information Association (CIRIA) C655 (Assessing risk posed by hazardous ground gases to buildings) or other classifications, as appropriate.

5.4.48 The criteria used to assess the magnitude of effects are presented in Table 5.23. This table is specifically for assessing the sensitivity of the geology and ground conditions receptors and complements the generic tables presented in Chapter 4.

Table 5.23 Land quality magnitude assessment criteria

Activity	Example Receptor Definition
High	Short term acute effect on human health affecting both site users and users of sites in the vicinity, arising from contamination on the proposed development site, or chronic damage to human health affecting users of both the site and other sites in the vicinity arising from contamination on the proposed development site. Catastrophic damage to buildings or property on the proposed development site arising from contamination.
Medium	Chronic damage to human health of users of the proposed development site. Significant damage to buildings or property.
Low	Non-permanent effects to human health e.g., short-term intermittent nuisance such as odours not hazardous to human health. Minor damage to buildings or property.
Negligible	Minimal economic or social uses. Repairable effects of damage to buildings, structures and services e.g., staining or discoloration of building materials.

5.4.49 Table 5.24 presents the matrix used for the classification of effects whilst Table 5.25 sets out the magnitude of impact criteria definitions.

Table 5.24 Classification of effects

Magnitude	**Value and Sensitivity of Receptor**		
	High	**Medium**	**Low**
High	High	High	Medium
Medium	High	Medium	Medium
Low	Medium	Medium	Low
Negligible	Low	Low	Negligible

Table 5.25 Land quality magnitude of impact assessment criteria

Magnitude of Impact	Description		
	Soil Contamination	**Ground Gas**	**Property**
High	Severe localised contamination present in discrete locations at concentrations significantly above assessment criteria in some samples. An acute or chronic adverse effect on human health defined as 'significant possibility of significant harm' (SPoSH).	Characteristic Situation 4 or 5 based on Table 8.5, CIRIA C665 Gas Screening Value >3.5 l/hr (i.e. moderate to high, high or very high risk as defined in CIRIA C665)	Catastrophic damage to buildings or property from contamination or geotechnical risks.
Medium	Localised contamination present in discrete locations at concentrations above assessment criteria in some samples. An acute or chronic adverse effect on human health but not likely to be defined as 'significant harm.'	Characteristic Situation 3 based on Table 8.5, CIRIA C665 Gas Screening Value >0.7 L/hr but <3.5 L/hr (i.e. moderate risk as defined in CIRIA C665) Soils with high organic content	Significant damage to buildings or property from contamination or geotechnical risks.
Low	Contaminants present at concentrations above detection limits but below assessment criteria in all samples. A preventable non-permanent adverse effect on human health.	Characteristic Situation 2 based on Table 8.5, CIRIA C665 Gas Screening Value >0.7 L/hr but <0.07 L/hr (i.e. low risk as defined in CIRIA C665) Soils with high organic content	Minor damage to buildings or property from contamination or geotechnical risks.
Negligible	Contaminants present at concentrations below both detection limits and assessment criteria in all samples. No adverse effect on human health or the environment.	Characteristic Situation 1 based on Table 8.5, CIRIA C665 Gas Screening Value <0.07 L/hr (i.e. very low risk as defined in CIRIA C665) Soils with low organic content	Repairable effects of damage to buildings, structures and services e.g. staining or discoloration of building materials.

5.4.50 The Directive for EIAs requires that a final judgement is made about whether the effects are likely to be significant. Following the classification of the magnitude of impact as detailed in Table 5.25, a clear statement is made as to whether the effect is 'significant' or 'not significant'. As a rule, high and medium effects are considered to be significant and low and negligible effects are considered to be not significant. However, professional judgement is also applied where appropriate.

Land contamination risk assessment

5.4.51 Risks from land (and water) contamination should be assessed as per the methodology set out in LCRM (note comments in Section 5.4.4 related to LCRM). This considers potential contamination sources, pathways and receptors to identify potential contamination linkages.

5.4.52 The FAC contaminant clean up target levels should be used for screening soils quality data as part of a quantitative assessment of the risks to human health receptors from land contamination. Further consultation should be undertaken regarding the screening criteria for arsenic, given the presence of naturally occurring arsenic in the soils of the Cayman Islands.

Assessment of ground gases and vapours

5.4.53 An approach to the assessment of ground gases and vapours is provided in British Standard BS8576:2013. Briefly, this includes preparation of an initial conceptual model, which includes consideration of the sources of ground gases and vapours in and around the site, pathways for gas migration and the potential receptors, e.g. human health and infrastructure.

5.4.54 The conceptual model is refined through site investigation, including the collection of ground gas and vapour data from monitoring boreholes and the nature of man-made soils including total organic carbon content.

5.4.55 Guidance on risk evaluation and characterisation is provided in the CIRIA guidance documents C665 *Assessing risk posed by hazardous ground gases to buildings* and C682 *The VOCs Handbook – Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination* as well as the *Ground Gas Handbook*.

Geotechnical (land stability) assessment

5.4.56 A review of existing geotechnical conditions is essential to determine adequate design conditions, and further geotechnical evaluations should be undertaken to augment existing information as required.

5.4.57 Geotechnical investigations of the proposed ISWMS Site and RWL should be undertaken to define site-specific soil, bedrock and groundwater conditions to facilitate engineering design and construction of the various site components and to identify subsurface zones susceptible to release of contaminants.

5.4.58 The investigations should consider the potential for solution features to be present in the bedrock at depth.

5.4.59 Geotechnical risk assessment report(s) should include:

- A review of existing sources of geological information;
- Site history;
- Site inspection;
- Intrusive site investigation;
- Assessment of land instability risks; and
- Mitigation measures.

The mitigation measures proposed will be clearly stated in the ES and will follow accepted engineering practice standards with clear confirmation that the proposed mitigative solutions are technically and environmentally sound. A review of regional tectonic and seismic information should also be undertaken as part of the assessment of facility vulnerability to natural hazards.

5.5 Landscape and visual

Introduction

5.5.1 The landscape and visual impact assessment (LVIA) consist of two related assessments that assess effects of the construction and operation of the proposed ISWMS on the landscape, concentrating upon effects upon the landscape and townscape character, and effects upon the views and visual

amenity of people who live, undertake recreational activities, work and/or travel through the area around the proposed ISWMS on the western side of Grand Cayman.

Applicable standards and technical guidance

Guidance

5.5.2 The LVIA will be undertaken in accordance with the third edition of the Guidelines for Landscape and Visual Impact Assessment (GLVIA3)[7] produced in the UK by the Landscape Institute and the Institute of Environmental Management and Assessment. GLVIA3 is widely regarded by the landscape and planning professions within and outside the UK as an 'industry standard' for providing landscape and visual assessment inputs into EIAs undertaken for all types of development. The LVIA will take account of the following technical note published by the Landscape Institute.

- Visual Representation of Development Proposals. Technical Guidance Note 06/19[8]

5.5.3 GLVIA3 provides the following definitions of landscape effects: "*An assessment of landscape effects deals with the effects of change and development on landscape as a resource. The concern is with how the proposal will affect the elements that make up the landscape, the aesthetic and perceptual aspects of the landscape and its distinctive character*."

5.5.4 This includes direct effects upon the landscape elements within the ISWMS site and direct and indirect effects upon landscape, townscape and seascape character and any landscape or townscape designations within the LVIA study area.

5.5.5 GLVIA3 provides the following definitions of visual effects: "*An assessment of visual effects deals with the change and development on views available to people and their visual amenity*."

5.5.6 The term 'visual receptors' is used in this LVIA and includes people with views from their residential properties, local communities, transportation routes; along with people undertaking outdoor formal and informal recreational activities ranging from walking along the beach to people playing golf or undertaking recreational activities off the western coast of Grand Cayman. Specific effects will arise from changes in the constituent factors in a visual receptor's view generated by the construction and operation of the proposed ISWMS.

Baseline conditions

Data gathering methodology

5.5.7 The LVIA study area (the 'study area') for the proposed ISWMS extends 3 km from the application site boundary – see **Figure 5.3: LVIA study area**. This study area has been used for the purposes of data collection and the subsequent assessment and has been defined to ensure that the LVIA concentrates upon receptors that are most likely to be significantly affected by the proposed ISWMS. It is derived from a review of the Final EIA Terms of Reference for a Cruise Birthing Terminal that was proposed for George Town[9]. It is considered that the height of the proposed ISWMS is broadly comparable to the height of cruise ships and that the baseline topography will be

[7] Landscape Institute and the Institute of Environmental Management and Assessment. (2013). *Guidelines for Landscape and Visual Impact Assessment*. 3rd edition. London. Routledge.
[8] Landscape Institute (2019). Visual Representation of Development Proposals. Technical Guidance Note 06/19. (17 September 2019). London. Landscape Institute.
9 Mott Macdonald for the Government of the Cayman Islands (2013). Final EIA Terms of Reference for Cruise Berthing Terminal for the Cayman Islands.

comparable given both developments are located in western Grand Cayman. The extent of the study area also reflects the assessors' experience of undertaking LVIAs for similar developments.

5.5.8 The study area accords with best practice, as set out in Sections 5.2 and 6.2 in GLVIA3, as well as the principle of proportionality set out in paragraph 3.16: "*The level of detail provided should be that which is reasonably required to assess the likely significant effects. It should be appropriate and proportional to the scale and type of development and the type and significance of the landscape and visual effects likely to occur.*"

5.5.9 A preliminary Zone of Theoretical Visibility (ZTV) has not been calculated for the proposed ISWMS to inform the scoping study and viewpoint selection. Based upon desktop studies which emphasise the flat topography of western Grand Cayman, a preliminary review of Digital Terrain Model (DTM) data and the proposed heights of the tallest components of the proposed ISWMS as shown in the BWSC drawing no. 3562-D2-111-101: Longitudinal Section, it is highly likely that a ZTV calculated using bare earth digital terrain data would extend across all the land and sea areas within the study area.

5.5.10 Use of Digital Surface Model (DSM) data[10] which takes account of the screening that will be provided by existing vegetation and, in particular, built development will be likely to refine the ZTV. It is understood that DSM data is commercially available at a suitable resolution of 8 m intervals and a 3 m vertical interval. A ZTV produced using such DSM data will require field verification.

5.5.11 Separate ZTVs are to be calculated to differentiate between locations in the study area where just the stack at the ERF component of the proposed ISWMS will potentially be visible and the locations where other components will potentially be visible. The stack has a height of 48.1 m (158 feet) above ground level (AGL) and is the tallest component of the proposed ISWMS. A second ZTV will be calculated for the other components of the ERF at heights of between 37.8 m AGL (124 feet) for the boiler house and 33.4 m AGL (110 feet) for the waste bunker. These are likely to be the tallest and therefore the most visible components within the overall proposed ISWMS. The resultant ZTVs are to be overlain on a single base map to facilitate an understanding of the visibility of the proposed ISWMS.

5.5.12 The data gathering methodology has been restricted to a desk study utilising a variety of websites, including:

- Visitcaymanislands.com – identification of principal tourist destinations in western Grand Cayman;
- En.wikipedia.org – general information and details of National Trust properties;
- Academic.emporia.edu – information on geology and topography;
- Brahmsonline.kew.org/cayman – information on geology and vegetation types;
- Camanabay.com – information upon tourist development and associated landscape planting in western Grand Cayman;
- Familyvacationcritic.com – for information on the height and accessibility of the Camana Bay Observation Tower;
- Review of baseline information in Final EIA Terms of Reference for a Cruise Ship Berthing Terminal; and
- Review of aerial photography:

[10] DSM data is available for purchase from Airbus Defence and Space.

- Imagery dated 21 November 2018 from Google Earth Pro; and
- Updated imagery from Bing Maps and Google Maps.

Current baseline

Landscape and townscape baseline – landscape elements within and close to the ISWMS site

5.5.13 The proposal site covers approximately 13.8 ha (34.1 acres) of land that is partially vacant and undeveloped on the eastern side of the west peninsula of Grand Cayman. The site has been disturbed by previous activities (including landfill) and consequently it contains no naturally occurring features. In common with large parts of Grand Cayman, the proposal site has a ground level height that is only a few metres above sea level as a result of the geology of low-lying limestone and dolostone rocks.

5.5.14 The proposal site is located on the northern edge of George Town in an area that is zoned 'Heavy Industrial' (HI). It is bounded to the east and south by other HI land-uses comprising a mixture of vacant lots and small-scale industrial businesses such as marine fitters; metal workers and processing of quarried stone. Areas of hardstanding are interspersed with areas of rough grass and patches of scrub vegetation. Immediately north of the site lies GTLF. To the west is an area of mangrove and the Esterly Tibbetts Highway, and to the northeast is the Cayman Islands wastewater treatment plant.

Landscape and townscape baseline – wider context

5.5.15 The high density of built development in the western part of Grand Cayman ensures that the study area contains a high proportion of developed land interspersed with a limited number of less developed areas. The latter vary between areas that are intensely managed vegetation utilised for recreational activities, such as parkland, gardens or most extensively, golf courses, and more naturalistic areas associated with low lying coastal habitats including mangroves. A high proportion of the western and eastern parts of the study area are formed by the sea: with the shallow lagoon (North Sound) to the east and the open sea beyond Seven Mile Beach to the west.

5.5.16 The southern part of the study area covers most of George Town: the capital of the Cayman Islands, and includes the Airport. The landward western part of the study area includes large swathes of built development associated with tourist accommodation, facilities, shops and restaurants sited close to the major attraction of Seven Mile Beach and other residential development. This built development is generally up to four storeys in height, but some built developments are up to seven-eight storeys high. In the northern part of the study area the peninsula is indented by several waterways linked to the lagoon. Alongside these waterways land-use is a combination of detached residential properties located in gardens and golf courses.

Landscape and townscape designations

5.5.17 There are no landscape or townscape designations in the Cayman Islands and therefore none are present in the study area.

Landscape, townscape and seascape character

5.5.18 The desktop study did not identify any extant landscape townscape or seascape characterisations for Grand Cayman. It is recommended that the LVIA baseline does nevertheless undertake suitable landscape, townscape and seascape characterisation as part of the development of a more detailed baseline. This characterisation will use desktop and field surveys and will be based upon

approaches set out in guidance provided by Natural England[11, 12, 13] and the Landscape Institute[14] which can be readily applied outside the UK and scaled to ensure that the approach is commensurate and proportional. The desktop survey work undertaken to inform this ToR indicates that the study area might be divided into the following character types:

- Industrial and commercial development townscape areas – located primarily to the immediate east and south-east of the proposal site;
- Low height, medium density residential development townscape areas – located primarily to the west and south of the proposal site;
- Medium height, high density residential, tourism and commercial development townscape areas, focused upon Camana Bay and inland from Seven Mile Beach i.e. north-west to south-west of the proposal site;
- Relic semi-natural, low-lying coastal landscape;
- Intensively managed parkland, recreational and golf course landscapes;
- Lagoon seascape to the east of the proposal site; and
- Seven Mile Beach seascape to the west of the proposal site.

5.5.19 These character areas are illustrated on **Figure 5.4: Seascape, landscape and townscape character areas**.

Visual baseline – existing visibility

5.5.20 The proposal site has highly limited visibility due to the absence of built development and its low elevation. Views into and across the proposal site are restricted to locations close to its boundaries such as from the unimproved access close to the northern boundary of the GTLF and from some of the vacant lots and commercial premises located on Seymour Road to the east. Ground and low-level views of the site are currently experienced from west, from along Esterly Tibbetts Highway, whilst views from the south are screened by the coalescence of built development on the northern edge of George Town.

5.5.21 It is likely that the proposal site is periodically visible in some elevated views that are available to residents and tourists residing in some of the taller residential blocks and hotels located on the landward side of Seven Mile Beach. These are by their nature private views and where available the proposal site will be a minor component in such extensive views. One exception is the 23 m (75 feet) high Observation Tower at Camana Bay to the north-west of the proposal site. This is a popular, free tourist attraction.

Visual Baseline – distribution of visual receptors

5.5.22 The distribution of visual receptors is concentrated in the more densely settled landward parts of the study area. These are the northern and central parts of George Town to the south; and the development associated with Seven Mile Beach and Camana Bay to the west. A moderate number

11 Natural England. (2014). An Approach to Landscape Character Assessment. London. (available for download at www.gov.uk/natural-england).
12 Natural England. (2012). An Approach to Seascape Character Assessment. London. (available for download at www.gov.uk/natural-england).
13 Natural England (2019). An approach to landscape sensitivity assessment – to inform spatial planning and land management. London. (available for download at www.gov.uk/natural-england).
14 The Landscape Institute. (2018). Townscape Character Assessment – Technical Information Note 05/2017 Revised April 2018. London. Landscape Institute.

of residential and recreational visual receptors are located in the northern part of the study area. The following specific groups of visual receptors have been identified in the desktop studies:

- Pupils and staff at the Cayman International School to the north-west;
- Residents in properties located on or close to Parkside Close and Marbel Drive to the north-west and west;
- Residents at Lakeside Villas to the west and south-west;
- Residents in properties on Spruce Lane to the west;
- Residents in properties on Woodpecker Close, Brushy Avenue and Woodlake Drive to the south (including worshippers visiting the United Pentecostal Church);
- Recreational receptors playing golf at and Blue Tip Golf Course;
- Recreational receptors visiting the Camana Bay Observation Tower;
- Some residents in the upper storeys of the taller residential blocks and hotels located along the closest section of Seven Mile Beach;
- Tourists on the taller cruise boats sailing off Seven Mile Beach;
- Tourists on boats in North Sound; and
- Employees at some of the businesses in the closest parts of the HI Zone to the immediate east, north-east and south.

5.5.23 These visual receptors are illustrated on **Figure 5.3: Landscape and visual assessment study area**.

Future baseline

5.5.24 The future baseline changes that have been identified are:

- Likelihood of on-going incremental built development concentrated in George Town and Camana Bay;
- An increase in the number of industrial and commercial development in the adjacent HI Zone; and
- Implementation of the gazetted arterial road along the eastern and northern boundaries of the proposal site (replacing the baseline unimproved access road along the northern boundary). The arterial road will form a link between the Airport (to the south in George Town) and the Esterly Tibbetts Highway.

Consultation

5.5.25 No consultation has been undertaken on landscape and visual issues to date. It is recommended that consultation is undertaken with EAB who will extend the consultation to any other relevant branches of the Cayman Islands Government. Issues that should be consulted upon include: verification of the identification of visual receptor groups; and viewpoint selection.

Scope of the assessment

Potential receptors

5.5.26 The identification of landscape and visual receptors that could be subject to likely significant landscape or visual effects will be guided by ZTVs for the proposed ISWMS which will be generated as part of the assessment process together with field survey observations.

5.5.27 With regard to potential receptors, consideration of the nature of the proposed ISWMS and the context within which it will be located (i.e., within an area that is zoned 'Heavy Industrial') has led to the judgement that receptors who may have an increased propensity to experience significant effects are those receptor groups assessed as being of a high or medium sensitivity to change.

Likely significant effects

5.5.28 The likely significant landscape and visual effects that have been taken forward for assessment are summarised in Table 5.26.

Table 5.26 Likely significant landscape and visual effects

Activity	Effect	Receptor
Construction activities including the temporary presence of cranes	The presence of construction activities which may alter the views and visual amenity of sensitive visual receptors	Receptors will generally include: • residents in communities; • tourists/visitors to outdoor attractions.; • people undertaking recreational activities where the focus of the activity involves an appreciation of the landscape or where it is likely that their surroundings have some influence upon their enjoyment (e.g., angling and golfing); and • people travelling through the landscape on roads or at sea.
Operation of the ISWMS	The presence of the operational ISWMS which may alter the views and visual amenity of sensitive visual receptors	Receptors will generally include: • residents in communities; • tourists/visitors to outdoor attractions.; • people undertaking recreational activities where the focus of the activity involves an appreciation of the landscape or where it is likely that their surroundings have some influence upon their enjoyment (e.g., angling and golfing); and • people travelling through the landscape on roads or at sea.

5.5.29 The assessment will be based on a viewpoint assessment for up to eight publicly accessible viewpoints (including the Camana Bay Observation Tower) which represent the views of the groups of visual receptors listed in the baseline section above. The viewpoint assessment will be supported by annotated photographic viewpoints presented in accordance with the Landscape Institute Advice Note 06/19 *Visual Representation of Development Proposals* and photomontages from four of the viewpoints to illustrate the visual effect of the proposed development. These four viewpoints will by necessity be restricted to publicly accessible locations within the study area (and ZTVs).

5.5.30 The effects scoped out from further assessment are:

- *Potential direct effects on landscape elements within the site boundary:* The proposed ISWMS is located on land which has been disturbed by previous waste management activities.

Consequently, there are no sensitive landscape elements which could be significantly affected by the construction or operation of the proposed development; and

- *Potential direct and indirect effects on landscape/townscape/seascape character within the study area:* The proposed development is located within an area defined as a Heavy Industrial (HI) Zone. The scale and location of the proposed development within this zone which already contains similar land uses reduces the potential for significant direct landscape effects upon the host area's key landscape and townscape characteristics. In terms of indirect landscape effects upon surrounding landscape/townscape/seascape character areas, these will primarily be a consequence of a visual effects pathway i.e., where some components of the proposed ISWMS during the construction and/or operation periods will become visible in outward views available from these character areas. However, the likely level of screening provided by built form within the northern and central parts of George Town to the south; and the development associated with Seven Mile Beach and Camana Bay to the west allied with the context within which the development will be viewed (i.e. within a zone in which industrial development and construction activities are common), will reduce the potential for the proposed ISWMS to have a significant characterising influence upon the character and key characteristics of these neighbouring landscape/townscape/seascape character areas.

Assessment methodology

Overview

5.5.31 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in sections 4.2. However, whilst this approach has informed the methodology that will be used in the LVIA, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of the LVIA for the proposed ISWMS.

5.5.32 The methodology outlined in this section is based on GLVIA3. GLVIA3 states that the assessment of significance is "*an evidence-based process combined with professional judgement*." All assessments and judgements must be transparent and capable of being understood by others.

5.5.33 The LVIA will differentiate between the construction and operation periods. Where suitable design information is available, the LVIA will incorporate proposed embedded and best practice mitigation measures e.g. for the selection of cladding type and colour and the reduction/avoidance of litter generation.

5.5.34 The recommendation to scope out landscape/seascape/townscape effects has the consequence that the assessment methodology that is set out in the following sections concentrates upon visual assessment.

Visual receptor sensitivity

5.5.35 The sensitivity of visual receptors will consider the susceptibility of the visual receptor to the visual change identified and the value that is likely to be attributed by the visual receptor to their baseline view. These are described as high, medium or low.

5.5.36 The visual receptors most susceptible to change are likely to include:

- people at their place of residence;
- people engaged in outdoor recreation (on land and at sea) whose attention or interest is likely to be focussed on the landscape and on particular views;

- visitors to tourist attractions where views of the surroundings are likely to make an important contribution to their experience; and
- people in their community where views contribute to their experience (e.g., users of public open spaces).

5.5.37 People using the transport network are usually considered to be moderately susceptible to change unless travelling on recognised scenic routes.

5.5.38 Visual receptors likely to be less susceptible to change include:

- people engaged in outdoor recreation that does not depend upon appreciation of views; and
- people at their place of work where views are not an important contributor to the quality of working life.

5.5.39 The factors influencing judgements regarding the value attached to views by receptors include:

- any recognition of the value attached to a view in relation to heritage assets or through planning designations; and
- any indications of value provided by guidebooks and tourist literature, the inclusion of specific observation points, provision of car parking and/or provision of interpretation materials.

5.5.40 Examples of the judgements made regarding the sensitivity of visual receptors used in this assessment are described in Table 5.27.

Table 5.27 Visual receptor sensitivity

Visual receptor sensitivity	Key determining criteria
High	Receptors in this category will generally include: • Residents within settlements or at related community outdoor spaces. • Tourists/visitors to outdoor attractions. • Walkers, cyclists and horse riders travelling on recreational routes through the landscape. • People generally, undertaking recreational activity on land or at sea where the focus of the activity involves an appreciation of the landscape or seascape
Medium	Receptors in this category will generally include people travelling through the landscape on roads or at sea and people undertaking recreational and sporting activities where it is likely that their surroundings have some influence upon their enjoyment (e.g., angling and golfing).
Low	Receptors in this category will generally include people for whom their surroundings are unlikely to be a primary concern or affect how they undertake their current activity. Receptors are likely to include people at their place of work, people travelling on main roads through built up areas or taking part in activities not involving an appreciation of the landscape (e.g., playing team sports).

Magnitude of visual change

5.5.41 The nature of visual effects or their magnitude of change resulting from the construction and operation of the proposed ISWMS will be assessed as high, medium, low or very low. The magnitude of visual change will be described by reference to the scale of visual change; the contrast with the baseline view; separation distance; the duration over which a view is available; the angle of view; levels of screening; and whether new visual elements are seen on a skyline or against a background.

5.5.42 Further guidance on the evaluation of the magnitude of visual change is provided in Table 5.28.

Table 5.28 Magnitude of visual change

Magnitude of visual change	Key determining criteria
High	A large and prominent change to the view, appearing in the fore to middle ground and involving the loss/addition of a number of features, which is likely to have a strong degree of contrast and benefits from little or no screening. The view is likely to be experienced at static or low speed and is more likely to be continuously/sequentially visible from a route.
Medium	A moderate and prominent/noticeable change to the view, appearing in the middle ground and involving the loss/addition of features and a degree of contrast with the existing view. There may be some partial screening. The view is likely to be experienced at static or low to medium speed and is more likely to be intermittently or partially visible from a route.
Low	A noticeable or small change, affecting a limited part of the view that may be obliquely viewed or partly screened and/or appearing in the background of the view. This category may include rapidly changing views experienced from fast-moving road vehicles or boats.
Very Low	A small or negligible change to the view that may be obliquely viewed and mostly screened and/or appearing in the distant background or viewed at high speed over short periods and capable of being missed by the casual observer.

Evaluating and explaining the significance of visual effects

5.5.43 The level of visual effects will be determined with reference to visual sensitivity and the magnitude of visual change likely to be experienced. For each receptor the evaluation process will be informed by use of a matrix as follows:

5.5.44 Likely significant visual effects arising from the construction and operation of the proposed ISWMS will be effects that are assessed as being likely or certain to result in effects that would be 'major'. Effects assessed as being 'moderate' would have the potential to be significant and whether they are assessed as significant or not significant will be justified in the detailed assessment for the relevant landscape or visual receptor. In line with the emphasis placed in GLVIA3 upon application of professional judgement, the adoption of an overly mechanistic approach through reliance upon a matrix will be avoided. This will be achieved by the provision of clear and accessible narrative explanations of the rationale underlying the assessment made for each receptor over and above the outline assessment provided by use of the matrix. Wherever possible cross references will be made to figures to support and explain the rationale.

Table 5.29 Significance evaluation matrix

		Magnitude of change			
		High	**Medium**	**Low**	**Very low**
Sensitivity	**High**	Major (Significant)	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)
	Medium	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)
	Low	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)

5.6 Air quality and greenhouse gases emissions

Introduction

5.6.1 Emissions of air pollutants are known to have an adverse impact on human health and ecological features. The activities proposed during the construction and operational phases of the ISWMS and associated activities have the potential to result in an increase of air emissions and, consequently could potentially affect the air quality in the vicinity of the proposed development, and therefore, a potential for significant effect on health and ecological features and so must be assessed as part of an EIA.

Applicable standards and technical guidance

5.6.2 Standards and guidance have been used to define the scope of the air quality assessment[15]. The Cayman Islands Government do not have any relevant published Standards and/or guidance specific to air quality and odour. A general reference to emissions sources that can have an impact on human health or cause a nuisance is made in the Cayman Public Health Law (2002 revision). Due to the lack of more specific guidance in the national legislation, this scoping report has relied on reference to relevant British and International Standards. The main Standards and Guidance are summarised in Table 5.30.

5.6.3 The Cayman Islands has not adopted numerical standards for ambient air quality. The most common standards applied in the Caribbean are from the United Kingdom and the United States. Those that apply to the UK (for England) are presented in Table 5.31.

5.6.4 In terms of emissions, the EU Industrial Emissions Directive (IED – 2010/75/EU), which stipulates acceptable emission values to atmosphere for waste incineration processes is used as term of reference.

[15] National environmental laws and regulations has been screened based on the documentation available on the Department of Environmental Health (http://www.deh.gov.ky/portal/page/portal/dehhome/help/legislation)

Table 5.30 Summary of standards and technical guidance

Standards and Technical Guidance	Summary
Cayman Public Health Law (2002 revision)	The Public Health Law (2002 revision) sets out powers in respect of nuisance from pollution. This Law provides provisions that apply to any "furnace, chimney, fireplace, bonfire or other place from which is emitted smoke or other unconsumed combustible matter…[and]…any vehicle or vessel, in such a condition as to be prejudicial to health or a nuisance". A nuisance is defined "as any act, omission, or thing occasioning or likely to occasion injury, annoyance, offence, harm, danger or damage to the sense of sight, smell or hearing, or which is or is likely to be dangerous or injurious to person or property". Under this Law, the Chief Environmental Health Officer can serve Notices requiring abatement of any source of pollution deemed to be a nuisance, with powers extending to the potential closing of activities that do not comply with such Notices.
EU Directive 2008/50/EC	The 2008 directive replaced nearly all the previous EU air quality legislation and was made law in England through the Air Quality Standards Regulations 2010. It sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health.
EU Industrial Emissions Directive (IED – 2010/75/EU)	The Industrial Emissions Directive is the main EU instrument regulating pollutant emissions from industrial installations, including waste incinerators and Energy Recovery Facility (ERF). It provides acceptable emission values and aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT).
Institute of Air Quality Management Guidance on land-use planning and development control: Planning for air quality 2017 v1.2	Presents a methodology for determining air quality impacts upon sensitive receptors from changes in road traffic emissions due to new developments. It provides criteria to define the significance of impacts
Institute of Air Quality Management Guidance for the Assessment of dust from demolition and construction 2014	Presents a methodology for determining impacts related to the generation of dust during construction activities. It provides criteria to define the sensitivity of receptors and the magnitude of impacts and combines them to define the risk of dust impacts
Air Quality Guidelines – Second Edition; World Health Organization. Copenhagen, Denmark, 2000	This document presents reasoning for, and establishes guidelines for, ambient air concentrations of hydrogen sulphide to avoid adverse health and odour impacts.
Institute of Air Quality Management Guidance on the assessment of odour for planning	This document provides a recommended scope for prediction and assessment of odour impacts by defining the sensitivity of receptors, the magnitude of impact and the risk of odour impacts
Cayman Islands' Climate Change Policy (2011)	The Climate Change Policy contains measures required to curb greenhouse gas (GHG) emissions from activities that contribute to the problem of continued climate change. This Climate Change Policy recognizes that the combined actions of responding to the inevitable impacts of a changing climate (adaptation) and reducing further contributions to climate change (mitigation) are cost-effective and urgently needed in order to ensure low-carbon climate-resilient development in the Cayman Islands.
International Finance Corporation (IFC) Guidance Note 3 (2006)	The Guidance Note states that during the development or operation of projects that are expected to produce significant quantities of GHGs (i.e. more than 100,000 tons of CO2eq per year), the operator should quantify direct emissions from the facilities owned or controlled within the physical project boundary and indirect emissions associated with the off-site production of power used by the project and evaluate technically and financially feasible and cost-effective options to reduce or offset project-related GHG emissions during the design and operation of the project.
Public Health (Infectious Waste) Regulations (2002 Revision)	Sets out the equipment and air pollution control requirements relating to the management of infectious waste including the operation of a medical waste incinerator in the Cayman Islands.

Standards and Technical Guidance	Summary
Florida Administrative Code (FAC) Chapter 62-709	Sets out the design, operating, testing, recording and reporting requirements for organics processing and recycling, including yard waste processing operations. This includes the requirements for odor control in accordance with subsection 62-296.320(2), F.A.C.

Table 5.31 UK Ambient Air Quality Standards

Pollutant	Averaging period	Air Quality Objective	Allowance
Nitrogen Dioxide (NO_2)	1-hour	200 µg.m^{-3}	18 per calendar year
	Annual	40 µg.m^{-3}	--
Sulphur Dioxide (SO_2)	15 minutes	266 µg.m^{-3}	35 per calendar year
	1-hour	350 µg.m^{-3}	24 per calendar year
	24-hour	125 µg.m^{-3}	3 per calendar year
Particulates (PM_{10})	24-hour	50 µg.m^{-3}	35 per calendar year
	Annual	40 µg.m^{-3}	--
Particulates ($PM_{2.5}$)	Annual	25 µg.m^{-3}	--

Baseline conditions

Data gathering methodology

The assessment scope has been based upon the results of a desk study. The desk study has involved reviewing web-based satellite mapping and imagery of the site and its surroundings within a 5 km study area – see **Figure 5.5: Study area for air quality**. Additional baseline data will need to be collected when carrying out the EIA. The details on monitoring to establish the site-specific air quality baseline data will be agreed with the EAB prior to collecting the data. In respect of the duration of background air quality monitoring to support the EIA for the proposed ISWMS, the accepted requirement is usually 3 months. This data is then "annualised" using, where possible, other publicly available data sets to allow for comparison against annual standards. IFC (International Finance Corporation) guidelines do not provide specific guidance on the duration of monitoring, and the experience of Wood's air quality specialists who have worked on several international EIAs is that a maximum survey period of 3 months would allow a robust assessment of air quality effects to be carried out – particularly in tropical climates, where seasonal variations are minimum. Indeed, the Air Quality specialist has noted that there is a precedent for a 3 month monitoring period in the Air Quality Report for the EIA of The Cayman Islands Berthing Facility, which states "Due to the lack of existing ambient air quality monitoring data available within the study area, a three month survey for nitrogen dioxide (NO2) and sulphur dioxide (SO2) was carried out using passive sampling devices (PSDs)". With this in mind, an Air Quality Method Statement will be prepared to supplement the ToR which will outline key parameters on the baseline monitoring program and reviewed in consultation with the EAB.

Current baseline

5.6.5 There is limited information available to quantify the baseline air quality conditions at locations surrounding the site. Air quality monitoring is not routinely undertaken on the Cayman Islands, and no data is publicly available on existing levels of air pollutants.

5.6.6 Due to the lack of existing ambient air quality monitoring data available within the study area, a literature review has been conducted. A draft ES for the proposed Cruise Berthing Terminal for the Cayman Islands published in June 2015 by Engineering and Engineering Consultancy Services includes in Appendix G the results of a three-month air quality monitoring survey undertaken at Whitehall Gardens (approximately 1,150m north west of the proposed ISWMS) for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) using passive sampling devices (PSDs).

5.6.7 Recorded values during the three-months survey showed that NO_2 and SO_2 concentrations were well below the applicable international standards. SO_2 concentrations were often found to be lower than the detection limit of the equipment, suggesting that SO_2 could be scoped out from the assessment.

5.6.8 There are no available data covering particulate matter but, considering the study area characteristics and meteorological conditions, it is considered likely that PM_{10} and $PM_{2.5}$ baseline concentrations are comfortably within the related standards.

5.6.9 The island has a limited number of stationary sources of pollutants, and it is expected that transportation is likely to be the biggest contributor to local NO_2 concentrations.

5.6.10 The Department of Environment collects data on electricity generation and fuel consumption, to calculate equivalent greenhouse gas (GHG) emissions produced, based on assumed emissions factors for the electricity generated and fuel used in road transport. Data is also collected and submitted on solvent use, waste management, mobile machinery, aircraft and air transport, shipping and agriculture and forestry.

5.6.11 Data show that by far the most significant GHG produced by the Cayman Islands is Carbon Dioxide (CO_2), with amounts of other greenhouse gases produced, e.g., Methane (CH_4) and Nitrous Oxide N_2O), being small in comparison[16].

5.6.12 As detailed in Section 2.1, the ISWMS project site is located immediately south of the existing GTLF and immediately west of Water Authority Cayman's wastewater treatment works. The impact of these facilities' operations on local air quality needs to be considered as part of the baseline data gathering exercise, so as to be able to distinguish between the ISWMS project and these other operations going forward.

5.6.13 The Proponent is currently recording H_2S concentrations at 5 locations (refer to **Figure 5.6** for locations) proximate to the ISWMS site together with wind direction information at 3 of the monitoring locations (all at nominal 10-minute intervals), which data will be provided as part of the EIA for the ISWMS project.

Future baseline

5.6.14 It is envisaged that contributions from road traffic sources will be expected to increase slightly in the future due to natural traffic growth and the impact of any new or amended development in the area.

5.6.15 The air quality baseline will change as a result of the proposed capping and restoration of the GTLF. In the short term, it is envisaged that emissions will reduce in increments in line with the

[16] Department of Environment website accessed on April 2019 (http://doe.ky/sustainable-development/carbon-footprint/)

phased programme of capping and restoration (2021 to 2024), then gradually again thereafter as the landfill degradation activity declines over time.

5.6.16 The future baseline should also reflect any known changes to the operation of Water Authority Cayman's wastewater treatment works, positive or negative.

Scope of the assessment

5.6.17 The scope of the assessment includes the construction and operational phases of the main ISWMS and the development of the RWL. The scope does not cover satellite developments, namely Little Cayman and Cayman Brac.

5.6.18 The particular details of the proposed activities relating to site operations and site construction are detailed in Section 2 of this ToR.

5.6.19 Satellite imagery for the islands of Grand Cayman has been reviewed to identify the nearest potential air quality sensitive receptors to each of the proposed developments and these have been listed below.

Potential receptors

5.6.20 This section identifies sensitive receptors that have the potential to be significantly affected by the main ISWMS development.

5.6.21 Local receptors should be identified, including residential and other properties close to the proposed development, as well as alongside roads significantly affected by the development, even if well away from the development site. These receptors will represent locations where people are likely to be exposed for the appropriate averaging time (dependent on the air quality objective being assessed against).

5.6.22 The closest receptors to be considered in the assessment will include:

- Locations within the Lakeside Development (residential dwelling immediately west of the ISWMS development, on the opposite side of the Esterly Tibbetts Highway).
- Locations within the OLEA residential development approximately 800 m north of the ISWMS development
- Properties on Parkside Close (residential dwelling approximately 800 m to the north west of the ISWMS development).
- Residential receptors located along Seymour Drive, approximately 300 m to the south east of the proposed ISWMS site.
- The Cayman International School (educational establishment approximately 800 m to the north west of the ISWMS development).
- The Seven Mile Beach corridor, which includes residential tourism properties.
- The employees of the industrial park in which it is proposed.
- The surrounding land use zoning could result in residential, commercial, tourism and other uses which are receptors that will potentially be affected.

5.6.23 The air quality assessment will also consider receptors up to 10 km from the ISWMS development as emissions from elevated stacks, such as the ERF, could reach receptors located several kilometres downwind of the point of release.

5.6.24 In addition to the receptors listed above, following consultation with the Cayman Islands Government (CIG) and other relevant stakeholders, additional sensitive receptors located in any proposed future development (either already granted permission or within the local planning system at the time of the EIA) will be included in the ES.

Likely significant effects

5.6.25 Emissions from the proposed ISWMS facilities including the ERF, RWL and Composting Area will need to be assessed against baseline conditions to assess if they can cause a significant change in air quality conditions at locations where the sensitive receptors are found.

5.6.26 The ERF will be a state-of-the-art controlled combustion facility that will render combustible waste to an inert ash and reduce the volume of the residual waste by 90 percent. Air pollution control (APC) and continuous emission monitoring (CEM) systems will ensure that ERF emissions meet the most stringent standards and not pose an adverse effect to the environment.

5.6.27 Bottom and fly ash are products of the ERF and, if not properly controlled, could contribute to the particulate impact upon the air shed. The Project design includes measures that will minimize the risk of impact from ash: bottom ash will be treated in a dedicated facility and fly ash will be stabilized with cement before disposal in the RLW. Under normal operating conditions is, therefore, unlikely that a significant effect will occur.

5.6.28 The potential for impacts arising from release of bioaerosols from the green waste composting operations will be assessed qualitatively based on the potential for significant bioaerosol releases and the proximity to nearby receptors. According to the UK Environment Agency, bioaerosol concentrations generally decline to background levels within 250 m of composting activities[17].

5.6.29 An increase in road traffic may occur, increasing traffic emissions, but it is likely that the number of additional vehicles associated with the ISWMS development will be limited.

5.6.30 The proposed development has the potential to generate emissions of greenhouse gases (GHG) during both construction and operation. The main GHG is considered to be CO_2, although small amount of CH_4could also be generated from the composting area.

5.6.31 The likely significant effects on air quality that have been taken forward for assessment are summarised in Table 5.32.

Table 5.32 Likely significant air quality effects

Activity	Effect	Receptor
Site construction	Emission of dust causing loss of amenity at sensitive receptors that occur near to work sites and haul road	Residential properties, schools, commercial sites, ecological sites
Site construction	Emissions from construction vehicles and plant through fuel combustion that could increase concentrations of pollutants that could affect human health (NO_2 and particulate matter)	Residential properties, schools, commercial sites, ecological sites
Site operations	Emission of air pollutants causing effects on human health and ecological receptors	Residential properties, schools, commercial sites, ecological sites

[17] Environment Agency, Position Statement - Composting and potential health effects from bioaerosols: our interim guidance for permit applicants, 2010 (http://www.organics-recycling.org.uk/uploads/article1822/Composting_%26_bioaerosols_position_statement_-_fina_2010l%5B1%5D.pdf)

Activity	Effect	Receptor
Site operations	Odour emissions causing effects on quality of life	Residential properties, schools, commercial sites
Site operations	Increased emissions from project vehicles on public highways that could increase concentrations of pollutants that could affect human health (mainly NO_2) at receptors near to road	Residential properties, schools, commercial sites, ecological sites
Site operations	Bioaerosol causing effects on human health	Residential properties, schools, commercial sites
Site operations	GHG emissions causing effects on climate	Climate
Site operations	Dust arising from the ash storage area causing effects on human health and quality of life	Residential properties, schools, commercial sites
Site operations	Dust arising from the production of the aggregate causing effects on human health and quality of life	Residential properties, schools, commercial sites
Site operations	Emissions arising from the RWL development activities.	Residential properties, schools, commercial sites, ecological sites

5.6.32 It should be noted that the proposed development includes closure and capping of the existing George Town dump. This closure plan will be not be addressed through this EIA but will be subject to a risk-based assessment. The closure is expected to result in the following benefits:

- Elimination of refuse odour from the dump;
- Elimination of landfill fires that have contributed to significant air emissions; and
- Reduction of GHG and volatile organics emissions through the collection of landfill gas.

Air dispersion modelling

5.6.33 The release and dispersion of pollutants from the main stack will be modelled using either the ADMS-5 model, the USEPA AERMOD model or the CALPUFF dispersion models. Emission rates will be determined using the IED emission limits (as a worst-case) combined with other plant-specific model input parameters. The ADMS-5 model will be run using 5-years of meteorological data from Owen Roberts International Airport, following international best practices.

5.6.34 ADMS-5 is the most used air dispersion model in the UK and is accepted by the UK Environment Agency. It is used to model the air quality impact of existing and proposed industrial installations. Its many features include allowance for the impacts of buildings, complex terrain, coastlines and variations in surface roughness; dry and wet deposition; NOx chemistry schemes; short term releases (puffs); calculation of fluctuations of concentration on short timescales.

5.6.35 The model will consider changing conditions of the ERF combustion efficiency with varying feed stocks and operating conditions and varying meteorological conditions such as the impact of the north-easterly prevailing winds towards the nearest development such as Lakeside and the Cayman International School and during an inversion, where dispersion is minimized.

5.6.36 ADMS-5 will be also applied to define the optimal stack height of the ERF, in order to minimize the risk of impact at identified sensitive receptors. This will be achieved by modelling emissions of NOx, which is the pollutant of main concern in this case.

5.6.37 The dispersion of emitted pollutants will be modelled at a series of sensitive receptor locations, representing both human exposure (e.g., residential properties and schools) and sensitive ecological habitats. A grid of receptors will also be used to allow contour plots of concentrations to be presented.

Assessment methodology

5.6.38 The relevant technical guidance in Table 5.32 above, will be used to predict and assess the significant effects construction and operational air and odour emissions from the facilities making up the ISWMS.

5.6.39 The significance of air quality impacts will be defined following the Institute of Air Quality Management Guidance on land-use planning and development control: Planning for air quality 2017 v1.2.

5.6.40 The significance of odour impacts will be defined following Institute of Air Quality Management Guidance on the assessment of odour for planning.

5.6.41 The assessment of odours from the proposed ISWMS facilities should follow a two-stage assessment process including an odour risk assessment and odour dispersion modelling. The second stage will be performed only if the risk assessment identifies a risk for odour impacts to take place. The assessment will take into account the beneficial effect of treating waste in the ISWMS facility rather than operating the existing dump. Cumulative effects from the surrounding odour emitting uses should be considered in the assessment. Odour monitoring and control systems will need to be specified and demonstrated to ensure impacts are acceptable within the local area.

5.6.42 There is no guidance that sets out how to determine the significance of bioaerosol impacts. A qualitative approach should be taken to the bioaerosol assessment, based upon the likelihood of the generation of bioaerosols, the quantity likely to be generated, the potential for them to be released to the air outside of the facility, and the potential for such releases to lead to significant impacts at the nearest sensitive receptors.

5.6.43 The IFC states in its Guidance Note 3 (2006)[18] that the significance of a project's contribution to GHG emissions varies between industry sectors and provides an indicative threshold of 100,000 tons CO2 equivalent per year for the aggregate emissions of direct sources and indirect sources associated with purchased electricity for own consumption. GHG emissions should be quantified annually in accordance with internationally recognised methodologies and reporting procedures. All reasonable attempts should be made to maximise energy efficiency and design facilities to minimise energy use.

5.7 Noise and Vibration

Introduction

5.7.1 An Environmental Impact Assessment (EIA) requires that the direct and indirect significant effects of a proposed development are to be identified, described and assessed. Unwanted noise & vibration are known to have an adverse impact on health and quality of life. The activities proposed during the construction and operational phases of the ISWMS have the potential to result in a measurable increase to levels of noise and vibration in the vicinity of the proposed development, and therefore,

[18] International Finance Corporation, Guidance Note 3, 2006 (https://www.ifc.org/wps/wcm/connect/02510c8048855308ad5cff6a6515bb18/GuidanceNote3.pdf?MOD=AJPERES)

a potential for significant effect on health and quality of life and so should be assessed as part of an EIA.

Applicable standards and technical guidance

5.7.2 Standards and guidance have been used to define the scope of the noise and vibration assessment. Since the Cayman Islands Government do not have any relevant published Standards and/or guidance on noise and vibration, this scoping report has relied on reference to relevant British and International Standards. The main Standards and Guidance are summarised in Table 5.33 below.

Table 5.33 Summary of standards and technical guidance

Technical Guidance	Summary
Construction & Operational road traffic noise – UK's Department of Transport Calculation of Road Traffic Noise, 1988 (CRTN)	Provides a calculation methodology for road traffic noise, which will be used if any increase in construction and operational Heavy Goods Vehicle (HGV) numbers is likely to result in an increase of more than 1 dB(A) in road traffic noise.
Construction & Operational road traffic noise – UK's Transport and Road Research Laboratory – Converting the UK traffic noise index $L_{A10,18hr}$ to EU noise indices for noise mapping, 2002 (TRL PR/SE/451/02)	A method for converting the road traffic noise indexes described in CRTN to produce outputs in the form of European Union indices, in particular *TRL Method 2* which outlines the conversion of the $L_{A10, 18hr}$ noise indices to the $L_{Aeq, 16hr}$ and $L_{Aeq,8hr}$ indexes.
Construction & Operational road traffic noise – UK's Highways Agency Design Manual for Roads and Bridges, 2011 (DMRB)	Presents a methodology for determining impacts upon noise sensitive receptors from changes in road traffic noise due to road projects.
Operational sound - Acoustics – Attenuation of sound during propagation outdoors: Part 2 General Method of Calculation, 1996 (ISO 9613-2)	Defines a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at distances from a source.
Construction noise & vibration – BS5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites; Part 1: Noise	This document provides a recommended scope for prediction and assessment of construction noise (the ABC Method) as presented in Annex E, BS 5228-1:2009+A1:2014, and which also gives example threshold values for potential significant effects at noise sensitive receptors based upon the results of ambient sound monitoring. Similar examples for long term earthworks are also provided.
Construction noise & vibration – BS5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites; Part 2: Vibration	This document presents guidance on the assessment of ground-borne vibration associated with activities such as demolition and construction
Operational vibration- BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting	Presents an assessment approach to determining adverse impacts from, e.g. road and rail traffic vibration within residential buildings.
Operational noise - BS4142:2014 Methods for rating and assessing industrial and commercial sound	Presents guidance on the monitoring and assessment of industrial and commercial sound sources, and is particularly designed to assess sound from factories, industrial premises, fixed installations or sources of an industrial nature in commercial premises affecting sensitive receptors.
UK's Institute of Environmental Management and Assessment Guidelines for Environmental Noise Impact Assessment, 2014 (IEMA)	Presents guidelines on how the assessment of noise effects should be presented within the Environmental Impact Assessment (EIA) process. The IEMA guidelines cover aspects such as; scoping, baseline, prediction and example definitions of significance criteria.
Potential noise impacts at educational facilities – Acoustic design of schools: performance standards: Building bulletin 93, 2015 (BB93)	BB93 sets out minimum performance standards for the acoustics of school buildings and describes the normal means of demonstrating compliance with the Building Regulations.

Baseline conditions

Data gathering methodology

5.7.3 The assessment scope has been based upon the results of a desk study. The desk study has involved reviewing web-based satellite mapping and imagery of the site and its surroundings.

Current baseline

5.7.4 There is limited information available to quantify the baseline acoustic environment at locations surrounding the site. A draft ES for the proposed Cruise Berthing Terminal for the Cayman Islands published in June 2015 by Engineering and Engineering Consultancy Services includes in Appendix H the results of noise monitoring undertaken at Whitehall Gardens (approximately 1,150 m north west of the proposed ISWMS). Sound levels measured at this location over a 24-hour period in June 2014 indicate an average $L_{Aeq, 1h}$ of 56-57dB and an average $L_{A90, 1h}$ (background level) of 50dB.

5.7.5 Review of satellite imagery indicates that the main source of noise in the vicinity of the site will be the existing landfill activities to the west and the Caribbean Utilities Co. Site to the south. In addition, properties to the west of the main ISWMS facility will be influenced by road traffic using the intervening Esterly Tibbets Highway.

Future baseline

5.7.6 It is envisaged that sound contributions from road traffic sources will be expected to increase slightly in the future due to natural traffic growth and the impact of any new or amended development in the area.

Scope of the assessment

5.7.7 The scope of the assessment includes the demolition, construction and operational phases of the main ISWMS.

5.7.8 The development also includes the construction of facilities on Grand Cayman's Sister Islands namely, Little Cayman and Cayman Brac. This assessment includes the construction phases of these facilities – the operational phases of the Sister Island facilities will be managed by the Department of Environmental Health and therefore the assessment of this not covered in this report.

5.7.9 Satellite imagery for the islands of Grand Cayman, Little Cayman and Cayman Brac has been reviewed to identify the nearest potential Noise Sensitive Receptors (NSRs) to each of the proposed developments and these have been listed below.

Potential receptors – ISWMS development

5.7.10 This section identifies Noise Sensitive Receptors (NSRs) that have the potential to be significantly affected by the main ISWMS development.

5.7.11 The choice of potential NSRs to be considered in the assessment will include:

- Locations within the Lakeside Development (residential dwelling immediately west of the ISWMS development, on the opposite side of the Esterly Tibbetts Highway);
- Properties on Parkside Close (residential dwelling approximately 800 m to the north west of the ISWMS development);
- Properties on Seymour Road (residential dwelling approximately 300 m to the south east of the proposed ISWMS development);

- The Cayman International School (educational establishment approximately 800 m to the north east of the ISWMS development); and
- Locations within the OLEA residential development approximately 800 m north of the ISWMS development.

5.7.12 These locations are illustrated on **Figure 5.6: Proposed noise sensitive receptors.**

Likely significant effects

5.7.13 The likely significant noise & vibration effects that have been taken forward for assessment are summarised in Table 5.34:

Table 5.34 Likely significant noise & vibration effects

Activity	Effect	Receptor
Site construction	Emission of noise & vibration causing effects on health and quality of life at sensitive receptors	Residential properties, schools, commercial sites
Site operations	Emission of noise causing effects on health and quality of life at sensitive receptors	Residential properties, schools, commercial sites

5.7.14 The effects scoped out from further assessment are:

Vibration effects due to site operations can be scoped out as there are no proposed site operations expected to cause vibration effects at the nearest receptors. Based on the proposed project activities during operations, potential vibration impacts are only anticipated during construction.

5.7.15 Baseline sound surveys are to be undertaken at the agreed NSRs using integrating averaging sound level meters (SLMs) or equivalent systems conforming to Class 1 or better as defined by BS EN 61672: Part1: 2013 (Electroacoustics, Sound Level Meters, Specifications). The SLMs should be field calibrated before and at the end of each survey by applying an acoustic calibrator or pistonphone conforming to the latest versions of BS EN IEC 60942:2018 (Electroacoustics - Sound Calibrators) to the microphone to check the sensitivity of the measuring equipment. Any drift in calibration levels should be noted. The equipment used for the noise monitoring must also have undergone laboratory calibration within a period not exceeding two years (one year for calibrators) prior to use.

5.7.16 A suitable weather station (or an alternative, reliable source of meteorological data, e.g., a local airport) should be also deployed at one of the long-term sound monitoring locations (around each facility) to monitor weather patterns over the survey period, for example, as per the methodology within BS 4142:2014. Such a weather station will enable the noise and vibration consultant to exclude any periods measured under unsuitable weather conditions from the final dataset. A night-time site visit to the development area to enable observations on the night-time sound environment to be undertaken, particularly if the individual facility operates pumps/fans 24/7.

5.7.17 The instrumentation used for the sound surveys should be set up to simultaneously log, as a minimum, $L_{Aeq,T}$, $L_{A90,T}$, $L_{A10,T}$, L_{AFmin} and L_{AFmax} sound levels over continuous sampling periods of 15 minutes, over a total period of, for example, 5-7 days including a weekend period (depending on the working hours of the individual facility). All measurements should be undertaken, where possible, in accordance with recognised relevant methodologies, for example, like those presented in BS 4142:2014. The baseline sound survey results should then be defined against, BS4142:2014 in

terms of background sound levels (defined as the $L_{A90,T}$ parameter) which will be in compliance with the requirements of the EAB scoping opinion. This opinion states in Section 5 that "noise levels from the proposed activities should be calculated and assessed against baseline conditions and relevant standards, taking into account cumulative effects of adjacent activities and land uses".

5.7.18 In addition, once haulage routes to and from the ports are determined for both the construction and operational phases, road traffic noise monitoring will be undertaken at agreed locations along the main route(s) to and from the facilities in accordance with the shortened method within the UK's CRTN "Calculation of Road Traffic Noise".

5.7.19 Vibration measurements will not be required as operational vibration has been scoped out of the assessment.

Sound propagation modelling

5.7.20 Stapelfelt's LimA, Cadna A, or similar computational noise modelling suites are recommended to be used to create a 3D noise model of the site, surrounding area, and the proposed plant. In order to construct the noise model, detailed information about the proposed plant and equipment to be used on site, including the type, any modifications/enhancements from the standard type and details of the construction of any housing/enclosures for the plant should be determined.

5.7.21 3D base mapping (if available) should be used within the noise models. It is envisaged that barrier attenuation due to natural landscape will be minimal due to the relatively flat nature of the Cayman Islands topography. Particular care should be taken with modelling inputs when predicting noise propagation over bodies of water.

5.7.22 It is expected that several iterations of the model will need to be run to account for the different construction and operational phases of the sites and to allow for any mitigation measures to be investigated and assessed.

5.7.23 Sound propagation for industrial noise sources should be calculated using the ISO 9613-2: 1996 methodology. It may also be necessary produce a noise model for the calculation of construction noise in which case the BS 5228 calculation methodology should be employed.

5.7.24 The first round of noise modelling should include any mitigation measures incorporated into the initial design of the facilities. Any additional mitigation that may be required as a consequence of this initial model should be investigated and assessed using subsequent modelling runs if necessary.

Assessment methodology

5.7.25 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in section 4.2. However, whilst this approach has informed the approach that has been used in this Noise & Vibration assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this noise & vibration assessment.

5.7.26 The relevant technical guidance in Table 5.32 above will be used to predict and assess the significant effects construction and operational noise from the facilities making up the ISWMS.

5.7.27 As stated in section 4.2, an ES chapter will need to be produced detailing the results of the above and including identification of Lowest Observable Adverse Effect Level (LOAEL) and Significant Observable Adverse Effect Level SOAEL levels. LOAEL and SOAEL are two established concepts from toxicology that are currently being applied to noise impacts and represents current best practice. An outline of any mitigation measures deemed necessary as a result of the assessment should also be provided.

Assessment of receptor sensitivity

5.7.28 Receptor sensitivity should be identified on a case-by-case basis with reference being made to Table 5.35. However, it is expected that most of the noise and vibration sensitive receptors identified will be assessed to have medium sensitivity as noise & vibration assessments primarily apply to residential receptors.

Table 5.35 Construction noise assessment criteria

EIA Sensitivity of receptor	Criteria
High	Such receptors include pupils in residential educational facilities and patients in healthcare facilities and are defined as a "vulnerable subgroup" with very high or continuous rates of occupancy.
Medium	Residential receptors usually fall within this category. Receptors are categorised as medium sensitivity where noise may cause disturbance and a level of protection is required but a level of tolerance is expected.
Low	Usually applies to areas used primarily for leisure activities including sports facilities and sites of historic or cultural importance. Receptors are categorised as low sensitivity where noise may cause short duration effects in a recreational setting although particular high noise levels may cause a moderate effect.

5.7.29 A discussion on vulnerable subgroups is given in World Health Organization's Guidelines for community noise (1999)[19] which could be referred to when assessing receptor sensitivity.

Assessment of construction noise effects

5.7.30 Sound power level data for construction noise should be obtained from either manufacturers' data sheets (where available) or from the tables in the annexes of BS5228-1:2009+A1:2014. Sound propagation to NSRs should be calculated using the methods described in BS5228-1:2009+A1:2014. Octave band sound power levels should be used where possible.

5.7.31 Construction noise will be predicted using the methodology indicated in BS5228-1:2009+A1:2014 for all the main phases of the construction works, including any cumulative noise associated with simultaneous operation of activities within different phases.

5.7.32 The results from these predictions will be assessed against the ABC methodology within Annex E of this Standard and will be based on the prevailing ambient noise levels measured as part of the study.

[19] Berglund, Birgitta, Lindvall, Thomas, Schwela, Dietrich H & World Health Organization. Occupational and Environmental Health Team. (1999). Guidelines for community noise. Geneva: World Health Organization. http://www.who.int/iris/handle/10665/66217

Table 5.36 Construction noise assessment criteria

Assessment category and threshold value period	Threshold value, in decibels (dB), $L_{Aeq, T}$		
	Category A[A)]	Category B[B)]	Category C[C)]
Night-time (23.00 – 07.00)	45	50	55
Evenings and weekends	55	60	65
Daytime (07.00 – 19.00) and Saturdays (07.00 – 13.00)	65	70	75

[A)] Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
[B)] Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
[C)] Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the are higher than as category A values.
[D)] 19.00 – 23.00 weekdays, 13.00 – 23.00 Saturdays and 07.00 – 23.00 Sundays.

5.7.33 A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. If the ambient noise level exceeds Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3dB due to site noise. Table 5.36 applies to residential receptors only.

5.7.34 Table 4.1 in section 4 suggests that each topic area scales the magnitude of change from *Very low* to *Very high* as best as possible and relevant to the needs of each topic area.

5.7.35 The assessment methodology described in Table 5.36, however, does not allow this on its own because it only states whether or not a significant effect has occurred. In order to rate the magnitude of this change, and therefore its significance in the form of a matrix, a further assessment of the significant effect needs to occur.

5.7.36 It is suggested that Table E.2 of BS5228-1:2009+A1:2014 which describes trigger levels which includes a temporal consideration be adopted to achieve this. BS5228:-1:2009+A:2014 trigger levels and temporal criterial have been applied to differentiate between levels of significant effect and produce the EIA magnitude of change scale shown in Table 5.37.

Table 5.37 Construction noise magnitude of change criteria

EIA Magnitude of change	Criteria
Very High	Exceeds BS 5228 threshold values for one month or more by 10 dB or more or any of the trigger levels for more than nine days in a 15-day period by 10 dB or more.
High	Exceeds BS 5228 threshold values for one month or more by less than 10dB or any of the trigger levels for more than 9 days in a 15-day period by less than 10 dB.
Medium	Exceeds BS 5228 threshold values or trigger levels by less than temporal criteria of significance.
Low	Is within < 10 dB below BS 5228 threshold values or trigger levels.
Very Low	Is more than 10 dB below BS 5228 threshold values or trigger levels.

Assessment of noise effects due to construction traffic

5.7.37 Using data from any traffic assessment the baseline traffic flows will be used to generate the Basic Noise Level (BNL) from CRTN using total flows, mean speed and %HGVs. Assuming that the road gradients etc. stay the same, the construction traffic BNL will be calculated, and the significance assessment will be made against the short-term impact criteria from DMRB. Table 5.38 sets out the relevant impact assessment criteria.

Table 5.38 Construction traffic short-term impact assessment criteria

EIA magnitude of change	Noise change $L_{A10,18h}$ (dB) criteria	DMRB short-term magnitude of impact
Very High	N/A	N/A
High	5+	Major
Medium	3 – 4.9	Moderate
Low	1 – 2.9	Minor
Very Low	0.1 – 0.9	Negligible
No Change	0	No change

Assessment of construction vibration effects

5.7.38 It is expected that during the construction phase there may be some items of plant that could give rise to significant levels of vibration due to activities such as piling if they occur close enough to the sensitive receptors. The assessment of vibration effects is to be made by using the empirical formulas in Table E.1 of BS5228-2:2009+A1:2014 and by referring to the historic data (or manufacturer's data, where available) within the same standard.

5.7.39 The assessment criteria given in Table 5.39 (below) has been adopted from Table B.1 of BS5228-2:2009+A1:2014 and should be used to assess the EIA magnitude of change.

Table 5.39 Construction traffic short-term impact assessment criteria

EIA magnitude of change	Peak Particle Velocity, PPV (mm/s) criteria
Very High	> 10 mm/s
High	Between 5 mm/s and 10 mm/s
Medium	Between 1 mm/s and 5 mm/s
Low	Between 0.3 mm/s and 1 mm/s
Very Low	< 0.3 mm/s

Assessment of operational noise effects

5.7.40 BS 4142:2014 for the assessment of operational sound due to fixed and mobile plant on site. A BS 4142:2014 assessment should use sound power level data obtained from the most appropriate available and reliable sources including but not limited to: manufacturers data sheets; and the annexes of BS5228-1:2009+A1:2014. 3D sound propagation modelling software should be

employed to determine the individual and cumulative impact of site operations on nearby receptors using the ISO 9613-2:1996 calculation methodology.

5.7.41 For each NSR the assessment methodology, as described in BS 4142:2014, comprises:

- ascertaining a representative $L_{A90,\,T}$ background sound level at the NSR from the results of baseline sound survey;
- calculating or modelling the free-field $L_{Aeq,\,Tr}$ specific sound level (due to each item of plant) at said NSR and applying a character correction (for tonality, intermittency and impulsivity, if appropriate) to obtain the free-field $L_{Ar,\,Tr}$ rating level – for the identification of tonality, reference should be made to 1/3rd octave data if such data is available;
- performing a decibel addition to obtain the cumulative effect (where appropriate) of all relevant $L_{Ar,\,Tr}$ rating levels on the NSR; and
- arithmetically subtracting the $L_{A90,\,T}$ background level from the cumulative $L_{Ar,\,Tr}$ rating level to obtain the excess of rating level over background level for the assessment.

5.7.42 The assessment criteria for EIA magnitude of change has been derived from the assessment criteria described in section 11 of BS 4142: 2014 and is given in Table 5.40.

Table 5.40 Operational sound assessment criteria

EIA magnitude of change	Excess of rating over background sound level, dB	Typical BS 4142:2014 assessment outcome
Very high	> 12	*A difference of around +10 dB or more is likely to be an indication of a significant adverse impact depending on context*
High	8 – 12	*A difference of around +10 dB or more is likely to be an indication of a significant adverse impact depending on context*
Medium	3 – 7	*A difference of around +5 dB is likely to be an indication of an adverse impact depending on context*
Low	0 – 2	*Less than an indication of adverse impact, depending on context*
Vert Low	< 0	*Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on context.*

5.7.43 For the purposes of BS4142:2014, adverse impacts include, but are not limited to, annoyance and sleep disturbance. However, it should be noted that not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

Assessment of operational traffic noise effects

5.7.44 Predictions of the relative increase in traffic noise levels will be undertaken where data indicates that there will be an increase of 25% or decrease of 20% in existing traffic levels or if there is an increase of more than 1 dB(A) due to HGV traffic increases on the main route(s) to the development. Any increase will be assessed in terms of the criteria given in DMRB using the same assessment methodology that has been described for the construction noise traffic above.

5.8 Traffic and transport

Introduction

5.8.1 It has been previously established that The Cayman Islands National Road Authority (NRA) consider that the activity is likely to be a low traffic generator and as such a Traffic Impact Assessment will not be required. However, some elements of the transport assessment approach will be needed to inform the operational assessments of the EIA (especially noise and air quality) and this may be contained within a Transport Statement.

Applicable standards and technical guidance

5.8.2 For the traffic and transport statement the following guidance will be used:

- Cayman Island EIA Regulations: National Conservation Council Directive for Environmental Impact Assessments Section 43, National Conservation Law, Extraordinary No.50/2016, June 2016; and
- Terms of Reference and Guidelines for Conduct of TIS in Cayman Islands, Transportation & Planning Unit, National Roads Authority (March 2013).

5.8.3 In addition, it is recommended that the UK Guidance: 1993 Institute of Environmental Assessments (IEA) publication 'Guidance Notes No. 1: Guidelines for the Environmental Assessment of Road Traffic' (the IEMA guidelines) or methodology's similar to these that are based on the assessment of the environmental effects of traffic and transport. IEMA are currently in the process of looking at how this advice can be updated, and it may be supplemented with advice notes that would need to be referred to if issued before the assessment is undertaken.

Baseline conditions

5.8.4 The site is located on the north side of the George Town area of the island with access to the site from the south. The access routes to the site will define the proposed study area.

5.8.5 The study area is defined as the route between the site and Esterly Tibbetts Highway, which has been identified as a strategic route for the Island. It is assumed that traffic to and from the site would arrive at Butterfield Roundabout from the north, west and south of the island and route to the site along North Sound Road and Seymour Road.

5.8.6 The study area incorporates a series of two-lane single carriageway roads and priority junctions/roundabouts, leading to an access into the site which currently terminates with no existing gatehouses or turning head.

Data gathering methodology

5.8.7 An extensive baseline data gathering exercise would be preferable to underpin the statement and ideally this data will include the following:

- Typical baseline traffic flows, percentage HGV and traffic speed data on links in the area (existing data or new traffic surveys). At this stage, it is assumed that Automatic Traffic Counts (ATCs) will be needed on the following links:
  - Site Access Road – Seymour Road, leading onto the Dump Road;
  - Seymour Road – Between the junction with North Sound Road and the site access; and
  - North Sound Road – Between the junction with Seymour Road and Esterly Tibbetts Highway.

- Overview of parking, loading and servicing arrangements at the site;
- Local public bus routes, bus stops and service frequencies;
- Proposed site traffic generation, staff vehicles, waste loads (light and heavy vehicles) – split across daily operating schedules;
- Proposed site construction traffic, number of vehicles, routes of vehicles, types of vehicles and construction staff;
- Destination and origins of the trips to and from the site;
- Type and size of HGV operating out of the site;
- A growth rate to be agreed with the NRA;
- Local pedestrian and cycling facilities, including public rights of way (PRoW); and
- Personal injury accident records on the local highways network.

5.8.8 However, in the absence of this data approximations and extrapolation could be used from data gathered:

- During the NRA 2016 Island Wide Traffic Collection Study at:
  - Intersection ID #8 - ETH / North Sound Rd and Godfrey Nixon Way (Butterfield Roundabout);
  - Intersection ID #28 - North Sound Rd and Dorcy Dr/Kentsville Dr;
  - Various ATRs.
- During a site visit such as:
  - Information on local public bus routes, bus stops and service frequencies, pedestrian and cycling facilities, including public rights of way (PRoW);
  - Information on the standard of highways to gauge levels of road safety in lieu of personal injury accident records on the local highways network.
- From the scheme plans, such as:
  - An overview of parking, loading and servicing arrangements at the site;
- From the current waste operator (and the intended operator if different), such as:
  - Proposed site traffic generation, staff vehicles, waste loads (light and heavy vehicles) per day with operating hours;
  - Type and size of HGV operating out of the site.
- From the intended construction contractor, such as the number of construction vehicles, routes, types of vehicles and the number of construction staff; and
- From any other historical counts undertaken in the vicinity of the site, possibly as part of another planning application.

5.8.9 As a minimum, the following information will be needed:

- Tonnages of waste to be processed and the site operating hours;
- A site visit; and

- Scheme plans.

Current baseline

Local Highways Network

The Dump Road

5.8.10 The Dump Road is a small, single carriageway unmade / informal road, running in a north-westerly direction off Seymour Road. This will be the point at which access is gained to the proposed ISWMS site.

Seymour Road

5.8.11 Seymour Road is a single carriageway road without road markings which links the North Sound Road with the informal Dump Road (and beyond that, the Cayman waste water treatment works). The road runs through a predominantly commercial/industrial area.

North Sound Road

5.8.12 North Sound Road is a two-lane single carriageway road with central white lines which runs between a roundabout with Esterly Tibbetts Highway and the entrance into George Town Yacht Club. The road runs through an area of industrial, commercial and residential land uses and has numerous junctions with minor roads. The road also currently provides access to the airport and numerous other key facilities on the coast as well as access into the commercial/industrial area where the proposed development is located.

Pedestrian and cycle facilities

5.8.13 There are 108 official PRoW on Grand Cayman most of which are relate to beach access. Details of these PRoW will be needed as part of the baseline data collection.

5.8.14 The local roads in the industrial estate do not have paved footways on the side of the carriageway but online photograph would indicate that users do walk in the carriageway on the Island. There are more formal footways provided on both sides of North Sound Road.

5.8.15 There are no designated cycle routes on the Island of Grand Cayman. There are some tourist routes which are advertised such as the Western Loop but none of these overlap the study area.

Bus, rail and air

5.8.16 A public mini-bus transport system connects all districts of Grand Cayman. The buses can be identified by numbers in a coloured circle and the nearest route to the proposed site is the Fuchsia Route (5A and 5B) which provides a loop that includes the Farmers Market, the International Airport and the Cayman Water Authority. These services run every 30 minutes.

5.8.17 The purple route (WB3) runs north south along North Shore Way and Easterly Tibbetts Highway and runs every 15 minutes.

5.8.18 In general bus services runs Monday to Thursday 06:00 to 23:00 and Friday and Saturday between 06:00-01:00. There are some limited services on a Sunday.

5.8.19 There are no railway lines on Grand Cayman, and the International Airport is located approximately 2.5 km as the crow flies south of the proposed development site.

Future baseline

5.8.20 The local road network is being improved and construction is underway to construct the $34 million, two-mile Airport Connector Road. This road is proposed to link the Camana Bay South Roundabout (Esterly Tibbetts Highway) and the Airport via a route passing to the north of the site before heading south to North Sound Road and then on to the Airport. The provision of this road will relieve the Esterly Tibbetts Highway and North Sound Road (west of Butterfield Roundabout) which are key routes proposed to be used by the operational traffic of the proposed development.

5.8.21 It is also noted that there will be a degree of background traffic growth because of population growth and car ownership growth on the Island. The NRA will be contacted to discuss:

- an agreed growth rate for the assessment; and
- details of any significant local developments that need to be considered; and
- any other highway schemes relevant to the study area.

Consultation

5.8.22 A discussion with the Cayman Islands NRA and EAB will be required to discuss a range of issues set out in the baseline and future baseline assessment sections above. One area for clarification will be the inclusion or exclusion of the Planned Development Area for Camana Bay and the proposed Cruise Berthing Facility within the baseline conditions, which at this stage should not be considered in the cumulative impact baseline for assessment.

Scope of the assessment

Potential receptors

5.8.23 As set out within the baseline section above the scope of assessment has been identified as the routes from the strategic Esterly Tibbetts Highway to the site access via local roads which are described within the current baseline section - see **Figure 5.7: Study area for transport assessment.**

5.8.24 The receptors on these roads will be the land uses adjacent to the carriageway and users of the roads.

5.8.25 It should be noted however that during the consultation with the NRA the scope of assessment will be discussed, and it may be widened depending on site specific details that the NRA may set out.

5.8.26 Table 5.41 sets out the initial locations of receptors. Should further receptors be identified their sensitivity to traffic flow will be determined according to the following examples:

- receptors of high sensitivity to traffic flow include schools, accident clusters and roads without footways/sidewalks that are used by pedestrians;
- receptors with medium sensitivity to traffic flow include congested junctions, shopping areas and roads with narrow footways/sidewalks; and
- receptors with low sensitivity include industrial adjacent land uses and places with adequate footway/sidewalk provision.

Table 5.41 Proposed initial receptors and estimated sensitivity

Receptor	Sensitivity	Justification
Seymour Road (from North Sound Road to the Dump Road)	Low	Industrial adjacent land uses
North Sound Road – Between Seymour Road and Esterly Tibbetts Highway	Medium/High	Urban / town centre adjacent land uses

Likely significant effects

5.8.27 The likely significant transport effects that have been taken forward for assessment are summarised in Table 5.42.

Table 5.42 Likely significant transport effects

Activity	Effect	Receptor
Operation and construction traffic increases on local road network	Visual effects	Local road users Adjacent land uses to the carriageway Pedestrian and cyclists
Operation and construction traffic increases on local road network	Driver severance and delay	Other vehicles using the local road network
Operation and construction traffic increases on local road network	Pedestrian severance and delay	Pedestrian using the local roads
Operation and construction traffic increases on local road network	Pedestrian amenity and intimidation	Pedestrian using the local roads
Operation and construction traffic increases on local road network	Accidents and safety	Local road users Adjacent land uses to the carriageway Pedestrian and cyclists
Operation and construction traffic increases on local road network	Hazardous and dangerous loads	Local road users Adjacent land uses to the carriageway Pedestrian and cyclists

5.8.28 The effects scoped out from further assessment are as follows:

- Decommissioning of the facility;
- Capacity of local highways junctions; and
- Ability to convey abnormal loads to site if required.

Assessment methodology

5.8.29 The generic project-wide approach to the assessment methodology is set out in Chapter 4, and specifically in sections 4.2. However, whilst this approach has informed the approach that has been used in this Transport environmental assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of the Transport assessment.

5.8.30 The traffic and pedestrian inputs (for both the construction and operational phases of the development) used in the EIA will be informed by the baseline data capture exercise and future

traffic flows estimated using a first principals' approach. The magnitude and significance of any environmental traffic and pedestrian effects will be determined and any suitable mitigation identified.

5.8.31 The EIA assessment process will adopt the established methodology as outlined in Guidelines for the Environmental Assessment of Road Traffic (Institute of Environmental Assessment, 1993). The assessment will also be undertaken in consultation with the Proponent and agreement on the following aspects will be sought:

- Identification of sensitive areas / affected parties;
- Forecast traffic levels and characteristics;
- Time(s) suitable for assessment (e.g. AM peak);
- Year of Assessment (year of construction and year of opening); and
- Geographical boundaries of the assessment.

5.8.32 The screening process to define the geographical scope of the EIA study will be based upon the established guidance which recommends that detailed environmental impact studies will only be triggered where road links experience a change in traffic greater than 30% for all vehicles (or HGV) or more than 10% where the links pass sensitive areas. However, as part of this ToR an initial review of the likely receptors to be affected have been made subject to agreement with NRA.

5.8.33 Traffic and pedestrian construction and operational impacts to be assessed will include:

- Driver severance and delay – at junctions or links subject to traffic flow increases which are either approaching capacity, or are over capacity (or delays resulting from traffic diversions);
- Pedestrian severance and delay – at locations where physical obstructions or increases in traffic flows more than 30% are forecast to result in an increase in severance;
- Pedestrian amenity / intimidation – at junctions or links subject to substantial increases in traffic flow in conjunction with any changes in footway widths or crossing facilities. The presence of sensitive user groups will also be considered;
- Accidents and safety – links and junctions (for which data is available) with existing accident rates more than national averages which may be subject to an increase in traffic flows; and
- Hazardous and dangerous loads – consideration of estimated number and composition of loads and assessment of accident risk if considered significant.

5.8.34 The criteria for evaluation will be based on Table 5.41 for the sensitivity of receptors and Table 5.43 for the magnitude of change.

Table 5.43 Guidelines for the Assessment of Impact Magnitude

	Magnitude of Impact			
Magnitude of Change	**Very Low**	**Low Medium**	**Medium**	**High**
Severance	Change in total traffic or HGV flows of less than 30%	Change in the total traffic or HGV flows of 30%-60%	Change in total traffic or HGV flows of 60%-90%	Change in total traffic or HGV flows of over 90%
Pedestrian and Cycle Delay	A professional judgement based on the routes in the context of the individual characteristics			
Pedestrian Amenity	Change in total traffic or HGV flow of <100%	A professional judgement based on the routes with >100% change in context of the individual characteristics		
Cyclist Amenity	Change in total traffic or HGV flow of <100%	A professional judgement based on the routes with >100% change in context of the individual characteristics		
Accidents and Safety	A professional judgement based on the level of baseline collision numbers and severity of collisions as well as the predicted change in collisions.			

5.8.35 Identified adverse effects will be categorised as 'slight', 'moderate' or 'substantial' as appropriate using the matrix presented in Table 5.44; with substantial, moderate/substantial and moderate classed as significant.

Table 5.44 Establishing the Level of Effect

	Sensitivity of receptors		
Magnitude of Change	**High**	**Medium**	**Low**
High	Substantial	Moderate/Substantial	Moderate
Medium	Moderate/Substantial	Moderate	Slight/Moderate
Low Medium	Moderate	Slight/Moderate	Slight
Very Low	Slight	Slight/Negligible	Negligible

5.8.36 Any departures from the guidelines will be agreed with the Proponent and will be clearly stated within the Environmental Statement. Mitigation will also be developed in consultation with the Proponent and will adopt the hierarchical principles of prevention, reduction and offsetting if required at all.

Inputs to other EIA Topics

5.8.37 The traffic team will supply existing and forecast data and analysis, relating to peak and average flows, Annual Average Daily Traffic (AADT) flows and traffic speeds, to inform other assessments within the EIA such as noise and air quality as required.

5.9 Socio-economics

Introduction

5.9.1 The assessment of socio-economic effects will consider the way in which the proposed development will affect people's way of life, their community, economic activity and culture.

Applicable standards and technical guidance

5.9.2 The project will be required to follow the social laws of the Cayman Islands. Key laws relevant to socio-economic issues include:

- Labour Law, 2011 Revision;
- Tourism Law, 1995 Revision and Tourism Regulations, 2002 Revision;
- Workmen's Compensation Law, 1996 Revision.

Baseline conditions

5.9.3 The Cayman Islands has a total population of around 65,000 people, most of whom reside on Grand Cayman. The capital city of Grand Cayman, George Town, is located in the George Town District where the project is to be located and has a population of around 30,000 people. The population of the Cayman Island's is young compared to most developed countries, with approximately 85% of the population below the age of 55.

5.9.4 The economy of the Cayman Islands is mainly fuelled by the tourism and financial services sectors. Various economic impact studies put the financial services sector at approximately 50 to 60% of gross domestic product (GDP), while the tourism sector contributes between 25 to 30% of GDP – the islands having received over 2 million visitors in 2016 (mainly from the USA). Other sectors include construction, property and other business activities.

5.9.5 In terms of employment, unemployment levels are low, with around 4% unemployment.

Consultation

5.9.6 Community engagement work has already been undertaken by the CIG to establish the ISWMS core policies, and this has helped ensure an early dialogue around the need for non-landfill-based waste management alternatives.

5.9.7 The Proponent submitted an EIA Request for Scoping Opinion to the DoE in October 2017, and the EAB responded in November 2017 with its EIA Scoping Opinion, summarising the potentially significant environmental effects of the project that will need to be addressed, as well as additional information requirements that the EAB deemed necessary to prepare an ES.

5.9.8 No additional consultation, beyond that carried out with the DoE in relation to the draft ToR, in relation to socio-economic effects has been undertaken at this stage; however, future EIA consultation should include but not be limited to the following organisations:

- DoE; and
- The Economic Statistics Office.

5.9.9 Consultation will be used to obtain further baseline information which will then be used to inform the socio-economic assessment.

Scope of the assessment

5.9.10 It is envisaged that the proposed development will result in the creation of significant additional employment opportunities. In addition to securing direct employment opportunities at the site, it is envisaged that a number of indirect and induced jobs will be supported, because of the need to service the site. Typically, these relate to the provision of a wide variety of goods and services, including specialist engineering assistance for plant maintenance and contractors for services such as fencing, provision of mobile plant etc.

5.9.11 It is recognised however, that proposed development could potentially have an effect on inward investment into the Cayman local economy. As such, it is considered that the socio-economic effects assessment should also consider the perceptions of the local business community and the extent to which the proposed waste management development could detract from the retention of existing businesses and attraction of new businesses into the area. Considerations around the effect that the proposed development may have on tourism will also be a significant issue for the socio-economic assessment. Specifically, the receptors to be assessed include existing local employers and potential future businesses (on sites being marketed for occupation or allocated in the extant Development Plan).

5.9.12 In summary, the socio-economic assessment will be primarily concerned about the effect on:

- Change in the local employment structure and effect on the local employment market;
- Employment opportunities and displacement;
- Increased / decreased local expenditure;
- New and improved facilities; and
- Effects on the 'quality of life' enjoyed by the local population.

Potential receptors

5.9.13 The following potential socio-economic and community receptors were identified:

- **Employment base** i.e. the local population that falls within the 16-65 age group (includes temporary and permanent employment);
- **Existing business** i.e. in the context of the retention of existing indirect and induced employment benefits, and in particular, consideration of the wider effects on the island's tourism industry.

Potentially significant effects

5.9.14 As with other assessments, potential significant effects are based on a combination of the sensitivity (or value) of existing receptors and the magnitude of change that is predicted to result from the proposed development.

5.9.15 For socio-economic issues, value is a qualitative judgement. In terms of the employment base, it will take into account whether retained and / or newly created jobs were skilled or unskilled (and/or attracted high or low wages/salaries), temporary or permanent, or whether or not a local workforce will be required. It may also take into account factors such as profile and whether the jobs are seen as traditional industry or high technology.

5.9.16 Magnitude is a quantitative assessment and in respect of employment, will take into account the number and type of jobs to be retained and / or created, and how these would relate to the existing employment base.

Assessment methodology

5.9.17 Baseline information will be collected from secondary data sources including but not limited to: local population census data, government planning documents, international financial institutions' statistics, nongovernmental organisations (NGOs) and business reports. Primary data sources will include consultation with key stakeholders, including local community and business representatives and NGOs. Relevant socio-economic indicator data will be gathered including information on income sources and livelihoods, and access to employment and business opportunities, as well as social services such as education and health.

5.9.18 This information will be used to consider potential direct, indirect and cumulative impacts of the proposed ISWMS. It will assess potential impacts due to construction, operation and maintenance of the various facilities including adverse impacts and economic benefits; employment for communities, skills training and tourism activities. Based upon existing data obtained through appropriate agencies and institutions, the EIA will evaluate the implications of the ISWMS facilities on factors such as public services, tourism activities, educational institutions and housing.

5.9.19 The ES will clearly identify the potential effects of the proposed facilities on existing socio-economic conditions in terms of population dynamics, infrastructure, economic and business status/opportunities, tourism and recreation both for the short and long term. The potential effects will be assessed based on their nature (beneficial/adverse), their temporal extent (short or long term) and their spatial context (local/national).

5.9.20 Significance will be determined using clearly defined qualitative criteria considering:

- Sensitivity of socio-economic receptors (individuals or social or economic groups), determined by their vulnerability to change or ability to take advantage of opportunities; and
- Magnitude of impacts, determined by effect on receptors, wellbeing, which refers to the financial, physical and emotional conditions of people or groups.

Appendix A
List of competent experts

Table A1 below outlines the list of competent experts who will carry out the EIA. Individual CVs are attached to the remainder of this Appendix.

Table A1 List of competent experts

ToR No.	Description	Lead	Reviewer
1	Marine ecology	Katja De Guzman	Bruno Dupre
2	Terrestrial ecology	Laura Lawlor	Bruno Dupre
3A	Hydrology	APEC - Ali Sabti APEC - Bob Minning APEC - John Bomba	Victoria Brayshaw
3B	Hydrogeology	APEC - Ali Sabti APEC - Dr Brian Jones	Rob Noden
4A	Land quality - geo-environmental	Jo Steele	Paul Nathanial Richard Ogden
4B	Land quality – geo-technical	Paul Nathaniel Richard Ogden	Hassan Gilani
5	Landscape and visual	APEC - Ronan O'Keeffe	Pallavi Mandke
5A	Air quality	Gord Reusing	Paul Quinn
6B	Greenhouse gas emissions	Katja De Guzman	Gord Reusing
7	Noise	Paul Quinn	Mike Masschaele
8	Traffic and transport	APEC - Denis Murphy APEC - Daniel McCarthy	Craig Adams
9	Socio-economics	Dr. Pallavi Mandke	Ian Dobrindt

Blair Shoniker
Solid Waste & Environmental Planner

Qualified: MA., Environmental Impact Assessment & Management (with Distinction, 1st in Class) University of Manchester, 2005; BURPl. Bachelor of Urban and Regional Planning, Ryerson University, 2003

Connected: Member and Registered Professional Planner (RPP), Ontario Professional Planners Institute (2007)

Professional Summary: Blair has over 17 years of waste and environmental planning experience, both in private consulting and the public sector. He has extensive waste system planning and environmental approvals experience and is well versed in legislation and policy governing waste systems and environmental approvals, at both the provincial and federal levels. Blair has extensive experience in the waste management field, including the development of and consultation on waste management master plans, system plans, and diversion studies, with a significant focus on strategic planning and approval processes for waste management facilities and systems. His professional skill set includes waste system planning within the context of an environmental assessment for new or expanding waste facilities and as part of long-term strategic plans; a thorough understanding of best practices in relation to various public/private sector clients; and project management experience with the implementation and operations models for waste management.

Mr. Shoniker is experienced in all phases of project planning and execution including strategic planning, implementation, management of large multi-disciplinary teams, and evaluation of projects. Mr. Shoniker is also experienced in the delivery and assessment of multidisciplinary projects undertaken in Australia, Canada, and the UK, and has worked on numerous environmental assessment and development planning applications in those countries. He is familiar with Canadian, Australian, UK, and EU environmental regulations and legislation.

Solid Waste Environmental Impact Assessments

Project Manager/ EIA Lead
Stoney Creek Regional Facility Expansion, Individual Environmental Assessment | Terrapure Environmental | Stoney Creek, ON

Project Manager for an Individual Environmental Assessment to increase the capacity of the existing Stoney Creek Landfill owned and operated by Terrapure Environmental. Expansion is seeking to increase the total approved waste capacity by 3.68 Million m^3. Responsible for preparing, coordinating and submitting the Terms of Reference and the EA and assisting with all consultation events with Agencies, Public and Indigenous communities. Terms of Reference approved in November, 2017 and currently awaiting EA approval by Minister (expected by October, 2019).

Project Manager/ EIA Lead
Vertical Landfill Expansion, Individual Environmental Assessment, Official Plan and Zoning By-Law Amendment | Brooks Road Environmental | Cayuga, ON

Project Manager for an Individual Environmental Assessment to increase the capacity of the existing Brooks Road landfill site in Cayuga, Ontario. In addition, lead the Official Plan and Zoning By-Law Amendment process to facilitate the extension of the northern boundary to include additional lands as buffer and stockpiling area. Responsible for preparing, coordinating and submitting the Terms of Reference and leading all consultation events with Agencies, Public and First Nations. Terms of Reference were approved by the Minister in August 2015, and the EA was approved on February 14, 2019.

Project Manager/ EIA Lead
West Carleton Environmental Centre Landfill Expansion Environmental Assessment (Waste Management) | Ottawa, ON

Project Manager responsible for preparing, coordinating and submitting the Terms of Reference and EA and leading the consultation events (Open House, facilitating workshops). Minister approved ToR (2010) and EA (2013).

Senior Environmental Planner
Clean Harbors Lambton Landfill Expansion Environmental Assessment | Clean Harbors Canada | Sarnia, ON

Developed the Cumulative Effects Assessment section of the Terms of Reference and prepared the draft Federal Project Description under Canadian Environmental Assessment Act 2012. EA has been submitted and approved.

Project Manager/ EIA Lead
Energy-From-Waste Facility, Environmental Screening | Port Fuels & Materials Services Inc. | Hamilton, ON

Project Manager for the Environmental Screening for a proposed 200,000 tonne per year Energy-From-Waste facility. Responsible for preparing and coordinating technical disciplines, preparing and leading the public consultation program, preparing the Environmental

Screening Document, and responding to Part II Order requests. Project has been bumped-up to Individual EA.

Project Manager

Landfill Expansion | The Town of Smooth Rock Falls | Smooth Rock Falls, ON

Currently undertaking an Environmental Screening under O. Reg 101/07 (Waste Management Projects) for the existing landfill owned and operated by the Town of Smooth Rock Falls. This undertaking was identified within the Strategic Waste Management Plan for the Town.

Federal – Canadian Environmental Assessment Act 2012

Federal EIA Lead

Boat Harbour Remediation Project | Nova Scotia Lands, Inc. | Boat Harbour, Nova Scotia | 2017-present

EIA Lead for the remediation of Boat Harbour Effluent Treatment Facility to restore Boat Harbour to a natural tidal estuary. Prepared the Project Description to determine Federal EIA applicability and currently preparing the Environmental Impact Statement (EIS) based on the EIS Guidelines provided by the Federal Impact Assessment Agency. Assisting Nova Scotia Lands in conducting engagement and consultation with the public and Pictou Landing First Nation community.

Federal EA Review and Support

Beaver Dam Mine Project | Atlantic Gold | Marinette, Nova Scotia | 2016-2017

Assisting the EA Project Team to review key sections of the Environmental Impact Statement for the development of a satellite surface mine with an approximate ore extraction rate of 2 million tonnes per year (t/y). EIS is currently under review.

Federal EA Lead

Clean Harbors Landfill Expansion | Clean Harbors | Lambton, Ontario | 2013

Federal EA lead in preparing a Project Description as required under the *Regulation Designating Physical Activities* (Hazardous waste) for submission to the Canadian Environmental Assessment (CEA) Agency. Agency determined that based on the Project Description, a Federal EA was not required.

Federal EA Lead

Port Fuels Energy-From-Waste Facility | Port Fuels & Materials Services, Inc. | Hamilton, Ontario | 2014-2015

Assisting the Hamilton Port Authority complete the requirements under Section 67 of CEAA 2012 for undertaking a project on Federal Lands. The Federal environmental effects determination is ongoing, and will utilize a number of mitigation measures developed by the proponent and CRA in the Provincial Screening report.

Federal EA Review

Review of Environmental Assessment Requirements at Grantley Adams International Airport | Canadian Commercial Corporation | Barbados | 2017

Undertook a review of Federal EA requirements for works outside of Canada, but subject to Section 68 of CEAA 2012. Proposed works included the rehabilitation of existing paved taxiways and aprons as well as the expansion of two new pavement sections in relation to an existing taxiway and apron at the Grantley Adams International Airport, Barbados. Canadian Commercial Corporation were the prime contractor for this project.

Federal Environmental Assessment – CEAA Screening and Comprehensive Study

Federal EA Lead

Highway 407 East Completion | Ontario Ministry of Transportation | Durham Region, Ontario | 2006-2009

Undertaken as a Comprehensive Study in parallel with the provincial EA, with the Department of Fisheries and Oceans acting as the lead RA.

Project Manager

Lake Ontario Anemometer | Toronto Hydro | Scarborough, Ontario | 2008-2010

Project Manager for the federal CEAA Screening relating to erecting an offshore wind monitoring station (anemometer) in Lake Ontario. The trigger was related to the equipment (anemometer) being loaned to Toronto Hydro from Natural Resources Canada (NRCan).

Project Manager

Serpent Mounds Park Rejuvenation and Expansion Plan Screening | Hiawatha First Nation | Serpent Mounds, Ontario | 2011

Project Manager for the completion of a federal CEAA Screening on behalf of the Hiawatha First Nation in relation to the rejuvenation and expansion plan for the Serpent Mounds Park. The trigger was related to Federal funding from the Federal Economic Development Agency for Southern Ontario.

Federal EA Support

Impact Assessment of the Fundy Tidal Energy Development Facility | Minas Basin, Nova Scotia | 2008-2011

Assisted with the joint federal provincial environmental impact assessment of Minas Basin facility. Three sea bottom turbines will be installed in the Minas Passage of

the Bay of Fundy, an area of extreme tidal displacement and excessive current strength. Responsible for assembling baseline data, and assessing, mitigating, and reporting impacts of both the terrestrial and marine components. Critical elements of the impact assessment and subsequent permit applications included developing monitoring technologies and methodologies to suit the unusual environmental conditions and extensive consultation with First Nation and other lobster fishers who utilize this portion of the Bay of Fundy.

Other EIA Experience

Environmental Planner
Highway 407 East EA | Ministry of Transportation | Durham Region | 2006-2010

Assisted the Project Manager in completing this Individual Environmental Assessment (EA) for the extension of Highway 407 from its terminus (Brock Road) to Highway 35/115 and two north-south links (West and East Durham) for a total of approximately 72 km of new highway. Blair was responsible for managing the numerous disciplines involved (i.e. Biologists, Air Quality, Socio-Economic, etc) and drafting all documentation for the final EA submission. Participated in all consultation events, including Public Open House events, a Wetland Workshop with Conservation Authorities and Ministry of Natural Resources, and a series of Community Value Plan meetings with local stakeholders. This was a joint provincial/ federal project, which required coordination efforts between the two levels of government. The Provincial EA was approved by the Minister of Environment in June, 2010.

Environmental Planner
Nirranda South Wind Farm Environmental Effects Statement | Shire of Moyne, Victoria, Australia | 2003-2004

Assisted the Senior Planner in preparing the Planning Policy Assessment for an Environmental Effects Assessment and planning application for the construction of 28 wind turbines. Reviewed existing state and local policy/legislation and assisted in drafting the documentation.

Solid Waste Planning

Landfill Management and Planning in Ontario | Ministry of Environment and Climate Change | Ontario, ON

Project Manager for the MOECC's study to understand current and projected landfill capacity in Ontario and development of options and recommendations for planning and managing landfills both at a regional and provincial scale. Project Team developed a database for the province to manage their landfill capacity projections over a 30 year planning horizon and developed recommendations on how to plan for future landfill capacity, while taking into consideration the diversion goals within the Waste Free Ontario Strategy.

Review of Solid Waste Management Services | Town of Whitby | Whitby, ON

Currently finalizing a report for the Town of Whitby that reviewed the current solid waste management services and makes recommendations to improve and optimize efficiencies and meet future waste collection needs. Financial analysis was provided that compared the per household costs in Whitby to other comparable municipalities in the GTA.

Solid Waste Planner/ Stakeholder Engagement Curbside Collection & Program Review | City of Fredericton | New Brunswick, NB | 2016 - ongoing

Reviewed the City's solid waste management programs and evaluated potential improvements related to:

- Implementing automated curbside collection including capital and operating costs estimates
- Implementing a source-separated organics (SSO) program including capital and operating estimates
- Improving diversion from the multi-unit residential sector
- Promotion and Education programs

In addition, a public survey was also developed and undertaken to solicit feedback from residents on potential program changes.

Solid Waste Planning Lead
Strategic Solid Waste Management Plan | The Town of Smooth Rock Falls | Smooth Rock Falls, ON

Completed a Solid Waste Strategic Plan for the Town of Smooth Rock Falls, reviewing their current landfill operations (extending the life of the landfill, improving operations, etc.), as well as investigating potential diversion strategies and synergies with neighboring rural municipalities, along with the financial implications for implementing strategies and changes to current operations. Consultation with the public was integral to obtaining buy-in on the Plan, as the residents are the key to increasing diversion through active participation.

Project Manager
Continuous Improvement Fund, Service Delivery Model for the North-Eastern Ontario Wasteshed | Ontario

Develop and evaluate service delivery models to optimize the management of recyclables in the North-Eastern Ontario wasteshed. The regional analysis included more than 20 municipalities, and addressed all stages of service delivery, including: waste generation, collection, consolidation, transfer, hauling and processing of recyclables. GHD developed a flexible evaluation tool that considered the impacts of moving from depot-based collection to curbside pick-up, changing material from

multi-stream to single stream, making efficient use of existing infrastructure and resources, and aligned with the diversion strategies of the individual municipalities. Capital and annual operating costs were calculated across different service delivery scenarios, and potential shared services arrangements were presented that optimized regional service delivery while balancing local conditions.

Facility Siting & Consultation Lead
Organic Processing Facility/Transfer Station | County of Simcoe | Simcoe County, ON

Undertake a site evaluation and selection to site a new Organics Processing Facility/ Transfer Station within the County of Simcoe. Although the Ontario EA Act does not apply to the proposed undertaking, the evaluation methodology was based on an environmental assessment process. A comparative evaluation of numerous sites was undertaken in order to arrive at the most appropriate site, taking into consideration, natural environment, social and economic factors. In addition, public consultation events were undertaken at key decision-points throughout the process, which GHD are responsible for coordinating, attending and developing responses to comments submitted by the public.

Senior Waste Planner and Consultation Lead
Stakeholder Outreach and Survey for potential changes to curbside collection | City of Medicine Hat | Medicine Hat, AB

Senior Waste Planner responsible for developing a Stakeholder outreach program to determine the public's desire to implement changes to the City of Medicine Hat's curbside collection program. The City currently collects waste at the curb and operates a number of recyclable drop-of depots. GHD was tasked with developing a public engagement plan to "take the temperature" of the public on the potential to implement a curbside recycling program. To that end, in addition to various community events and marketing material, a survey was developed and is currently being administered to the public to gauge their interest in altering their residential curbside program. The results of the stakeholder outreach and survey will be summarized in a report and presented to Council in early 2016.

Senior Waste Planner
Update to Regional Solid Waste Management Plan | Northern Rockies Rural Municipality | Northern Rockies, BC

Undertaking a review of the existing Regional Solid Waste Management Master Plan, as required under provincial legislation (BC). A review of the current state of waste management within the Municipality will take place, which includes analysis on how effective the current programs are, along with alternative municipal solid waste strategies that may be implemented. This project is in its formative stages.

Senior Waste Planner
Opportunities & Barriers for Organics Waste Diversion & Reduction, Stakeholder Survey & Interviews | Canadian Council of Ministers of the Environment (CCME) | Canada

Senior Waste Planner responsible for developing a stakeholder survey to determine the key opportunities and barriers to organics waste diversion across provinces and territories. Survey questions were developed to cover the broad range of stakeholders in the organics and food waste sector, including municipalities, commercial businesses and policy makers. Follow-up interviews to the survey are also to be completed to augment the survey data. Final report summarizing the barriers, opportunities and best practices in organics diversion/ food waste reduction is due to be presented to CCME in the January 2016.

Senior Project Planner
Cap & Trade Research for Ontario's Waste Management Sector | Ontario Waste Management Association (OWMA) | Ontario, Canada

Senior Project Planner responsible for reviewing various cap-and-trade regimes and making specific recommendations on how the government of Ontario could recognize the Waste Sector in the Cap-and-Trade program. Assisted in the development of a tool that can be used to analyze the potential impacts of Greenhouse Gas (GHG) savings in the Waste Sector. The results of this study will be presented to the Ontario Ministry of the Environment and Climate Change (MOECC) on behalf of the provincial waste management sector.

Project Manager

Site Search/Evaluation for potential Organics Facility | Confidential Client | Southern Ontario

Completed a detailed site search for a confidential client to identify potential properties that could be leased or purchased and subsequently developed and permitted to process organic wastes. In addition, a comparative evaluation of the numerous sites identified was undertaken in order to arrive at the most appropriate sites, taking into consideration, natural environment, social and economic factors.

Solid Waste Planner
Assessment of Waste Collection Services Methods | Town of Richmond Hill | Richmond Hill, ON

Undertook an assessment of waste collection service methods for the Town of Richmond Hill, Ontario. Work included a review of the Town's current waste management system, generation of anticipated service needs over a 7-year study period, a marketplace assessment of collection containers (e.g., bins, carts) and collection vehicles (e.g., semi-automated,

fully-automated), and a review of case studies from other municipalities. Specific options were developed for the Town with varying service methods and service levels. A cost-benefit analysis was undertaken for each option, and recommendations were made regarding the most feasible and economical alternative. A variety of funding mechanisms were also identified that could be put in place to pay for the programs.

Senior Waste Planner
Curbside Collection System Review | The Townsite of Fort Nelson, Northern Rockies Regional Municipality | Northern Rockies, BC

Assisted in completing a review of available collection systems for municipal solid waste (MSW) and made recommendations to meet the needs of Fort Nelson's needs and expectations. This report set the groundwork for developing and implementing a curbside collection program, which is currently looking at drafting a By-Law for mandatory curbside collection.

Other related areas of interest

Additional Training

- Project Management Bootcamp, PSMJ
- Municipal Class Environmental Assessment Training Course, Ministry of the Environment

Courses Taught

- Skills Sharpening Workshop – Applying Strategic Environmental Assessment in Ontario – Ontario Association for Impact Assessment (OAIA) (with Tom Wlodarczyk of SLR)
- Cumulative Effects Assessment and Strategic Environmental Assessment – Ministry of Environment and CEAA staff (co-taught with Tom Wlodarczyk)

Published Article

- "Climate Change Adaption: Building resilience for tomorrow while reducing vulnerability today", WasteEdge, Vol.10 No.2 Fall/Winter 2014 pp. 16-17 (with M. Muffels)

Presented

- Shoniker, B and E. Jollymore. 2016
  Waste Management Surveys – Strategies to Engage the Public
  Submitted and accepted to Solid Waste Association of North America Northern Lights Chapter Annual Conference, May 11-13, 2016, Calgary, Alberta, Canada
- Shoniker, B. 2016
  Planning for Increased Recyclable & Organic Material in the Multi-Family Housing Sector
  Submitted and accepted to the Solid Waste Association of North America Atlantic Chapter Canadian Waste Resources Symposium, April 27-29, 3016, Halifax, Nova Scotia, Canada
- Shoniker, B. and A Varkey. 2015
  Zero Waste in Schools – From Design to Implementation
  Submitted and accepted to the Florida Educational Facilities Planners' Association (FEFPA) Winter Conference, February 3-5, 2015, Jacksonville, Florida, USA
- Shoniker, B. and T. Gidda. 2014
  Increasing Organics Diversion Participation – heavy hand or a little nudge?
  Submitted and accepted to the Solid Waste Association of North America 7th Canadian Waste Resources Symposium, March 31 - April 4, 2014, Vancouver, British Columbia, Canada
- Muffels, M., M. Radulescu and B. Shoniker. 2013.
  Climate Change Adaptation & Waste Management - From Planning/Designing New Facilities to Application to Existing Facilities.
  Submitted and accepted to the Solid Waste Association of North America 7th Canadian Waste Resources Symposium, March 31 - April 4, 2014, Vancouver, British Columbia, Canada
- Muffels, M., M. Radulescu and B. Shoniker. 2013.
  Climate change adaptation - building resilience for tomorrow while reducing vulnerability today.
  Submitted and accepted to the 4th Canadian Waste Sector Symposium, November 18 - 20, 2013, Montreal, Quebec, Canada

Work history

2013 – present	GHD (formerly Conestoga-Rovers & Associates), Newmarket, Ontario
2006 – 2013	AECOM (formerly Gartner Lee Limited), Markham, Ontario
2005 – 2006	Town of Whitby, Whitby, Ontario
2004 – 2005	Oldham Council, Oldham, England
2003 - 2004	ERM, Melbourne, Australia

Curriculum Vitae

Katja De Guzman
Marine Ecology Specialist

Qualified. MS in Environmental Science (Hydroecology), Institute of Environmental Science and Meteorology, University of the Philippines−Diliman
BS in Environmental Science, Ateneo de Manila University

Pen portrait. Katja has over 13 years' experience in undertaking environmental work in numerous sectors—including public infrastructure—in Asia, Australia, and the UK. Her Master's degree had concentration in Hydroecology and her broad environmental experience include impact assessment and approvals, contamination and hazardous materials assessment, climate change, and marine ecology. She has particular strengths in organising and planning, problem resolution and decision making on field, and seeing a project through from inception to fruition.

Katja's extensive experience in marine and freshwater systems include a decade leading the environmental monitoring of impacts from a coal-fired power plant in the Philippines, as well as ongoing impact assessment projects for offshore oil and gas activities in the southern North Sea in the UK. Katja has been continually involved in various natural resources management projects in the area of environmental monitoring, baseline assessments, and ecological risk assessment. She also has experience in environmental modelling as a tool for the assessment of potential impacts of proposed development projects on the receiving environment.

Project Manager/EIA Specialist
Frigate EU EIA

One of GHD's global oil and gas clients is investigating the potential for increasing tight gas production in one of its existing offshore gas production systems in the southern North Sea. GHD is providing various environmental advisory assistance during this process, including preparation of the Environmental Impact Assessment justification document submitted to the offshore environmental regulator to enable the project to proceed. Other permits required for the project, for which Katja and her team conducted specific risk and impact assessment studies include an EIA Direction, Consent to Locate, and a Chemical Permit. Ongoing.

Project Manager
Japan-Guam-Australia Submarine Cable

Project manager for the permitting and approvals process in Australia waters for the installation of a fibre-optic submarine cable between Guam and Sydney, Australia. An Environmental Assessment was prepared and submitted to the Australian Department of Energy and Environment under the Commonwealth Referral process in accordance with the Environment Protection and Biodiversity Conservation Act 1999. A Marine License from Parks Australia was also obtained for the project, to enable crossing through a marine protected area on the Australian eastern continental shelf. The scope of work also included stakeholder engagement and an assessment of environmental constraints for the cable alignment, which included a review for the presence of cultural heritage sites, submerged aboriginal archaeology, and Native Title claims. April 2018-April 2019.

Project Manager
Sunshine Coast Submarine Cable

Katja is project manager for similar submarine cable permitting and approvals for a branching unit from the above JGA cable, to connect to Sunshine Coast in Queensland Australia. The scope is similar to the above, with additional State-specific environmental approvals also required, such as the Development Consent for proposed tidal works in State-controlled waters from the Queensland Department of State Development, Manufacturing, Infrastructure, and Planning. Extensive stakeholder engagement was undertaken across various fisheries organisations and government departments with respect to the project. The above is in addition to the EPBC Referral from the DoEE and the Permit to install a submarine cable in non-protected waters from the Australia Communications and Media Authority. December 2018-present.

Project Manager/EIA Specialist
Offshore platform decomplexing EIA

A global oil and gas client has undertaken refurbishment works on one of its normally unattended installation platforms in its offshore gas production network in the Leman field in the southern North Sea. An EIA Direction was produced in support of the applications for a Consent to Locate (CtL) for the Seafox 4 jack-up rig required for the works, as well as for a Marine License for placement of scour protection. Permits were obtained in November 2017. Ongoing assistance with environmental approvals for project implementation is also being undertaken. July 2017 - Ongoing.

Project Manager/EIA Specialist | MMO Notification for Scientific Instrument

In order to improve understanding around the relationship between the motion of offshore pipelines in freespan, and the wave and currents that act on the pipeline, a global oil and gas client is proposing to deploy a data collection device on the seabed proximate to the pipeline of concern. Katja assisted with complying with the requirements for marine licensing for the device, in accordance with the Marine and Coastal Access Act being administered by the Marine Management Organisation. November 2018.

Environmental Specialist | EIA for Doha Port Redevelopment Marine Works, Qatar

Katja was involved in the preparation of the environmental impact assessment for dredging activities to repurpose the Old Doha Port into a marina and cruise ship terminal. The project involved environmental baselining and impact assessment, towards the production of an Environmental Statement for the approvals process. May 2018.

EIA Manager
EIS Preparation of a proposed Consolacion International Container and Bulk Terminal in Cebu, Philippines

Environmental and social studies for the proposed Consolacion ICBT project, an 85 ha coastal reclamation development to be delivered as a Public-Private Partnership Project between the Consolacion local government and Mega Harbour Port and Development Inc. The study scope includes environmental impact assessment, stakeholder engagement, and traffic impact assessment. March-June 2017 (Project ongoing)

Project Manager/Technical Lead
Marine ecology, oceanography, and ecotoxicology monitoring for Quezon Power Plant

Involvement in continuing monitoring works of marine and coastal ecosystems in the vicinity of the Quezon Power Plant, including monitoring the condition of coral reefs, fish, seagrass, soft-bottom benthos, plankton, and giant clams. 2007-2016

Project Manager/Technical Lead
Marine ecology monitoring for RPE

Katja developed a marine ecology monitoring plan for the coastal site of a proposed power station in Redondo Peninsula, Zambales, Philippines and led a team that undertook semi-annual marine ecology monitoring of coral reefs, reef fish, benthic in-fauna, and plankton. Marine water quality was also monitored. 2014-2016.

EIA Manager
EIS Preparation of a proposed power station in Batangas, Philippines

Technical lead and project management of EIA related studies and preparation of the Environmental Impact Statement for a proposed power station on the west coast of Luzon, Philippines for submission to the Department of Environment and Natural Resources. Various baseline environmental studies and impact assessment were undertaken, including marine ecology (benthic resources, plankton, coral reefs, reef fish, etc) and estuarine ecology (benthic organisms, primary productivity, plankton). 2013-2016

Environmental Scientist/Component Lead
Marine ecology baselining for ESIA of Burgos Wind Project

Marine ecology baselining for the preparation of an IFC-compliant ESIA for the Burgos Wind Farm JettyConduct of the baseline marine ecology assessment for the above project, including:

- Coral and reef fish assessment
- Benthic macro-invertebrates assessment
- Capture fisheries interviews

The study outcomes input into an Environmental and Social Impact Assessment prepared in accordance with the International Finance Corporation's Performance Standards for Environmental and Social Sustainability. November 2014.

Project Manager
Baseline marine ecology assessment in Taytay, Palawan Philippines

As part of permitting requirements for a proposed inter-island fibre-optic submarine cable network, baseline marine ecological assessment was required for several landing site options in Taytay, Palawan. The study outcomes were incorporated into Initial Environmental Examination reports to obtain environmental approvals for the project. March 2012.

Project Manager
Marine and Freshwater Ecology Monitoring of Berong Nickel Project

Involvement in annual monitoring of marine ecology (coral reefs, seagrass, soft-bottom benthos, plankton) at Berong Nickel Project in Quezon, Palawan. 2009-2012.

Project Manager
Baseline marine assessment of proposed port & coastal facilities, Sta Cruz, Zambales

Involvement in baselining activities for marine water quality, marine ecological assessment, and resource mapping of a coastal area proposed to be the site of port and associated coastal facilities in Brgy Bolitoc, Sta Cruz, Zambales. Project coordination for the two sampling events undertaken for the wet (October) and dry (April) seasons. Report preparation for inclusion in the Baseline Environmental Study for the Acoje Nickel Project EIS. October 2011 to April 2012.

Competency Areas

- **Project management and delivery:** Katja has managed and successfully delivered numerous projects in various fields, including environment, energy and engineering. She has particular strengths in organising and planning, problem resolution and decision making on field, and seeing a project through from inception to fruition.
- **Leadership and teamwork—**While Katja has functioned in some form of leadership position throughout her academic life and professional career, she has benefited immensely from the mentoring and coaching she has received from her role models and the various training opportunities she has had in this area. She now strives to share her learnings in influencing her team and peers, towards not just the overall success of the organisation, but also individual growth.
- **Technical contribution and quality—**Katja draws on her qualities of thoroughness and attention to detail in striving for consistent quality in her endeavours, and builds upon her environmental science training which taught her to see interrelationships while never losing sight of the big picture.
- **Communications, writing and editing—**Katja has excellent command of the English language and has had long and continuous experience with writing, reviewing, and editing technical work for consulting output, conservation advocacies, and scientific publications. She often gives presentations, many of them impromptu, to clients and stakeholders, and has presented in conferences and symposia on various environmental topics.

Discipline Areas

- **Advisory and Due Diligence**—Katja has experience with undertaking independent environmental and social advisory work for both lenders and developers. Her work in this area includes involvement in due diligence work for acquisition of assets in the power sector, where compliance of the existing facilities were assessed against the IFC's Performance Standards for Environmental and Social Sustainability. She also has experience with advising project proponents in infrastructure design, in accordance with national environmental legislation, international environmental conventions, and best available technology assessments for improved project design.
- **Aquatic Sciences (Freshwater and Marine)**—Katja's extensive experience in marine and freshwater systems include a decade leading the environmental monitoring of impacts from a coal-fired power plant in the Philippines, as well as ongoing impact assessment projects for offshore oil and gas activities in the southern North Sea in the UK. She has also undertaken water quality projects in Southeast Asia and Australia.
- **Climate Change and Sustainability**—Recognising the need for projects that address not only the climate change problem but also aids in promoting sustainability, Katja led GHD Philippines' efforts in this area. Her experience in the climate change space includes the conduct of greenhouse gas inventories for various sectors, preparation of mitigation and adaptation management plans, and incorporation of sustainability and disaster risk reduction in environmental studies. Katja has international experience with assessments of project impacts on and from climate change in various sectors, including the power industry and infrastructure. She has undertaken climate change impacts, mitigation, adaptation, and resiliency research and assessments.
- **Contamination Assessment and Remediation**—Katja led the provision of contamination assessment and environmental compliance projects in GHD Philippines, continues to undertake similar projects in the UK, and also has broad experience in undertaking compliance audits. She has been involved in various asbestos surveys and other hazardous material projects, and assessment of various types of contamination under varying sectors, including oil and gas, power, and property development.
- **Ecology and Ecosystems Services**—Katja has been continually involved in various natural resources management projects in the area of environmental monitoring, baseline assessments, and ecological risk assessment. She also has experience in environmental modelling as a tool for the assessment of potential impacts of proposed development projects on the environment.
- **Environmental and Social Impact Assessment and associated approvals**—Katja's extensive EIA experience includes the conduct of environmental baselining and impact assessments for various components in the energy and oil and gas sectors, environmental monitoring projects (e.g., water and air quality, marine ecology and ecotoxicology, etc.) and environmental performance and management studies. She is familiar with environmental legislation in the UK and the EU, as well as in various countries in Asia (Philippines, Malaysia, Indonesia, and Cambodia), and Australia.
- **Stakeholder Engagement and Social Sustainability**—While the consideration of the impacts of development on surrounding communities and stakeholders is a key component of all environmental impact assessment work that Katja has been involved in, she also has specific experience in the conduct of stakeholder engagement and social impact assessment for the energy, infrastructure, and mining sectors.
- **Water Quality and Resources—**Katja has undertaken water quality projects in the marine and aquatic environments, including baseline and impact assessment, monitoring, and compliance assessment for projects located in, and having impacts on, the estuarine environment, including coal-fired power plants, reclamation projects, inter-island bridge link and causeway, ports, and other coastal facilities.

Bruno Dupré, Biol., M.Sc.
Associate

Qualified: M.Sc. in Biology, Université Laval, 2006, B.Sc. in Biology, Université Laval, 2001

Connected : Quebec Business Council on the Environment (CPEQ), Association québécoise pour l'évaluation d'impacts (AQÉI), Réseau Environnement, Secrétariat international francophone pour l'évaluation environnementale (SIFÉE)

Professional Summary: Responsible for managing a multidisciplinary team, Mr. Dupré applies his extensive experience to overseeing numerous environmental studies. He has also directed and served as a risk assessment expert on a multitude of environmental and human health risk assessments. His work at GHD has equipped him with a solid background in conducting impact studies and analyzing risks to the environment and human health as well as those posed by technological hazards. Mr. Dupré has also contributed to projects in Morocco, Benin, and Angola.

Environmental Assessments and Impact Studies

Project Director

- Environmental impact assessment of a project to mitigate public safety risk related to unexploded ordnance (UXO) at Saint-Pierre Lake | Defence Construction Canada | Nicolet, QC | 2018-Present
- Environmental impact assessment and monitoring of a ten-year maintenance dredging program for the shipping channel from Mines Seleines to Grande-Entrée (2008-2018) | The Canadian Salt Company Limited | Îles-de-la-Madeleine, QC | 2015-2018
- Structure dismantling and deconstruction, Rocher aux Oiseaux, Îles-de-la-Madeleine | PSPC for the CCG | Îles-de-la-Madeleine, QC | 2017-2018
- Dismantling and cleaning of the SS Corfu Island, Étang-du-Nord, Îles-de-la-Madeleine | PWGSC for the CCG | Îles-de-la-Madeleine, QC | 2017-2018
- Environmental assessment of the restoration of the Fraser Point wildlife management plan in the Lac-Saint-François National Wildlife Area | PWGSC | Dundee Township, QC | 2016 and 2018
- Biological and physiochemical characterization during the construction of a new container terminal in Contrecoeur | Montréal Port Authority | Contrecoeur, QC | 2012-2015
- Annual maintenance dredging of the St. Lawrence waterway (2016-2018), EEE in 2016, 2017, and 2018 from Montréal to Cap Gribane | Canadian Coast Guard (DFO-CCG) | St. Lawrence River, QC | 2015-2016
- Berth clearing in Montréal and Contrecoeur, 2015-2020 | MPA | St. Lawrence River, QC | 2015-2016
- Maintenance dredging of the L'Anse-à-Brillant harbour in 2015, Public Works and Government Services Canada (PWGSC) | Gaspésie, QC | 2014-2015
- Oil field renovation project in Sèmè, Benin | Roche ltée and South Atlantic Petroleum | Sèmè, Benin | 2012-2014
- Environmental impact assessment for the expansion and renovation of Rio Tinto Fer et Tintane port facilities | Rio Tinto, Fer et Titane | Havre-Saint-Pierre, QC | 2010-2013
- Environmental impact and technological hazard assessments and an annual emergency plan update at a chemical and petroleum storage terminal for IMTT-Quebec | City of Québec | 2008-2013
- Assessment and identification of study needs and a cost estimate for various compensation programs linked to the construction of a new bridge over the St. Lawrence River | PWGSC | QC | 2015
- Vopak and IMTT-Québec facility modifications at the Port of Québec, Beauport sector | Greenergy Fuels Canada Inc., Vopak Terminaux de l'est du Canada and IMTT-Québec | Québec, QC | 2015

Project Manager

- Port of Québec quay 53 consolidation project | Québec Port Authority (QPA) | Québec, QC | 2012
- Loading ramp replacement for tanker trucks at a bulk liquid chemical and petroleum product terminal | confidential client | Quebec, QC | 2012
- Expansion and renovation of Rio Tinto Fer et Tintane port facilities | Rio Tinto, Fer et Titane | Havre-Saint-Pierre, QC | 2010-2011
- Options assessment for managing dredged sediment during Port of Montréal maintenance dredging | MPA | Montréal, QC | 2009-2010

- Environmental impact study of a project to inspect halieutic products in the Cotonou, Benin fishing port | Roche ltée and MCA-Benin | Benin | 2009-2010
- Environmental impact studies for two multimodal train-truck platforms in Lobito and Huambo, Angola | TECOR-Angola | Angola | 2009
- Environmental impact studies regarding the installation of gas stations in Angola | TECOR-Angola | Angola | 2009
- Environmental impact studies of petroleum product terminals in Malanje and Huambo| TECOR-Angola | Angola | 2009

Toxicological and Ecotoxicological Risk Assessments

Project Director

- F.X. Drolet building | Laboratoires d'Expertises de Québec | Québec, QC | 2019-Present
- Planning ecotoxicological risk assessments and risk management | Parks Canada's Lachine Canal National Historic Site | PWGSC | Montréal, QC | 2019
- Former Lac-du-Coude work camp | Public Works and Government Services Canada (PWGSC) | La Mauricie National Park, QC | 2016-2019
- Federal training centre | Public Works and Government Services Canada (PWGSC) | Laval, QC | 2018
- Former Irving gas station | Irving | Causapscal, QC | 2018
- Residential property on D'Aiguillon Street | confidential client | Québec, QC | 2018
- Opinion on risks affecting a commercial building on Jean-Talon Street West | Confidential Client | Montréal, QC | 2018
- Jean-Charles Chapais Experimental Farm | Public Works and Government Services Canada (PWGSC) | Lévis, QC | 2016-2018
- Former Irving oil product storage facility | Irving | La Tuque, QC | 2017
- Former Irving oil product storage facility | Irving | Trois-Rivières, QC | 2017
- Vacant lot, former Michelet snow dump | Akifer / City of Québec | Québec, QC | 2017-2018
- Vacant lot, obsolete Estimauville snow dump | SM Environnement / City of Québec | Québec, QC | 2016-2017
- Testing division of the Defence Research and Development Canada (DRDC) | PWGSC | Valcartier, QC | 2014-Present
- Risk management plan for five lighthouses | PWGSC | Îles-de-la-Madeleine and Île d'Anticosti, QC | 2016-2017
- Îles-du-Grand-Caouis and Île-aux-Oeufs; rear light on Point-à-Basile navigation aid | PWGSC | Gulf of St. Lawrence and Lévis, QC | 2014-2017
- Îles des Esquimaux quay | PWGSC | Bonne-Espérance, QC | 2015-2016
- Bonaventure Project | S.M. Environnement | Montréal, QC | 2015-2016
- Lots bordering the 911 site at Parks Canada's Lachine Canal National Historic Site | PWGSC | Montréal, QC | 2014-2016
- Risk management plan for 7 lighthouses on Île d'Anticosti | PWGSC | L'Île d'Anticosti, QC | 2015-2016
- Property bordering an airport in Mirabel | PWGSC | Mirabel, QC | 2015-2016
- Risks associated with vapour intrusion into HMCS Champlain buildings | Defence Construction Canada (DCC) | Saguenay, QC | 2015-2016
- Cap-des-Rosiers and Grande-Grave harbours | PWGSC | Forillon National Park, QC | 2014-2015
- Southern redoubt | Public Works and Government Services Canada (PWGSC) | Royal Military College Saint Jean, Saint-Jean-sur-le-Richelieu, QC | 2014-2015
- Former IPC plant | City of Saint-Jean-sur-Richelieu | Saint-Jean-sur-Richelieu, QC | 2011-2015
- Former residual materials landfill in Trois-Rivières | confidential client | Trois-Rivières, QC | 2013-2015
- Problem statement concerning the Redoute Sud | Biogénie | St-Jean Royal Military College, Saint-Jean-sur-le-Richelieu, QC | 2013-2014
- Rouge Island lighthouse station | PWGSC | Tadoussac, QC | 2013-2014
- Former Northern Electrical building on Richardson Street | Inspec-Sol | Montréal, QC | 2014
- Residential building in Québec | Société Action Chambreurs | Québec, QC | 2014
- St-Denis commercial space | Groupe C. Laganière | Montréal, QC | 2014
- Bercy public works storage facility | S. M. Environnement | Montréal, QC | 2014
- Galerie des Cantons shopping mall | S. M. Environnement | Coaticook, QC | 2013-2014
- Residential building in Québec | confidential client | Quebec, QC | 2013

- Opinion on toxicological and ecotoxicological risks associated with seeking a technical impracticality waiver for soil remediation at a Lachine industrial and manufacturing installation | CRA | Lachine, QC | 2013
- Former industrial site in Lachine | CRA | Lachine, QC | 2012
- Apartment building in Québec | confidential client | Québec, QC | 2013
- Development of effluent criteria for groundwater coming from the west sector of the Pointe St-Charles Technoparc along the Saint Lawrence River near the Parc d'entreprises de la Pointe St-Charles (PEPSC) | JCCBI and PWGSC | Montréal, QC | 2012
- Residential / commercial property in Shawinigan | Roche ltée | Shawinigan, QC | 2012
- Shawinigan Ecocentre | City of Shawinigan | Shawinigan, QC | 2012

Project Manager

- Opinion on toxicological and ecotoxicological risks associated with seeking a technical impracticality waiver for soil remediation at an industrial and manufacturing installation | CRA | Québec, QC | 2011
- Waste snow dump and road materials storage platform at the Julien-Lord depot | City of Longueuil | Longueil, QC | 2011
- Train marshaling and maintenance yard construction | SM Environnement | Montréal, QC | 2009-2011
- Ecological risk assessment of the Port of Montréal's waste snow management on the Saint-Lawrence River ecosystem | Montréal Port Authority (MPA) | Montréal, QC | 2009-2011
- Industrial and manufacturing installation in Lachine | CRA | Lachine, QC | 2008-2011
- Daycare centre in Westmount | Qualitas ltée | Montréal, QC | 2011
- Industrial installation in Lebel-sur-Quévillon | Biogénie | Lebel-sur-Quévillon, QC | 2010-2011
- Vacant land in Longueuil | Qualitas ltée | Longueuil, QC | 2010
- École de Technologie Supérieure (ETS) building in the Sud-Ouest Borough of Montréal | Qualitas ltée | Montréal, QC | 2010
- Commercial installation in Montréal's Hochelaga-Maisonneuve Borough | Qualitas ltée | Montréal, QC | 2010
- Future residential site in the St-Hubert Borough | Qualitas ltée | Longueuil, QC | 2010
- Industrial installation in Boucherville | Groupe C. Laganière | Boucherville, QC | 2010
- CBSA College in Rigaud | PWGSC and Canada Border Services Agency (CBSA) | Rigaud, QC | 2009-2010
- Compost valorization project in Grosse-Île | PWGSC and PC | Grosse-Île, QC | 2009
- Human health impact assessment of the Turcot interchange reconstruction, expertise provided at BAPE public hearings | MTQ / Dessau | Montréal, QC | 2009
- Pointe Sud-Ouest lighthouse station on Île-d'Anticosti | PWGSC and DFO | Québec, QC | 2009
- Bagot Cliff (Pointe Sud) lighthouse station on Île-d'Anticosti | PWGSC and DFO | L'Île-d'Anticosti, QC | 2009
- Commercial installation in Montréal's Ville-Marie Borough | confidential client | Montréal, QC | 2008
- Berth at the Port of Québec | Québec Port Authority | Quebec City, QC | 2008
- Cartier-Brébeuf National Historic Site | PWGSC and PC | Québec, QC | 2008
- Sainte-Marie Island lighthouse station | PWGSC | Côte-Nord, QC | 2007
- East quay at Mont-Louis | PWGSC and Transport Canada | Gaspésie, QC | 2007
- Waste management site | City of Lévis | Lévis, QC | 2007
- Risks associated with a contaminated water spill | Groupe SM | St-Damien, QC | 2007

Water, Soil, Sediment, and Biological Characterizations

Project Director

- Sediment characterization for berth clearing operations at the Port of Montréal in Montréal and Contrecoeur | MPA | Montréal, QC | 2012-Present (annual)
- Identification of a suitable location for implanting artificial reefs, characterization of the reference state, and update of the reef maintenance plan | PWGSC and TC | Mont-Saint-Pierre (Gaspésie) | in progress
- Compliance monitoring of lobster reefs in Baie de Plaisance | PWGSC, DFO, and TC | Îles-de-la-Madeleine, QC | in progress

- Survey of ornamental hardwood trees at CFB Valcartier, the Citadelle of Québec, Pointe-à-Carcy, the Saint-Malo military complex, the Sainte-Foy armoury, and a CFHA property on Saint-Louis Street | Defence Construction Canada | Québec, QC | 2017-2018
- Exhaustive environmental characterization (air, noise, soil, sediment, surface and ground water) and land and marine (benthic) environment surveys for an oil field redevelopment project in Sèmè, Benin | Roche ltée and South Atlantic Petroleum | Sèmè, Benin | 2012-2014
- Sampling and physiochemical characterization of surface water and mollusks in aquaculture sites in Baie de Gaspé and water column characterization | PWGSC and TC | Gaspésie, QC | 2013-2014
- Sediment, soil and groundwater characterization at the Paspébiac quay | PWGSC | Gaspésie, QC | 2013
- Sediment characterization in the St. Lawrence seaway upstream from lock 4 between Cornwall and Beauharnois | St. Lawrence Seaway Management Corporation | Saint Lawrence River, QC | 2013
- Biological and sediment characterization to update drinking and fire-prevention water treatment and distribution at the La Macaza Institution | PWGSC | Québec, QC | 2013
- Habitat characterization at a Baie-Comeau ocean disposal site | PWGSC and TC | Baie-Comeau, QC | 2012
- Sediment characterization and benthic organism identification at the Port of Trois-Rivières during maintenance dredging | TRPA | Trois-Rivières, QC | 2012

Project Manager

- Sediment characterization during berth clearing operations at the Port of Montréal | MPA | Montréal, QC | 2011
- Sediment characterization of Port of Montréal property in Contrecoeur | MPA | Contrecoeur, QC | 2011
- Fish habitat characterization at Cap-aux-Meules and Grosse-Île ocean disposal site | Environment Canada | Îles-de-la-Madeleine, QC | 2010-2011
- Sediment and fish habitat characterization on a Rio Tinto Fer et Tintane (RTFT) property in Havre-St-Pierre in the Basse-Côte-Nord region (Quebec) | Rio Tinto Fer et Tintane | Havre-Saint-Pierre, QC | 2010-2011
- Sediment and fish habitat characterization at the L'Anse-au-Griffon harbour | Fisheries and Oceans Canada and Public Works and Government Services Canada | Gaspésie, QC | 2010
- Sediment characterization at the Port of Trois-Rivières | Trois-Rivières Port Authority | Trois-Rivières, QC | 2010
- Benthic characterization on Port of Montréal property | MPA | Contrecoeur, QC | 2010
- Sediment characterization, screening, and a compensation project during a Rimouski harbour breakwater extension project | Rimouski-Est (Quebec) | Fisheries and Oceans Canada and PWGSC | 2010
- Environmental characterization prior to maintenance dredging in a Pointe-Basse harbour | PWGSC | Îles-de-la-Madeleine, QC | 2009
- Environmental characterization, screening, and a compensation project during a Tourelle harbour breakwater extension project in Gasépsie (Quebec) | DFO | 2009
- Sediment sampling at Traverse du Nord dredging and dumping sites (St. Lawrence maritime seaway), near Île d'Orléans | Canadian Coast Guard | St-Lawrence River, QC | 2007
- Sediment sampling at the Port of Cap-aux-Meules, analysis and identification of benthic organisms, sea floor description based on video surveys | PWGSC | Cap-aux-Meules, QC | 2007

Emergency Plans and Technological Hazards

- Semi-annual update of the emergency response plan (ERP) for a chemical and petroleum tank farm in Quebec | IMTT | Québec, QC | 2008-present
- Public safety plan for the Lake-Saint-François National Wildlife Area | Parks Canada | Dundee, QC | 2015-2016
- Identification of target species, tanker-transported products, and research needs for three response zones in eastern Canada | PWGSC and DFO | 2015
- Technological hazards study for a hydrogen peroxide storage terminal | IMTT-Quebec | Québec, QC | 2011
- Emergency response plan for a petroleum product terminal | TECOR-Angola | Malanje, Angola | 2010
- Emergency response plan for a petroleum product port terminal | TECOR-Angola | Luanda, Angola | 2010
- Technological hazards studies for two multimodal train-truck platforms in Lobito and Huambo, Angola | TECOR-Angola | Angola | 2009

Development and Revegetation Plans

- Management plan for the restoration of a disturbed conservation area in Beauharnois, QC | City of Beauharnois | 2016
- Revegetation plan for a retaining wall reconstruction project on the banks of a waterway in Sainte-Adèle, QC | confidential client | 2015

Plant and Wildlife Surveys, Wetland Identification and Delineation, and other Field Work

Project Director

- Invasive alien species monitoring and intervention at the St-Bruno shooting range and Farnham training area (DND) | Defence Construction Canada | St-Bruno, QC | in progress
- Preparation of a plant and wildlife survey plan (amphibians, reptiles, birds, micromammals, bats, and fish) at the Royal Military College Saint-Jean | Defence Construction Canada | Saint-Jean-sur-Richelieu, QC | 2018
- Herpetofauna survey at CFB Valcartier (Department of National Defence) | Defence Construction Canada | Québec, QC | 2017-2018
- Survey of wetlands, plants, wildlife, and invasive alien species at the DND's Munitions Experimental Test Centre (METC) in Nicolet | Defence Construction Canada | Nicolet, QC | 2017-2018
- Invasive alien species detection, monitoring and intervention at the St-Bruno shooting range and Farnham training area (DND) | Defence Construction Canada | St-Bruno, QC | 2017
- Wetlands, plants, and wildlife survey and CA request (section 22 of the EQA) for peatland in Sainte-Jeanne-d'Arc, QC | Lambert Peatmoss inc. | 2013 - present
- Monitoring and supervision during a project to improve the free passage of brook trout a stream near Havre-Saint-Pierre, QC (fish habitat compensation project) as part of the expansion and renovation of Rio Tinto Fer et Tintane port facilities | Rio Tinto Fer et Tintane | Havre-Saint-Pierre, QC | 2013-present
- Wildlife and vegetation surveys on MPA property in Contrecoeur, QC | MPA | 2008-2017
- Identification of wetlands for a development project in Saint-Charles-Borromée, QC | 9191-2352 Québec inc. | 2016-2017
- Plant and wildlife survey on a QPA property in the Beauport area | QPA | Beauport, QC | 2015 - 2016
- Ecological description for building demolition in Beaconsfield, QC | City of Montréal | 2016
- Physical and biological characterization of a quay in Saint-Maxime-du-Mont-Louis in Gaspésie, QC | Transport Canada (TC) | 2014 and 2016
- Wetlands study in the Chaudière area in Québec, QC | City of Québec | 2015
- Vegetation survey and watercourse delineation in Petite-Rivière-Saint-François, QC | Le Massif de Charlevoix Immobilier | 2013

Project Manager

- Sampling of benthic macroinvertebrates in rivers and streams at the Valcartier Garrison in Québec using CABIN methodology | Defence Construction Canada / Department of National Defence | Valcartier, QC | 2012-2013
- Reference state determination of submerged vegetation at an ice boom near Yamachiche in Lake Saint-Pierre | Canadian Coast Guard | 2010-2011
- Characterization of ichthyofauna in Mont-Châtel Stream | City of Québec | Québec, QC | 2011
- Surface water, sediment and ichthyofauna characterization in a stream in Sorel, QC | Rio Tinto Fer et Titane | Sorel, QC | 2011
- Wildlife survey and plant and wildlife management in Cartier-Brébeuf Park, Quebec | PC | Quebec, QC | 2010-2011
- Reference state determination of submerged vegetation and turbidity monitoring during excavation operations to replace an ice boom anchor near Yamachiche | Canadian Coast Guard | Saint-Pierre Lake, QC | 2010
- Plant and wildlife surveys at the Massif de Petite-Rivière-Saint-François ski resort | Groupe Le Massif | Petite-Rivière-Saint-François, QC | 2009
- Plant and wildlife survey on a Port of Montréal property in Contrecoeur | MPA | Contrecœur, QC | 2008-2009
- Environmental characterization for an artificial reef for lobster in Plaisance Bay | PWGSC and TC | Îles-de-la-Madeleine, QC | 2008-2009
- Wildlife survey on private property in Laval | Inspec-Sol | Laval, QC | 2008-2009
- Ecosystem monitoring for ecological restoration of the St. Charles River bank project, phases III, IV, V and VI | City of Québec | Québec, QC | 2008
- Wildlife survey on private property in Mercier | Inspec-Sol | Québec, QC | 2008

International Projects

Project Manager

- Millennium Challenge Corporation (MCC) Morocco Compact - independent engineering services for the Fez Medina Artisan projects | Roche and MCC | Morocco | 2011-2014
- Environmental impact study for an offshore oil field redevelopment project in Sèmè, Benin | Roche ltée and South Atlantic Petroleum | Benin | 2012-2014
- Environmental audit for the dismantling and demolition of offshore oil platforms in Sèmè, Benin | Roche | Benin | 2013
- Emergency response plan for a petroleum product terminal in Malanje | TECOR-Angola | Malanje, Angola | 2010
- Emergency response plan for a petroleum product port terminal in Luanda | TECOR-Angola | Luanda, Angola | 2010
- Environmental impact study of a project to inspect halieutic products in the Cotonou, Benin fishing port | Roche ltée and MCA-Benin | Benin | 2009-2010
- Environmental impact studies regarding the installation of gas stations in Angola | TECOR-Angola | Angola | 2009
- Environmental impact studies of petroleum product terminals in Malanje and Huambo | TECOR-Angola | Angola | 2009
- Environmental impact and technological hazards studies for two multimodal train-truck platforms in Lobito and Huambo, Angola | TECOR-Angola | Angola | 2009
- Environmental impact studies of petroleum product port terminals in Luanda and Lobito, Angola | TECOR-Angola | Angola | 2008

Environmental Monitoring and Follow-up

Project Director

- On-site acoustic monitoring of detonating unexploded ordnance (UXO) at Saint-Pierre Lake | Defence Construction Canada | Nicolet, QC | 2018-2019
- Groundwater monitoring for the construction of a new bridge over the St. Lawrence | PWGSC and Infrastructure Canada | Saint Lawrence River, QC | 2015
- Cetacean monitoring during dredging activities in the Port of Rimouski | PWGSC and Transport Canada | Rimouski, QC | 2013

Project Manager

- Environmental monitoring and water quality assessment of the maintenance dredging of berths at the Port of Montréal | MPA | Montréal, QC | 2007-2008, 2010
- Environmental monitoring during deepening dredging and extension of berths 76-77 at the Port of Montréal | Port of Montréal Authority (MPA) | Montréal, QC | 2010
- Monitoring of maintenance dredging at the port of Becancour | Société du parc industriel et portuaire de Bécancour (SPiPB) | Becancour, QC | 2010
- Environmental monitoring and follow-up of maintenance dredging of the Grande-Entrée channel | The Canadian Salt Company Limited | Îles-de-la-Madeleine, QC | 2008

Reference Documents and Training

- Risk analysis seminar for graduate students enrolled in a course on environmental site assessment | Université de Sherbrooke | 2010-present
- Identification of environmental responsibilities and good practice when using hovercrafts near navigation aids | PWGSC for the DFO | 2015-2016
- Identification of environmental responsibilities and good practice when using helicopters near navigation aids | PWGSC for the DFO | 2014-2015
- Review of the screening guide published by Small Craft Harbours | DFO-SCH | 2007

Other Projects

- Expert opinion for a legal case involving the environmental processes involved in constructing a temporary bridge | Dentons Canada | 2013-2016
- Expert opinion for a legal case involving the redesign of a stream alleged to be the source of flooding on a property on the banks of Ouareau Lake, QC | Desjardins Insurance | 2013-2015
- Identification and classification of contaminated aquatic sites in the Saint Lawrence River | PWGSC and EC | 2008-2009
- Evaluation of securities to be included in a Desjardins environmental fund | Desjardins Funds | Montréal, QC | 2007
- English-French translation and report writing | GHD | 2007-present

Fisheries and Oceans Canada

- Management of the Canadian Ballast Water Database | Mont-Joli, QC | 2006-2007
- Organization of the 35th Benthic Ecology Meeting | Mont-Joli, QC | 2006

- Marine mammal tagging, radio tracking, and biopsy sampling in the St. Lawrence River | Fisheries and Oceans Canada | Saint Lawrence River, QC | 2003
- Marine mammal survey of the Gulf of St. Lawrence | Fisheries and Oceans Canada | Gulf of St. Lawrence | 2002
- Surveying, sampling, and identification of marine mammals and benthic organisms | Mont-Joli, QC | 2001-2007

Other related areas of interest

Recognized (Certifications/Trainings)

- Guidelines for the Federal Contaminated Sites Action Plan (FCSAP) targeting purification strategies, long-term monitoring, and site closing | Environment and Climate Change Canada | 2017
- OSHA (Occupational Safety and Health Administration) - HAZWOPER (Hazardous Waste Operations And Emergency Response) 40-hour course | Inspec-Sol | 2014
- Radiotelephone Operator's Certificate | Canadian Coast Guard | 2014
- Emergency planning workshop on the federal Environmental Emergency Regulations - Environment Canada | Rimouski, QC | 2010
- Workplace first aid training (CNSST) Centre de Formation en Secourisme du Quebec | 2011
- Vapour intrusion workshop | Health Canada | Montréal, QC | 2009
- Identification of catostomid and cyprinid fish | Ministère des Ressources naturelles et de la Faune | Longueuil, QC | 2009
- Pleasure Craft Operator Card, Canadian Coast Guard, 2002

Work history

2017 - present	Associate, GHD, Québec
2012	Director, GHD (formerly Inspec-Sol Inc.), Québec
2006 – 2007	Fisheries and Oceans Canada
2005	Canadian Society of Zoologists
2001 – 2002	Maurice Lamontagne Institute, Mont-Joli, QC
2001	Centre d'expertise en analyse environnementale du Québec (Explos-Nature, Bergeronnes, QC)

Laura Lawlor
Associate, Senior Ecologist

Qualified: M.Sc. Biology (Paleolimnology), Queen's University, 2006; B.Sc. Honours Earth Science and Biology, Dalhousie University, 2001; Certified Ecologist, Ecological Society of America

Connected: Member, Society of Canadian Limnologists; Member, Ecological Society of America

Professional Summary: As the Natural Resources Service Line Lead in North America, Laura provides the necessary technical expertise and project execution experience that results in effective deliverables through all project stages from study design, data collection, data review, and reporting. Laura's extensive project experience across many client sectors allows her to provide expert review and strong team management. Laura has successfully managed multi-disciplinary project teams to achieve project objectives and excels in developing and sustaining effective communication within project teams, and amongst agencies and stakeholders.

Natural Environment Characterization, Assessment, Monitoring and Design

Lead Ecologist
Materials Management Facility and Organics Processing Facility EIS and Design Development | Simcoe County | Springwater, ON | 2016 - present

GHD was retained to provide consulting services related to site selection, permitting and design associated with a new combined Materials Management Facility (MMF) and Organics Processing Facility (OPF). As lead ecologist, Laura was responsible for workplan development, coordination of field staff and primary authorship of an EIS for the proposed facility. Natural constraints associated with the site included regulated land use designations (Greenlands, County Forest, and Provincially Significant), Species at Risk, and significant wildlife habitat. GHD's ecology team successfully navigated the regulatory system to ensure the commitments associated with the works were acceptable to the reviewing agencies, while significantly reducing the permits required. Further, Laura is managing the development of Compensation Planting, Wildlife Management and Environmental Management plans which feature mitigation of and or compensation for sensitive species and habitats.

Project Manager/Ecologist
Private Residence Development and Maintenance of Site Structures | Erin, ON | 2015 - present

GHD's client is developing a personal residence on a property constrained by open water, Provincially Significant Wetland, and upland woodland. Services provided to-date by GHD have included: geotechnical investigation of site soils, water and sediment quality assessment, hydrologic and hydraulic model development, preliminary septic system design, structural design of outlet structure repairs, agency liaison, basement shoring design (including sheet pile and soil anchors), compaction testing, bathymetric mapping, and contract preparation and issuance of the bid package for dam repair works. These activities have resulted in successfully obtaining multiple permits from CVC, a groundwater Permit to Take Water (PTTW) with addenda, and a Work Permit for dam outlet repairs under the Lakes and Rivers Improvement Act. GHD continues to provide support services for the on-going sediment dredging, dam outlet repairs and trail improvement works. As project manager, Laura continues to successfully manage 8 technical disciplines while coordinating with site contractors and approvals agencies.

Project Manager/Ecologist
Various Environmental Impact Studies and Assessments | ON | 2009 - present

Laura routinely completes Environmental Impact Studies (EIS) and Assessments for site development and evaluation. As Project Ecologist Laura is responsible for liaison with applicable authorities and stakeholders. Laura has coordinated and supervised various field activities to satisfy multi-disciplinary EIS's including wetland boundary delineations, breeding bird surveys, Ecological Land Classification, Species at Risk (SAR) screening, vegetation inventories, tree inventories, flow monitoring, hydrology and hydrogeology studies, and wildlife surveys. Many of these EIS's have required special considerations due to SAR potential presence and their proximity to natural heritage features such as Provincially Significant Wetlands (PSW), significant habitats and slope hazards. Notable projects include: City of Brantford Southwest Sports Complex, Voluntary Site Remediation (removal and restoration of 55 acres within Canagagigue Creek floodplain), Ferrero Canada Facility Expansion (Brantford), and North Clair Lake and Clair Creek Rehabilitation (Waterloo).

Project Ecologist
Salt Impacts on the Natural Environment | Various Municipal and Industrial Sites | 2011 - present

As project ecologist, Laura has been responsible for the assessment of road salt impacts from different approaches at municipal and industrial sites in southern Ontario. Her experience ranges from Environmental Impact Studies (EIS) that consider the direct impacts of snow disposal facility runoff on adjacent natural features (e.g. City of Guelph Snow Disposal Facility), planting plan design for large industrial site parking lots, to biological monitoring downstream of snow disposal facilities (e.g. City of Kitchener, Battler Road Snow Disposal Facility).

Project Manager
Wetland Function and Mapping Methodologies Assessment | MNRF | Peterborough, ON | 2017 - 2018

In 2017, the Ministry of Natural Resources and Forestry (MNRF) issued A Wetland Conservation Strategy for Ontario; 2017-2030, the first wetland strategy publically distributed in Ontario. GHD was retained by MNRF to provide non-consulting services pertaining to a literature review of wetland functions, methods of function measurement, and comparative review of wetland mapping and measurement by comparable agencies. As Project Manager, Laura manages the progress of the project team, is the client contact, and provides technical guidance for the evaluation and reporting to ensure the project objectives and client expectations are met or exceeded.

Technical Advisor
Sediment Removal from Carruthers Creek as Part of Highway 7 Widening Project | Dufferin Construction Company | Brooklin, ON | 2012

GHD, as part of a multi-disciplinary project team, completed construction oversight for the removal of non-native sediment deposits within Carruthers Creek, a Species at Risk (SAR) sensitive water body. Laura advised on and provided construction oversight for the removal of only targeted sediment from the creek using vacuum trucks.

Project Coordinator/Ecologist
Rehabilitation of North Clair Creek and Clair Lake | City of Waterloo | Waterloo, ON | 2009 - 2015

Laura worked closely with a multi-disciplinary team through numerous phases of the project related to the rehabilitation of an urban online pond and associated creek. The project started with a technical evaluation of a Class Environmental Assessment (EA) recommendation for taking an urban pond offline; based on technical abilities and overall performance, GHD's contract was extended to include preparation of an addendum to the EA, preliminary design, detailed design, and construction inspection and administration. Laura coordinated and prepared a Scoped Environmental Impact Statement (EIS) and O. Reg. 150/06 development permit application for the proposed rehabilitation works. Field surveys conducted and/or coordinated by Laura throughout the various project stages included updating the Ecological Land Classification assessment, delineation of wetland boundaries, incidental wildlife surveys, flow monitoring, temperature monitoring, installation and operation of an on-Site weather station, and tree inventory. Technical evaluations included PC-SWMM and HEC-RAS modelling, sediment quality characterization, assessment of need for design of rehabilitation measures to improve floodplain functionality, reduce sediment loading, and provide additional floodplain storage, and detailed design. Laura, as part of the project management team, developed a strong relationship and excellent communication skills with the various stakeholders (City, community task force, public, agencies and contractors).

Technical Advisor/Ecologist
Tree Inventories and Arborist Reports | Various (ON) | 2007 - present

Laura has been responsible for conducting or been the technical advisor for over 20 tree inventories or arborist reports in the regions of Waterloo, Wellington, York, Halton, Bruce and Brant. Ownership has ranged from private woodlots to municipal rights-of-way. These inventories and reports were prepared in support of successful development applications (municipal site plan, natural features by-laws, and conservation authorities).

Project Ecologist
Northeast Vaughan Water and Wastewater Class EA | York Region | Vaughan, ON | 2015 - present

As project ecologist, Laura is working with the Class EA project team to aid in the identification and assessment of natural features along the proposed wastewater routes in the City of Vaughan. The project includes baseline environmental investigations and technical evaluation for the Class EA. Laura has coordinated and directed both secondary source information reviews as well as high-level field investigations to refine and update the existing conditions. Data reviewed, complied and/or collected has included: natural heritage features present within the study area, breeding bird surveys, vegetation inventories, species at risk screening, and wildlife observations. Laura's responsibilities also include liaison with the relevant agencies, preparation of a Baseline Conditions report, and support for the alternatives assessment.

Lead Ecologist
Various Landfill Sites in British Columbia | Naut'sa Mawt Tribal Council | British Columbia
2015 - 2018

Laura has been the technical lead for Species at Risk (SAR) screenings of six landfill/material transfer station sites in the Fraser Valley, Okanagan Valley, and northwest coast of British Columbia. These include desktop screenings of provincial and federal data, under the Canadian Environmental Assessment Act (CEAA). Laura conducted a site reconnaissance of two of the sites to assess habitat and guide the assessment of on-site availability of habitat, and/or likelihood of presence. Laura also managed the assessments of impact from proposed works to any identified SAR and associated habitat.

Lead Ecologist
Environmental Review and Permitting | Kitasoo/Xai'Xais First Nation | Klemtu, B.C. | 2017 - 2018

GHD was retained to prepare the Environmental Assessment documentation and permitting support associated with upgrades to the water supply for the remote community of Klemtu. As lead ecologist, Laura provided technical guidance and review of the Species at Risk component of the environmental screening, and compliance with the *Fisheries Act* through self-assessment, DFO review, and on-site support through design changes. This included guiding the client through the implications of the presence of critical habitat of a federally threatened species (Marbled Murrelet) within the Study Area to ensure protection of the species and their habitat and conformance with the federal *Species at Risk Act*.

Restoration Specialist/Ecologist
Various Restoration Plan Designs | AB, B.C. and ON | 2007 - present

Laura has been responsible for completing or providing technical review of over 25 small scale restoration designs for disturbed sites in Western Canada, New Brunswick and Ontario. Ownership has ranged from private lands, transportation and municipal rights-of-way, remote rural areas, park lands, and public lands. These plans have been prepared as part of detailed design packages, emergency response, inventories and reports were prepared in support of successful development applications (municipal site plan, natural features by-laws, and conservation authorities).

Lead Ecologist
Environmental Assessment – New Landfill Facility | Secure Energy Services Inc. | B.C. | 2016 - present

GHD was retained by Secure Energy Services Inc. (SES) to complete and Environmental Assessment application under the Canadian Environmental Assessment Act (CEAA) for a proposed facility in northern British Columbia. Laura led the development of the field activity workplans, was the coordinator of the baseline monitoring (including both client and GHD biologists), conducted field surveys and site characterization and is responsible for the Existing Conditions Natural Environment reporting associated with the site Environmental Assessment for two short listed sites.

Project Ecologist
Aquatic Impact Assessment | Class EA – Collingwood WPCP Upgrades | Collingwood, ON | 2009

Laura conducted a desktop risk assessment of anticipated water pollution control plant discharges from a proposed expanded and upgraded facility to the aquatic community of the adjacent provincially significant wetland and Georgian Bay harbour.

Project Ecologist
Pre-Design, Detailed Design and Environmental Monitoring for the Upper York Sewage Solutions | York Region | East Gwillimbury, ON
2014 - present

GHD was retained to transition the project from the completed Individual Environmental Assessment (IEA) stage to the design/construction stage involving the pre-design, detailed design, contract administration and site inspection for the three components of the project namely, the Water Reclamation Centre (WRC), modifications to the existing York – Durham sewage system, and the total phosphorous off-setting program. As project ecologist, Laura is responsible for the technical evaluation of all aspects of the flora and fauna components (aquatic and terrestrial), including implementation of the UYSS EA environmental effects monitoring (EEM) commitments, liaison with reviewing agencies for any modifications of the EEM program, updating the Environmental Impact Assessment (EIA) reports, preparation of and obtaining all appropriate related approvals, reporting, and providing support throughout the design process with respect to natural features.

Project Manager/Ecologist
Fisheries Act and Species At Risk Screening Class I Railroad | Ingersoll, ON | 2013 - 2014

As part of the permits and approvals stage of railway bridge footing repair work, GHD was retained to prepared a Request for Review and supporting documentation under the Fisheries Act (as updated in 2012). Laura coordinated aquatic habitat assessment which included both a desktop screening assessment and site reconnaissance. Through the screening process GHD identified the potential for species at risk (SAR) mussels to occur in the vicinity of the bridge. Laura's project responsibilities included liaison and an on-site habitat survey with a Fisheries and Oceans Canada species at risk biologist and the client to establish next steps to

ensure that project could proceed under all applicable regulations.

Project Manager/Senior Ecologist
Wetlands Biodiversity Assessment | Confidential | Southwestern, ON | 2015 - 2016

GHD was retained to develop and implement a workplan to inventory and evaluate the biodiversity of wetlands created on restored former aggregate pit and quarry properties. This project focused on benthic macroinvertebrates, but also included shoreline and aquatic vegetation and incidental wildlife observations (insects, birds, reptiles, and mammals). Laura developed the workplan, provided over-sight for the field activities, and provided recommendations for consideration in design of future landscape-level rehabilitation plans.

Project Manager/Senior Ecologist
DFO Review and Bird Nest Surveys | Canadian National Railway | Stoney Creek, ON | 2015

GHD was retained by CN to provide natural environment technical guidance with respect to Site works that involved a new bridge and twining of the rail line. Laura completed the self-assessment for the three culvert crossings in accordance with Fisheries and Oceans Canada (DFO) guidance documents. Laura was the technical advisor for GHD staff who completed breeding bird and nest surveys to determine breeding bird presence in an area intended for vegetation removal. This was done to prevent any incidental take of migratory birds, and their nests and eggs, as defined in the Migratory Bird Convention Act.

Project Ecologist/Phase Coordinator
Waste Water Treatment Plant Upgrade | City of Owen Sound | Owen Sound, ON | 2010 - present

Laura worked closely with the Ministry of the Environment, Saugeen First Nation, and the City to develop a benthic macroinvertebrate monitoring program that met the requirements of the Class Environmental Assessment monitoring requirements of the planned water treatment plant upgrades in Owen Sound. The workplan included benthic macroinvertebrate monitoring, sediment characterization, field water quality parameters and macrophyte identification. Two baseline events were conducted in 2012 and 2013, with the remaining two events scheduled for 2017 and 2018 (post-construction). Laura coordinated the field data events, authored the first baseline report and provided senior review of the second baseline report.

Project Ecologist
Burnhamthorpe Road Watermain Class EA | Region of Peel | Mississauga, ON | 2014 - 2015

Laura participated in GHD's multi-disciplinary team to prepare a Class EA for upgrades to the water supply infrastructure along Burnhamthorpe Road. Laura's responsibilities included: liaison with the conservation authority, ecological background review, assessment of affected natural features (including street and natural area trees), and preparation of the baseline natural features assessment report. Laura also contributed to the assessment of alternative alignments and shaft sites, as pertained to the natural features.

Project Coordinator/Ecologist
Beetle Habitat Screening and Fisheries Review CP Rail | North Shore of Lake Superior, ON | 2014

During the course of planning for clean-up of residual inert materials from a beach, the Ministry of Natural Resources (MNR) identified the possible presence of a rare beetle. Laura was the liaison with the MNR, coordinating a GHD/MNR site visit to survey for the beetles and/or their structures, interpretation of results, and proposed alternative clean-up methods amenable to all parties. Laura also was the liaison with Fisheries and Oceans Canada, ensuring works work completed within applicable legislation. Through timely meetings and collaborative effort GHD facilitated the client proceeding with their pre-scheduled work on very short notice.

Technical Advisor
Overall Benefit Monitoring | Sharp Electronics Corporation | Smiths Falls, ON | 2014 - 2015

Laura was responsible for workplan guidance and reporting review of Bobolink (*Dolichonyx oryzivorus*) surveys conducted in support of a Ministry of Natural Resources and Forestry Overall Benefit Permit.

Aquatic Biologist
Water Pollution Control Plant Upgrade | Region of York | Kleinburg, ON | 2009

In reaction to changing legislation mid-stream of the project, Laura was added to the project team for the Kleinburg Water Pollution Control Plant (WPCP) works to conduct an impact assessment of the upgraded WPCP design on redside dace within the Humber River. Timely communication and coordination between the reviewing agencies (Ministry of Natural Resources, Toronto Region Conservation Authority), client, and within the project team was critical to keep the overall project on schedule. The assessment was submitted as supporting documentation for an O. Reg. 166/06 development permit application.

Senior Ecologist
Repair/Replacement of 16 Watercourse Crossing Structures along Highways 11 and 583 | Ontario Ministry of Transportation (MTO) | Northeastern, ON | 2016 - present

GHD was retained MTO to prepare the detailed design of the repair or replacement of 16 watercourse crossing structures along Highways 11 and 583, West of Hearst, Ontario. As the senior ecologist, Laura is providing workplan and reporting guidance, along with technical review of the natural sciences and impact assessment reports under multiple contracts.

Project Ecologist
Class EA, Detailed Design and Contract

Tendering for Improvements to Taunton Road | Region of Durham | Clarington, ON | 2017 - present

GHD was retained the Region of Durham to complete Class Environmental Assessment (EA), detailed design, permitting and contract tendering for road repairs and intersection upgrades along Taunton Road between Regional Roads 55 and 57. This study area includes wetland, provincially significant wetlands, wildlife passage corridors, watercourses and wooded areas. As Lead Ecologist, Laura provides guidance in workplan development, QA/QC review of natural environment reporting, natural environment design guidance, and coordination with the project team and agencies.

Project Ecologist
Vegetation Community Assessment | Confidential | Peterborough, ON | 2015

GHD was retained to conduct an ecological risk assessment (ERA) of a property with historic arsenic impacts. Laura completed the field and reporting activities to compare the composition of site wetland communities with those of the Jackson Creek East Provincially Significant Wetland (PSW). The site vegetation communities (wetland and upland) were used as proxy in one line of evidence in the ERA with respect to potential arsenic impacts in the local environment.

Project Ecologist/Field Coordinator
Benthic Biomonitoring, Aquatic Recovery Monitoring and Trail Restoration | City of Cambridge | Cambridge, ON | 2009 - 2012

Natural constraints of the trunk sewer installation works included tunneling underneath Moffat Creek and associated Moffat Creek Provincially Significant Wetland (PSW). Laura assisted in coordinating a number of natural environment activities associated with the trunk sewer installation activities. These included construction-phase surface water monitoring (flow, field chemistry parameters and mini-piezometers), trail relocation through the PSW, trail restoration and native plant planting plan, and monitoring of post-construction surface water, groundwater and benthic macroinvertebrate community recovery. Laura coordinated and reviewed the field activities and preparation of final deliverables.

Project Ecologist
Benthic Macroinvertebrate Sampling | Mountain Road Landfill | St. Catharines, ON | 2014

Laura worked closely with an interdisciplinary team of scientists and engineers to develop a monitoring program designed to identify and evaluate opportunities for refinement of the surface and groundwater compliance monitoring program at a closed landfill. Laura was the technical advisor for the benthic macroinvertebrate field activities and primary author of the monitoring report. Analyses community metrics and Hilsenhoff Biotic Index.

Project Ecologist
Benthic Macroinvertebrate Monitoring | Green Lane Landfill | St. Thomas, ON | 2007 - 2012

Dodd Creek was the receiving watercourse of the landfill stormwater discharge. GHD annually completed benthic macroinvertebrate monitoring within this creek as part of the site Certificate of Approval monitoring conditions. Laura was responsible for completing the annual field and reporting activities associated with benthic macroinvertebrate data collection from Dodd Creek. Data analyses included a suite of community structure metrics and BioMAP.

Technical Advisor/Ecologist
Gap Analysis for Due Diligence Risk Assessment and Trail Restoration | Infrastructure Ontario | Guelph, ON | 2014 and 2016

GHD conducted a review of a Phase Two Environmental Site Assessment (ESA) document to identify data gaps for conducting a Due Diligence Risk Assessment for the site. Laura provided guidance regarding the surface water, sediment, and electrofishing programs. In 2016, Laura also provided liaison with the conservation authority and technical guidance on the pedestrian trail restoration design.

Project Ecologist/Phase Coordinator
Fisheries Study | Infrastructure Ontario | Toronto, ON | 2013 - 2014

GHD was retained to prepare a Fisheries Study for Ontario Place in support of an Individual Environmental Assessment. The scope of work included a detailed review of secondary source information, identification of data gaps, recommendations for additional surveys, additional survey work, and preparation of the fisheries study report. GHD has completed the first three of these tasks; the fourth is on hold. Laura's project responsibilities included workplan development, liaison with the Toronto Region Conservation Authority, coordination of field staff, and reporting.

Project Ecologist
Baseline Water Chemistry and Benthic Macroinvertebrate Monitoring | Kawartha Ethanol | Havelock, ON | 2009 - 2010

Laura developed the workplan for and conducted a survey of surface water chemistry data and benthic macroinvertebrate community within the Plato Creek Provincially Significant Wetland and Plato Creek. This was conducted to document the baseline conditions prior to initiation of Site stormwater discharge from the new ethanol facility and establish discharge criteria for the stormwater ponds.

Project Ecologist
Headwater Drainage Feature Evaluation | Region of York | Nobleton, ON | 2009 - 2010

Laura evaluated an Oak Ridges Moraine greenfield site slated for development and prepared a scoped Natural Heritage Evaluation report. Laura also assisted in conducting a headwater drainage feature classification assessment of the site which contained two drainage features and a wetland. These evaluations were documented and submitted as supporting studies for an O. Reg. 166/06 permit application for construction of an elevated water supply tank.

Emergency Response and Preparedness

Technical Advisor/Ecologist
Derailment Remediation, Restoration and Monitoring | CP Rail | Banff, AB | 2014 - 2017

GHD was retained to provide emergency response environmental services following the derailment of train carrying fly ash and grain near Banff, Ontario. The derailment occurred on a creek within a Provincial Park. Laura responsibilities are as an advisory role, guiding the SAR and wildlife screenings, wildlife mitigation measures, development of the emergency DFO authorization, sediment and erosion control monitoring, surface water monitoring program, commentary on the remediation methodologies, and site restoration design. Laura continues to provide senior technical guidance and review for the benthic macroinvertebrate, sediment and surface water sampling program (total of four events).

Technical Advisor/Ecologist
Emergency Preparedness Exercises | Various | AB and ON | 2014 - 2017

Laura routinely participates as a project ecologist supporting the Incident Command System (ICS) in Emergency-preparedness mock spill scenarios for Trans-Northern Pipelines. The spill scenarios routinely involve dozens of active participants, including emergency response contractors, federal and provincial agencies, city and regional officials. Among the many plans developed by GHD, Laura is responsible for SAR and wildlife screenings, development of the wildlife management plan, and mitigation/avoidance of any environmentally sensitive areas and SAR in the vicinity of the mock spill.

Natural Environment Lead
Emergency Spill Response, Monitoring and Restoration Plan Design | Class I Railroad | Gogama, ON | 2015 - present

GHD was retained to provide emergency response environmental services following the derailment of 35 cars carrying crude oil near the rural community of Gogama. As the derailed train cars rested both on (Crown) land and in the Makami River, remediation of the site involved both terrestrial and aquatic environments. Laura has been involved in the project as the Senior Ecologist from the emergency response phase through remediation and restoration planning. Her responsibilities included collaborative development of the sediment and fish tissue collection workplans with project toxicologists; development of wildlife management plans and wildlife monitoring programs; design of erosion and sediment control plan and inspections; implementation of workplans and associated reporting; contractor oversight; management of project biologists and arborists; and preparation of the restoration design. This was accomplished while working in a team environment with the remediation engineers, contractors, client, and other stakeholders to ensure appropriate scheduling of work activities balancing seasonal, staffing, and budget considerations with agency, public, and Mattagami First Nation (MFN) considerations. Laura was the technical liaison for the Science Table discussions that involved a variety of federal and provincial agencies throughout the project (e.g., Fisheries and Oceans Canada, Environment Canada, Canadian Wildlife Service, Ministry of Natural Resources and Forestry), in addition to being the technical liaison with the public and MFN representatives.

Project Ecologist
Emergency Spill Response and Restoration Plan | CP Rail | Nipigon, ON | 2015

As part of GHD's emergency response services following a train derailment into brook trout spawning migration watercourse, Laura directed the initial species at risk screenings and consulted on the surface water monitoring program. Laura was the lead in developing the aquatic restoration plan (including an analysis of the existing creek habitat and hydraulics), terrestrial restoration landscape plan, and phased erosion and sediment control measures, protective of the highly sensitive aquatic environment and brook trout life history. Laura was also responsible for liaison with the MNRF and DFO, and to ensure that the works proceeded in accordance with the applicable natural environment regulations. Innovative measures were employed to monitor the site through freshet conditions and site establishment.

Project Ecologist/Phase Coordinator
Emergency Spill Response and Restoration Plan | CP Rail | White River, ON | 2013

As part of GHD's emergency response services Laura conducted species at risk screening for the site and surrounding area. Habitats included both upland forest, coniferous swamp, and a cool water river. Laura visited the site and coordinated development of the restoration landscape plan, including erosion and sediment control measures, wetland features and upland features. Laura's responsibilities also included coordinating with site engineers to source and analyze suitable topsoil and additives for restoration of the landscape features.

Select other areas of interest

Other Training

- DFO Fisheries Protection Program Fisheries Act Training, 2015
- DFO Ontario Freshwater Mussel Identification Workshop, 2014
- Earthquest Field Ornithology Course, 2014
- MNR Consultant Session – Improvements to the Implementation of the Endangered Species Act, 2013
- MNR Ontario Wetland Evaluation System, 2012
- MNR Fish Identification Level I Certification, 2012
- MNR Ecological Land Classification, 2010
- MOE Ontario Benthos Biomonitoring Network, 2008

Refereed Publications

- J. Kurek, L. Lawlor, B.F. Cumming & J.P. Smol (2012): Long-term oxygen conditions assessed using chironomid assemblages in brook trout lakes from Nova Scotia, Canada, Lake and Reservoir Management, 28:3, 177-188

Select Presentations

- Lawlor, L., 2018. One Size (Doesn't) Fit All – Lessons Learned in Effective Communication, Natural Channel Systems Conference, Guelph, Ontario, May 2018.
- Lawlor, L. and A. Pawlisz, 2016. Integrated Environmental Risk Assessments of Two Crude Oil Train Derailments and Fires in Northern Ontario, REMTech, Banff, Alberta, October 2016.
- Lawlor, L. and J. Peister, 2016. Brook Trout Creek Restoration Under Challenging Conditions. Natural Channel Systems Conference, Niagara Falls, September 2016.
- Lawlor, L. and F. Moreau, 2014. Understanding Changes to the Fisheries Act and the Impact on Rail Industry Projects. Rail Transportation and Engineering Center RREC, Urbana, Illinois, October 2014.
- Schrumm, L., B.F. Cumming, J. Sweetman, B.K. Ginn and J.P. Smol, 2005. Chironomidae as Indicators of Hypolimnetic Oxygen Decline in Nova Scotia Brook Trout Lakes: A Paleolimnological Assessment. (Poster) Society of Canadian Limnologists Annual Conference, Windsor, Ontario, January 2005.
- Schrumm, L., J.P. Smol and B.F. Cumming, 2004. Paleolimnological assessment of recent environmental changes in Nova Scotia. North American Chironomid Paleoecology Workshop, Fredericton, New Brunswick, May 2004.

Work history

2006 - present	GHD (formerly Conestoga-Rovers & Associates), Waterloo, ON
2004 - 2005	Queen's University, Kingston, ON
2001 - 2005	Frontline Environmental Management Inc., Kitchener, ON
2001	Wavefront Environmental Technologies, Cambridge, ON
1999 - 2000	Frontline Environmental Management, Kitchener, ON (student)
1999 - 2001	Dalhousie University, Halifax, NS

Victoria Brayshaw
Associate Director

Qualified: Masters in Civil Engineering, MEng (Hons) Class 1, University of Warwick, 2006; Chartered Civil Engineer, CEng, The Institution of Civil Engineers, 2010.

Connected: Chartered Civil Engineer, Supervising Civil Engineer, The Institution of Civil Engineers.

Professional Summary: Victoria is a multi-disciplinary Chartered Civil Engineer with over 15 years' experience in planning, design and construction.

Heading the Leeds Flood Risk and Development Infrastructure Team, Victoria is responsible for land development schemes throughout the UK. The team provides wide ranging advice from feasibility studies and options appraisal to detailed design and construction support.

Victoria also delivers flood risk assessments, both in the UK and oversees, and has experience of 1D flood modelling.

Associate Director

Flood Study | Kingdom of Saudi Arabia

GHD were engaged to undertake a flood study for a proposed tourism development near Tabuk in the Kingdom of Saudi Arabia. The Kingdom of Saudi Arabia, which is known typically to have dry climate, is highly susceptible to flooding during extreme rainfall events. Most of the annual rainfall is typically in the form of a few intense thunderstorm events of relatively short duration during the wet season. The flood study utilised geo-spatial data along with the available rainfall data for the region to provide a catchment wide analysis of the flood risk to and from the proposed development. GIS Mapping tools were used to present model outputs to the client.

Project Director

Bridlington Road | Bellway | Driffield

GHD were appointed to provide foundation design for 293 traditional load bearing masonry homes in Driffield, East Riding of Yorkshire.

The foundation strategy was complex due to the presence of existing hedges and trees in cohesive ground. GHD were able to provide a rapid turnaround on this element of the scheme design, in accordance with the client brief.

Project Director

Cornbrook Works | Manchester

Cornbrook Works is a private rented sector residential development delivering 308 apartments, 15 duplexes and 40 townhouses. Public amenity space is provided along the central avenue.

GHD were appointed to resolve the below ground drainage and section 278 highways design on the 2.1 ha site. Surface and foul water drainage systems needed to service all buildings whilst coordinating with proposed foundations, crane bases and utility apparatus. Significant below ground attenuation was required either side of the existing onsite culverted watercourse. The highway works involved extinguishing public highway, closing redundant access points and providing new access points and laybys.

GHD worked with the wider design team to consolidate and simplify the drainage solution. In accordance with best practice guidance, the drainage strategy adopted a hierarchical approach to surface water disposal. The existing surface water drainage regime was assessed and agreed with the Lead Local Flood Authority. A 50% reduction in the peak surface water flow rate was proposed in accordance with local design standards. Opportunities were put forward in relation to the above ground drainage to mitigate the number of slab penetrations and below ground clash points. Hydraulic modelling was undertaken to validate the drainage design and ensure that the site would not flood during a 1 in 100 year storm event with an allowance for climate change. GHD met the Highway Authority on site to discuss and agree the scope and extent of highway works required ahead of the production of Section 278 technical layout drawings and details.

Associate Director

Norfolk Vanguard Onshore Works | Norfolk

Vattenfall are developing the Vanguard and Boreas offshore windfarms, requiring a cable route to a substation 60km in land where the current can be converted and connected to the National Grid.

GHD prepared flood risk assessment reports for the full 60km cable route, as well as the converter and substations and used GIS mapping to plot the full cable route against flood zone locations and geological mapping to create a full view of the pressing issues along the route.

Associate Director

Pooley Bridge | Cumbria

Pooley had been home to an iconic three arch stone bridge for over 250 years. The bridge became an attraction in its own right until 2015 when the bridge was swept away during flooding caused by heavy rainfall during storm Desmond. GHD were appointed to produce a flood risk assessment that incorporated a full model of

the potential impacts of replacing the current, clear span temporary bridge with a permanent bridge which better encapsulates the history of the site.

Project Director

Burlington Square | Manchester

Located in the heart of Manchester's 'learning quarter' Burlington Square is a high quality residential development comprising 273 apartments over 9 storeys with ground floor communal facilities, central garden courtyard and a rooftop communal area. The scheme has been designed with the rental market in mind with quality throughout and efficient layouts.

GHD were appointed to resolve the below ground drainage and external works design on this heavily constrained site. Surface and foul water drainage systems needed to service all buildings whilst coordinating with proposed foundations, crane bases and utility apparatus. To mitigate flood risk, significant below ground attenuation also needed to be accommodated.

GHD worked with the project team to highlight the infrastructure constraints at the outset of the scheme. Once the principles of coordination were established it was possible to accommodate design iterations efficiently. Flood flow routing formed a critical component of the external works design and GHD worked with the team to ensure that the landscape proposals provided a holistic design solution that would mitigate flood risk to people and property over the lifetime of the development.

Project Director

Octagon Theatre | Bolton

Highway improvements to Bolton's Octagon Theatre as part of a dramatic extension and modernisation scheme to create a new rehearsal space, new seating for the main auditorium and improved backstage facilities, meaning that the building's studio theatre can become available for use all year round.

GHD were required to provide vehicle tracking and highway design to this constrained site within the centre of Bolton. As the site was so difficult to access it was necessary to validate that construction vehicles would be able to reach the site.

GHD worked with the design team to understand the aspirations for the highway scheme both in the construction phase and on completion. Vehicle tracking analysis was undertaken to validate delivery arrangements in a digital environment rather than by trial and error in a city centre location.

Lead Engineer

Ings Lane Masterplan | Brough

Victoria had responsibility for the outline design for the development of 50 ha of land at Ings Lane, Brough, to provide 800 dwellings, a relief road and bridge, a transport interchange, food store, hotel, leisure facilities, petrol station, care home, primary school and nursery. Victoria undertook the highway and drainage design for the Reserved Matters Application and developed the principal infrastructure strategy for the scheme.

Project Director

North Connect | Peterhead, Scotland

Victoria was responsible for the Civil Engineering enabling works design for a converter station at Peterhead, which was proposed to be 19 m below existing site levels. A comprehensive earthworks exercise was required to determine the balance of material post construction.

Lead Engineer

Newton Kyme, North Yorkshire

Victoria had overarching responsibility for technical delivery including demolition and remediation works, earthworks, foundations, highways, including Section 278 works and drainage for the 128 house scheme. She developed the principal infrastructure strategy in line with the recommendations of the Remediation Strategy and commissioned and oversaw the detailed engineering design.

Project Director

Tanton Road | Stokesley, North Yorkshire

Victoria was responsible for the planning, design and delivery of the highway engineering design for this multi-phased 226 house residential development. At the request of the Highway Authority, the highway design was undertaken in accordance with Manual for Streets. The design was particularly challenging due to a history of ground water and surface water flooding. Victoria met with Hambleton District Council Lead Local Flood Authority and Planning Team to explain the engineering solution and secure approval.

Project Director

Darton Masterplan | Barnsley, South Yorkshire

Victoria was responsible for the site access roundabout design, the onsite highways and external works design and the earthworks volumetric analysis for the 11.86 ha residential site. The highway works included the provision of a strategic link road which was to be designed in accordance with national standards. The wider highway network was to be designed in accordance with local guidance. Victoria liaised directly with the master planning architects to develop a masterplan that took account of the challenging topography, mineshafts and other engineering constraints.

Senior Engineer

York Road | Easingwold, North Yorkshire

As developer on this scheme, Victoria had overarching technical responsibility for the roads and sewers. This included attendance during highway inspections and testing and reporting defects, along with providing practicable engineering solutions to satisfy the local Highway Inspector. Victoria oversaw a program of testing on the highway subgrade and commissioned

further laboratory testing of base course material to demonstrate compliance with design standards.

Project Director

Black Rock Mills, Huddersfield

Victoria oversaw the planning and delivery of the highway engineering design for this 113 house scheme, including works to a culverted main river. The onsite highway design was particularly challenging due to the steep topography of the site. The offsite highways works were challenging as the existing highway was significantly steeper than local and national highway design standards would permit. Victoria led negotiations with the Highway Authority and the Environment Agency to ensure that the works were negotiated, approved and on site in a timely manner.

Senior Engineer

Four Arm Roundabout | Wombwell Bypass

Victoria was responsible for the outline and detailed design of a four arm roundabout on Wombwell Bypass in an area of historic flooding with a complex network of watercourses and culverts. She undertook road geometry design, drainage design, catchment and capacity analysis of the adjacent watercourses and culverts and led negotiations with Barnsley highways and planning teams, the Environment Agency and the Dearne and Dove Drainage Board.

Other related areas of interest

Masterplanning

- Victoria has significant experience in this field as a developer and as a consultant. Notable projects include Thorpe Park, Leeds and North Shore, Stockton-on-Tees. She is delivery led and keen to ensure that constraints are identified early.

Highways

- Victoria has significant experience of road geometry design and has more than a decade of experience in this field. Victoria is also proficient in highway drainage design and the detailed design of highway culverts, intakes and outfalls.

Flood Risk

- Victoria is passionate about providing Flood Risk Assessments that truly mitigate risk and can be effectively delivered.

Hydraulic Modelling

- Victoria has produced hydraulic models for both private drainage and adoptable sewers and has worked with the Environment Agency, Lead Local Flood Authorities and Sewerage Undertakers to secure technical approval.

Work history

2017 - Present	Associate Director, GHD
2015-2017	Associate, Later Associate Director, Dudleys
2012 – 2015	Senior Engineer, Redrow
2008 – 2012	Engineer, Later Senior Engineer Buro Happold Engineering
2006 - 2008	Graduate Engineer, WSP
2005	Assistant Engineer, JMP
2003	Assisstant Engineer, Mayer Brown

Jo Steele

Principal Consultant

Qualified (Education): MEng Environmental Engineering, First Class (Hons), University of Nottingham, 2005

Connected (professional affiliations): Chartered Scientist (CSci) 2020, Fellow of the Geological Society (FGS), 2011. Member of the Chartered Institution of Water and Environmental Management (MCIWEM), 2017.

Professional Summary: Jo has worked in environmental consulting since 2005. She has managed and coordinated a variety of projects, and specialises in contaminated land assessment related to due diligence, planning support and environmental permitting. She has experience working across a wide range of sectors, including oil and gas, waste, property development, food and beverage, automotive, aerospace, defence, nuclear and chemical industries.

Jo has managed, coordinated and completed Phase I and II environmental site assessments (ESAs), detailed site-specific environmental and human health risk assessment, asbestos in soils risk assessment, contamination trend analysis, remediation, Brownfield redevelopment, environmental permitting support including site closure and surrender, and compliance auditing.

Key Experience - Due Diligence and audits

Project Director and Technical Specialist Acquisition Due Diligence Phase I ESA | South East England

Jo managed a due diligence Phase I at a former sewage works for an industrial developer interested in acquisition of the site. The Phase I comprised a site walkover and review of pertinent records, including reports describing intrusive site investigation. The Phase I identified environmental data gaps relating to the condition of the groundwater at the site and the nearby surface water features. As a result, groundwater monitoring and detailed quantitative risk assessment were completed for the site. This allowed the client to better understand the constraints to site redevelopment and environmental liabilities associated with the purchase.

Project Director Environmental auditing, specialist vehicle manufacturing sites | Spain, France, Bulgaria, NI

Jo was the project director for a project comprising multiple environmental audits at manufacturing facilities across Europe. The client's global environmental manager requested these audits for internal purposes to understand the environmental performance of the selected facilities under their regular auditing programme. The sites were visited by Jo's team and specialist contractors local to the sites. Audit reports were generated and submitted to the client with recommendations for improvements at the sites, where applicable.

Project Manager and Technical Specialist Acquisition Due Diligence Geotechnical and Environmental Phase I and II ESAs | Midlands, UK

Jo supported one of GHD's development sector clients with their due diligence for potential acquisition of a former agricultural site located in the Midlands. The client wished to understand any environmental liabilities associated with the site and geotechnical development constraints ahead of submitting their bid for site purchase. Despite being a Greenfield site, vegetated mounds of unknown materials were discovered during the Phase I walkover. A Phase II was recommended and it was determined that significant quantities of fill material had been deposited on the site, which would require improvements to enable development of warehousing.

Project Manager and Technical Specialist Acquisition Due Diligence, Phase I and II ESAs | Turkey

Jo supported a client based in North America with the acquisition due diligence for a company operating multiple metal manufacturing sites in Turkey. The project comprised site reconnaissance with a local consultant to identify potential contaminated land risks and environmental legislation compliance issues at each of the sites. This was then followed by intrusive site investigation at the sites where potential land contamination had been identified. Costs were estimated for site improvements to ensure compliance with Turkish environmental legislation. The project enabled the client to make an informed decision on the purchase of the company and sites.

Project Manager and Technical Specialist Acquisition Due Diligence, Phase I ESAs | Germany

Jo supported a client based in in North America with the acquisition due diligence for a company operating

over 40 sites in Germany. With the assistance of a local consultant, an environmental desk study was carried out for each of the sites with reconnaissance at five of the sites selected as having the most potential for land contamination due to presence of fuel storage. The client was presented with a table that summarised the site history, current operations, surrounding land uses, and potential liabilities associated with each of the sites.

Project Manager and Technical Specialist
Acquisition Due Diligence, Phase I ESA | South East England

Jo provided support to a commercial property developer during their acquisition due diligence phase of works for a vacant plot of land in close proximity to a major motorway. The client required a rapid turnaround with a last minute mobilisation to site to carry out an inspection and completion of a records review. The Phase I comprised both environmental and geotechnical aspects. Jo produced a report that clearly identified the potential environmental risks associated with the site and the technical difficulties associated with future construction of a warehouse. Jo coordinated her team to provide all necessary aspects of the assessment with delivery of a comprehensive report to the client on a tight timescale.

Project Manager and Technical Specialist
Acquisition Due Diligence, Phase I and II ESAs with Drainage Survey | Scotland

Jo provided environmental due diligence assistance for a vehicle hire company's acquisition of a business based in Scotland. At the inception of the project, the client had regarded the site as being low risk with regards to environmental liability. By completing a detailed Phase I ESA the potential for land contamination was identified at the site due to current and historical use and storage of oils and fuels both above and below ground. Jo also identified that the business was discharging car wash water without consent. The client approved the recommendation to progress to a Phase II ESA and drainage survey to investigate the ground condition and discharge of waste water through site drains. The works were required on an expedited turnaround due to the tight acquisition due diligence deadlines. The project enabled the client to set a baseline for lease of the property and to progress operations of the acquired company with the appropriate type of discharge consent.

Project Manager and Technical Specialist
Acquisition Due Diligence, Brownfield Redevelopment | South East England

Jo provided support to a property developer from acquisition through planning and redevelopment of a Brownfield site. The site's historical land uses included heavy industry and vehicle manufacturing. The project comprised due diligence to determine the level of environmental risk associated with the site which was found to be contaminated by metals, hydrocarbons, solvents and asbestos in soils. The project then progressed to a planning application requiring a Phase I and II ESA, conceptual site model and detailed risk assessment. On grant of conditional planning permission, Jo supported the client to ensure environmental planning conditions were met. Jo built excellent working relationships with the regulators throughout the project and demonstrated that the environmental risk was assessed comprehensively.

Technical Specialist
Acquisition Due Diligence, Closed Landfill | London, UK

Jo carried out an acquisition due diligence Phase I environmental site assessment for a closed landfill which her client planned to redevelop for commercial land use. Jo visited the site to visually assess the potential for land contamination and sensitive receptors. Jo interviewed current site occupants to determine whether their business operations had the potential to impair the land quality. The Phase I also included a desk study of relevant environmental records and historical mapping and discussions with the local authority. A report was submitted to the client, including all information pertinent to the site, summarising the potential environmental liabilities associated with purchase and development of the site.

Technical Specialist
Acquisition Due Diligence, Large Portfolio of Sites | UK

Jo was part of a team working on acquisition due diligence for a large portfolio of over 60 Brownfield sites which her client planned to redevelop for commercial land use. The client required a rapid turnaround on the project to gain understanding of the environmental liabilities associated with each of the sites. The team travelled around the UK to visually assess each of the sites with findings summarised in tabular form, ranking the sites in relation to their likelihood of land contamination. The project was carried out within the timescale and budget required by the client and the information gathered was used to negotiate purchase price for the properties, taking into account the anticipated costs for investigating, assessing and remediating the sites for their intended future uses.

Technical Specialist
Phase I ESA Due Diligence, Property Lease | Ireland

Jo carried out a Phase I ESA to assist a client with their planned lease of a commercial property in Ireland. Jo visited the site to visually assess the property and surrounding area for potential environmental liabilities associated with the land uses. Jo also contacted the local authority to gain information about the historical uses of the site. A report was prepared for the client, describing the site and environmental aspects including historical map review and search of available environmental regulatory records. The report set a

qualitative baseline environmental condition for the site prior to the client continuing with the lease agreement.

Technical Specialist
Phase I ESA Acquisition Due Diligence | Yorkshire, UK

Jo carried out a Phase I environmental site assessment for a metal works in Yorkshire. Jo's client was considering purchase of the metal works company and the property. Jo visited the site to observe the daily operations and environmental management practices to identify the potential for land contamination and environmental liabilities associated with the operations. Jo interviewed current site occupants and carried out a desk study of relevant environmental records and historical mapping. Discussions were also held with the local authority. A report was submitted to the client, including all information pertinent to the site, summarising the potential environmental liabilities associated with purchase of the company and its property.

Technical Specialist
Phase I ESA Annual Audit | Norfolk, UK

Jo conducted a Phase I ESA at a client's site as part of an annual environmental audit. Jo visited the site to conduct a walkover of all areas of the property, including production areas and external areas. During the visit Jo interviewed relevant site personnel to understand their waste management, production processes, chemical use, chemical storage etc. to identify any areas requiring improvement in their environmental management of the site. Jo also carried out a review of historical data including environmental databases and land use maps to check for the potential for legacy contamination in the subsurface of the site. Jo prepared a report to document all of the findings, along with recommendations.

Technical Specialist
Phase I ESA acquisition due diligence | Aberdeen, UK

Jo carried out an acquisition due diligence Phase I environmental site assessment at the facility of a manufacturer of specialist offshore oil & gas equipment. Jo's client was looking to acquire the company and property and required an understanding of any environmental liabilities and business environmental risks. Jo visited the site to interview environmental managers and other relevant personnel to learn about their processes and how they complied with environmental regulations. Jo visually assessed the internal and external areas of the property to identify any operational areas requiring improvement and the potential for land contamination and surrounding sensitive receptors. The Phase I also included a desk study of relevant environmental records and historical mapping and discussions with the local authority. A report was submitted to the client, including all information pertinent to the site, summarising the potential environmental liabilities associated with purchase of the company.

Technical Specialist
Phase I ESA at a Rail Engineering Facility | Midlands UK

Jo supported a client based in North America with the acquisition due diligence for a company operating a railway engineering facility in the UK. The project comprised site reconnaissance to identify potential contaminated land risks and environmental legislation compliance issues at the site. The site comprised a mechanical workshop for repair and maintenance of locomotive engines. A desk study was also completed to evaluate any potential environmental risks from historical land uses and surrounding industries. The project enabled the client to make an informed decision on the purchase of the company and the property.

Technical Specialist
Phase I ESA Annual Audit, distillery | France

Jo conducted a Phase I ESA at a client's site as part of an annual environmental audit. The client was based in North America and the distillery under audit was located in France. Jo visited the site to conduct a walkover of all areas of the property, including beverage production and bottling areas and external areas. During the visit Jo interviewed relevant site personnel to understand their production processes, chemical use, chemical storage, waste management, etc. to identify any areas requiring improvement in their environmental management of the site. Jo prepared a report to document all of the findings, along with recommendations.

Project Manager and Technical Specialist
Phase I ESA Acquisition Due Diligence | Cambridge UK

Jo managed and completed a Phase I ESA for an investment company looking to purchase a commercial property that was occupied by a banking firm as office space. Jo attended a site visit to interview the site occupants and to observe any potential polluting operations at the site and surrounding area. A desk study was carried out to understand the historical land uses at the site. The desk study identified that tanks of unknown content were present within the current site boundary. Jo suggested to the client that a limited intrusive investigation (Phase II) should be carried out due to the potential for contaminants to have entered the ground in the area of the historical tanks; especially as the contents of the tanks could not be confirmed. The Phase II was conducted using a dynamic sampling drilling rig to observe shallow soil conditions and to facilitate the collection of soil samples for laboratory analysis. The Phase II found hydrocarbon contamination at the site, and the client realised that the investment was not low risk as they had expected. Jo provided the client with estimated costs for further investigation, risk assessment and remediation; these

costs were factored into the client's acquisition decision.

Project Manager and Technical Specialist
Phase I ESA Acquisition Due Diligence | Leeds UK
Jo carried out a Phase I environmental site assessment for a group of commercial properties in Leeds City Centre. The site comprised a multi-storey car park, hotel, offices and retail units. Jo's client was considering purchase properties as an investment. Jo visited the site to observe the daily operations and environmental management practices to identify the potential for land contamination and environmental liabilities associated with the properties. Jo interviewed current site occupants and carried out a desk study of relevant environmental records and historical mapping. Discussions were also held with the local authority to identify any problems that had not been identified in the environmental databases. A report was submitted to the client, including all information pertinent to the site, summarising the potential environmental liabilities associated with purchase of the properties.

Technical Specialist
Phase I ESA Annual Audit | Salisbury, UK
Jo conducted a Phase I ESA at a client's site as part of an annual environmental audit. The site assembled electronic equipment. Jo conducted a walkover of all areas of the property, including assembly areas and external areas. During the visit Jo interviewed the site manager to understand their waste management, production processes, chemical use, chemical storage etc. to identify any areas requiring improvement in their environmental management of the site. Jo also carried out a review of historical data including environmental databases and land use maps to check for the potential for legacy contamination in the subsurface of the site. Jo prepared a report to document all of the findings, along with recommendations.

Technical Specialist
Phase I ESA for Planning Application | Runcorn, UK

Jo carried out a Phase I ESA at a residential property development site for the client's planning application. The site comprised a disused area of land between existing residential properties in Runcorn. There was a potential for the site to be contaminated due to the area's industrial past. Jo visited the site to observe the condition of the land and identify the potential for land contamination. A desk study was carried out comprising review of relevant environmental records and historical mapping. Discussions were also held with the local authority to identify any problems that had not been identified in the environmental databases. A report was submitted to the client and local planning authority, including all information pertinent to the site, summarising the potential environmental risks associated with redevelopment of the site for residential purposes.

Project Manager
Phase I ESA Acquisition Due Diligence | Berlin, Germany
Jo supported a client based in in North America with the acquisition due diligence for a company operating a chemical manufacturing facility in Germany. Jo's team member visited the site to carry out a walkover and interviews with the site managers. A desk study was not required for the Phase I. The site observations and information gathered during the interviews was reported back to the client to inform their due diligence process.

Key Experience – Environmental Risk Assessment

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Site Redevelopment | UK

Jo managed an intrusive investigation at a former biosolids site for a commercial developer planning on construction of a logistics park. The investigation assessed the soil, leachate, groundwater and surface water quality at the site and within the major river bordering the site. Jo carried out a detailed quantitative risk assessment (DQRA) for the contaminants of concern at the site using ConSim software. The DQRA assessed the potential for site contaminants to migrate to the major river at the site's boundary. The risk assessment identified the contaminants and source materials in the site's subsurface that required remedial effort to remove unacceptable risk. This enabled the preparation of remedial options appraisal and remediation strategy documents for the successful redevelopment of the land. The DQRA was submitted to the local authority in support of planning condition discharge.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Acquisition Due Diligence | UK

Jo supported a property developer client with due diligence for site acquisition of a former sewage works. During the due diligence it was noted that there was an unknown risk to controlled waters receptors. Therefore, Jo completed a detailed quantitative risk assessment for the site, using all available groundwater monitoring data. The DQRA evaluated the feasible pollutant linkages within the conceptual site model that set out the potential sources, pathways and receptors associated with the site. A risk was identified pertaining to nitrate at the site in consideration of the nearby surface water features, including a river and a lake. The risks were communicated to the client along with

possible mitigation measures to enable redevelopment of the site.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Historical Release of Contaminants | UK

Jo supported a chemical manufacturing client with a detailed quantitative risk assessment to determine whether site contaminant concentrations posed a risk the workers at the site and/or to a down-gradient surface watercourse. Contaminants were observed in the ground during maintenance and removal of an underground pipeline. The contaminants were present as free-phase hydrocarbons and a dissolved phase plume. The dissolved phase plume was modelled using ConSim to determine the concentrations that could be reaching the down-gradient water course. The free-product was assessed qualitatively. Vapour inhalation and free-phase hydrocarbons continuing to contribute to the dissolved plume were identified as the main areas of risk. The implications with regard to UK legislation and remediation options were discussed with the client. The project involved liaison with the local Environment Agency Officer to ensure all proposed remedial works were in line with their expectations and that they were in agreement with the detailed risk assessment methodology and results.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Operational Oil and Gas Facility | UK

Jo completed a site-specific detailed quantitative risk assessment (DQRA) to assist an oil and gas sector client with long term management of legacy soil and groundwater contamination at their operational facility. The project involved a detailed study of the site's hydrogeology and environmental data to form a conceptual site model. Three separate groundwater plumes were identified at the site, which were assessed using ConSim to model the fate and transport of the contaminants in the plumes with respect to off-site receptors. The results of the DQRA were presented to the client's UK and Global environmental managers; the client used the information to investigate potential sources of the contaminants with GHD's assistance. A long-term groundwater monitoring programme was also designed and implemented.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Continued Site Management | UK

Once an oil and gas sector client ceased operations and surrendered their refinery's environmental permit, Jo completed a detailed study of the site's hydrogeology and environmental data to form a conceptual site model and identify any contaminant plumes. While plumes were not identified, spikes in contaminant concentrations had been identified over a decade's worth of regular monitoring results. To determine whether the concentrations occasionally found in groundwater may be impacting down-gradient receptors, Jo used ConSim to carry out a detailed quantitative risk assessment. The results showed there was no unacceptable risk posed by the contaminants and recommended a limited groundwater monitoring programme to confirm that contaminants were not present in the site's groundwater at consistently elevated concentrations. This enabled the client to appropriately manage the site while dormant.

Project Manager
Human Health Risk Assessment | Gas Terminal, UK

An oil and gas client approached Jo for assistance to determine whether an area of red dust accumulated on their site posed a risk to human health. Initially an investigation was carried out to discover the source of the dust, which was found to contain heavy metals including arsenic and lead. The potential risk to site workers' health was assessed by completing a site-specific human health risk assessment, examining the potential for the dust to be inhaled. This identified the contamination concentration which would pose a risk to site workers via various exposure scenarios. The project also involved the design of remedial measures.

Project Manager and Technical Specialist
Groundwater Trend Analysis | Gas Terminal, UK

Jo undertook a statistical trend analysis to determine whether certain contaminants were increasing in concentration in the groundwater beneath a gas refining facility, which may indicate active sources or migrating contaminant plumes. The assessment also plotted contours to show where the higher contaminant concentrations were present in the shallow and deep aquifers beneath the site, to identify potential sources and resultant plumes.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Remedial Target Derivation | Greater London, UK

Jo's client was redeveloping a brownfield site, previously used for wastewater treatment. A Detailed Quantitative Risk Assessment (DQRA) was carried out that identified a risk to off-site surface water receptors from nitrate contamination in the soils at the site. The DQRA was submitted to the local planning authority and informed a remedial options appraisal and strategy. The preferred remedial option was stabilisation and solidification of the soils, with placement under hardstanding. The ConSim DQRA model was used to confirm that reduced leaching of contaminants would adequately remove the risk. The model was also used to iteratively derive remedial targets for comparison to leachate tests carried out during bench-scale testing and field trials of the stabilisation and solidification method. The adapted risk assessment model and remedial targets were

submitted to the local authority to support the discharge of planning conditions.

Technical Specialist
Detailed Quantitative Risk Assessment for Remedial Target Derivation | Bedfordshire, UK

Jo supported a property developer with the assessment of a brownfield site that they were planning to redevelop for commercial warehousing. The Site had been used for manufacture of heavy good vehicles and was found to be contaminated by hydrocarbons, solvents and asbestos. Jo used the intrusive investigation and monitoring data, hydrological and hydrogeological information to identify potential contaminant sources, pathways and receptors. The risk to human health was carried out by generic quantitative assessment to determine if the condition of the subsurface of the site was suitable for the intended future use. The asbestos contamination was qualitatively assessed. As no sensitive controlled waters receptors were identified down-gradient of the Site within 1 kilometre, the risk to an arbitrary controlled waters receptor was assessed using the Environment Agency's Remedial Targets Worksheet. Remedial targets were derived and agreed with the local regulators for use in a remediation strategy.

Technical Specialist
Detailed Quantitative Risk Assessment for Site Redevelopment | Gloucestershire, UK

Jo supported a property developer client with due diligence for a joint venture looking to purchase and redevelop a site being used as a manufacturing facility. Due to the industrial nature of the site, the due diligence included intrusive investigation and detailed quantitative risk assessment (DQRA) using the soil and groundwater obtained. Various sources of contamination were identified in the soils and groundwater, including hydrocarbons and solvents. A river was located along the site's southern boundary and represented the most sensitive receptor. Jo used ConSim to predict the contaminant concentrations that would reach the river over time from the sources at the site. The sources that were found to pose a risk to the receptor were then included in a remedial strategy for the site.

Technical Specialist
Detailed Quantitative Risk Assessment for Remedial Target Derivation | UK

Jo's oil and gas client was evaluating the potential to repurpose one of their facilities. Part of this work comprised environmental and geotechnical assessment of the site. The environmental assessment identified various contaminants in the subsurface that would require remediation in the event of the site being redeveloped. Therefore, Jo used the Environment Agency's Remedial Targets Worksheet to derive remedial targets protective of the controlled waters environment and provided soil remedial targets for protection of human health.

Technical Specialist
Detailed Quantitative Risk Assessment for Remedial Target Derivation | South East, UK

Jo supported a property developer with the assessment of a site that was historically used for vehicle manufacture. The client was planning to redevelop the site for commercial warehousing. The Site was found to be contaminated with hydrocarbons being the main contaminants of concern. The risk to human health was carried out by generic quantitative assessment to determine if the condition of the subsurface of the site was suitable for the intended future use. Jo carried out a DQRA to assess the risk to controlled waters using the intrusive investigation and monitoring data. The site's hydrological and hydrogeological setting was used to identify feasible pathways and receptors. The site was in close proximity to a source protection zone and was located above a chalk aquifer. The Environment Agency's Remedial Targets Worksheet was used to determine if the concentrations of contaminants at the site were unacceptable with respect to migration down-gradient to the potable water source. Remedial targets were derived for pump and treat of groundwater sources and to validate soil reuse during the groundworks. The risk assessment and remedial targets were submitted to the local planning authority for discharge of planning conditions.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Operational Chemical Manufacturing Site | UK

Jo's client was found to be releasing contamination to a local municipal sewer system and river. The contamination was linked to an historical spill where a tanker delivering benzene released a significant volume of product to ground. Jo completed a site-specific detailed quantitative risk assessment (DQRA) to assist the client with long term management of the soil and groundwater contamination at their operational facility and to provide remedial targets for the clean-up of the contamination. The project involved a detailed study of the site's hydrogeology and environmental data to form a conceptual site model. Groundwater plumes were identified at the site, which were assessed using ConSim to model the fate and transport of the contaminants to off-site receptors. The results of the DQRA were presented to the client for their submission to the local authority. A long-term groundwater monitoring programme was also designed for the site.

Project Manager and Technical Specialist
Detailed Quantitative Risk Assessment for Operational Oil and Gas Facility | UK

Jo's client discovered that a mound of soils at their operational facility had not been appropriately assessed and the content of the mound was unknown.

Jo and her team investigated the mound, collecting soil samples for laboratory analysis of a range of typical contaminants. The laboratory results showed the presence of hydrocarbons and metals. To understand whether the presence of these contaminants was suitable for the site and the surrounding controlled waters receptors, a DQRA was carried out using ConSim. The risk assessment model examined the pollutant linkages identified in a conceptual site model. The contaminants in the mound were found to be present at concentrations that did not pose an unacceptable risk. The client used this information to inform the local regulators that the mound materials were suitable for use at the site.

Key Experience – Environmental Statement

Technical Specialist
Environmental Statement | Birmingham, UK

Jo produced the contaminated land sections of an Environmental Statement and Non-Technical Summary for a planning application for redevelopment of a Brownfield site located in the West Midlands. The Environmental Statement considered the potential risks to sensitive receptors posed by the proposed redevelopment of the site. Multiple potentially contaminative land uses at the site included collieries, landfill, brickworks, and lime and cement works.

Technical Specialist
Environmental Statement | London, UK

Jo supported a property developer by preparing the contaminated land portions of an Environmental Statement and Non-Technical Summary for a planning application for redevelopment of a former landfill site located in the south east. The Environmental Statement considered the potential risks posed by the proposed redevelopment of the site. Sensitive receptors included surrounding residential land and a neighbouring nature reserve. The site's former use as a landfill and its current use as a waste transfer station were considered.

Key Experience – Landfill Assessment

Technical Specialist
Closed Landfill Assessment | London, UK

Jo worked on a project assessing a closed landfill for redevelopment. The project comprised an intrusive investigation followed by groundwater and ground gas monitoring. The data obtained was used to prepare a conceptual site model and environmental risk assessment, taking into account the historical findings from the previous investigations and newly obtained data.

Technical Specialist
Former Landfill Site | Lincolnshire, UK

GHD provided a broad scope of services for a large property company to assess the condition of a decommissioned landfill with nearby residential areas. Assessments were performed to develop a sustainable management plan, including subsequent ground gas and groundwater monitoring. The client also required an assessment of ongoing liability associated with the property.

Key Experience – Geo-Environmental Site Assessments

Project Manager
Pre-Planning Application Phase I and II Geotechnical and Environmental Assessments | UK

Jo managed a project involving combined environmental and geotechnical Phase I and II assessments at a former chemical works in Grangemouth, Scotland. The client required an understanding of development constraints ahead of submitting a planning application for developing an industrial facility. The Site was highly contaminated presenting health and safety challenges that were overcome by generating and complying with site-specific risk assessment and method statements. Other complications included difficult drilling conditions and artesian groundwater. The project successfully identified the environmental risks associated with the site and provided recommendations for foundation and pavement design.

Project Manager
Geotechnical and Environmental Phase I and II ESAs | UK

Jo supported one of GHD's development sector clients with their due diligence for potential acquisition of a Greenfield site located in the Midlands. The client wished to understand any environmental liabilities associated with the site and geotechnical development constraints ahead of submitting their bid for site purchase. Despite being a Greenfield site, mounds were present that required investigation. It was determined that significant quantities of fill material had been deposited on the site, which would require improvements to enable development of warehousing. GHD liaised with the local regulators to confirm that the elevated contaminant concentrations encountered in groundwater at the site were from natural sources and would not require remediation to protect an adjacent watercourse.

Project Manager and Technical Specialist
Phase II ESA, Detailed Quantitative Risk Assessment, Remedial Design | UK

Jo supported a chemical manufacturing client with investigation of their site at which contamination had been encountered on removal of an underground pipe. Phase II intrusive investigations were carried out in stages, one targeting the potential sources of contamination at the site, followed by another to delineate the impact. Laser Induced Fluorescence technique was used to delineate an area of contamination. Light non-aqueous phase liquid

(LNAPL) and a dissolved phase plume were encountered beneath the site. The project also involved environmental forensic analysis to pinpoint the source of the LNAPL by comparing the contaminant signature to the products stored at the site. The investigation data was used to carry out a detailed quantitative risk assessment to determine whether the site contaminant concentrations posed a risk to a down-gradient surface watercourse. The implications with regard to UK legislation and remediation options were discussed with the client. The project involved liaison with the local Environment Agency Officer to ensure all proposed remedial works were in line with their expectations.

Project Manager
Phase I and II ESAs with Drainage Survey | Scotland, UK

Jo supported a client with their acquisition of a vehicle hire and maintenance site. After completion of a Phase I ESA that identified the potential for land contamination, a Phase II ESA was carried out. The Phase II targeted current and historical use and storage of oils and fuels both above and below ground. The Phase II utilised cable percussive drilling techniques and included the installation of groundwater monitoring wells. Soil and groundwater samples were submitted for laboratory analysis of the contaminants associated with the site. The business was discharging car wash water without consent therefore, a drainage survey was carried out to understand how the wastewater was leaving the site boundary. The works were required on an expedited turnaround due to the tight acquisition due diligence deadlines. The project enabled the client to set a baseline condition for lease of the property and to progress operations with the appropriate type of discharge consent.

Project Manager
Brownfield Redevelopment | UK

Jo provided support to a property developer from acquisition through planning and redevelopment of a Brownfield site. The project comprised due diligence to determine the level of environmental risk associated with the site which was found to be contaminated by metals, hydrocarbons, solvents and asbestos in soils. The project then progressed to a planning application requiring a Phase I and II ESA, conceptual site model and generic risk assessment. On grant of conditional planning permission, Jo supported the client to ensure environmental planning conditions were met. Jo built excellent working relationships with the regulators throughout the project and demonstrated that the environmental risk was assessed comprehensively.

Team Member
Phase II and Remediation at an Operational Manufacturing Facility | UK

Jo was a member of a project team supporting a manufacturing client with a release of cutting fluids to ground at their operational facility. Jo supervised the drilling and installation of groundwater monitoring wells surrounding the building where the loss of cutting fluid was known to have occurred. Once the plume of dissolved/emulsified cutting fluid had been delineated, a remediation strategy was designed to remove the contaminated groundwater via a pump and treat system. Jo supervised the drilling of wells inside the building and the installation of remediation pumps. The remediation system and the groundwater were routinely monitored until the source and resulting plume had been sufficiently managed.

Team Member
Phase II ESA for property extension at a football ground | UK

Jo was part of a team carrying out intrusive investigation to gather environmental and geotechnical data for an extension to a football stadium to house the new team merchandise shop with residential apartments above. The project comprised drilling of boreholes, excavation of trenches to locate historical buried foundations, ground gas assessment and groundwater monitoring. Soil and groundwater data were assessed by generic quantitative risk assessment. The ground gas data were evaluated using CIRIA guidance to calculate a gas screening value for the site and determine the site's Characteristic Situation. A report was generated to support the planning application, providing a summary of the works completed and the recommendations to facilitate site redevelopment.

Project Manager
Phase II ESA for chemical manufacturing facility | UK

Jo was a project manager for a Phase II ESA for a client who voluntarily required an intrusive investigation at their chemical manufacturing and laboratory facility. The client's internal environmental management system required a 10 yearly assessment of ground conditions at the site. The investigation was designed to target potentially polluting activities at the site, and from the site's historical uses. Jo's team visited the site to drill multiple boreholes for collection of soil samples and installation of monitoring wells, subsequently developed and purged for groundwater sampling. The soil and groundwater samples were submitted for analysis of potential contaminants of concern at the site pertaining to current and historical land uses. The data were compared to generic assessment criteria for the protection of human health and controlled waters receptors. Contaminants were not present above the generic assessment criteria and no further work was deemed necessary.

Team Member
Phase II ESA for photo-chemical manufacturing facility | UK

Jo was part of a team carrying out intrusive investigation to gather environmental data for an areas of suspected legacy contamination at a chemical

manufacturing facility in the North West. The project comprised drilling of boreholes, excavation of trial pits and groundwater monitoring. Soil and groundwater samples were collected and submitted to a laboratory for analysis of contaminants associated with the site's past and present activities. The environmental data were compared to generic assessment criteria to determine if contaminants present at the site may pose a risk to the human health of site workers or to controlled waters (surrounding surface water features and aquifers).

Team Member
Phase II ESA for site redevelopment | UK

Jo was a site supervisor completing ground gas and groundwater monitoring on an active construction site. The work was necessary to support ongoing monitoring required by planning application conditions. The site comprised a building that had been stripped and was due to be renovated to house numerous residential apartments in Fulham. The monitoring works were planned around the construction activities. The groundwater samples were submitted for laboratory analysis and the ground gas data were subject to an assessment in accordance with CIRIA ground gas guidance. A report was generated to support the planning application, providing a summary of the works completed, a generic quantitative risk assessment, the site's calculated gas Characteristic Situation, and the recommendations to facilitate site redevelopment.

Team Member
Groundwater monitoring for redevelopment | UK

Jo provided site supervision support for an intrusive investigation in the yard of a fire station where an extension was planned. The investigation comprised drilling of shallow boreholes for soil sample collection and installation of groundwater monitoring wells. The investigation was carried out to determine if the subsurface conditions would be suitable for the proposed development, considering potential risk to human health and controlled waters receptors.

Team Member
Phase II ESA, ground gas and groundwater monitoring for redevelopment | UK

GHD was commissioned by a paper mill facility to carry out a broad scope of environmental works involving various services to assess a site measuring approximately 48 acres. The assessments were carried out for the purpose of selling the property for redevelopment into residential and commercial properties. In order to prepare a package for submission to potential purchasers of the site, the works and investigations listed below were undertaken by GHD: archaeological desk study, type 3 asbestos survey, noise and vibration survey, services and capacities report, initial tree survey, phase II ground investigation, environmental investigation and geotechnical investigation.

Team Member
Phase II ESA, ground gas and groundwater monitoring for redevelopment | UK

GHD's client in the property development sector owned a former industrial property adjacent to a disused airfield in the south of England with the potential for future redevelopment. The site soil and groundwater was known to contain contaminants, which required regular monitoring. Jo provided the site supervision support for the groundwater and ground gas monitoring. A contamination delineation investigation was also carried out at the site by use of trial pits to identify the extent of assumed hotspots that would require remediation prior to site redevelopment.

Project Manager
Phase II ESA, ground gas and groundwater monitoring for redevelopment | UK

Jo managed an intrusive investigation with follow up monitoring works at an agricultural property. The client was looking to acquire the site for redevelopment and the Phase II ESA supported their due diligence and pre-planning application assessments. The Phase II comprised both geotechnical and environmental assessment of the site. The constraints to the redevelopment were presented to the client to assist with their decision on site purchase.

Project Manager
Phase II ESA for LNAPL delineation | UK

During regular groundwater monitoring at a client's oil and gas facility, light non-aqueous phase liquids (LNAPL) were encountered in one of the monitoring wells. Jo managed a project to delineate the contamination with the aim to identify the source of the LNAPL and to understand the extent of the impact in the subsurface. The project comprised sampling of the LNAPL for forensic analysis to identify its composition and age – this was carried out to help identify which on-site process the contamination was originating from or had historically been released and migrated to the well. Additional monitoring wells were installed in the vicinity of the impacted well. Regular groundwater and vapour monitoring rounds were carried out to determine whether the LNAPL contamination was causing contaminants to migrate down-gradient via the shallow aquifer. The investigation informed a remediation options appraisal and remedial strategy which was subsequently implemented to remove the LNAPL.

Team Member
Groundwater monitoring at a UK airport hangar | UK

GHD was contracted to verify the ground investigation findings of another consultancy that had provided our client with environmental data for an airport hangar in

the south of England. The consultancy had been appointed by the landowner who was selling the site to GHD's client. GHD attended the site to collect groundwater samples from the established monitoring well network.

Team Member
Phase II ESA, ground gas and groundwater monitoring for redevelopment | UK

GHD supported a property developer client with an assessment into the geotechnical and environmental condition of a site they were potentially purchasing for a large scale multipurpose redevelopment. The property comprised an operational aerospace manufacturing facility and an area of open ground adjacent to an airport. The site had an historical legacy of contamination comprising hydrocarbons and chlorinated solvents, among other chemicals. The Phase II comprised an extensive network of boreholes with installation of groundwater and ground gas monitoring wells. Jo coordinated and supervised the intrusive investigation and subsequent monitoring rounds. The data obtained from the investigation was used to inform a detailed risk assessment.

Team Member
Ground gas and groundwater monitoring at a former landfill | UK

Jo was the member of a team that carried out ground gas and groundwater monitoring at a closed landfill in Lincolnshire. The network of wells was monitored on a six-monthly programme to determine whether the gas and leachate were stabilising and to identify any migration of contaminants beyond the site boundary. The former landfill was located adjacent to a residential development.

Team Member
Phase II ESA for human health risk assessment | UK

A client identified a suspected contaminated dust on the surface of the soils and gravel surface in an area of their operational industrial facility. Jo designed and implemented a sampling programme to determine what contaminants were contained in the dust and to understand whether those contaminants had impacted deeper strata. The dust was found to contain heavy metals, potentially from shot blasting works carried out during site maintenance activities. The data obtained from the investigation was used to inform a human health risk assessment to evaluate the risk posed to site personnel working in the vicinity of the contaminated soil surface.

Team member
Phase II ESA, ground gas and groundwater monitoring at a fuel filling station | UK

GHD's client was a property agent managing the potential sale of an operating fuel filling station. Jo coordinated and supervised an intrusive ground investigation with the aim to determine whether contaminants had been released from the underground fuel infrastructure, including the pump islands, underground pipelines and underground storage tanks. The site remained open during the investigation and therefore the project required controls to mitigate risks from/to traffic movements and members of the public. The investigation comprised shallow drilling for in-situ volatile organic compound monitoring, soil sample collection and installation of monitoring wells. Subsequent groundwater and ground gas monitoring rounds were carried out.

Project Manager
Phase II ESA to delineate impact of a paint spill | UK

GHD was appointed by a vehicle manufacturing client on discovery of a solvent odour during excavation works to install a foundation pad. The odour was suspected to be linked to an unknown release of paints to the subsurface. Jo managed the project that investigated the area of the odour impact to target the potential sources of the contaminants. Shallow drilling works were completed for collection of soil samples for forensic analysis. The laboratory aimed to identify the product type that had been released to ground using the site's material safety data sheets for their chemical inventory. The investigation narrowed down the location where the contaminants were likely to have originated, which allowed the client to further evaluate whether the source was active or historical.

Project Manager
Phase II ESA to delineate contamination in groundwater | UK

A detailed groundwater risk assessment completed for the client identified a potential groundwater plume of dissolved phase hydrocarbons at their gas refinery asset. As a result, it was recommended that additional groundwater monitoring wells were installed at the site boundary down-gradient of the plume to determine whether contaminants were migrating off-site to neighbouring properties – delineating the lateral extent of the plume. The well locations were selected mindful of the on-going site operations and underground infrastructure and utilities. Boreholes were drilled by rotary-sonic technique due to the required depth and difficult ground conditions. The soils were examined in the field for evidence of hydrocarbon contaminants, and samples were submitted to a laboratory for analysis. Shallow and deep groundwater wells were installed and monitored on a six monthly basis.

Project Manager
Phase II ESA for site redevelopment | Cyprus

GHD was approached by a property developer to assist them with the construction of a hotel and leisure complex in Cyprus. Jo managed the project, which comprised a site walkover assessment and sampling of soils for laboratory analysis. The aim of the project was to determine whether the environmental ground

conditions were suitable for the intended future use of the site, to satisfy the requirements of the local authority.

Project Director
Phase II ESA, ground gas and groundwater monitoring for redevelopment | UK

Jo was project director for a project supporting a client with the prospective purchase of a Brownfield site near London. The due diligence Phase I ESA identified a potential for contaminants to be present in the site's subsurface from historical use and storage of hazardous materials at the site, and a portion of the property was located on an inactive landfill. Therefore, a Phase II intrusive investigation was designed to target the areas of concern for collection of soil and groundwater samples and ground gas monitoring. The investigation comprised window sampling, cable percussion and dynamic probe techniques. The investigation provided an overview of geotechnical constraints to future redevelopment and identified an area of light non-aqueous phase liquids (LNAPL) and dissolved phase contaminants in groundwater. GHD provided the client with estimated abnormal costs for delineation, risk assessment and remediation.

Project Director
Groundwater monitoring for on-going site management | UK

An oil and gas sector client decommissioned their facility and required on-going monitoring of the groundwater well network. Jo project managed and then became project director of the on-going monitoring. The project assisted the client with their on-going responsibilities with respect to owning and managing legacy contaminants in the soil and groundwater at the vacant site.

Team Member
Groundwater monitoring | Nuclear Defence, UK

A nuclear defence client required on-going monitoring of their groundwater monitoring well network at their operational manufacturing facility. Jo provided site engineer/supervisor services during the monitoring programme, and follow up reporting.

Key Experience – Remediation

Project Manager and Technical Specialist
Phase II ESA, Detailed Quantitative Risk Assessment, Remedial Design | UK

Jo supported a chemical manufacturing client with investigation of their site at which contamination had been encountered on removal of an underground pipe. Phase II intrusive investigations were carried out in two stages, one targeting the potential sources of contamination at the site, followed by another to delineate the impact. Light non-aqueous phase liquid (LNAPL) and a dissolved phase plume were encountered beneath the site. The project also involved environmental forensic analysis to pinpoint the source of the LNAPL by comparing the contaminant signature to the products stored at the site. The investigation data was used to carry out a detailed quantitative risk assessment to determine whether the site contaminant concentrations posed a risk to a down-gradient surface watercourse. The implications with regard to UK legislation and remediation options were discussed with the client. The project involved liaison with the local Environment Agency Officer to ensure all proposed remedial works were in line with their expectations.

Project Manager
Remediation of a Former Petrol Filling Station and Garage | UK

Jo managed a project for a property developer to delineate contamination and implement a remedial strategy to satisfy planning for the development of a commercial property at a former petrol filling station and garage. The project involved intrusive investigation, risk assessment, remedial strategy design and implementation with long term monitoring to validate the effectiveness of the remediation works. The project concluded with the sign-off of environmental planning conditions. The site was successfully redeveloped as a car dealership.

Project Manager and Technical Specialist
Phase II and Detailed Quantitative Risk Assessment | UK

Jo managed an intrusive investigation at a former biosolids site for an industrial developer planning on construction of a logistics park. The investigation assessed the soil, leachate, groundwater and surface water quality at the site and within the major river bordering the site. The investigation included testing for heavy metals, inorganic contaminants and coliform bacteria within the biosolids, groundwater and surface water, amongst other contaminants of concern. Jo carried out a detailed quantitative risk assessment for the contaminants of concern at the site enabling the preparation of remedial options appraisal and remediation strategy documents for the successful redevelopment of the land. The project involved watching brief and validation of the remediation works for the effective discharge of planning conditions.

Team Member
Phase II and Remediation at an Operational Manufacturing Facility | UK

Jo was a member of a project team supporting a manufacturing client with a release of cutting fluids to ground at their operational facility. Jo supervised the drilling and installation of groundwater monitoring wells surrounding the building where the loss of cutting fluid was known to have occurred. Once the plume of dissolved/emulsified cutting fluid had been delineated, a remediation strategy was designed to remove the contaminated groundwater via a pump and treat

system. Jo supervised the drilling of wells inside the building and the installation of remediation pumps. The remediation system and the groundwater were routinely monitored until the source and resulting plume had been sufficiently managed.

Project Director and Technical Specialist
Remediation Strategy and Derivation of Remedial Targets | UK

Jo was a project director for a project comprising planning application and site redevelopment support for a Brownfield site. The site was redeveloped for warehousing purposes at a former wastewater treatment works. Jo derived remedial targets for the contaminants of concern at the site, pertaining to allowable concentrations in soil leachates. The remedial options appraisal and remediation strategy was prepared by Jo's team, with the selected remediation method comprising stabilisation and solidification of the made ground at the site. The remediation method provided a cost effective and sustainable approach to retaining site won materials. The remediation documentation was submitted to the planning authority and teleconferences were held to discuss the project and to gain regulatory approval.

Team Member
Rebound Assessment – Chlorinated Solvents | Nuclear Defence, UK

Jo carried out the scientific analysis of groundwater contamination data to determine the degree of effectiveness of remediation that had been implemented at a nuclear defence manufacturing site in the UK. The assessment involved extensive data review and generation of spreadsheets to calculate the reduction and rebound of contaminant concentrations over time in consideration of the dual phase extraction system's operational phases. Jo presented the findings of the assessment to the client's environmental managers during a meeting and prepared a report to summarise the project.

Key Experience – Planning Support, Environmental Impact Assessment

Team member, Project manager – multiple projects | UK

Jo has provided clients with support for their planning applications for redevelopment of brownfield sites, including preparation and review of environmental statement chapters and management of environmental report development. During these projects, Jo strongly believes in building a relationship with the regulators while delivering to the needs of her clients. Examples of projects include installation of an emergency vent stack at an operational oil and gas facility, redevelopment of a landfill to warehousing, redeployment of former industrial land, etc.

Key Experience – Environmental Permitting and Compliance

Project Manager and Technical Specialist
Environmental Permit Surrender | UK

Jo supported an oil & gas sector client with the environmental aspects of closing their refinery, which comprised preparation of a Surrender Site Condition Report (SSCR) for their environmental permit and an assessment of legacy contamination for continued diligent management of the site once operations had ceased. The project involved a large scale ground investigation and groundwater monitoring to obtain surrender data for comparison to the Environmental Permit baseline condition of the site. The data were examined to determine whether the site was in a satisfactory state to allow surrender of the Environmental Permit. In addition to assessing the soil and groundwater data, the SSCR contained a summary of the client's robust environmental records maintained over the life of the permit to demonstrate the site was managed appropriately without release of pollutants to land. The project culminated in a comprehensive SSCR that successfully demonstrated that the land quality had not deteriorated as a result of the permitted operations.

Project Manager
Site Condition Report for Energy from Waste Facility Environmental Permit | UK

Jo assisted a client with the preparation of their Site Condition Report (SCR) for their Environmental Permit application for operation of an energy from waste facility. The site was contaminated from historical use as a brick works and tannery with multiple historical investigations completed prior to acquisition and redevelopment. The site was also undergoing remediation to meet planning conditions. Therefore, a large dataset was available to set the baseline condition of the soil and groundwater in the SCR. The SCR also described the risk to environmental receptors from site operations and how those risks would be robustly mitigated by implementation of comprehensive procedures and installation of containment measures.

Technical specialist
Site Condition Report for Environmental Permit Application | UK

Jo was a member of a team preparing the application for an environmental permit for a client planning to import and store sustainably sourced palm oil. The application required a site condition report to set a baseline condition for the site's soil and groundwater. Historical intrusive site investigation data and desk study information were used to describe the contaminants of concern at the site and their

concentrations in the soil and groundwater prior to operations commencing at the installation.

Team Member
Site Protection and Monitoring Programme, Silver Refinery | UK

Jo worked on a project to support a silver refining and fabricating facility with their Environmental Permit requirements. Jo's work included the supervision of drilling contractors installing groundwater monitoring wells at the site and the subsequent groundwater monitoring, which was completed on an annual basis.

Team Member
Site Protection and Monitoring Programme, Food Manufacturer | UK

Jo worked on a project to support a food manufacturing client with their Environmental Permit requirements. Jo's work included the supervision of drilling contractors installing groundwater monitoring wells at the site and the subsequent groundwater monitoring, which was completed on an annual basis.

Team Member
Site Condition Report for Environmental Permit Variation | UK

Jo was a member of a team preparing the variation application for an environmental permit for a client extending their aerospace manufacturing facility. The application required a site condition report to set a baseline condition for the site's soil and groundwater. Jo visited the site to collect shallow soil samples from the foundations being excavated at the site's building extension. The soil samples were analysed for contaminants of concern pertaining to historical land uses and the planned operations at the site. The soil data were used to set the baseline soil condition. Existing monitoring wells were used to collect groundwater samples, which were also analysed for the contaminants of concern to set the groundwater baseline.

Team Member
Design of Site Protection and Monitoring Programme, Natural Gas Refinery Complex | UK

Jo was a member of a team supporting four oil and gas sector clients at a natural gas terminal with their individual environmental permit applications (previously pollution prevention and control permits). Jo's work included the design of Site Protection and Monitoring Programmes for each site, to enable the collection of soil and groundwater baseline data and the ongoing regular groundwater monitoring to satisfy permit conditions. The general site condition was assessed and the soil and groundwater samples were analysed for contaminants associated with natural gas refinery sites. The baseline data was set to enable a comparison to data collected at permit surrender to demonstrate the site subsurface had not been deteriorated by operations under the permits. In addition, the Site Protection and Monitoring Programmes included infrastructure monitoring plans, to ensure pollution prevention measures were maintained appropriately.

Project Manager
Site Condition Report for Solid Fuel Manufacturing Facility | UK

Jo assisted a client with the preparation of their Site Condition Report (SCR) for their Environmental Permit application for operation of a solid fuel manufacturing facility. The site was located at a port and was known to be contaminated from historical use. Jo's team visited the site to supervise the drilling of boreholes for soil sample collection and installation of groundwater monitoring wells. Soil and groundwater samples were tested for contaminants of concern associated with the site's historical land uses and the planned operations at the site, to set a baseline of ground conditions. The application site condition report included the baseline as well as describing the potential risk to environmental receptors from planned site operations and how those risks would be controlled, both physically and by implementation of environmental management procedures.

Project Manager
Site Condition Report for Energy from Waste Facility Environmental Permit | UK

Jo assisted a client with the preparation of their Site Condition Report (SCR) for their Environmental Permit application for operation of an energy from waste facility. The site was contaminated from historical use as a brick works and tannery with multiple historical investigations completed prior to acquisition and redevelopment. The site was also undergoing remediation to meet planning conditions. Therefore, a large dataset was available to set the baseline condition of the soil and groundwater in the SCR. The SCR also described the risk to environmental receptors from site operations and how those risks would be robustly mitigated by implementation of comprehensive procedures and installation of containment measures.

Project Manager
Site Protection and Monitoring Programme, Natural Gas Refinery Complex | UK

Jo coordinated and completed the fieldworks tasks and reporting for the Site Protection and Monitoring Programmes at four sites at a Natural Gas Refinery Complex. Jo then progressed to managing the projects. The projects comprised the 6-monthly monitoring of an extensive network of wells at the complex, and the preparation of individual reports for each of the clients, which were then submitted to the Environment Agency on an annual basis to meet permit conditions. Every 4 years, the Site Protection and Monitoring Programmes were reviewed to ensure their scope remained appropriate for the identification of pollution incidents at

each installation. The reviews were also submitted to the Environment Agency.

Project Manager
Converting Application Site Reports to Site Condition Reports, Natural Gas Refinery Complex | UK

Jo assisted her clients at a Natural Gas Refinery Complex with updating their application site reports and site protection and monitoring programmes due to a change in regulations. The data available for the sites were transferred into the new site condition report format that the Environment Agency had requested. The site condition report was then used as a live document that could be updated with new data and information when available. The site condition reports aim to assist the clients when they come to surrender their environmental permits, which was proven to be successful when one of the sites was decommissioned.

Technical specialist
Site Condition Report for Environmental Permit Application, Aerospace Manufacturing | UK

Jo was a member of a team preparing the application for an environmental permit for a client planning to manufacture aviation parts at a new facility. The application required a site condition report to set a baseline condition for the site's soil and groundwater. Historical intrusive site investigation data and desk study information were used to describe the contaminants of concern at the site and their concentrations in the soil and groundwater prior to operations commencing at the installation. The information was entered into a site condition report that supported the permit application.

Technical Specialist
COMAH CDOIF Assessment for an onshore oil facility | UK

Jo's client operated an onshore oil facility in the south of England. The site was regulated under the COMAH Regulations 2015 and required a Chemicals and Downstream Oil Industry Forum (CDOIF) assessment. The CDOIF assessment evaluated a number of 'Major Accidents to the Environment (MATTEs)' scenarios using the CA-approved methodology, including explosion, fire, spill of oil and chemicals. Environmental receptors that could be impacted were identified and the pollutant linkages assessed to determine if they met the definition of a MATTE. Risk assessments determined whether the MATTE risks were acceptable, tolerable or intolerable etc. Recommendations were made for the reduction of identified risks.

Technical Specialist
COMAH CDOIF Assessment for a munitions facility | UK

Jo supported a munitions manufacturing client with their Chemicals and Downstream Oil Industry Forum (CDOIF) assessment, as their site was regulated under the COMAH Regulations 2015 due to exceedance of the threshold for inventory of dangerous substances. The CDOIF assessment evaluated a number of 'Major Accidents to the Environment (MATTEs)' scenarios using the CA-approved methodology, including explosion, fire, spill of explosive material and spill of oil and chemicals.

Key Experience – Asbestos

Project Manager and Technical Specialist
Asbestos in Soils, Investigation, Risk Assessment and Monitoring | UK

Jo supported an industrial client that had discovered a legacy of asbestos contaminated soils at their decommissioned facility. The project comprised an investigation focussing on asbestos contamination at the soil surface and within made ground. The soil data was used to identify asbestos in soil sources that comprised hotspots with higher concentrations of fibres and a widespread impact at very low concentrations. Jo completed a site-specific detailed quantitative risk assessment (DQRA) to determine the risk posed to human health from environmental exposure to the asbestos contaminated soils. Excess lifetime cancer risks were calculated for a range of receptors and exposure scenarios. Jo then supported the client through installation of short term mitigation measure at the hotspots of contamination and developed an air and dust monitoring programme to measure fibre concentrations in air arising from the widespread low fibre concentrations. The programme comprised air sampling during various seasons and weather conditions to assess the fibre release assumptions in the DQRA. Once the monitoring programme was complete, the results were used to update the DQRA and validate the remedial approach.

Project Manager and Technical Specialist
Asbestos in Soils Investigation | UK

Jo supported an oil and gas client with an investigation to determine whether asbestos containing soils were present at their facility. Asbestos containing materials were known to the present in the site's infrastructure and buildings, with some identified in poor condition. The project comprised an investigation focussing on asbestos contamination at the soil surface and within shallow made ground. Asbestos containing soils were identified in a number of areas at the site, and Jo discussed the implications of this and provided recommendations to ensure protection of staff working in those areas.

Project Director
Asbestos in Soils – personal monitoring programme | UK

Jo was a project director for a project entailing the supervision of personal asbestos monitoring in the breathing space of personnel at a former oil and gas facility. Asbestos was known to be present in the soils at the site and a limited number of staff were present at the site to carry out maintenance activities. Remediation works pertaining to asbestos containing soils hotspots had been conducted at the site, and restrictions were in place to ensure staff did not come into contact with asbestos fibres. To validate the safety of the site staff, six personal monitoring rounds were carried out over a six month period. The monitoring was carried out by a specialist asbestos contractor under the supervision of Jo's team, and the filters obtained from the personal monitoring pumps were submitted for identification of asbestos fibres.

Project Manager and Technical Specialist
Asbestos in Soils, Investigation, Assessment and Monitoring | UK

Jo supported an industrial client that had discovered a legacy of asbestos contaminated soils at their decommissioned facility. The project comprised an investigation focusing on asbestos contamination at the soil surface and within made ground. The soil data was used to identify asbestos in soil sources that comprised hotspots with higher concentrations of fibres and a widespread impact at very low concentrations. Jo completed a site-specific detailed quantitative risk assessment (DQRA) to determine the risk posed to human health from environmental exposure to the asbestos contaminated soils. Excess lifetime cancer risks were calculated for a range of receptors and exposure scenarios. Jo then supported the client through installation of short term mitigation measure at the hotspots of contamination and developed an air and dust monitoring programme to measure fibre concentrations in air arising from the widespread low fibre concentrations. The programme comprised air sampling during various seasons and weather conditions to assess the fibre release assumptions in the DQRA. Once the monitoring programme was complete, the results were used to update the DQRA and validate the remedial approach.

Project Manager
Asbestos refurbishment and demolition survey and GIS | UK

Jo's client operated a natural gas refinery that was due to cease operations, be decommissioned and ultimately demolished. The plant had been in operation since the 1960s and the complex infrastructure was known to include asbestos containing materials. Jo managed a refurbishment and demolition survey to as far as practicable identify all asbestos at the site and to determine the extent of the materials and their condition. The asbestos survey and sampling data was managed in an interactive GIS platform generated for the site. The survey and GIS informed the bidding process for specialist contractors who would be responsible for safe removal of the asbestos hazards prior to demolition.

Project Manager and Site Supervisor
Asbestos management survey annual programme| UK

Post demolition of a large and complex natural gas processing equipment, Jo's client was left with a site containing administration buildings that were originally constructed in the 1970s and 1980s. Past asbestos surveys had identified asbestos containing materials within the fabric of the residual buildings that would require annual survey to ensure the condition of the materials remained suitable. Jo managed a programme of annual surveys at the site and maintained their asbestos register.

Project Manager
Asbestos abatement works | UK

Jo managed a project to support a client with the required abatement of poor condition asbestos containing materials at their operational facility. The project also comprised the removal of asbestos containing dusts. Clean air and clearance certificates were obtained on completion of the abatement work.

Project Coordinator
Asbestos management survey and abatement works | UK

Jo's client was responsible for operating a number of gas extraction platforms in the Southern North Sea. Parts of the platforms, mainly the accommodation blocks and offices were constructed with materials that contained asbestos. Jo coordinated the management surveys for the platforms and assisted with the scheduling of necessary abatement works.

Site Supervisor
Asbestos management survey | UK

Jo carried out an asbestos management survey for a block of offices that were due to be leased by her client. This involved visual inspection of the building and collection of samples for laboratory determination of asbestos presence. The survey was carried out to ensure that normal use of the building would not pose a risk to the occupants. A materials assessment and asbestos register was created for the client.

Site Supervisor
Asbestos management survey | UK

Jo carried out an asbestos management survey for an industrial site that comprised warehousing and offices that were owned and occupied by her client. This involved visual inspection of the buildings and collection of samples for laboratory determination of asbestos presence. The survey was carried out to ensure that normal use of the buildings would not pose

a risk to the occupants. An asbestos register was created for the client that showed the location, extent and condition of the asbestos, along with a materials assessment.

Key Experience – Miscellaneous

Team Member
Swab sampling, battery storage facility | Ministry of Defence Property

Jo provided environmental support to a demolition contractor working at a Ministry of Defence property in central England. The project involved validation that a building had been suitably decontaminated prior to demolition. The building had previously been used for storage of batteries and acid products. Jo carried out swab sampling on all surfaces of the building, with the swabs being analysed at a specialist laboratory for the contaminants of concern. The project identified that the building's internal areas had been suitably cleaned, allowing demolition to proceed.

Project Manager
On-going Environmental Support and Advice | Gas Terminal, UK

Jo provides a range of consultancy services to a gas refining installation in the UK. This work has included surveys to determine whether paints and coatings contained lead, and whether residues in process vessels and pipes contained mercury and/or naturally occurring radioactive material (NORM). The data obtained was used to assist in the overall EHS management of the site.

Technical Specialist
Provision of contaminated land assessment training | UK

Jo prepared and presented a one-day training course for IEMA at a local college in the Midlands. The training course covered the assessment of land contamination, and included relevant legislation, typical sources of contamination at sites, behavior of contaminants in the environment, and how to assess the contamination status of a site. The training also included interactive sessions and activities to engage the attendees. Jo also presented this course at a client's site for a group of their environmental managers taking part in the Associate IEMA course.

Project Manager
Assessment of waste products for sustainable disposal | UK

Jo's client required assistance with understanding which contaminants were present in their waste stream, to determine if a more sustainable disposal option than landfilling could be employed. The client's waste included nylon beads used in industrial laundry processes. Jo and her team supported the client by submitting samples of the various types of beads for specialist laboratory analysis to determine whether hazardous chemicals present would prohibit recycling options, and for calorific value assessment to determine their suitability for incineration. GHD made contact with various waste and recycling companies, and the contact details of those that confirmed they would receive the beads were passed to the client.

Technical Specialist
Processing stack monitoring data for a manufacturing facility | UK

Jo was the member of a team on a project supporting a client with an assessment of their stack monitoring data. Jo was responsible for organising data from over 70 stacks at the client's manufacturing facility and ensuring the data was in the correct units and format for emissions and odour modelling. Jo was also responsible for updating a 3D model of the site to include all 70 stacks, ensuring their location, height and identification were correct.

Technical Specialist
Decommissioning support for a former pharmaceutical manufacturing facility | Belgium

Jo was part of a team supporting a client with the decommissioning of their manufacturing facility in Belgium. The site was formerly used for the production of penicillin. Jo and the team were responsible for validating that the buildings had been properly decommissioned and cleaned to remove traces of penicillin. This involved taking photographs and collection of swab samples from the internal surfaces of the building, including floors, walls and ceilings using a grid sampling system. The swabs were then submitted for analysis at a specialist laboratory. Where unacceptable levels of penicillin were identified, the areas were re-cleaned and resampled for validation.

Project Manager
Generation of an eDAT GIS for an oil and gas facility and provision of training | UK

Jo was the project manager for an oil and gas client with an abundance of soil and groundwater data for their gas terminal, comprising over a decades' worth of information. Jo recommended that the data could be easily stored and accessible in an eDAT GIS system. The client's data was collated and the eDAT for their site was produced initially with the soil and groundwater data, then adding borehole logs, geological cross-sections, asbestos, lead in paint, NORM and other environmental management information. The eDAT has been updated on a regular basis as and when new data have been obtained for the site. Jo presented training sessions for the client's personnel to introduce them to eDAT and demonstrate how to access the information within the GIS.

Team Member
Global Reporting Initiative Auditing | Germany

Jo was part of a team auditing the environmental data collated by numerous facilities in Germany. This involved verification of the data they had supplied pertaining to energy use, waste production and disposal, raw product use and wastewater generation etc. using their internal records. The audit also involved a telephone interview with the facilities operations managers and environmental managers.

Work History

2017 – present	Gutteridge Haskins & Davey Ltd, Principal Consultant
2015 - 2017	Gutteridge Haskins & Davey Ltd, Senior Consultant
2010 - 2015	Conestoga-Rovers & Associates (Europe) Ltd, Senior Consultant
2009 - 2010	Golder Associates (UK) Ltd, Environmental Engineer
2005 - 2009	Conestoga-Rovers & Associates (Europe) Ltd, Graduate to Senior Consultant
2005	University of Nottingham, Research Assistant

Other related areas of interest

Recognised certifications/trainings

- IATP Registered Non-Licensed Asbestos Removal, September 2017
- MS Word 2007 Intermediate/Advanced, Vantage Training Ltd, April 2012
- MS Excel 2007 Intermediate/Advanced, Vantage Training Ltd, March 2012
- P402 – Buildings Surveys and Bulk Asbestos Sampling for Asbestos Proficiency Certificate, British Occupational Hygiene Society, November 2010
- IOSH Managing Safely in Construction Industry Training Board, June 2009
- Toxicology, Land Quality Management Ltd, June 2007
- Logging for BS 5930:1999, Emerson Moore, First Steps Ltd, November 2006

Dr Paul Nathanail

Technical Director Contamination Assessment & Remediation
Technical Service Leader Environmental Solutions

Qualified: PhD Engineering Geology (EQF Level 8); MSc (Distinction) and DIC in Engineering Geology (EQF Level 7); BA Natural Sciences (EQF Level 6).

Connected: Chartered Geologist; Specialist in Land Condition, NQMS Suitably Qualified Person, Member, Sino – EU Panel on Land and Soil, 2018 - to date; Chair, National Brownfield Forum, 2020 – to date. Chair, ISO Working Group on Sustainable Remediation. Former Member, Defra expert panel on contaminated land, 2012 – 2018.

Professional Summary: Paul is a world recognised expert in risk based contaminated land management and brownfield redevelopment. He has led teams that have developed national, European and International guidance. Expert witness in hydrocarbon groundwater pollution assessment and remediation. Directed development of operating windows for benzene monitored natural attenuation; diesel fingerprinting and probabilistic nano particle fate and transport models.

Work experience

Technical Director Contamination Assessment and Remediaiton (GHD)

July 2020 – to date

Technical lead on contamination related projects across the UK, Europe, Middle East and Africa.

As a Chartered Geologist and Specialist in Land Condition, Paul's professional work involves the investigation, assessment and remediation of contaminated sites and the regeneration of brownfields. Technical Services Leader for Environment – including Maritime & Coastal Engineering, Sustainability, Contamination, Emergency Response, Environmental Impact Assessment.

His proficiencies lie in the following areas:

- Technical leadership
- Development of conceptual site models
- Risk assessment
- Sustainable remediation
- Spatial data science
- Research and development
- Proposal writing
- Project management
- Development and delivery of CPD to private and public sector on contaminated land management

Managing Director Land Quality Management (LQM) Ltd | Nottingham | 1997 – 2020

Paul was Managing Director at LQM with overall responsibility for the management of the firm. LQM is a specialist environmental consultancy with a strong reputation for assessing and managing risks to human health and the environment by contaminants in soil.

Among many accomplishments, Paul:

- led development of the UK's most comprehensive set of assessment criteria – the S4ULs,
- conceived and led the development of the Dose Response Roadmaps
- Expert witness on hydrocarbon groundwater pollution in England, Northern Ireland and Republic of Ireland
- Part IIA risk assessment of hazardous landfill site
- led the ISO working group that developed ISO 18504 Sustainable Remediation
- Lead author of Ciria C733 on Asbestos and led the development of the Ciria online Non Licenced Work with Asbestos in Soil training

Professor of Engineering Geology | University of Nottingham | UK | 1998 – 2018

Paul led the development and delivery of vocational MSc & MRes degrees in contaminated land management.

Paul carried out research in all aspects of risk based contaminated land management, groundwater remediation, brownfield redevelopment and sustainable regeneration.

Paul led the environment and society research theme which spans the entire spectrum of geography from the physical through to the cultural. He also taught core modules, including field mapping, on the University's BSc Environmental Geoscience programme.

Senior Geologist
Wimpey Laboratories | Springfield Road, Hayes MIDDX | 1987 – 1994

As a Senior Geologist, Paul was involved in:

- Site investigations
- Reserve evaluation (mainly coal)
- Rock slope design and stability evaluation
- Spoil mound stability
- Statistical and geostatistical analysis of site data
- Geohazard mapping
- Petrographic analysis of aggregates

Dr Paul Nathanail

Technical Director Contamination Assessment & Remediation
Technical Service Leader Environmental Solutions

Other related areas of interest

Honours and awards

- Glossop Medal 2009;
- Geological Society public lecture 2014 : Contaminated Land: What is it Good For? (https://www.geolsoc.org.uk/contaminatedland)
- CRC CARE Fellow 2017,
- Society of Chemical Industry Environment medal 2019

Headline presentations

- Glossop Lecturer 2009;
- Brian Robinson Memorial Lecturer 2017;
- SCI Environment Lecturer 2019;
- Numerous keynotes, including Agility for Resiliency – A Prerequisite for Sustainable Remediation Keynote NZ Land & Groundwater eConference 2020; Application of Sustainable Remediation to a PFAS Contaminated Site Ecoforum 2020

Languages

- English: Fluent
- Greek: Proficient
- French: Basic

Selected Publications

BERIRO, D., ABRAHART, R. and NATHANAIL, C. P. 2013. Comparison of genetic programming with neuro-fuzzy systems for predicting short-term water table depth fluctuations Computers & Geosciences. 56, 216-220

BERIRO, D., ABRAHART, R., NATHANAIL, C.P., MORENO, J. & BAWAZIR, A. 2013. A typology of different development and testing options for symbolic regression modelling of measured and calculated datasets Environmental Modelling & Software. 47, 29-41

CHENG, Y., TANG, Y. and NATHANAIL, C.P., 2017. Determination of the Potential Implementation Impact of 2016 Ministry of Environmental Protection Generic Assessment Criteria for Potentially Contaminated Sites in China. Environmental Geochemistry and Health. 1-19

COULON, F, JONES, K, LI, , HU, Q, GAO, J, LI, F, CHEN, M, ZHU, Y, LIU, R, LIU, M, CANNING, KATE, HARRIES, NICOLA, BARDOS, P, NATHANAIL, C.P., et al. 2016. China's soil and groundwater management challenges: Lessons from the UK's experience and opportunities for China Environment International. 91, 196-200

M.R. CAVE, C. H. VANE, A. KIM, VICTORIA L. MOSS-HAYES, JOANNA WRAGG, CLAIRE L. RICHARDSON, HEATHER HARRISON, C. PAUL NATHANAIL, R. THOMAS AND G. WILLS, 2015. Measurement and modelling of ingestion bioaccessibility of polyaromatic hydrocarbons in soils Environmental Technology & Innovation. 3, 35 – 45

NAIDU, R., WONG, M. H. & NATHANAIL, P., 2015. Bioavailability - the underlying basis for risk-based land management. Environmental Science & Pollution Research. 22(12), 8775-8778

R. NAIDU, P. NADEBAUM, C. FANG, I. COUSINS, K. PENNELL, J. CONDER, C.J. NEWELL, D. LONGPRÉ, S. WARNER, N.D. CROSBIE, A. SURAPANENI, D. BEKELE, R. SPIESE, T. BRADSHAW, D. SLEE, Y. LIU, F. QI, M. MALLAVARAPU, L. DUAN, L. MCLEOD, M. BOWMAN, B. RICHMOND, P. SRIVASTAVA, S. CHADALAVADA, A. UMEH, B. BISWAS, A. BARCLAY, J. SIMON, P. NATHANAIL. 2020. PFAS: Current status and research needs. Environmental Technology & Innovation, 19 https://doi.org/10.1016/j.eti.2020.100915.

NATHANAIL, C.P., GILLETT, A., MCCAFFREY, C., NATHANAIL, J. AND OGDEN, R., 2016. A Preliminary Risk Assessment Protocol for Renegade Nanoparticles Deployed During Nanoremediation Remediation Journal. 26(3), 95-108

C.P. NATHANAIL, A GILLETT, CAROLINE MCCAFFREY, JUDITH NATHANAIL, R. OGDEN. 2016. A preliminary risk assessment protocol for renegade nanoparticles deployed during nanoremediation. Remediation Journal 26(3) 95-108

D. SCOTT, M. ASHMORE, C.P. NATHANAIL. 2005 Operating windows to assess whether monitored natural attenuation is a technically feasible remediation option for BTEX-contaminated groundwater. Remediation Journal

YAN, J., GAO, W., DONG, M., HAN, L., QIAN, L., NATHANAIL, C.P.AND CHEN, MENGFANG, 2016. Degradation of trichloroethylene by activated persulfate using a reduced graphene oxide supported magnetite nanoparticle Chemical Engineering Journal. 295, 309-316

Work history

2020 – to date	Technical Director & Technical Services Lead Environment, GHD
2018 – to date	Honorary Research Associate, British Geological Survey
1997 – 2020	Managing Director, Land Quality Management Ltd
1998 – 2018	Professor of Engineering Geology, University of Nottingham.
1987 – 1994	Senior Geologist, Wimpey Laboratories, Hayes MIDDX

Richard Ogden

Lead Environmental Scientist

Qualified: BSc (Joint Honours) Biochemistry & Marine Biology (EQF Level 6), PhD Thesis title "The *bphS* regulatory gene found in *Pseudomonas* sp.Strain IC: a molecular analysis" (EQF Level 8)

Connected: Practitioner Member of the Institute of Environmental Management and Assessment (PIEMA), Full member of the Institution of Environmental Sciences (MIEnvSc)

Professional Summary: Richard is an experienced technical specialist widely recognised for expertise in land contamination risk assessment and remediation and commitment to robust, data-led decisionmaking. He has over 20 years' of related experience in research institutions, blue-chip multinationals and specialist consultancies. Richard's interests cover a wide-range of environmental and sustainability issues; with particular experience in land contamination assessment and remediation, and brownfield redevelopment. He is a hugely experienced trainer having delivered courses for numerous clients, regulators and practitioners and has also presented at many industry conferences and seminars.

Work experience

Lead Environmental Scientist / Project Manager | GHD, Nottingham | July 2020 – to present

Senior Environmental Scientist
Land Quality Management (LQM), Nottingham | April 2003 – June 2020

LQM is a specialist land contamination consultancy with a reputation for providing peer review and expert witness services, contract research and training courses land owners, developers, practitioners and local auuthorities. As a Senior Environmental Scientist and Project Manager Richard's key experience is in:

- Project management
- Training development and delivery
- Site investigations, data analysis and report writing
- Risk assessment: Human-health; gases/vapours & controlled waters
- 3rd party report review (incl. Part 2A and Planning contexts)

Key projects Richard was involved in include:

- Co-author of Ciria's guidance on the investigation, assessment and remediation of asbestos-containing soils (C733)
- Co-author of LQM/CIEH Generic Assessment Criteria (1st and 2nd Editions) & S4ULs for Human Health.
- Development of LQM Dose Response Roadmaps (Part 2A risk assessment tool).
- Supporting a Local Authority deliver its Local Plan incl. peer review and representation at the Planning Inspectorate hearings with respect to the allocation of a contentious former landfill.
- Contaminated land risk assessments and modelling: human health (incl CLEA & in-house deterministic and probabilistic modelling); controlled waters (ConSim and RTM);
- Phase 1 and 2 contaminated land investigations, reporting, advice and review work.

Post-doctoral Researcher
Centre for Ecology & Hydrology, Oxford, UK | June 2002 – March 2003

The UK Centre for Ecology & Hydrology is an independent, not-for-profit research institute, carrying out environmental science across water, land and air.

As a Post-doctoral Researcher, Richard was responsible for conducting research on biodegradation and phytoremediation of organic and inorganic contaminants.

Bioremediation Manager
BAE Systems, Westcott, Aylesbury, UK | June 1998 – May 2002

Working within a specialist property and environmental team managing legacy defence industry sites, Richard was responsible for:

- Managing a NATO research project into sustainable munitions, including the biodegradation of component energetic compounds.
- Managing bioremediation activities at a former munitions site during decommissioning.
- Scientific and technical support to site investigation and remediation teams.

Laboratory assistant, University of Wales, Bangor, UK | Sept 1992 – Sept 1993

As a laboratory assistant, Richard was responsible for conducting experiments relating to the molecular genetics of microbial biodegradation

Richard Ogden
Lead Environmental Scientist

Other related areas of interest

Relevant publications

- Nathanail, C. P., Gillett, A., McCaffrey, C., Nathanail, J. and Ogden, R. (2016), A Preliminary Risk Assessment Protocol for Renegade Nanoparticles Deployed During Nanoremediation. Remediation, 26: 95-108. doi:10.1002/rem.21471
- Nathanail CP, McCaffrey C, Gillett AG, Ogden RC, & Nathanail JF. (2015). The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, a Division of Land Quality Management Ltd: Nottinghamshire, UK.
- Nathanail C, Jones A, Ogden R, & Robertson A. (2014). C733 - Asbestos in soil and made ground: a guide to understanding and managing risks. CIRIA: London, UK.
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Work history

April 2003 – July 2020	Senior Environmental Scientist, Land Quality Management Ltd, Nottingham
June 2002 – Mar 2003	Post-doctoral Researcher, Centre for Ecology & Hydrology, Oxford, UK
June 1998 – May 2002	Bioremediation Manager, BAE Systems (Property & Environmental Services), Westcott, Aylesbury, UK
Sept 1992 – Sept 1993	Laboratory Assistant, School of Biological Sciences, University of Wales, Bangor, UK

Hassan Gilani, M.Sc. P.Eng.

Senior Geotechnical Engineer

Qualified: M.Sc. Civil and Environmental Engineering, 1993; B.Sc. Civil Engineering, 1984

Connected: Registered Professional Engineer: Ontario, Alberta, New Brunswick; Member, Canadian Geotechnical Society; Member, North American Geosynthetic Society; Committee Member, American Society for Testing and Materials, (ASTM) D18 on Soil and Rock; Registered for Pavement Design (low complexity), Pavement Evaluation (flexible), and Soils and Pavement Investigation (routine) under the Ministry of Transportation of Ontario (MTO) Registry, Appraisal and Qualification System (RAQS)

Professional Summary: Hassan is a senior geotechnical engineer with 35 years of experience in geotechnical engineering, including finite element method-based analysis of soils and soil-structure interaction problems. His work history also covers geo-environmental engineering, materials and pavement engineering, and construction for project across North America and the Middle East. His extensive pavement design and evaluation experience is based on MTO's MI-183 "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (2008). Additionally, he is also experienced in cost/benefit analysis of pavement rehabilitation options and life cycle cost analysis of pavement structures.

Seismic and Dynamic Analyses

Lead Geotechnical Engineer

Geotechnical Engineer
Cobble Hill Landfill | BC Ministry of Environment and Climate Change Strategy | Shawnigan Lake, Victoria Island, British Columbia | 2019

GHD was retained by the Ministry of Environment and Climate Change Strategy (MECC) to provide a third party opinion of the 'soil wedge' and related static and seismic stability calculations that are discussed in the Cobble Hill Landfill 2019 Closure Plan dated, 2019 prepared by others. GHD identified the potential instability risk under seismic conditions associated with the use of smooth geomembrane at the interface between the proposed stabilizing earthen wedge and existing landfill. GHD also recommended that instead of using Hynes-Griffin and Franklin method of reducing the seismic coefficient to 50 percent of the PGA value with the implicit assumption that up to 1 m of permanent displacement would be acceptable, the designer should determine the seismic coefficient relative to the Site-specific acceptable permanent deformation.

Geotechnical Engineer
Burgoyne Bridge Replacement Project | Regional Municipality of Niagara | St. Catharines, ON | 2014 - 2017

Carried out engineering stability evaluations of the heavy-duty construction equipment with respect to their loads and vibrations on approximately 20 m high natural slopes comprised of relatively soft lacustrine deposits. Provided recommendations for allowable limits of peak particle velocities and associated frequencies. Recommendations were provided for allowable inclinations of cut and fill slopes and Reinforced Soil Slopes for working pads built on the natural valley slopes

Lead Geotechnical Engineer
Raw Waterline | City of Lockport, NY | Lockport, NY | 2014 - 2015

The approximately 100 year old cast-iron raw water transmission line is the only permanent source of drinking water. Lafarge as part of their Lockport Quarry expansion proposed blasting in the area bordering the pipeline. The current condition of pipe line was investigated through test pits and ultrasonic techniques and was found to be in poor condition. Blasting data provided by Lafarge was reviewed and its effect on the pipeline was evaluated. Based on the results, the City was advised to replace the pipeline bordering the quarry before issuing the blasting permit.

Lead Geotechnical Engineer
Site Specific Seismic Analysis, Elevated Raw Water Tank | The City of Brantford, ON | Brantford, ON | 2018 - 2019

Conducted a Site-Specific Seismic Site Response Analysis study for the proposed Shellard Lane Elevated Water Storage Tank site in accordance with the 2012 Ontario Building Code 2010 National Building Code of Canada. The purpose of the analysis was to determine the site-specific seismic design parameters for the ±60 m high elevated tank structure.

Seismic Specialist

Municipal Pier | Queen Evans Architects | San Francisco, California | 2020

Due to sloping bedrock overlain by dense sands at the shallow end and very soft bay mud at deeper depths, a single set of seismic spectral accelerations could not be applied to the replacement pier structure proposed to comprise a concrete deck supported on pile foundations. Multiple site-specific ground motion analyses were carried out along the length of the pier structure and a combined response spectrum was developed that would be

applicable to the whole length by combining the critical components of the individual response spectra developed for each location.

Lead Geotechnical Engineer

Geotechnical Engineer
Creston Landfill | Regional District of Central Kootenay | Nelson, British Columbia | 2005 - 2006

The closure side slopes were proposed at 2.5H:1V to maximize its volume instead of 3H:1V mandated by the British Columbia Ministry of Environment and Climate Change (BC MECC). BC MECC required detailed analyses to demonstrate that the 2.5H:1V side slope would be stable under static and seismic conditions. GHD conducted static and pseudo-static seismic slope stability analyses, which showed the side slopes to be slopes. The free-field condition liquefaction analyses, suing the SPT and CPT data showed that the thin sand and silt seams within the glaciolacustrine clay underlying the landfill are susceptible to liquefaction under the mounded groundwater conditions. Free-field analysis did not consider the increase in pressure due to landfill, and was therefore its results were considered conservative. Moreover, the sand and silt seams within a glaciolacustrine deposit are discontinuous and confined. Therefore, the probability of the localized liquefaction of the confined, discontinuous sand/silt seams ranging in 0.1 m to 0.3 m in thickness was considered low and not expected to trigger sliding along a continuous potentially weakened plane. Cumulative effect of liquefaction of embedded sand/silt seams could however result in some localized settlement of the ground surface, causing damage to the cover system, which could be readily repaired. BC MECC accepted the GHD report and issued to permit for construction at a steeper slope.

Pavements

Geotechnical Engineer
Geotechnical Investigation 2016 Road Resurfacing Program – Trelawn Parkway | Corporation of the City of Welland | Welland, ON | Completed 2016

GHD was retained by the Corporation of the City of Welland for the Trelawn Parkway Rehabilitation Project. Project included pavement and subsurface soils and groundwater investigation and determination of Pavement Condition Index to confirm the need of rehabilitation. Road rehabilitation recommendations were provided that were specific to the section of the road being investigated. analyses of materials based on conditions encountered and project specifications.

Lead Geotechnical Engineer
Queen South Rehabilitation| Municipality of Chatham-Kent | Tilbury, ON

Completed September 2011

Managed geotechnical investigations on the 1025 m long section of Queen Street South extending from Bond Avenue to Middle Line. Soils and pavement investigations performed for the proposed rehabilitation and/or reconstruction. Scope included determining types of distresses whether due to fatigue (thermal and wear/tear) or weak subgrade. Supplemented with borehole investigation recommendations for pavement rehabilitations options consisting of Expanded Asphalt, and complete reconstruction using flexible or rigid pavement structures were provided. Design options were based on traffic analyses, converting the provided AADT data into EASL for 20 years design life using the provided growth rates. Pavement component thicknesses were calculated using the procedure outlined in the MTO Publication 'Adaptation and Verification of AASHTO Pavement Deign Guide, for Ontario Conditions dated March 2008. Life Cycle Cost Analysis (LCCA) for each design option was provided.

Lead Geotechnical Engineer
Geotechnical Investigation Program | Regional Municipality of Waterloo | Cambridge/Kitchener/Waterloo, ON

Completed 2011

Managed the geotechnical investigations for the 20 roads included in the 2011 geotechnical investigation program, and provided rehabilitation and reconstruction recommendations, and the life cycle cost analyses for each option. The rehabilitation options comprised of asphalt overlay, and overlay combined with foamed Asphalt and Cold-in-Place Recycling. The reconstruction option comprised of flexible pavement structures. The pavement design recommendations were based on the results of visual inspections and borehole investigations. The primary causes of distress in the existing pavements were identified and design recommendations were provided accordingly. The structure umber based designs were carried out in accordance with the MTO Publication 'Adaptation and Verification of AASHTO Pavement Deign Guide, for Ontario Conditions dated March 2008.

Slopes Stability

Geotechnical Engineer
Duffins Creek Stable Top Assessment | Marshall Homes, | Pickering, ON

Carried out detailed assessment of the long-term-stable top of slope along Duffins Creek running along the proposed residential subdivision. Scope of work included visual inspection and review of the results of the geotechnical investigation. Based on the slope stability assessment, recommendations were provided to set the

stable top of bank at a distance of 10.5 m landwards from the existing top of bank for the development purposes due to the presence of relatively soft lacustrine deposits and evidence of previous landslide activity.

Geotechnical Engineer
Beard Lane | Haideral & Maxima Development Ltd.| St. Catharines, ON

Determined the stable top of the slope for the 5-storey residential condominium development proposed to be developed on the 0.5 hectares tableland above the 19 m high slope. Conducted geotechnical investigation comprised of deep boreholes and carried out slope stability evaluations. Existing top of slope was found to be stable. Different recommendations were provided for soil bearing resistance for footings placed inland and closer to the slope, respectively.

Geotechnical Engineer
Kerns Road Stable Top Assessment | Infrastructure Ontario| Burlington, ON

Infrastructure Ontario (IO) retained GHD to carry out a geotechnical evaluation of the stability of the slope along the southern limits of the 2.08 hectares irregular shaped property to confirm that the physical top of the bank is the stable top of the bank due to proximity of the top of the slope to the existing structure. Carried out a study comprised of borehole investigation and visual inspection and provided its findings confirming that the existing top of the bank is the stable top of the bank.

Geotechnical Engineer
Castlemore Road, Stable Top Assessment | Infrastructure Ontario| Brampton, ON

Infrastructure Ontario (IO) retained GHD to carry out a geotechnical evaluation to determine stable top of bank along the north property boundary abutting the Salt Creek valley. The geotechnical evaluation comprised of visual inspection and borehole investigation, and slope stability analyses which confirmed that the exiting top of the slope is the stable top of the slope. Erosion hazard allowance was needed to be added in the northeastern portion of the property due to the creek flowing at the toe of the valley slope.

Landfills

Lead Geotechnical Engineer
The City of Toronto Closed Landfills – Disco Landfill, Stand Wadlow Landfill, Coe Hill Landfill and Sunrise Landfill | City of Toronto | Toronto, ON | 2016 - 2018

Planned and conducted geotechnical investigations for the proposed blower enclosure structures and associated landfill gas collection pipes for the remedial systems to be installed in the closed landfills located in different areas and different geological settings within the City of Toronto. The main challenge encountered that the stratum comprised of thick deposits of aged municipal solid waste fill, typically requiring deep foundations to support above-ground structures. Recommendations were provided to support the blower structure on geogrid reinforced engineered fill. Design details for the reinforced engineered fill were provided. Similarly pipe bedding was also recommended to be reinforced with a layer of geogrid. Design support during construction of these works was provided on as-needed basis.

Lead Geotechnical Engineer
12th Street Landfill | Otsego Township | Allegan County, Michigan

It was proposed to excavate approximately 12,000 cubic yards of the surficial paper sludge materials in the surrounding areas and to place the excavated materials on the existing paper sludge landfill resulting in its vertical expansion. The landfill was to be capped after completion of filling operations. Carried out geotechnical evaluation of the stability of the proposed side slopes for the redesigned landfill at 4H:1V. The design side slopes were achieved by cutting back the existing side slopes, which were typically around 2H:1V but were as steep as 1.5H:1V. The geotechnical assessment of the proposed landfill grading plan was carried out with respect to stability of the planned landfill side slopes taking into out changes in porewater pressures due to the cutting and filling operation. Sliding stability analyses of the proposed cover system was also carried out.

Lead Geotechnical Engineer
Buckeye Reclamation Landfill | Chartis | St. Clairsville Belmont County, Ohio

Kings Run located east of the landfill, was realigned further to the east as part of the remedial measures under US EPA priorities list in early 2000s. Realignment involved cutting into the toe of the existing Dunkard group bedrock slope comprised of mudstone and siltstone interbedded with thin layers of coal. The realignment has caused frequent slope instabilities along the approximately 5,000 feet long realignment due to over steepening and undermining. Provided remedial measured for the slope failures to-date in 2010, and provided slope face and slope crest drainage improvement recommendations as prevent measures, which have reduced the incidents of slope movements significantly. GHD is still actively involved in the landfill in monitoring works.

Lead Geotechnical Engineer
Bailey Landfill | City of Chilliwack | Chilliwack, BC | 2005, 2011, 2013 - Present

Reviewed the design and installation specifications of helical piles supporting the gas control plant, pump station and drum flare over ±2.5 m thick peat deposits. Conducted settlement and stability analyses of the northwest landfill cell addition over ±9 m thick peat

deposits, proposed to piggyback on to the existing landfill. The settlement of the new cell was predicted to be in the order of 1.5 m. Based on FEM based analyses it was shown that the basal geomembrane under the proposed cell and geotextile in the cover system of the existing landfill will move independently of each other. It was also demonstrated that the elongation in the geomembrane due to settlement will remain within allowable range. It was also shown that the settlement differential between the toe of the existing landfill and the south edge of the NW cell would be much less than the 1.5-m maximum settlement.

Lead Geotechnical Engineer
Technical Feasibility Study | Chaumox Landfill | Fraser Valley Regional District | Boston Bar, BC | 2014 - Present

As part of the Closure Plan, carried out analyses of the landfill cover stability and proposed final conditions of the landfill located on outwash sand and alluvial terrace deposits for static and seismic conditions. The analyses included liquefaction and stability of the steep valley slope under both static and pseudo-static conditions. Recommendations were made to flatten the valley side slope to 2H:1V from the existing approximately 1.7H:1V to improve the Factor of safety under static conditions fro, 1.27 to 1.5.

Lead Geotechnical Engineer
Final Closure Plan Review | Cobble Hill Landfill | British Columbia Ministry of Environment and Climate Change Strategy | Shawnigan Lake Bar, BC | 2019

Provided a third party opinion of the ‘soil wedge’ and related static and seismic stability analyses carried out by others as part of the final closure plan for the landfill. A potential risk was identified due to the proposed use of a smooth membrane on a 2.5H:1V slope of the landfill against which the wedge will be supported. It was recommended that either a textured membrane be used or more rigorous methods of analyses should be used to demonstrate stability than the empirical methods currently used to show a marginally stable slope under static and seismic conditions. The Ministry accepted the gHD position to the extent that the landfill owner was required to prove the materials’ strength parameters used in the analyses through laboratory testing.

Lead Geotechnical Engineer
Port Hope Long-Term Waste Management Facility (LTWMF) | Atomic Energy Canada Ltd. | Port Hope, ON | 2011 – 2016

Carried out analyses of the proposed waste storage mound stability including its slopes, base and cap liner, and settlement potential under both under static and pseudo-static (seismic) conditions using finite element method (FEM) based suite of software. The work was reviewed by Dr. Rowe of Queens University on behalf of Atomic Energy Canada Ltd.

Lead Geotechnical Engineer
Creston Landfill | Regional District of Central Kootenay | Creston, British Columbia

GHD requested a variance to use steeper 2.5H:1 slopes to maximize the MSW landfill operating capacity from the permitted 3:1 slopes. Analyses were performed to demonstrate that the steeper slopes will remain stable under static and seismic conditions. Liquefaction analyses were also performed as part of the submittal to the British Columbia Ministry of Water, Land and Air Protection, which was approved.

Lead Engineer

Green Lane Landfill | City of Toronto | St. Thomas, ON

Carried out engineering stability evaluations based on analytical and observational methods of the excavations in more than 6 m (20 ft.) deep MSW materials for placement of manholes required for extension of the leachate collection system.

Carried out veneer stability analyses cover against under equipment and increased soil thickness when temporary clay cap thickness was required to be increased on a 2:1 slope to prevent leakage of landfill gases. Recommendations for soil placement, its compaction and safe operation of equipment were provided. Clay cap thickness was increased successfully.

Provided recommendations for building the stockpiles of clayey soils obtained from excavating up to 20 m (65 ft.) deep cells along the property boundary.

Lead Geotechnical Engineer
Hazardous Waste Landfill | Clean Harbors Canada Inc. | Sarnia, ON | Design Phase 2009 – 2010, Construction Phase 2010 – On-going

Carried out analyses of failure of an approximately 18-m high below-grade side slope excavated at 1H:1V. Analyses comprised of numerical modelling of the slope failure using the available laboratory and field data consisting of triaxial shear test results and pre and post failure vibrating wire piezometers. Using the analyses the cause of failure was identified as quicker dissipation of excavation induced negative pore water pressure than rate of filling of the cell. Based on numerical analyses, due to the precious air space, the new design introduced only one 10 m wide bench approximately at 6 m depth from the ground surface in the 1H:1V slope to ensure enough time is available to place waste at the toe of the slope to buttress it before negative pore water pressure dissipates such that the factor of safety never drops below 1.1. The cell side slope was constructed as recommended and cell filled as planned without any further issues. The failure happened in June 2009; design and construction works

were completed same year and filling was completed in 2009-2010.

Lead Geotechnical Engineer
Slope Repairs Landfill Vault | Confidential Client | Bedford, IN | 2005

Compacted clay liner (CCL) over the south slope of the under-construction below grade landfill failed twice. After a site visit and field investigations comprised of crown to toe trenching and test pits, cause of failure was identified as perennial seepage from the subgrade layers. Based on FEM based seepage, stress-deformation, and slope stability analyses compacted clay liner was recommended to be constructed at a slightly flatter slope to avoid placing it on the disturbed subgrade in combination with construction seepage collection drains. CCL was completed as recommended, waste material placed and the landfill has since been capped.

Water/Wastewater

Lead Geotechnical Engineer
Wastewater Implementation Strategy and EA Addendum | District of Muskoka | Huntsville, ON | 2018 – present

A variety of feasible solutions to convey wastewater from the Mountview CWP to the Golden Pheasant CWP were evaluated by GHD. Hassan conducted a desktop study of the proposed route including the outfall, and provided geotechnical input into the implementation strategy to develop the preferred solution including selection, concept design and constructability of the proposed Golden Pheasant CWP outfall route, a Public Information Centre in November 2018, stakeholder notification and response, and dispersion/thermal modelling of the proposed new Golden Pheasant CWP outfall. Completion and filing of the EA Addendum is pending private property easement or acquisition.

Geotechnical Engineer
York Durham Sewage System (YDSS) Forcemain Twinning | Regional Municipality of York | Newmarket, ON | 2016 – 2018

Performed geotechnical investigations for the infrastructure components of the UYSS project, including the new 40 MLD Water Reclamation Centre (Sewage, Air/Noise) and the YDSS modifications. The YDSS modifications include the provision of 5 km of 1,050-mm diameter and 800 m of 350-mm diameter concrete forcemain through the Town of Newmarket, to twin existing infrastructure between the Newmarket Sewage Pumping Station (SPS), the Bogart Creek SPS and to the Aurora Sewage Pumping Station to the south.

Lead Geotechnical Engineer
Pelee West Shore WTP Rehabilitation and Class EA | Township of Pelee | Pelee Island, ON | 2014 – 2016

GHD was retained to complete a Class B Municipal Class Environmental Assessment investigating water-servicing options for small municipal drinking water systems in southwestern Ontario, followed by detailed design, contract administration, and construction oversight. Hassan planned and conducted the geotechnical investigation and provided geotechnical design and construction recommendations.

Lead Geotechnical Engineer
Owen Sound WWTP Class EA and Upgrade | City of Owen Sound | Owen Sound, ON | 2008 – 2014

The City of Owen Sound required a Class EA (Schedule C) to upgrade to secondary treatment with consideration of the existing 24 MLD primary treatment facility. Hassan planned and conducted multistage geotechnical and hydrogeological investigation on this project with a total project capital value of $45M. The surface conditions were challenging with soil overburden comprised of hard till and shallow bedrock on the east side of the proposed upgrade changing to soft sediments overlying relatively deep bedrock on the west side closer to the lake. Hassan provided excavation, dewatering and foundation recommendations that allowed completion of the project seamlessly and economically.

Lead Geotechnical Engineer
16th Avenue Watermain Rehabilitation | Regional Municipality of York | Markham, ON | 2011 – 2013 | $8M

This project re-established vital infrastructure to maintain potable water for existing development within the Region. The client wanted trenchless installation to maintain traffic and allow the crossing of Bruce and Berczy creeks. Also significant detailed design was complete within a relatively short period focused on secured approvals. Delivery was extended slightly due to challenging ground conditions.

The project involved preliminary and detailed design, subsurface utility locates, lane restriction, tendering, construction administration, and inspection services to implement the recommendations for Jefferson Sideroad Watermain Rehabilitation (which had failed as a result of over mining by a previous tunnelling contract). The project included the rehabilitation of 1,450 m of 500-mm diameter water main by horizontal directional bore. Significant coordination was required to obtain approval from Region's Traffic department, TRCA, MNR, and DFO. Hassan planned and conducted the geotechnical investigation for the 16th Avenue Watermain Rehabilitation, and provided geotechnical design and construction recommendations based thereon.

Lead Geotechnical Engineer
Kleinburg Water Supply Project | Regional

Municipality of York | Kleinburg, ON | 2009 – 2013 | $14M

This project incorporated vital infrastructure to allow for future development within the Region. Key to the client was the commissioning of the main to enable continued development. Significant detailed design was complete within a relatively short period, approvals were secured without challenge and project was delivered on time and within budget.

The project included installing 3,800 m of 750-mm diameter watermain along Huntington Road and 2,400 m of 400-mm diameter watermain to be constructed along Islington Road. In concert with the transmission main, the team designed a new booster station for pressure district PDKn at the site of the existing Kleinburg elevated water storage tank site. Trenchless construction methods were used for one CP rail crossing, a crossing of Major Mackenzie Drive and four environmentally sensitive waterways. Significant coordination was required to obtain approvals from TRCA, MNR, CP Rail, and City of Vaughan engineering and traffic department. Hassan planned and conducted the geotechnical investigation for the watermain as well as elevated water tank, and provided geotechnical design and construction recommendations based thereon.

Lead Geotechnical Engineer
Parsons Watermain Phase II | Regional Municipality of Wood Buffalo | Fort McMurray, AB | 2009 – 2012

Planned, conducted and prepared the geotechnical investigation for the watermain proposed to be installed using directional drilling methods across approximately 0.6 km wide and 60 m deep Goat Head Creek valley. Boreholes up to 56 m were installed on either side of the valley and on the valley side slopes using conventional drilling methods with SPT sampling and HQ coring to determine continuous soil overburden and bedrock profile across the valley. Based on field and laboratory testing, potential issues such as bit balling in bituminous sand layers, loss of drilling fluid in sand layers, swelling of clay shale of Fort McMurray Formation, and deflection of bit due to embedded thin siltstone and sandstone layers in the Fort McMurray formation were identified.

Dams

Lead Geotechnical Engineer
Dalewood Dam Hazard Potential Evaluation | Kettle Creek Conservation Authority | St. Thomas, ON | 2019

Reviewed the available background information and inspected the earthen embankment structure to document deficiencies, if any. Currently carrying out stability assessment of the earthen embankment using the soil strength properties derived from the available borehole information for a range of water levels, in conjunction with the hydrotechnical analysis.

Lead Geotechnical Engineer
Thomson Lake Dam Evaluation | Credit Valley Conservation | Erin, ON | 2017

Inspected and evaluated the stability of the approximately 150-m-long, ±100 years old earthen dam structure with two concrete spillway structures located within the earthen dam. Recommended remedial measures for the spillway structures based on the structural evaluation carried out in accordance with the Technical Bulletin titled Structural Design and Factors of Safety dated August 2011 (Technical Bulletin) issued by the Ontario Ministry of Natural Resources (OMNR) to improve the factor of safety for the Usual (Winter), Unusual (Flood) and Unusual (Winter) conditions. Spillway remedial works designed by GHD have been completed.

Mining

Lead Geotechnical Engineer
Kam Kotia Mine Rehabilitation Tailings Berm Evaluation | Ministry of Northern Development and Mines | Timmins, ON | 2015 – 2016

Carried out geotechnical investigation comprised of boreholes and evaluated the static and seismic stability of the existing rock berm for the closure condition of acid generating waste rock placed over the approximately 52 m deep mostly below grade tailings. Recommendations were provided to buttress the berm using a compacted mineral material with a minimum thickness of 2 m and downstream slope of 2.5H:1V. Analyses also included anticipated settlement of the 52-m thick tailings under the load of approximately 13-m thick waste rock, and the effect of resulting lateral stresses on the stability of the rock berm.

Lead Geotechnical Engineer
Kam Kotia Mine Rehabilitation | Ministry of Northern Development and Mines | Timmins, ON | 2015

Carried out geotechnical investigation comprised of boreholes and CPT at the approximately 240 hectares Mine site for the proposed sludge disposal and polishing ponds, and for evaluating the rock berm stability that dams the eastern end of the open pit. The open pit will be used for disposal of acid generating waster rock. Analyses included anticipated settlement of the tailings that were used to fill the 52 m deep open pit under the weight of the waste rock and their effect on the final cap cover, and the effect of lateral stresses on the stability of the rock berm holding the tailings at the east end of the open pit.

LITIGATION SUPPORT/EXPERT TESTIMONY

- Expert witness before the Division of Hearings and Appeals, State of Wisconsin regarding the

geotechnical aspects of design and operation of waste water storage lagoons of a dairy facility.

Work history

2004 – present	GHD (formerly Inspec-Sol Inc.), Waterloo, ON
2003 – 2004	Courtland Engineering, Kitchener, ON
2002 – 2003	Soil Probe Ltd., Toronto, ON
2000 – 2002	Sarafinchin Associates, Toronto, ON
1993 – 2000	NESPAK Pvt. Ltd, Pakistan
1984 – 1993	Ministry of Irrigation, Pakistan

Recognized (Certifications/Trainings)

- 2020 – 4 hr. Webinar ‘Site Specific Design Ground Motions as per ASCE 7-16’ by American Society of Civil Engineers
- 2016 – 2 hr. Webinar ‘Lessons Learned from 10 Years+ of Using Full-Depth Reclamation for Road Rehabilitation’ by the US Transport Research Board
- 2015 – 2 hr. Webinar ‘Materials for Unbound Granular Pavement Layers’ by the US Transport Research Board
- 2013 – 2 hr. Webinar ‘Composite Pavement Systems’ by the US Transport Research Board
- 2013 - One Day Short Course 'Horizontal Directional Drilling (HDD) Pipeline Construction, Design and Quality Assurance' Centre for the Advancement of Trenchless Technologies, University of Waterloo
- 2015 –One Day Short Course ‘Role and Importance of Geotechnical Engineer in Trenchless Projects’ Centre for the Advancement of Trenchless Technologies, University of Waterloo
- 2013 - One Day Short Course 'Horizontal Directional Drilling (HDD) Pipeline Construction, Design and Quality Assurance' Centre for the Advancement of Trenchless Technologies, University of Waterloo
- 2013 - Three Day Course 'Design and Construction of Micro-tunneling Projects' American Society of Civil Engineers (ASCE), New Jersey, USA
- 2011 - Three Day Course 'Geotechnical Earthquake Engineering, Geotechnical Research Centre, Department of Civil and Environmental Engineering, University of Western Ontario, London
- 2011 - One Day Short Course on Cone Penetration Testing for Geotechnical Analysis and Foundation Design presented by Dr. Paul Mayne of Georgia Institute of Technology,
- 2008 - Annual Geotechnical Modeling Workshop, Four day Workshop by Geo-Slope International Limited, Banff, Alberta
- 2007 - Design of Piled Foundations, A one-day workshop by B. H. Fellenius,
- 2007 Evaluation of Soil Liquefaction and It's Link to 2005 National Building Code of Canada, 2005, A short course by Dr. Peter Robertson, University of

Curriculum Vitae

Dr. Pallavi Mandke

Principal Consultant, Social Impact Assessment

Qualifications: PhD in Social Development, University of Queensland, 2007.
Relevance to Project: Pallavi is GHD's National Technical Director for socio-economic impact assessments (SEIA), social investment planning, community needs assessment, stakeholder engagement, multi-criteria analysis and social risk analysis, with 20 years of experience in successfully leading, managing and delivering a number of SEIAs in mining and oil and gas industry in Australia and overseas.
Pallavi has in-depth understanding of resource industry Social Performance Standards and government and community expectations to gain and maintain a social license to operate. Through her extensive experience in WA, Queensland, NT and NSW, Pallavi has a thorough understanding of complex social issues arising from mining projects. With her qualification and experience Pallavi is well placed to develop tailored methodologies to drive social research to inform decision making and ultimately work with our clients to maintain a social licence to operate. Her project experience in technical lead role includes Rio Tinto Argyle Diamond Mine closure pre-feasibility study, BHP Billiton Petroleum's SEIA for all their assets across Australia, BHP Billiton Nickle West socio-economic contributions assessment across their five assets in WA, SEIA for Mount Peake Mine Project, technical reviewer for the social impact assessment for Nolans Rare Earth Project and Mount Todd Gold Mine Project.

Project Manager and Technical Lead Rio Tinto Argyle Diamonds Limited | Mine Closure Social and Economic Impact Assessment Phase 1 and 2 | Western Australia

Pallavi lead and managed the social and economic impact assessment for the pre-feasibility mine closure planning study. The purpose of the study is to identify and describe direct and indirect social and economic impacts of mine closure on the East Kimberley region as a whole but more specifically on particular stakeholder groups and to identify future economic and social sustainability opportunities for the region. The study was based on a robust methodology applying data triangulation techniques to ensure reliability of the findings of the study. The study has involved in-depth desktop research, trend and pattern analysis, extensive stakeholder consultation, client workshops and detailed report writing.

Project Manager and Technical Lead Rio Tinto Gove | Mine Closure Social and Economic Impact Assessment | Northern Territory

Pallavi is currently leading the mine closure pre-feasibility SEIA study for Gove Operations.

BHP Billiton Petroleum | Social Impact and Opportunity Assessment Australia Wide Operation| Perth, Western Australia

Technical lead to undertake a review of BHP Billiton's Community Development Management Plan (CDMP) and an assessment of social impacts and opportunities arising from their off shore construction and operations activities. It involved reviewing and assessing impacts on communities in transition from construction to operations phase in one regional community and sustained operation phase in three regional communities in Western Australia and Victoria. The project involved developing a unique, tailored methodology based on a desktop approach to review the success and gaps in implementing the CDMP, identify social impacts generated, analyse the trend of impacts over time and identify opportunities to inform manage impacts and enhance social responsibility. Provided recommendations to address gaps in the CDMP.

Technical Lead Confidential Client | Social and Economic Contribution Assessment | Perth, Western Australia

Technical lead to undertake a study to assess the

social and economic contributions of mining and related operations to the communities where the operations are based in Western Australia. The study methodology involved a project inception meeting and data validation process, economic impact modelling, a qualitative social and economic assessment, community profiling, internal interviewing, and the preparation of an interim report and succinct final report. As a result of the assessment, GHD was able to provide the client with a range of insights into its social and economic contribution within each of the communities in which they operate, as well as their contributions across Western Australia as a whole.

Technical Reviewer

Arafura Resources Limited | Nolans Rare Earth Project Social Impact Assessment | Alice Springs, Northern Territory

The technical review of the social impact assessment report was conducted to satisfy the NT EPA Economic and Social Impact Guidelines and confirm that the impact assessment was undertaken under industry best practice frameworks. The focus of the review was to ensure that generic social impacts of mining activities on Indigenous communities formed the contextual framework, and were clearly differentiated from the actual impacts of the proposed project activities on the local communities.

Technical Lead

TNG Limited | Mount Peake Social Impact Assessment | Alice Spring, Northern Territory

Technical lead to undertake the social impact assessment of a magnetite ore mine in Northern Territory, Australia. The work has involved identifying the social area of influence for the mine related work, developing a social baseline of the small remote community located near the mine site and identifying and management impacts of the mine on to the local community. The process involved briefing and training stakeholder consultation teams to discuss and identify social issues with stakeholders and reviewing consultation inputs to develop the social impact assessment.

Technical Advisor

Vista Gold | Mt Todd Gold Mine Project | Katherine , Northern Territory

Technical advisor to develop appropriate SIA methodology including stakeholder consultation and survey questionnaires. Also reviewed the technical report and final deliverables.

Technical Lead

Santos| Narrabri CSG Project | Narrabri, NSW, Australia

Technical lead to undertake a social impact assessment and develop appropriate management strategies for the gas field component of the project. The work involved developing a tailored methodology for the social impact assessment taking into account legacy social issues, Director-General's Requirements and impacts associated with affected landholders as well as wider regional communities. Issues related to community values, social cohesion and ability of the region to maintain its character were some of the key concerns addressed as part of the SIA and the responses to submissions to the EIS. The preparation of the social impact assessment involved a robust stakeholder consultation process, engaging with a number of stakeholders across the region including with groups representing the local and state government agencies, community groups, industry groups, and service providers..

Technical Lead

Adani Mining Ltd | Carmichael Coal and Rail Project | Brisbane, Queensland, Australia

Technical lead to develop and finalise the Social impact assessment, Social impact management plan and Integrated Housing Strategy for the Carmichael Coal Mine and Rail Project. This involved developing the draft SIA technical reports for public exhibition, reviewing and addressing submissions, updating technical reports to address submissions and developing the final impact management strategies.

Dr Paul Thomas Quinn
Senior Environmental Consultant

Qualified: PhD Atmospheric Physics, Aberystwyth University, UK, 2002, BSc (Hons), Planetary and Space Physics, Aberystwyth University, UK, 1997,

Connected: Graduate Member of the British Institute Physics (GradInstP), 1997, Certified Air Quality Professional (CAQP), CASANZ 2016

Professional Summary: Dr. Quinn brings over ten years consulting experience globally. Returning to the UK, having been previously based in Australia, projects have included EIAs and air quality studies for major infrastructure and resources programs across Australia, Africa and South-East Asia. Paul has consulted to the Australian Government, conducted a major study of the Australian goldfields mining region and reviewed five industry technical emissions manuals for the Australian National Pollutant Inventory (NPI).

Professional Experience

Senior Air Quality and Noise Scientist | Kampala-Jinja Expressway | Uganda | 2018

Air quality and noise impact models for EIA in Kampala city and rural Uganda for 77 km major highway

Senior Air Quality and Noise Scientist | Okvau Gold Project, Renaissance Minerals, Cambodia | 2017

Supplied meteorology, noise and air quality models for ESIA for exploration near remote WWF habitat in Cambodia

Senior Air Quality and Noise Scientist | Barapha Timber Mill and Agroforestry, Laos | 2017

Produced meteorology, air quality, noise baselines and models for timber mill ESIA in central Laos

Senior Air Quality Scientist | Mofe Creek Iron Exploration, Tawana Resources, Liberia | 2016

Analysed historical climate, and produced air quality models for site close to RAMSAR wetland

Senior Air Quality and Noise Scientist | Mako Gold Project, Toro Gold, Senegal | 2013

Air quality and noise monitoring, models and training, for mine EIA close to UNESCO chimpanzee habitat

Senior Air Quality Scientist | KFBG Botanical Gardens, Hong Kong, various sites Australia | 2013-2018

Development of wood waste-to-energy technology for sustainable, agricultural biochar production

Senior Air Quality Consultant |South Cardup Landfill, Australia | 2012

Produced air quality and odour models for waste facility outside Perth city in Western Australia.

Senior Air Quality Consultant | The National Pollutant Inventory (NPI), Emissions Estimation Technique Manuals, ACT, Australia | 2007-2011

Produced emissions reviews for fuel storage, organic liquids, mercury, crematoria and the dental industries, including consideration of sources and wastes.

Senior Air Quality Consultant | Department of Environment & Conservation (DEC), Western Australia | 2009

Published Kalgoorlie goldfields regional airshed study in association with National Pollutant Inventory

Senior Air Quality Consultant | Boyne Aluminium Smelter, Queensland, Australia | 2009

Produced air quality risk models for Australia's largest aluminium smelter, located close to Great Barrier Reef

Senior Air Quality Consultant | BP Australia, Fremantle Port, Perth, Western Australia, Australia | 2008

Produced stack design and impact models for port near Perth city. BP assisted in NPI fuel storage review

Senior Air Quality Consultant | Various | 2006-2012

Conducted Continuous Emissions Monitoring Systems (CEMS) audits and technology reviews for;

Alcan; Stanwell Power Station; Blue Circle Cement; Verve Energy; and Rio Tinto.

Dr Paul Thomas Quinn
Senior Environmental Consultant

Other related areas of interest

Fields of special competence

- Dispersion models (CALPUFF, TAPM, AERMOD, AUSPLUME, TANKS, CALINE4)
- Ambient air and Continuous Emission Monitoring Systems (CEMS), UV-IR, DOAS and FTIR technology
- Meteorological monitoring, analyses and climate change reviews
- Software and computing (Surfer, GIS, WinDOAS, Matlab, IDL, UNIX, FORTRAN)
- Emissions calculations, auditing and reporting (licensing, NPI)
- World Bank/IFC, US EPA, Australian and UK air quality requirements

Selected Publications & Presentations

- National Pollutant Inventory, Emission Estimation Technique Manual for Crematoria v1.0,

  Commonwealth Dept of the Environment, Water, Heritage & the Arts, 2011
- Kalgoorlie Region Aggregated Air Emissions Study,

  Western Australia Department of Environment & Conservation, September 2009
- Introduction to Fourier Transform Infrared Technology for Emission Reporting,

  Clean Air Society of Australia & New Zealand, July 2008
- National Pollutant Inventory Mercury Review, *National Pollutant Inventory,*

  Commonwealth Dept of the Environment, Water, Heritage & the Arts, March 2008
- National Pollutant Inventory Fuel Storage Review, *National Pollutant Inventory,*

  Commonwealth Dept of the Environment, Water, Heritage & the Arts, May 2007
- SAOZ Measurements of Stratospheric NO_2 at Aberystwyth 1991-2004

  Royal Society of Chemistry, Journal of Environmental Monitoring, Vol 8, issue 3, pp 353-361, 2006
- Ground-based Validation of ENVISAT Atmospheric Chemistry with NDSC Network Data

  1st ENVISAT Validation Workshop, European Space *Agency*, Italy, SP-531, 2003
- Satellite Observations of Ozone Minima in the Lower Stratosphere

  European Geophysical Society XXVII, abstract #2920, Nice, France, April 2002

Other educational courses

- CALPUFF Model Training Course, CASANZ, Australia, April 2011
- Oracle SQL Database Course, Oxford House, UK, October 2005
- Natural Environment Research Council (NERC) PhD Graduate Management Course, UK, May 2000
- Quantitative Earth Observation Course, Oxford University, UK, April 1999
- Global Environmental Fluid Dynamics Course, Cambridge University, UK, September 1998

Work history

2019 - present	Senior Environmental Consultant, GHD
2017 - 2018	Senior Environmental Scientist, Earth Systems, UK
2013 - 2017	Senior Environmental Scientist, Earth Systems, Perth, Australia
2006 - 2012	Senior Environmental Consultant, Environmental Consultancy Services, Perth, Australia
2003 - 2005	Travelled Africa, Asia & Australia, experience with professional wildlife photographer
2001 - 2003	Atmospheric Research Assistant, Aberystwyth University, UK

Gord Reusing, P.Eng.
Senior Air and Noise Engineer

Qualified: Master of Applied Science in Engineering (M.Sc.), Bachelor of Applied Science in Engineering (B.Sc.)

Connected: Professional Engineer in Ontario, Professional Engineer in Michigan; Air and Waste Management Association, Institute of Noise Control Engineering, Ontario Air and Noise Practitioner Groups

Professional Summary: Gord is a Principal-in-charge of the Air, Noise and Greenhouse Gas Services Groups. Gord is an engineer with extensive experience in industrial, transportation, construction and land development noise and vibration assessments, measurements, modelling and design of attenuation measures. He is a an expert in the air quality field including dispersion modeling, emissions inventories, compliance and permitting, stack testing, odour assessments, ambient air testing, and emissions abatement and control technologies. Gord is an accredited lead verifier and lead validator for greenhouse gas reports and offset projects for numerous programs including those under the United Nations and the American National Standards Institute.

Noise and Vibration

Various Clients | North America

- Prepared over 100 Acoustic Assessment Reports and Acoustic Audit Reports for a wide variety of industrial, manufacturing, energy and waste management facilities in Ontario as part of the Environmental Compliance Approval permitting process.
- Noise and vibration impact assessments and attenuation for equipment and traffic sources at over 50 manufacturing facilities, residential developments, and landfill sites.
- Noise impact assessments for wind farms including noise modeling and noise monitoring of various proposed and existing wind farm projects in Barrie, Ontario and New York State in accordance with applicable noise guidelines, bylaws, and regulations.
- Noise impact assessments and abatement for a variety of clients involved in food processing including ice cream, cheese manufacturing, meat processing, and chemical preservatives.
- Conducted noise impact assessment for Oklahoma Highway 64 expansion using Federal Highway Administration Traffic Noise Model (TNM).
- Prepared residential noise barrier design for highway noise impacts using Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT) model.
- Completed railroad noise assessments for residential developments using the Ontario Sound from Trains Environmental Analysis Method (STEAM) model.
- Managed noise monitoring programs and impact studies for a variety of facilities, including two lime mining and manufacturing facilities with large kiln operations and traffic impacts.
- Managed noise studies for landfill sites including road traffic and on-site equipment and barrier design.

Air Quality

Various Clients | North America

- Air compliance audits, Title V permitting, State permitting, Federally Enforceable State Operating Permits (FESOPs)/Synthetic Minor permitting, and evaluation and implementation of applicable NSPS, NESHAP, and MACT standards for manufacturing facilities including chemical, automotive, cellophane, coating, distillery, energy, fiberglass, food, glass, locomotive, metal finishing, molding, petroleum, secondary metals, steel and wood furniture manufacturing sectors in the United States, Canada, and the UK
- Completed over 100 Ontario Emission Summary and Dispersion Modelling (ESDM) Reports for a variety of industries in Ontario as required for Environmental Compliance Approval applications
- Environmental Impact Statements (EIS) and Environmental Assessments (EA) for numerous sites
- Air emissions modeling, air dispersion modeling, permitting, risk assessments, noise assessments and ambient air monitoring programs for quarries, mines, aggregate processing equipment, cement manufacturing, landfills and site remediation facilities
- Risk Management Plans (112R RMPs) including hazard assessments and off-site consequence analyses
- USEPA Community Right to Know Application for a Continuous Release
- USEPA Clean Air Act Emission Reduction Credit (ERC) Applications for emissions trading
- Project Manager and primary technical resource for the General Motors Corporation EPCRA Corporate Manual and the General Motors of Canada Limited NPRI and OnAir Corporate Manual inclusive of the development of the associated training programs. Key components include detailed OEM process knowledge, VOC emission quantification methods and regulation compliance

- Developed and manage numerous ambient air monitoring programs for particulate (PM, PM10, PM2.5), VOCs, TRS, and ozone
- Expert for quantification of emissions reductions as part of GHD's role as an Applicant Entity (AE) for Clean Development Mechanism (CDM) projects in the United Nations Framework Convention on Climate Change and for Alberta Environment offset project emissions
- Manage and conduct corporate training programs for US EPCRA and Canadian NPRI Reporting
- Managed and conducted EPCRA, NPRI, and OnAir Reporting for over 50 facilities
- Air emissions inventories, dispersion modeling and permitting for over 200 manufacturing facilities
- Air emissions assessments, permitting, and monitoring for over 30 hazardous waste site remedial actions including groundwater treatment systems, soil remediation systems and fugitive emissions
- Litigation support including expert testimony
- Odor emissions assessments and preparation of remedial action plans for numerous facilities in the food, chemical and automotive sectors
- Incinerator/oxidizer design, installation, permitting and trial burn stack testing including a RCRA hazardous waste incinerator
- Air emissions assessments for over ten landfill sites including estimation of landfill gas generation rates and particulate and evaluation of off-site impacts of odor and VOCs and NSPS requirements
- Managed and conducted stack testing programs for over 50 facilities

Environmental Assessments and Land Development

Air Quality and Noise Engineer
Various Clients | North America

- City of Toronto Projects:
  - Bridgepoint Hospital air impact assessment and Ontario Municipal Board expert report and testimony
  - Waste management sites odour, air and noise studies for compatibility assessments with nearby residential properties (Green Lane Landfill, biosolids facilities)
  - Dufferin Street Noise Impact Study and abatement alternatives for residential properties
  - W.R. Allen Road Noise and Vibration Impact Study and abatement alternatives for residential properties
  - Community drop in centre noise study and building features abatement design
- Regional Municipality of York - Large scale air, noise, odour, vibration data collection, and land use compatibility assessments for industrial and residential uses
- Huron County –Guideline D-6 dust, odour, noise impact studies for Official Plan amendments
- City of Burlington - Highway, road and rail traffic noise assessments for residential land uses
- Grey County - Noise impact assessments and abatement for annual music festival
- City of Collingwood - Industrial/residential air compatibility study peer review
- City of Ajax - Air and noise compatibility studies for biomass district energy plant
- Mondelez Canada Inc. - Industrial/residential noise compatibility reports, Ontario Municipal Board expert report, testimony and negotiations for multiple sites
- Stackpole Ltd. - Industrial/residential noise compatibility report, Ontario Municipal Board expert report, testimony and negotiations
- Imperial Oil - Gas station/residential air compatibility report, Ontario Municipal Board expert report and testimony
- Vinemount Quarry - Quarry/residential air compatibility report, Ontario Municipal Board expert report and testimony
- Drysdale Quarry - Quarry/residential noise compatibility report, Ontario Municipal Board expert report and testimony
- Clean Harbors - Odour, air and noise data collection, modelling and mapping for compatibility assessment with residential properties as part of Environmental Assessment
- Chemtura Chemicals and Sulco Chemicals - Industrial/residential odour, air and noise compatibility reports, Ontario Municipal Board expert reports, testimony and negotiations
- Oneida-Herkimer Landfill - Landfill/residential air compatibility report and New York Judicial Review expert report and testimony

Greenhouse Gas Validation and Verification

GHG Lead Validator and Verifier
Various Clients | North America

- Lead Verifier, Lead Validator and Peer Reviewer with extensive experience including GHG Programmes in Alberta, BC, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure

Project (CDP), and the Verified Carbon Standard (VCS)

- Extensive GHG verification experience in the oil and gas sector, including validations and verifications of upstream oil and gas (in situ, SAGD and mining oil sands) and downstream oil and gas (refineries) facilities in Alberta, Ontario, BC, and Quebec in Canada and California and Massachusetts in the United States. Strong knowledge of both associated GHG emission sources, in particular fuel combustion, hydrogen production, catalytic cracking, sulphur recovery and flaring, as well as saleable outputs
- Extensive GHG emissions inventory and verification experience in the chemical, cement, transportation, pulp and paper, general industrial, electronics, power generation and waste management sectors. Completed dozens of bottom-up GHG emissions inventories. Very familiar with stationary combustion, manufacturing and reaction processes which generate GHG emissions
- Expert for quantification of emissions reductions in accordance with GHD's role as a Designated Operational Entity (DOE) in the United Nations Framework Convention on Climate Change (UNFCCC)
- Numerous GHG verification projects for the government of Alberta for GHG Compliance Reports, Baseline Reports and GHG offsets under the Alberta Specified Gas Emitters Regulation. Experience with upstream oil and gas (in situ, SAGD and mining oil sands), downstream oil and gas (refineries), chemical plants, pulp and paper, sawmills, coal-fired power plants, co-generation systems, hydrogen plants and biomass power plants.

Other related areas of interest

Recognized Certifications

- ISO 14064 Part 1 "Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals"
- ISO 14064 Part 2 "Specification with Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements"
- ISO 14064 Part 3 "Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions."
- OSHA 40-hour and annual 8-hour refreshers Hazardous Waste Health and Safety Training

Published Reports

- Reusing, G.L, et al., "Locomotive Emissions Monitoring Program 2011 Report", Railway Association of Canada
- Reusing, G.L, et al., "Locomotive Emissions Monitoring Program 2010 Report", Railway Association of Canada
- Reusing, G.L, et al., "Locomotive Emissions Monitoring Program 2009 Report", Railway Association of Canada and Transport Canada

Published Refereed Papers

- "An Investigation of HVAC Directivity: Theory versus Reality 2.0", InterNoise 2015, San Francisco, August 2015
- "An Investigation of HVAC Directivity: Theory versus Reality" INCE, Noise-Con 2014, Fort Lauderdale, Florida, September 2014
- "Community Noise and Optimal Industry Siting", ICA 2013, 21st International Congress on Acoustics, Montreal Quebec, June 2013

Conference Papers and Presentations

- "An Investigation of HVAC Directivity: Theory versus Reality 2.0", InterNoise 2015, San Francisco, August 2015
- "Environmental Regulation and Compliance 2015", presentations given at the CANECT '15 Conference, International Conference Center, Mississauga, April 27, 2015.
- "An Investigation of HVAC Directivity: Theory versus Reality" INCE, Noise-Con 2014, Fort Lauderdale, Florida, September 2014
- "Environmental Regulation and Compliance 2014", presentations given at the CANECT '14 Conference, International Conference Center, Mississauga, May 5, 2014
- "Community Noise and Optimal Industry Siting", ICA 2013, 21st International Congress on Acoustics, Montreal Quebec, June 2013
- "Environmental Regulation and Compliance 2013", presentations given at the CANECT '13 Conference, International Conference Center, Mississauga, April 29, 2013
- "Quantifying the Ambient Environment: Siting Within the Urban Din", Inter-Noise 2012 Conference, New York, NY, August 19-22, 2012 (with T. Wiens, G. Grozev, Z. Zehr)
- Reusing, G.L., "Greenhouse Gas Verification Methodology", Lecture given to University of Waterloo School of Environment, Enterprise and Development, June 21, 2012

Work history

1990 – present	GHD (formerly Conestoga-Rovers & Associates), Waterloo, Ontario
	Named Principal, 2003

Mike Masschaele
Noise & Vibration Practice Leader

Qualified. Bachelor of Environmental Studies (BES), 2006, Limited Engineering License – Acoustical Engineering (PEO)

Connected. Canadian Acoustical Association

Professional Summary: Mike is an acoustic specialist in environmental engineering and Practice Leader in the Noise & Vibration Services Group. Mike is an expert in measurement, analysis, and acoustical modelling of environmental noise sources, conducting peer reviews and developing cost-effective noise control programs for clients in various sectors. Mike also possesses skills that allow for effective procedure development and reporting, targeted communication and good organization towards a successful project outcome. He has successfully permitted a large number of industrial facilities from automotive to power generation as well as numerous land development and transportation projects over the last 13 years.

Noise and Vibration Engineering

Acoustic Specialist
Three Valley Drive Noise Study | City of Toronto | Toronto, ON

The assessment was required in order to evaluate the environmental noise impact from the Don Valley Parkway on the adjacent Three Valley Drive residential area.

The Study was initiated to investigate noise complaints from residents in this area due to existing earthen berms not accommodating a large section of residential area along Three Valley Drive.

A feasibility study was completed for a proposed barrier wall to determine if beneficial to the residents. Alternative barrier wall designs and a cost/benefit analysis completed.

Mike was responsible for the design and coordination of the project including the monitoring program, predictive noise modelling, analysis, mitigation evaluation, and report preparation.

Acoustical Specialist
Judson Triangle Land Development Study | City of Toronto

- Mr. Masschaele managed the noise assessment report for the Judson Triangle Land Development Study undertaken by the City of Toronto.
- Completed background noise and vibration measurements of road traffic, railway operations and industrial operations near the Triangle.
- Assessed potential land development options and acoustic barrier design options.

Noise and Vibration Technical Lead
Large Scale Municipal Waste Water Treatment Facility and Infrastructure Upgrades EA | York Region, ON

Mike directed all noise and vibration technical work to support a large scale Environmental Assessment (EA) approval for York Region's proposed state-of-the-art municipal waste water treatment facility and associated infrastructure upgrades. A road and rail traffic noise model was created for the 200 km^2 area under consideration for the installation. A noise model was used to evaluate the environmental noise anticipated based on the preliminary design for the facility. The potential off-site environmental noise impact exposure was based on the ambient noise limits and preliminary industry standard noise controls were recommended to achieve those limits at the property boundary. The recommended short-list of preferred sites was determined from over 30 available sites within the project area, which were ranked based on the lowest net effect noise impact exposure. This project work has continued to the pre-construction phase. Most recently, GHD prepared a Noise & Vibration Environmental Monitoring Plan to evaluate the potential noise and vibration impact from construction and post-construction activities at residential and historic properties of interest.

Land Development Acoustics
Various Clients | North America

- Prepared Land Use Compatibility Studies in accordance with Ontario D Series Guidelines. Assessed residential, daycare, commercial, industrial, waste management and wastewater treatment plant compatibility with surrounding land uses.
- Class 4 Land Development. Conducted studies and assisted with legal agreements between developer, industry and municipalities to implement Class 4 land use designations as specified in Ontario noise guideline NPC-300. This allowed compatible development of residential properties near industrial operations.
- Highway and arterial roadway and railway traffic noise assessments conducted for residential land use studies and Ontario industrial operating permits. Designed noise barriers, vibration isolation and land use features to ensure compliance with Ontario noise limits.
- Expert reports and testimony at Ontario Municipal Board (OMB) and other judicial hearings.

Noise Technical Lead
Old Hammond Highway Phase 2 Expansion | Baton Rouge, LA

Mike was responsible for the development and execution of the Protocol for Noise Technical Analysis, which was used to prepare a Noise Technical Report for the highway expansion. The protocol encompassed simultaneous collection of sound level and traffic count data, modelling of future noise impacts for multiple road configurations, and analysis of noise abatement options factoring in both effectiveness and cost. Mike provided oversight to the project team and peer reviewed all of the technical work and reports.

Project Manager
Building Acoustics for Large Condominium Development Projects | Kitchener, ON

Comprehensive acoustic consulting and design services were provided for condominium projects. Responsibilities included the review of architectural, mechanical, electrical, and structural plans to provide design comments and practical solutions to achieve or improve the acoustic performance (STC rating) of the floor assemblies and wall partitions. The design improvements eliminated unnecessary building elements and reduced overall project costs in some cases. The on- and off-site environmental noise impact from the proposed mechanical equipment for the buildings were also evaluated and suitable controls were designed to meet the Ontario Ministry of the Environment noise limits defined under the appropriate guidelines. Inspections were conducted on every floor during construction to review workmanship and to ensure all acoustic design recommendations were implemented. Sound Transmission Testing for floors and/or walls were completed post construction in accordance with ASTM E336-11.

Project Manager
Acoustic Assessment Report | Mondelez Canada Facility | Hamilton, ON

Mike has been assisting Mondelez with all areas of environmental compliance and in particular with air quality and noise permitting to secure a Ministry of the Environment and Climate Change (MOECC) Environmental Compliance Approval (ECA).

Mondelez was issued an ECA documenting site-wide compliance with a complex noise abatement plan. Mike continues to support Mondelez for ongoing environmental permitting requirements and facility expansion designs.

Mike also provided environmental consulting services in support of the Ontario Municipal Board (OMB) proceedings for the Mondelez facility with respect to a proposed residential development by a local developer adjacent to the facility. Mike reviewed documents, prepared technical reports, and participated in meetings with lawyers, the developer, the developer's noise consultant, and the MOECC.

Project Manager
Various Acoustic Assessment/Audits for Transformer Stations | Hydro One Networks Inc., ON

Acoustic Assessment Reports were prepared for Hydro for various Transformer Stations across Ontario. The work at the transformer stations was to submit an Application for ECA at each station for the existing transformer units or proposed replacement units. Manufacturer specifications for the new transformer units were supplied by Hydro One and the future sound level impacts were modelled. We conducted long-term background noise measurements at a near-by receptor to establish new site-specific limits. It was concluded that the station's sound level impact off-site is below the applicable site-specific limits. Due to the number of noise sources and the station's proximity to residential homes, noise abatement measurements were proposed at some of the stations which included barrier walls designed to control the noise emissions.

Environmental Scientist
Acoustic Assessment Report/ Environmental Assessment | Index Energy Inc. | Ajax, ON

Acoustic Assessments and Noise Abatement Action Plans were prepared in support of Applications for ECA approval for a proposed power generation facility. This work required advanced noise measurement techniques and complex acoustic modelling of stationary indoor and outdoor noise sources and mobile heavy equipment. Indoor noise propagation was evaluated through wall, roof and window construction elements based on the transmission loss and sound absorption co efficient qualities of the construction materials. Noise abatement including discrete controls such as silencers, enclosures and barrier walls or construction materials with enhanced acoustic qualities are designed to meet the applicable standards.

Acoustic Specialist
Indoor Noise Control Engineering and Abatement Study | Rockwell Automation Canada Ltd. | Cambridge, ON

Mike evaluated appropriate engineering control measures for select manufacturing areas including welding, machining, stamping and painting.

The analysis involved the measurement and mapping of these areas during worst-case or peak noise producing activities to evaluate the worst-case worker exposure levels and to define noise control improvements.

Mike evaluated noise exposure levels against the applicable Ministry of Labour (MOL) Lex8 of 85 dBA (8-hour Time Weighted Average) as per the Occupational Health and Safety Act, R.R.O. 1990, Regulation 851, Section 139 and Regulation 565/06.

Process modifications and/or engineering controls were recommended including silencers for compressed air / bleed off valves, barrier walls, and/or enclosures.

Environmental Scientist
Noise Complaint Investigation for Tall Process Exhausts | Georgia-Pacific LLC | Newington, NH

Mike completed a noise complaint investigation in response to noise complaints from nearby residents. Mike evaluated several tall process exhausts on-site and under various operating parameters and with the stacks individually turned on and off. Simultaneous far field noise measurements were also conducted at the complainant's residence. Acoustic modelling was used to validate the study.

Other related areas of interest

Recognized (Certifications/Trainings)

- Industrial Hygiene Sampling and Analysis, Conestoga College, 2008
- Hoover & Keith Inc. – Noise Control for Buildings, Manufacturing Plants, Equipment and Products, 2010
- Datakustik – Cadna A Acoustic Modelling Advanced Seminar, 2011
- Datakustik – Cadna A Acoustic Modelling Expert Industry Seminar, 2011

Papers Presented and Published in Conference Proceedings

- An Investigation of HVAC Directivity: Theory versus Reality, NoiseCon 2014, U.S. National Conference on Noise Control Engineering, August 2014

Work history

2006 – present	GHD (formerly Conestoga Rovers & Associates), Waterloo, ON

Craig Adams

WYCA Specialist Professional Consultancy Framework

Qualified. ND Civil Eng, 1995; BSc (Hons) Information Technology, 2004.

Connected. Institution of Civil Engineers (Member) working towards TRR.

Relevance to project. Craig is a highly experienced engineer with over 20 years spent consulting widely in the traffic and transport industry in the United Kingdom, Australia, Asia and Africa with specific expertise in directing projects, traffic engineering and transport planning.

Within the wider transport sector, he has undertaken leading roles in the development and implementation of transport strategies and the procurement and management of large multimodal contracts and associated schemes for both private and public sector clients. Through strong ability in early stage preparation work, he has taken projects from concept design through all stages of the project process including business case, feasibility, preliminary and detailed design, construction, operation and decommissioning.

Project Director | Ground Transport Plans for Western Sydney Airport Sydney | Australia

The proposed airport is expected to develop over the next 50 years to eventually accommodate more passengers than Heathrow (United Kingdom). Craig and his team provided master plan support in shaping the overall road layout of both landside and surrounding associated airport development sites starting from a blank slate. This was achieved by modelling a number of different landside and development land use layouts using strategic modelling (EMME) and local modelling (Sidra) and associated trip distribution analyses to understand how the future road network will operate at opening and in the future.

Project Director | A131 and A133 Corridor Route-Based Strategy (RBS) | Essex County Council

Craig led a team to complete the Scheme Identification Stage for both corridors identifying the preferred solutions that would demonstrate a robust Business Case suitable for submission to the South East Local Enterprise Partnership (SELEP) for funding. The RBS identified modelled (LinSig and Junctions 9) options which resulted in improvements to economic performance and regeneration through the introduction of initiatives focused on improving safety, journey time reliability, reducing congestion and increasing sustainable travel patterns

Project Director | Gateway to Colchester and Colchester Town Station Study | Essex County Council

Craig developed a number of modelled (using LinSig) design options in consultation with stakeholders to include a functional public realm orientated solution for the A134 (St Botopl h's Circus) in Colchester. Negating any impacts on capacity or journey times was key to this as well as taking into account any previous work done to date, a revised collision study, a new line from Sudbury planned for 2019/2020, Rapid Transit and development proposals. The LTP transport priorities (which included air quality) and Essex County Council's Corporate Outcomes Framework were used as the wider policy framework for this study.

Project Director and Design Lead Bow and Preston's Roundabout mitigation design and modelling | Transport for London

Craig developed designs and models using LinSig to mitigate the impact of the increased traffic that will pass through certain junctions in East London after the completion of the Silvertown Tunnel in 2022 / 2023. The proposed mitigation design focused primarily on ensuring the junctions could accommodate the Assessed Case Flows however consideration was also given to the needs of pedestrians and cyclists when developing the mitigation designs.

Project Director | M11 Junction 7a | Junction Capacity Assessment | Essex County Council

Craig undertook a feasibility design and modelling assessment of 3 concept proposals which detailed junction improvements on the M11 Junction 8 and the A120 roundabout at Stansted Airport. The main objectives of the feasibility assessment was to determine the viability of each proposal to improve junction capacity and safety and present findings to the Local Highway Authority, Essex County Council (ECC). The feasibility design for each proposal location was developed taking into consideration EH and Highway England (HE) operational requirements, existing site constraints, provisional construction costs and identified key risks. A preferred solution was put forward which demonstrated a robust Business Case suitable for submission to the South East Local Enterprise Partnership (SELEP) for funding.

Project Manager and Designer | A2 Silvertown Congestion Relief Study | Transport for London

Craig authored two detailed reports which analysed measures to assist in the Silvertown Congestion Relief Project work streams developed for the 2014 informal consultation. Working with strategic modellers, The RXHAM 1 model was used to determine the extent of future year PM peak congestion along the A2 corridor, with and without the addition of the Silvertown Tunnel. Craig assessed potential mitigation interventions of

southbound congestion at all junctions south of Blackwall Tunnel towards the Danson Interchange and prepared outline mitigation options (concept design level) taking into account likely future Blackwall / Silvertown flows. The concepts included, but were not limited to, hard shoulder running, variable speed limits, ramp metering, signalised junctions and tidal flow.

Project Manager - Design Lead | A2 Smarter Roads Study | Transport for London Outcomes Delivery, Network Management Team

Craig was the Project Manager, design lead and co-authored a supplementary detailed business case report for Transport for London which engineered a key high-speed arterial Smart Roads Pilot / Connected Corridor on the A2 to improve network reliability in day-to-day operation, and network resilience for incident management. The report and extensive strategic, microsimulation and local junction modelling was completed in a 3 month window meeting TfL's tight timescales set for this project. Craig led the design which included various options and up to 6 Design Packages with multiple design scenarios within each package, which covered 22km of carriageway between the M25 Junction 2 and Blackwall Tunnel. The concept design variations included locations for hard shoulder running, variable mandatory speed limits, ramp metering, tidal flow, dynamic/priority lane use and short length tunnelling.

Traffic Engineering and Design Lead | City in the East Opportunity Area Bus Priority Study | Transport for London

Craig was part of a multi-disciplinary project team that produced a stakeholder-supported prioritised plan for strategic bus priority investment to support growth and improve reliability for the City in the East Opportunity Area in London for TfL. Stage 1 involved a data-driven and strategic Modelling (using SATURN) approach to identify targeted areas where the benefits of bus priority measures would be maximised, and concept designs were then developed for a number of Stage 1 priority locations during Stage 2. Craig led a team to undertake all aspects of Stage 2 creating a bespoke Assessment Data Sheet which captured the corridor's performance, the concept design development rationale, the current issues (based on site visits and desk top assessments), summary of benefits (value per hour per annum), an assessment of buildability and lastly an estimate of outturn cost.

Principal Engineer | 2012 Olympic Games | Transport for London

I was responsible for the design, modelling and delivery of the traffic management proposals for all central London Games Venues (Horse Guard Parade, The Mall and Hyde Park). I devised and integrated all road space plans for vehicle and pedestrian movement and parking which protected Games Fleet arrival and departure times and safeguarded the movement of pedestrians and spectators across Central London (including stations). I was responsible for the traffic related input to the programmed stakeholder engagement strategy for Central London, creation of detailed design, construction drawings, pedestrian (Legion) and traffic modelling (LinSig, VISSIM, ARCADY, PICADY) and diversion plans. Using Future Base and Do Something LinSig and VISSIM models to model Central London venues and associated car parks to inform and enhance the traffic management design process, ensuring that the proposed highway designs were fit for purpose from a Games Family journey time, operational, and capacity perspective. This project involved complex links between local, microsimulation and strategic HAM models and the design process, and the importance of defining a clear quality assured method statement at project inception to undertake adequate data collection, minimal abortive work, capture of lessons learnt, and a realistic delivery programme to be developed to an immovable deadline.

Project Manager and Design Lead Pan London Bus Pinch Point Study | Transport for London

As Project Manager and Design Lead Craig undertook a detailed 6 month desk top and on site assessment of over 100 bus pinch point locations across London. The assessment involved the retrieval, validation and detailed manipulation and analysis of iBus data and supporting on-bus survey information to arrive at a robust ranking system which prioritised the most beneficial schemes to receive funding ahead of those with least benefit. Craig created a bespoke Assessment Data Sheet for all 100 locations which captured the corridor's performance, the concept design development rationale, the current issues (based on site visits), an assessment of buildability and lastly an estimate of outturn cost

Work history

2017 – present	Gutteridge, Haskins & Davey Ltd. (GHD), Associate Director
2007 – 2017	Jacobs, Associate / Technical Director
1998 – 2007	Mouchel, Principal Engineer / Section Leader
1996 – 1998	Hyder Consulting, Highways Engineer
1993 – 1996	Student
1992 – 1993	Engineering Management Services (Subsidiary of Murray and Roberts)

Ian Dobrindt, MCIP, RPP, EP
Principal

Qualified: B.A. Honours Geography with Internship Option, 1990

Connected: Member, Canadian Institute of Planners (MCIP); Registered Professional Planner, Ontario Professional Planners Institute; Certified Environmental Professional, Environmental Careers Organization (ECO) Canada

Professional Summary: Ian is a senior environmental planner and stakeholder engagement facilitator with 29 years of experience leading Environmental Assessment (EA) and post EA permitting and approval processes for public and private sector clients. Over the span of his career, Ian has led 10+ Individual EAs and 150+ Class EAs, making him extremely familiar with the EA Act and parent Class EA processes. These projects are often of a large and complex nature, with controversial issues and political sensitivities that require strategic direction and multidisciplinary team management for project success. Furthermore, he has set industry benchmarks for successfully delivering stakeholder and public engagement programs, realizing positive outcomes by applying an early, inclusive, and transparent approach. In addition to his facilitation skills, Ian is highly effective in securing productive participation and guiding individuals with different personalities and work styles to a common outcome.

Individual EAs

Ian has led a significant number of Individual EAs for various undertakings including landfill expansions, new wastewater infrastructure, multiple municipal transportation improvements, and new provincial highways. As a result, he has a strong working knowledge of the EA Act and the Ministry of Environment, Conservation and Parks' (MECP's) Codes of Practice.

With this knowledge, Ian has successfully authored both Terms of References and Environmental Assessments streamlining their requirements through focusing strategies that reduce timelines and overall costs while still providing approval certainty. The following assignments illustrate Ian's Individual EA experience:

Strategic EA and Stakeholder Engagement Advisor
Stoney Creek Regional Facility IEA | Terrapure Environmental | Hamilton, ON | 2016 – present

As part of the GHD Team, Ian is providing strategic EA and stakeholder engagement advice and assistance to Terrapure. Terrapure is proposing to expand their existing landfill in the upper Stoney Creek community in the City of Hamilton. New residents to the area are unfamiliar with Terrapure, owner and operator of the non-hazardous landfill, and were previously told that the landfill would be closing. Additionally, several long-time residents harbor distrust of Terrapure and are actively opposing the expansion.

With this in mind, Ian developed a Consultation Plan targeting individual stakeholders with tailored constructive engagement activities based on the results of a Stakeholder Sensitivity Analysis. Implementation of the proactive engagement activities reduced the initial opposition to the proposed landfill expansion taking a number of concerns "off of the Minister's table". This has allowed the Minister to more easily approve the IEA Terms of Reference allowing Terrapure to move forward and prepare the actual environmental assessment.

Ian has continued his strategic advisory role during preparation of the EA including meeting with the host municipality (City of Hamilton) to draw out and address their specific requirements on a department-by-department basis. In addition, Ian provided oversight to the preparation of the draft, final draft and final EA Report submitted to the Ministry of the Environment, Conservation and Parks for review and approval. The Minister is currently reviewing the proposed undertaking for approval.

Co-Project Manager – EA/Consultation Lead
Upper York Sewage Solutions (UYSS) IEA | Regional Municipality of York | Newmarket, ON | 2008 – present

Ian was the co-project manager as part of a consortium of firms responsible for carrying out the Individual EA and preliminary design assignment. As co-project manager, Ian was directly responsible for leading the EA and consultation work programs. This included formulating a sound and defensible justification/need (problem/opportunity statement) for the undertaking based on Provincial policies. The project will provide a sustainable sewage servicing solution to accommodate the provincially-approved growth forecasted to occur in the UYSS service area to the year 2031 (Towns of Aurora, Newmarket, and East Gwillimbury).

In this role, Ian strategically developed the generation, screening, assessment, and comparative evaluation methodologies for several integrated components of the proposed undertaking to satisfy public and agency scrutiny: linear and modular fixed infrastructure. He coordinated the nine environmental investigations (archaeological, agricultural, cultural heritage, land use, natural environment, noise/vibration, odour, traffic, visual) carried out during the Individual EA to generate a detailed

understanding of the potentially affected environment so that the developed methodologies could be applied to identify a recommended site, outfall location, and routes.

In addition, Ian directed all project-related documentation prepared during the Individual EA by the technical and environmental disciplines. He was the primary author of the Draft Environmental Assessment Report (519 pages). In total, the documentation comprised three volumes plus 43 reference documents (technical and environmental supporting studies). Ian was ultimately responsible for submitting the Final EA Report and supporting documentation to the Minister of the Environment for review and approval on behalf of York Region. As part of the pre-submission and formal EA review periods, Ian was the primary author for responding to comments submitted by review agencies, First Nations, and the public.

Co-Project Manager – EA/Consultation Lead Western Vaughan Transportation Improvements IEA | Regional Municipality of York | 2006 – 2011

Ian was the co-project manager as part of a consortium of firms responsible for carrying out the Individual EA and preliminary design assignment for a comprehensive area transportation plan for the western part of the City of Vaughan. The area transportation plan developed through the EA included arterial road improvements, York Region Transit/Viva rapid transit improvements, Traffic Demand Management/Traffic System Management, and cycling and pedestrian enhancements. Ian was directly responsible for leading the EA and consultation work programs the duration of the entire contract.

As EA Lead, Ian strategically developed the methodology to how the alternatives were generated to capture the multi-modal transportation systems being considered by York Region and expected by stakeholders. He coordinated the six environmental investigations (archaeological, cultural heritage, land use, natural environment, noise, air quality) carried out during the Individual EA.

He was involved in all rounds of consultation carried out during the Individual EA including preparation for and attendance at Public Consultation Centres, review agency meetings, the two advisory committees, reviewing notices, drafting responses to comments received, etc. In addition, Ian directed all project-related documentation prepared during the Individual EA by the technical and environmental disciplines. He was the primary author of the Draft and Final EA Report and supporting technical and environmental studies.

EA/Consultation Lead Southeast Collector Trunk Sewer IEA | Regional Municipalities of York and Durham | Markham/ Pickering, ON | 2004 – 2010

Ian was hand-picked by York Region to obtain EA Act approval after the Minister of the Environment accepted a stakeholder Part II Order request to elevate the project to an Individual EA from a Schedule B Class EA led by other consultants. As part of this strategic role, Ian developed a new EA work program that addressed the previous deficiencies that MOE cited in their decision: inadequate need and justification for the Undertaking, range of alternatives to the Undertaking considered, traceability of evaluation methodology and decision-making, and inadequate understanding of the study area's groundwater regime.

Ian led meetings with MOE, the Ministry of Natural Resources (MNR), the Toronto Region Conservation Authority (TRCA), the multi-stakeholder advisory committee, and First Nations to gain their buy-in into the redeveloped work program. The Individual EA Terms of Reference (ToR) reflecting the redeveloped EA work program was approved by the Minister allowing York and Durham Regions to carry out the EA. As the EA and Consultation Lead for the Individual EA, Ian was involved in the day-to-day affairs of the project directly responsible for:

- Developing a sound and defensible need and justification for the proposed project
- Directing the generation, screening, assessment, and comparative evaluation of the alternative sewer routes, alignments, and construction methodologies leading to a recommended sewer route, alignment, and construction methodology
- Leading the Communications and Consultation Program with review agencies, First Nations, and the public (individual and group meetings, advisory committee meetings, Public Information Forums and workshops, letters, newspaper advertisements, newsletters, emails, website, etc.)
- Coordinating the environmental investigations
- Preparing the Draft EA Report and supporting documentation for pre-submission review
- Submitting the Final EA Report and supporting documentation to the Minister for review and approval
- Responding to comments submitted during the pre-submission and formal EA review periods
- Addressing Conditions imposed by the Minister

Following Minister approval, Ian has helped York Region fulfil the EA commitments and conditions of approval first as part of the design of the sewer infrastructure and then during the actual construction. As part of the $550 million capital program, he was asked by York Region to be the

facilitator for the Minister's conditioned Southeast Collector Advisory Committee made of MOE, municipal, and stakeholder representatives and public members because of the client's dissatisfaction with the previous two facilitators.

EA/Consultation Lead
407 East Completion IEA | MTO | Durham Region, ON | 2005 – 2010

Ian was the Senior EA and Consultation Lead as part of a consortium of firms responsible for carrying out the Individual EA and preliminary design for extending Highway 407 east from Brock Road to Highway 35/115 as well as the two connecting highway between the new highway and Highway 401 links (Highway 412 and Highway 418). The project also included conceptual design of a transitway paralleling the proposed mainline highway and links as well as Park N Ride locations. Ian was directly responsible for leading the EA and consultation work programs for the duration of the entire contract including the following:

- Coordinating the eight environmental investigations (archaeological, agricultural, cultural heritage, socio-economic, natural environment, noise, air quality, landscape architecture)
- Leading the assessment and comparative evaluation of the Alternatives To the Undertaking and alternative routes
- Directing the development of the project specific mitigation and post EA monitoring plans with the environmental disciplines and technical design staff to address potential adverse effects, respond to review agency requirements, and public concerns
- Leading the Communications and Consultation Program with review agencies and the public (review agency meetings, advisory committee meetings, Public Information Centres and workshops, drafting notices and responding to comments received, etc.)
- Being the primary author of the Draft and Final EA Reports and developing the report templates for the supporting environmental investigative studies

EA/Consultation Lead
Pine Valley Drive Transportation Corridor IEA Terms of Reference | City of Vaughan| 2004 – 2005

Ian led the preparation of the IEA Terms of Reference (ToR) for the controversial Pine Valley Drive extension through the environmentally sensitive Boyd Conservation Area in the City of Vaughan. The City brought Ian in to prepare the IEA ToR after the Minister of the Environment accepted multiple stakeholder Part II Order requests including one from the Toronto Region Conservation Authority (TRCA) to elevate the project to an Individual EA from a Schedule C Class EA led by other consultants.

As part of this strategic role, Ian developed a new EA work program that addressed the previous deficiencies that MOE cited in their decision: inadequate need and justification for the Undertaking, range of alternatives to the Undertaking considered, traceability of evaluation methodology and decision-making, and inadequate understanding of the study area's natural environment.

Ian led numerous working sessions and meetings with TRCA to gain their buy-in into the redeveloped work program. In addition, Ian brought the York Region into the Project as a co-proponent with the City to give greater assurance to the TRCA that the new process would be carried out differently. The Minister approved the IEA ToR reflecting the redeveloped EA work program allowing the City to proceed to the next step of IEA process and actually carry out the Environmental Assessment.

EA Lead
Warwick Landfill Expansion IEA Terms of Reference | Canadian Waste Services Inc. | Watford, ON | 2004 – 2005

Ian led the preparation of the revised IEA Terms of Reference (ToR) for submission to the Minister of the Environment in light of the Ontario Divisional Court decision on the approved ToR for the Richmond landfill site. Unlike the original Minister approved ToR, the revised ToR covered all EA Act phases including assessing Need and Justification and identifying and evaluating "Alternatives To".

Ian revised IEA ToR to take advantage of as much of the project work carried out before the Court decision was handed down in 2003. The Minister accepted this approach and approved the revised IEA ToR allowing Canadian Waste Services Inc. to complete the actual Environmental Assessment in a more efficient manner.

Municipal Class EAs

Ian is extremely knowledgeable and experienced with the Municipal Class EA (MCEA) having successfully carried it out for a variety of transportation, water, wastewater, and stormwater projects throughout Ontario for both upper tier and lower tier municipalities as well as private developers. As result, he has led the MCEA process for individual projects (i.e., Schedule 'B', Schedule 'C') as well as integrating it with other Regulatory approval processes like the *Planning Act*.

He is also experienced in preparing Addendums to Environmental Study Reports (ESRs) and Project Files to address significant changes in a project or a lapse in time from EA Act approval to construction.

Likewise, he has also successfully completed MCEA Phases 3 and 4 for specific projects recommended in Transportation and Infrastructure Master Plans that satisfied MCEA Phases 1 and 2 done by other consultants. The following highlights a few example

MCEA projects Ian has led recently or is presently leading.

Strategic EA/Consultation Advisor Mid-Block Arterial Road Class EA | Town of Whitby & Private Landowners | Whitby, Ontario | 2019 – On-going

The Town of Whitby retained GHD to be their owner engineer for the proposed mid-block arterial road connecting Cochrane Street in the Town of Whitby to Thornton Road in the City of Oshawa led by private developers to ensure that the MCEA Schedule 'C' process and preliminary design was carried out appropriately and their interests were protected. As part of GHD's owner engineering team, Ian is providing Senior EA/Consultation oversight to the project, which has included the following:

- Preparing the project's Terms of Reference so that the private landowners' retained consultant could develop their proposal for submission to the Town
- Reviewing and commenting on the retained consultant's proposal including discipline specific work plans
- Reviewing and commenting on the retained consultant's draft project schedule
- Reviewing and commenting on draft EA and consultation deliverables
- Attending ongoing monthly progress meetings with the Town, private landowners' representatives and retained consultant

Project Manager & EA/Consultation Lead North Markham Future Urban Area Proposed Collector Roads Network Class EA | Private Landowners | Markham, Ontario | 2018 – On-going

Mr. Dobrindt was retained individually by four groups of private landowners to complete MCEA Phases 3 and 4 for a series of collector roads that were initially proposed by the City of Markham through their completed Class EA Phases 1 and 2 Transportation Master Plan. The proposed collector roads are part of the planned infrastructure for servicing the North Markham Future Urban Area (approximately 1,100 gross hectares with a planned residential population of 45,000).

As part of initiating the Project, Ian led a series of working meetings with five key review agencies (City of Markham, Ministry of the Environment, Conservation, and Parks, Ministry of Natural Resources and Forestry, York Region, and the Toronto Region Conservation Authority to obtain their "buy-in" to the MCEA Phases 3 and 4 work plan.

Specifically, agreement was obtained on the range of alternative design concepts considered (e.g., water crossings, road alignments, intersection requirements, level of design, etc.), studies needed (e.g., climate change, air quality, species at risk, etc.), consultation expectations, and overall approach (e.g., 4 separate Environmental Study Reports with one for each individual residential block to allow for flexibility of implementation).

To date, the Notice of Commencement has been issued and the first of the two planned Public Open Houses have been held.

Project Manager & EA/Consultation Lead Northeast Vaughan Water and Wastewater Servicing Class EA | York Region | Vaughan, Ontario | 2014 – 2019

Ian was the overall project manager as well as the EA and consultation lead for developing water and wastewater solutions for accommodating Provincially approved growth in northeast Vaughan to 2051. As project manager, Ian was responsible for integrating the two technical study components of the Project into the MCEA process so that their inputs and requirements were efficiently coordinated: Optimization Study (MCEA Phase 1 focus) and Preliminary Design (MEA Phase 3 focus).

As part of the MCEA process, Ian was responsible for all facets of the Project including:

- Leading the stakeholder engagement program (Agencies, Indigenous Communities, Utilities and the Public) including a Stakeholder Sensitivity Analysis, a First Nations Consultation Protocol, a Technical Advisory Committee, a Stakeholder Advisory Committee, 2 rounds of Public Consultation Centers, individual stakeholder meetings, comments/responses tracking, and issues resolution with concerned stakeholders
- Managing the environmental investigations (e.g., archaeology, built heritage, land use, air quality, noise/vibration, geotechnical, hydrogeology, natural environment, property contamination, etc.) including the permission to enter process
- Developing the site and routing generation, assessment, and evaluation processes for the proposed infrastructure including water storage facilities, pumping stations, watermains, and a trunk sewer
- Preparing the Class EA and consultation documentation including drafting and finalizing the Project File Report

Ian worked closely with the City of Vaughan (multiple departments), Toronto Region Conservation Authority, and private landowners to ensure their interests were addressed during completion of the MCEA process. In light of this, the Project File Report was filed for review and no "Part II" Order requests were received allowing York Region to proceed to detail design.

Project Manager & EA/Consultation Lead Kedron Part II Planning Area Major Roads Class EA | Private Landowners | Oshawa, Ontario | 2016 - 2019

Ian successfully completed MCEA Phases 3 and 4 for 8 arterial and collector roads recommended by the City of Oshawa in their MEA Phases 1 and 2 Transportation Master Plan. The arterial and collector roads are part of the planned infrastructure for servicing the Kedron Part II Planning Area (1,150 acres), which is the next major residential community in Oshawa.

Ian developed a specific work plan for completing MECA Phases 3 and 4 that efficiently re-confirmed the previous work carried out by the City, met current regulatory requirements, and took into account the private landowners' efforts associated with their draft plans of subdivision process. All key agencies "bought in" to the work plan including the City, Durham Region, Ministry of Environment, Conservation Parks, and Central Lake Ontario Conservation Authority (CLOCA). As part of the work plan, MEA Phase 2 was re-visited confirming the alignment for each of the new arterial and collector roads prior to initiating MCEA Phase 3.

With the alignments confirmed, the focus of MCEA Phase 3 was determining the most appropriate cross-section for each of the roads, type of watercourse crossing structure, and intersection control. A series of working meetings were held with the City, Durham Region, and CLOCA to gain their acceptance of the preferred design alternatives.

The Environmental Study Report was filed and no Part II Order requests were received allowing the private landowners to move forward into detailed design and approval of their draft plans of subdivision.

Project Manager & EA/Consultation Lead Bruce Creek Crossing Class EA | Private Landowners | Markham, Ontario | 2017 – 2019

When the City of Markham directed the private landowners of the York Downs Golf Course to complete a Schedule C MCEA in concert with their *Planning Act* applications for redeveloping the golf course for residential purposes, they requested Mr. Dobrindt to lead the integration of the two planning processes. As a result, Ian met with the City confirming their expectations and requirements and undertook a gap analysis prior to developing the integration approach for satisfying both planning processes.

With this in mind, Ian narrowed the focus of the MCEA process to the primary collector road having the water crossing of Bruce Creek within the residential development versus the entire proposed collector road network. The focused approach drove the range of alternatives considered (solutions and design concepts), degree of information collected, and extent of input sought, which all collectively streamlined the two processes and shortened the overall Project schedule.

Ian re-packaged much of the information collected for the *Planning Act* applications to meet the requirements of the MCEA process so that no additional environmental studies were needed to satisfy the City, Ministry of Natural Resources and Forestry, and the Toronto Region Conservation Authority.

Similarly, the mandatory public meeting held for the *Planning Act* applications was also used as the first of the two planned public open houses associated with the MCEA process to minimize the Project's overall consultation requirements and costs to the private landowners.

The Environmental Study Report was filed in support of the *Planning Act* applications (two plans of subdivision, Official Plan Amendment, and Zoning By-Law Amendment) and no Part II Order requests were received allowing the private landowners to move forward into detailed design and development of the residential development.

EA/Consultation Lead Burnhamthorpe Road Trunk Watermain | Regional of Peel | Mississauga, ON | 2014 – 2015

As the Senior EA and Consultation Lead on the project, Ian was responsible for directing the Schedule 'B' MCEA process for a new 1,500-mm diameter trunk watermain in the heart of Mississauga's downtown. In this lead role, Ian worked with the Region of Peel's Communications Services Division to develop and deliver the agency/public consultation program including:

- Preparing the project specific Consultation Plan
- Preparing notifications (Notice of Study Commencement, Notice of Public Information Centre (PIC) No. 1, Notice of PIC No. 2, and Notice of Study Completion)
- Establishing and maintaining the project's contact database,
- Drafting responses to comments received
- Preparing PIC displays
- Meeting with review agencies

In concert with this consultation lead role, Ian applied the MCEA process to obtain *EA Act* approval while allowing for flexibility in the future detail design and construction stages. This included developing and assessing the alternative alignments for the new watermain and shaft site locations for constructing it to minimize stakeholder concerns/ issues being raised and potentially being escalated to the Ministry of the Environment and Climate Change.

Ian was also responsible for coordinating the environmental disciplines involved in the project (i.e., archaeology (Stages I and II), cultural heritage, geotechnical, hydrogeological, natural environment, noise/vibration, and property contamination) and incorporating their findings and recommendations into the project (e.g., baseline conditions, assessment of the alternatives, future work commitments, etc.). In addition, Ian authored the Project File documenting the MCEA process followed.

No "Part II" Order requests were received and the Region of Peel proceeded to detail design.

Ministry of Transportation Class EAs

Ian has undertaken/managed numerous Class Environmental Assessments for provincial highways for the Ministry of Transportation (MTO) in all five Regions. As a result, he is very familiar with the Ministry's *Class Environmental Assessment for Provincial Transportation Facilities* and *Environmental Reference for Highway Design* documents and environmental approaches specific to each Region.

Ian's successful history of working for MTO in all Regions includes all stages of project development, from planning through preliminary and detailed design. He is familiar with all three classifications (Group A, B, and C projects) and is responsible for leading the Class EA process, directing the consultation program, coordinating involved environmental disciplines, and authoring required documentation (TESRs, ESDs, etc.).

His experience and knowledge ensures that MTO's environmental and consultation responsibilities are fully satisfied and appropriately integrated into the project's engineering design. Ian works closely with his MTO counterpart during project implementation, attending progress meetings, design review meetings, etc.

The following provides a couple of recent examples of Mr. Dobrindt's Provincial Transportation Facilities Class EA experience:

- **Structural Rehabilitation of Bridges on Highway 403 Detailed Design and Class EA, City of Hamilton.** As the Senior Environmental Planner, Ian was responsible for completing the Group 'C' Class EA process, leading the consultation program including preparing the project's consultation plan, corresponding with review agencies and preparing the Environmental Screening Document. The project included obtaining a noise by-law exemption from the City.
- **Pavement and Structural Rehabilitation of 13 Structures on Highway 35/115 Detailed Design and Class EA, Region of Durham.** As the Senior Environmental Planner, Ian is responsible for fulfilling the Group 'C' Class EA process. This includes leading the consultation program (e.g., preparing the project's consultation plan, corresponding with review agencies, responding to comments received, etc.), coordinating the environmental disciplines (fish and fisheries habitat, terrestrial, land use, contamination and waste management, archaeology, cultural heritage), and preparing the various EA deliverables like the Environmental Screening Documents (1 per contract for a total of 2).

Other Class EAs

In addition to being well acquainted with both the Municipal Class EA and Provincial Transportation Facilities Class EA processes, Ian has successfully carried out other Class EA processes for public sector proponents. The following summarizes the other Class EA processes Ian has experience with in gaining *EA Act* approval:

- Ministry of Infrastructure Public Work Class EA
- Class EA for MNRF Resource Stewardship and Facility Development Projects

Ontario Energy Board Act Approvals

Project Manager & EA/Consultation Lead | Liberty Village Natural Gas Pipeline Project | Enbridge Gas Distribution Inc. | Toronto, ON | 2017 – 2018

Ian successfully led the planning process in accordance with the Ontario Energy Board (OEB) Environmental Guidelines for the Location, Construction, and Operation of Hydrocarbon Pipelines and Facilities in Ontario (Guidelines) for a new natural gas pipeline that Enbridge was proposing through Liberty Village in the City of Toronto. As the Project Manager, Ian's responsibilities included the following:

- Attending all meetings with Enbridge
- Ensuring the planning process carried out fully complied with the Guidelines
- Directing the stakeholder engagement program including preparation for the 1 Public Open House
- Coordinating the Cumulative Effects Assessment and discipline specific investigations
- Establishing the Environmental Report's contents and outline
- Providing senior review to all project deliverables

The Leave to Construct Application was approved allowing Enbridge to proceed to project implementation.

Transit Project Assessment Process

Senior Environmental QA/QC Lead
Sheppard East Light Rail Vehicle Maintenance and Storage Facility | Toronto Transit Commission | Toronto, ON | 2010

Ian was the Senior Environmental QA/QC Lead responsible for ensuring the environmental work performed by internal disciplines as well as sub-consultants fulfilled the RFP specified requirements and the Transit Project Assessment Process (TPAP) being followed for the Sheppard East Light Rail Vehicle Maintenance and Storage Facility. This included reviewing the draft Environmental Project Report (EPR) to ensure it and the various environmental studies undertaken supported the conclusions and recommendations developed.

In this role, Ian recommended various changes to streamline the EPR, address logic gaps, and make it more reader friendly to the general public by reducing jargon and complex technical language and incorporating more graphics to simplify the content.

Canadian Environmental Assessment Act, 2012

Senior Environmental QA/QC Lead | Boat Harbour Remediation Project | Nova Scotia Lands Inc. | Pictou Landing, Nova Scotia | 2019 - Present

Ian is the Senior Environmental QA/QC Lead responsible for ensuring that the Environmental Impact Statement (EIS) being prepared by GHD on behalf of Nova Scotia Lands Inc. for the Boat Harbour Remediation Project is done in accordance with the Guidelines for the Preparation of an Environmental Impact Statement pursuant to the *Canadian Environmental Assessment Act, 2012* (*CEAA, 2012*). This role is even more critical for this Project because of the level of scrutiny from Federal agencies and departments, the affected Pictou Landing First Nation, and area residents.

As a result, Ian is carrying out a highly detailed QA/QC review of each of the eight sections as they are drafted against the documentation requirements specified in the Guidelines and proposing revisions to address content deficiencies. In addition, as part of his review, Ian has recommended a number of changes to make the document more reader friendly to the public by reducing jargon and complex technical language and incorporating more graphics to simplify the content.

Stakeholder Engagement Programs and Delivery

Ian has developed and led numerous stakeholder engagement programs as part of seeking EA Act and post EA approvals and permits for projects. Programs encompass external (e.g., review agencies, Indigenous communities, and the public) and internal (e.g., proponent staff) stakeholders and are tailored to the project. Ian carefully considers potential controversy, the dynamics of potential stakeholder groups and anticipated levels of interest/opposition, history of consultation, regulatory scrutiny, and imposed limitations (e.g., cost and schedule) when developing and implementing stakeholder engagement programs. Depending upon project and client needs, Ian skillfully uses consultation tools to secure effective and productive participation, including the following:

- Stakeholder Sensitivity Analysis
- Consultation and communications plans
- Public meetings and information centres
- Advisory committees
- Notifications
- Comment/response tracking databases
- Issue resolution strategies
- Project-specific websites

In leading the stakeholder engagement process, Ian provides an unbiased viewpoint that encourages participation and meaningful dialogue. Specifically, he develops stakeholder engagement strategies, facilitates public meetings and open houses, facilitates stakeholder workshops and advisory committee meetings, prepares written and visual display materials, provides follow-up responses, helps resolve issues, and presents before municipal committees and councils.

Facilitation

Facilitator
Development Charges By-Law Update | Regional Municipality of York | York Region, ON | 2014

Based on results achieved on several previous EA projects for York Region, Ian was invited to facilitate a series of interdepartmental working sessions as part of updating the Region's Development Charge By-Law. Ian's facilitation helped to achieve results for critical work within compressed timelines imposed by the Province. He also achieved consensus from groups with differing viewpoints, as multiple opinions between departments and staff had created a challenging work environment. Through tactful facilitation, Ian helped staff identify commonly desired outcomes to generate a more positive work environment.

Facilitator
Upper York Sewage Solutions IEA | Regional Municipality of York | 2009-2014

Ian was invited by York Region to facilitate a number of Review Agency Advisory Committee meetings, Community Liasion Forum meetings, and Public

Information Forum meetings when the project's Independent Public Facilitator was unavailable. Ian facilitated a total of six events during the Individual EA process maintaining the Project's schedule despite community opposition to the proposed undertaking.

Facilitator
Southeast Collector Trunk Sewer Advisory Committee | Regional Municipality of York | Markham and Pickering, ON | 2010 – 2012

When the original facilitator stepped down, Ian stepped up to facilitate two Advisory Committee meetings. The Advisory Committee provided a forum for open dialogue with the community during design and construction of the Southeast Collector Trunk Sewer in the Cities of Markham and Pickering, following a particularly contentious Individual EA process.

Facilitator
Western Vaughan Transportation Improvements IEA | Regional Municipality of York | Vaughan, ON | 2007 – 2012

When the independent facilitator was unavailable, Ian stepped in to facilitate a number of public consultation centres. He facilitated two events near the end of the IEA process, when the proposed undertaking was being finalized. As a result, Ian focused on keeping a two-way dialogue between York Region and potentially affected community members, to address issues within the process and avoid escalation to the Ministry of the Environment and Climate Change.

Environmental Management and Compliance

Environmental Compliance Manager | TTC McNicoll Bus Garage – Design Build | Toronto Transit Commission | Toronto, ON | 2017 – Present

Ian is the Environmental Compliance Manager as part of a Joint Venture Design Build of Toronto Transit Commission's McNicoll Bus Garage in Scarborough. In this role, he is responsible for meeting the obligations in the 2015 Environmental Project Report and subsequent Ministry of the Environment, Conservation and Parks' approval conditions. As part of the design phase of the project, Ian undertook the following:

- Developed a project-specific Environmental Management System and Environmental Management Plan, which TTC approved
- "Stepped-in" at the request of the Joint Venture and worked with the TTC to address their on-going concerns with the 10 individual construction environmental management plans prepared by the Joint Venture
- Reviewed and provided input to the needed permits and approvals

Following completion of the design phase, Ian took on the following responsibilities during the subsequent 2-year plus construction phase:

- Undertaking monthly on-site environmental inspections
- Preparing and submitting a monthly environmental management report documenting the results of the inspection noting any deficiencies and recommending corrective actions for the Site Superintendent to implement

Environmental Manager/Consultation Lead
Upper York Sewage Solutions Detailed Design and Contract Administration | Regional Municipality of York | Towns of Aurora, Newmarket, and East Gwillimbury | 2014 – present

Ian is responsible for directing post-EA follow up environmental investigations, securing permits/ approvals from regulatory agencies, and leading communications with external agencies, First Nations, local area municipalities, and the public as part of detailed design for the project. This dual role will continue as part of the construction stage for the proposed Water Reclamation Centre (plus conveyance infrastructure and new outfall) in developing East Gwillimbury, new 950 mm diameter forcemain through Newmarket's built up area, and retrofits to 8 existing stormwater management ponds in upper York.

As a result, he has established the environmental compliance tracking system as part of detail design for implementation and reporting during construction.

As Communication Lead for this $580 million capital program, Ian has prepared a number of stakeholder specific consultation plans in cooperation with York Region's Corporate Communications Department. Planned communication strategies that Ian has recommended, which York Region has agreed to include:

- Print and electronic notifications
- A stakeholder advisory committee
- A project website
- Social media
- A 1-800 telephone hotline
- A complaint management system
- Regulatory agency and key stakeholder meetings
- Briefings
- Public information centres

Environmental Manager/Communications Lead Southeast Collector Trunk Sewer Detailed Design and Contract Administration| Regional Municipalities of York and Durham | 2010 – 2012

Following *EA Act* approval from the Minister of the Environment, Ian took on the Environmental Manager/Communications Lead as part of detailed design and construction of the approved Undertaking. Specifically, Ian was responsible for directing all post-EA follow up environmental investigations, securing environmental permits/ approvals from regulatory agencies, and establishing and tracking all EA commitments, Minister Conditions of Approval, and environmental monitoring and reporting.

The tracking and reporting was a requirement of the Minister as part of *EA Act* approval and was done on a monthly basis to the Ministry of the Environment. Toronto Region Conservation Authority, and local area municipalities during construction of the 14.1-km-long trunk sewer and various ancillary surface facilities.

In addition, Ian supported York Region's communications with regulators, the local area municipalities and the public during construction including

- Preparing and issuing construction notices
- Establishing the complaint response protocol
- Presenting compliance management updates to the project's Stakeholder advisory committee (met semi-annually)
- Drafting responses to concerns/issues

Work history

2013 – present	GHD (formerly Conestoga-Rovers & Associates), Markham, ON
	Named Principal, 2014
2008 – 2013	AECOM
2004 – 2008	Garter Lee Limited
1999 – 2004	Earth Tech
1990 – 1999	Proctor & Redfern Limited

TRAFFIC & TRANSPORTATION

APEC brings together an engineering team, based in its George Town office, with extensive international experience in the planning, design and construction monitoring of transportation projects. APEC's team of professional engineers ensures the safe, timely and well-resourced completion of transportation improvements.

Figure 1:ETH Overpass at Kaaboo

APEC has enjoyed working closely with the National Roads Authority (NRA) since its formation on the design of key public infrastructure improvements; most notably the extension of the Esterley Tibbetts Highway to Batabano and widening to George Town, the widening of the East West Arterial, the design of the future Airport Connector Road, renovation of Dorcy Drive, Smith Road, Shedden Road, Eastern Avenue and the installation of the sea defence wall on Sea View Road, East End. APEC has also worked closely with the NRA on numerous private development projects including Camana Bay, Dragon Bay, the Cayman Islands Yacht Club, the George Town Yacht Club, amongst others.

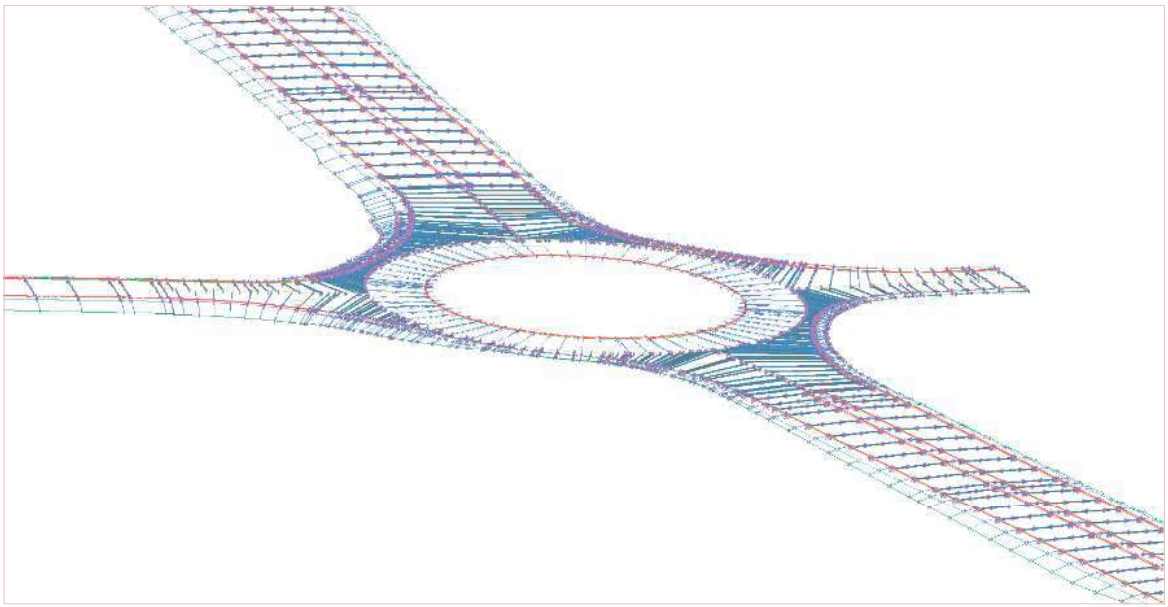


Figure 2: Civils 3D model of a roundabout

Traffic impact assessment have become a key tool in the planning and design of public and private infrastructure. APEC has prepared several traffic analyses in accordance with NRA standards and the Institution of Transportation Engineers guidelines over the last decade. Our experience is diverse, from small junction upgrade analysis to large network modelling using advanced modelling software.

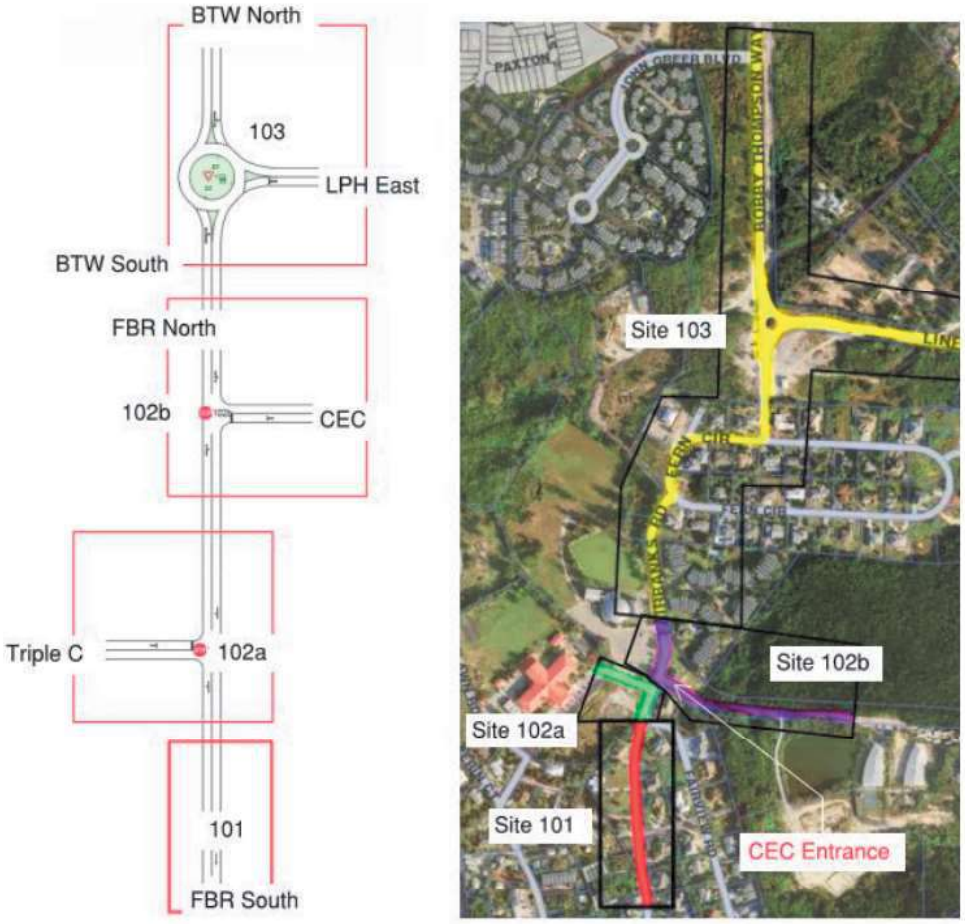


Figure 3: Network Modelling along Fairbanks Road

The following is a list of noteworthy projects APEC has provided engineering services for over the last decade

Cayman Enterprise City Traffic Impact Statement

APEC was the engineer of record for the Cayman Enterprise City (CEC) masterplan and development plan. The Central Planning Authority subsequently required a TIS be submitted as a condition of planning approval for the first phase of the development. APEC completed the requisite traffic engineering study to NRA standards and the TIS was approved

Figure 4: Cayman Enterprise City masterplan

George Town Road Network Improvements

Roadway design engineering services for several upgrades on behalf of the NRA including Smith Road, Shedden Road, Godfrey Nixon Extension, and North Church Street. Responsible for the preparation of construction drawings, specification and bills of quantities

Waste Management Facility and George Town Landfill

APEC provided all engineering services for the design and environmental impact assessment (EIA) of a new waste management facility and the remediation of the existing George Town Landfill. The EIA included a full traffic impact assessment for the proposed Bodden Town site

Elgin Avenue Dorcy Drive Connection

Roadway design engineering services for a new road linking Elgin Avenue to Dorcy Drive to NRA standards. Responsible for the preparation of construction drawings, specification and bills of quantities

Esterley Tibbetts Highway Realignment & Widening

Highway and civil engineering design services to realign an urban aretial road with a widening to six lanes. Geometric design of the roadway and four major roundabout intersections. Design of two highway tunnel structures to AASHTO standards capable of supporting up to three stories of buildings above

Figure 5: First bridge beam being installed at the ETH underpass

Owen Roberts International Airport Traffic Impact Assessment

APEC completed an assessment of the road network surrounding the airport in collaboration with Burns Engineering Inc. APEC conducted on-site traffic counts, forecasting of network demands due to the expansion of the airport, along with proposed adjacent developments and reported near term and long term forecasts

Airport Connector Road

Project lead of an international multi-disciplinary team for the design of a four lane urban arterial road from Owen Roberts International Airport to Camana Bay. Full construction documents were completed for the NRA

Camana Bay Phase 2 Traffic Impact Assessment

APEC completed an update to Camana Bay's original 2001 TIA incorporating road network modifications and he development's eisting demands and projected expansion

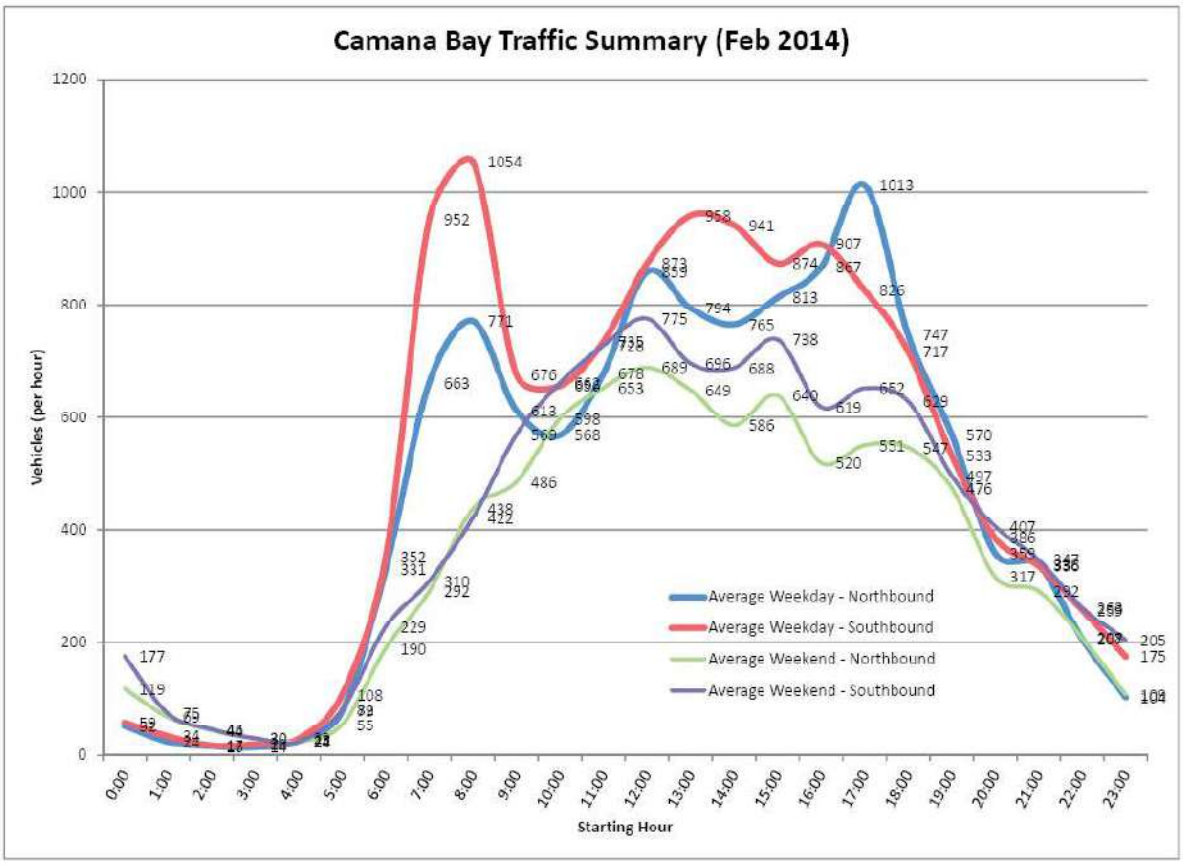


Figure 6: Camana Bay peak traffic data

Esterley Tibbetts Highway Extension

The design of a two-mile extension of a four lane urban arterial road, three roundabout intersections, one overpass structure and several access roads. Full construction documents completed for Dart Realty (Cayman) Ltd and Cayman Islands National Roads Authority. Provided construction observations duties, inspections, responding to site queries, submittals review, etc.

Dorcy Drive Road Improvement Works

The road improvement works included improving the vertical alignment of the roadway, provisions of new drainage, sidewalks curbing, etc on behalf of the National Roads Authority. Responsible for the preparation of construction drawings, specification, tender documents and cost estimate. APEC also managed the tendering process on behalf of the NRA.

CURRICULUM VITAE

Name: **ALI SABTI,** BSc (Eng) MSc (Structures) MIEI

Birth/Citizen/Status: 1962, Caymanian, Married

Disciplines: Civil/Structural Engineer

Position: Senior Engineer

Academic Qualifications: Bachelor of Science (Engineering)
University of Dublin, Ireland 1985
Master of Science (Structures)
Trinity College, University of Dublin, Ireland 1987

Registrations: Chartered Member of the Institution of Engineers of Ireland (MIEI)
Chartered Member Cayman Society of Architects Surveyors & Engineers (CASE)

Professional Experience:

1996- Present APEC Consulting Engineers Limited
Grand Cayman
Cayman Islands
Senior Civil/Structural Engineer

1995 - 1996 Wexford Quay Extension
Wexford Main Drainage Scheme
Wexford Town, Ireland
Executive Resident Engineer

1988- 1995 T.J. O' Connor & Associates, Consulting Engineers
Dublin, Ireland
Project Engineer

Ali has been a Senior Civil/Structural Engineer with APEC since 1996. He is a Chartered Engineer with expertise in civil and structural engineering. Ali has been extensively involved in numerous large civil, structural and infrastructure projects in the Cayman Islands and Europe. Recent projects include the Esterley Tibbetts Highway Realignment, Camana Bay civil engineering enabling works and a proposed canal bridge structure. Ali provides expert advice on contract procurement and administration as well

PROJECT EXPERIENCE

Cayman Islands. Senior Civil/Engineer responsible for the design and supervision and contract administration of numerous commercial, resort, residential and governmental engineering projects.

Civil Engineering and Infrastructure Projects:

- Ritz Carlton Civil Engineering
- The CUC Engine Room 5 foundation, ground floor and civil works
- The Cayman Island Yacht Club and Marina
- The Port Authority Marina Development at Dragon Bay
- Infra-structure design of many private developments including Salt Creek and the Exclusive Resorts
- The Esterley Tibbetts highway Extension overpass and embankments

Commercial:

- Fosters Food Fair
- Harbour View
- The Ritz Carlton
- Boundary Hal
- Willow House
- Camana Bay Blocks 1, 2A and B and 3
- School Road Development

Educational and Institutional:

- Cayman International School Major Expansion (2016-present)
- Cayman International School (2004)
- Two Government High Schools – John Gray, Clifton Hunter
- The Aston Rutty Hall and Hurricane Shelter, Cayman Brac
- The new Hurricane Shelter at Cayman Brac

Wexford Quay Extension, Ireland. Project Engineer, responsible for the engineering design of various elements of the works (dredging, land reclamation, coastal protection jetty construction and large diameter pipe lines construction) and the preparation of the contract documents. Construction cost estimate IRP 10.3 million 1992 - 1995.

Civic offices for South Dublin County Council. Senior Structural Engineer responsible for the structural design of the super structure and foundation construction. Cost estimate IRP 8 million - 1993.

Kilkenny Shopping Centre, Ireland. Senior Structural Engineer responsible for the structural design of the superstructure and foundations of the shopping centre. Cost estimate IRP 24 million 1992 - 1993.

The "Square" Town Centre, Tallaght, Dublin. Structural Engineer responsible for the design and detailing of various elements of the structure. Cost estimate IRP 60 million 1988- 1991.

ROBERT C. MINNING, L.P.G.

EDUCATION:
M.S. Geology/Hydrogeology; *University of Toledo*, Toledo, Ohio
M.A.T. Earth Science; *Indiana University,* Bloomington, Indiana
B.A. Geology; *Wittenberg University,* Springfield, Ohio

REGISTRATION:
Professional Geologist: AIPG #2565; Indiana #123; Wisconsin #1053
Certified Mediator: State of Florida No. 7716C
Qualified As "Special Master" for proceedings under the Harris Act and Dispute Resolution Act, Ch. 95-181 of the Laws of Florida

PROFESSIONAL ORGANIZATIONS:
National Ground Water Association - 1968 to Present
- Director, 1977-1978
- Chairman, Technical Division (AGWSE), 1977-1978
- Secretary/Treasurer, Technical Division (AGWSE) - 1976
- M. King Hubbert Award - 1978

American Water Works Association - 1971 to Present – Lifetime Member
American Institute of Professional Geologists – 1972 to Present
- President, Michigan Section, 1978
- Secretary/Treasurer, Michigan Section, 1977

Florida Academy of Professional Mediators, Inc. – 1995 to 2018
Florida Conflict Resolution Consortium - Roster Listing - 1996 to 2018
U. S. Institute for Environmental Conflict Resolution – Roster Listing – 2000 to Present

SUMMARY OF PROFESSIONAL EXPERIENCE:

Mr. Minning has had extensive experience with respect to hydrogeologic and multidisciplinary investigations and remedial program development. He has been involved as project director for numerous RCRA and CERCLA investigations, feasibility studies and corrective action programs. He has expertise pertaining to all aspects of subsurface investigation and interpretation of investigative plans to assess soil and groundwater contamination, the development and execution of remedial plans for soil and aquifer restoration, the planning and permitting of land disposal of wastewater programs, and the exploration, development and permitting of groundwater resources.

Mr. Minning's experience in water resources development includes the use of surface and borehole geophysics, aquifer performance testing and conjunctive use of surface and groundwater supplies. His experience includes small systems of 50 gallons per minute up to 20 million gallons per day supplies for municipalities which required wellfield layout, design, and computer modeling.

Mr. Minning has also provided oversight and objective second or third-party reviews and opinions on environmental issues of significant economic and political impact. He has been involved in high-level negotiations with local, state and federal regulatory agencies and personnel. He has considerable experience as an expert witness and in assisting counsel in strategy formulation. His expertise also includes providing comprehensive alternative dispute resolution services including: binding and non-binding arbitration, mediation, mediation/arbitration, response cost allocations and negotiations.

ROBERT C. MINNING, L.P.G.

PRESENTED PAPERS AND PUBLICATIONS

"Financial & Technical Considerations for Wellhead Protection Programs", Training Session presented at the Indiana Water & Wastewater Association 16th Annual Conference, April 9, 1998, Jasper, Indiana

"Forensic Review of Environmental Reports in Administrative and Judicial Settings", paper presented at Environmental and Land Use CLE Seminar, Hillsborough County Bar Association, Tampa, Florida. May 30, 1997.

"Financial Considerations of Brownfield Projects", paper presented at the Florida Environmental Expo, Tampa, Florida, October 2, 1996

"How To's of Environmental Auditing - Applying Scientific Techniques, Explaining the Results", paper presented at Seminar on Implications of Environmental Law in Real Estate Transactions, Troy and Grand Rapids, Michigan. May 14 & 16, 1991 respectively paper published in proceedings: Homeward Bound Seminars, Real Property Law Section, State Board Michigan

"Environmental Audits", paper presented at seminar on Environmental Real Estate Issues, Institute of Continuing Legal Education and Negligence and Environmental Law Sections, Michigan State Bar, Southfield, Michigan, Paper published in course handbook, pp. 21-29, December 20, 1989

"The Role of the Hydrogeologist in Ground Water Contamination Studies", paper presented at the 1982 Annual Environmental Law Section Meeting, State Bar of Michigan, September 24, 1982.

"Monitoring Well Design and Installation", proceedings of the Second National Symposium on Aquifer restoration and Ground Water Monitoring, May 26-28, 1982, pp. 194-197

"Contamination Study - Geophysical Techniques", paper presented at the 6th Conference on Ground Water Contamination, East Lansing, Michigan, March 6, 1981

"Land and Groundwater Contaminants", paper presented at Symposium on Hazardous and Toxic Materials and their Disposal, Engineering Society of Detroit, April 22, 1980

"The Ott/Story Chemical Company Case", paper presented with Mr. Gary Klepper, Michigan Department of Natural Resources at the Fifth National Ground Water Quality Symposium, Las Vegas, Nevada, October 9, 1980

"Ground Water Resource Management: Chemical Spills, Contaminants", paper presented at Annual Meeting, Michigan Section, American Water Works Association, Southfield, MI, September 27, 1978

"Use It Wisely", Guest Editorial, Journal of Groundwater, September/October, 1977

"Hydrogeologic and Geophysical Methods and Considerations for Locating Underground Water Supplies", 1976-77

"Ground Water Contamination", paper presented at Seminar on Principles and Applications of Ground Water Hydraulics, East Lansing, Michigan, February 13, 1975.

"The Cost of Geophysical Exploration", The Water Well Journal, v. 28, No. 8, 1974

ROBERT C. MINNING, L.P.G.

PRESENTED PAPERS AND PUBLICATIONS

"Effects of Ground Disposal of Sewage Sludge on Ground Water Supplies", paper presented at 34th Annual Meeting, Michigan Section, American Water Works Association, Grand Rapids, Michigan, September 13, 1973

"The Earth Resistivity Method", The Water Well Journal, v. 27, Nos. 6 & 7, 1973

"Drainage Hydrology of Land Disposal Sites", paper presented at Seminar of Principals and Applications of Ground Water Hydraulics, East Lansing, Michigan, December 7, 1972, published in Symposium Proceedings

"Aquifer Exploration and Development: Case Histories", paper presented at Seminar on Principles and Applications of Ground Water Hydraulics, East Lansing, Michigan, February 11, 1972

SELECTED PROFESSIONAL EXPERIENCE

Waste Management Facility
Full scale hydrogeological investigation for a proposed state-of-the-art solid waste management facility on Grand Cayman Island. Investigation included the installation and monitoring of 12 observation well nests, surface water monitoring stations, climatological monitoring, hydrological budget, tidal influences, three-dimensional delineation of groundwater flow system, aquifer delineation, aquifer characteristics and MODFLOW computer modeling. Report submitted to Water Authority Cayman for review and approval and was accepted.

Resort Hotel Chiller System Groundwater Supply and Disposal
Full scale hydrogeological investigation for a resort hotel chiller system groundwater supply and disposal on Grand Cayman Island. Project requirements were for a 2,700 gallon-per-minute (gpm) supply and injection of 2,600 gpm with 100 gpm to supply Reverse Osmosis system. Project required that the heated injection water be hydraulically isolated from the extraction zone and adjacent groundwater users. Investigation included the installation and monitoring of 4 monitor wells, delineation of groundwater flow system, aquifer delineation and characterization, tidal influences, 3-dimensional hydraulic conductivity properties and MODFLOW computer modeling. Report submitted to Water Authority Cayman for review and approval and was accepted. Project is under construction.

Expert Witness in the matter Robert G. Tuomela, et al v Ford Motor Company, et al., Court File No. D96-9333-NO, Circuit Court, County of Dickinson, Michigan. The project involved a private home owner and neighbors who experienced the intrusion of methane into their homes and properties. The accumulation of methane in one home resulted in an explosion and severe injury to the owner. The other homeowners experienced evacuations and relocations, intensive and lengthy investigations within their homes, on their properties, and in the area. Responsibilities included advising the homeowners and their counsel on the source(s) of the methane, the migration pathway(s) in the soil and groundwater flow system, review and comment on work plans, data, reports, and applicability of proposed remediation systems prepared by consultants to Ford Motor Company and Kingsford Products, Inc. Represented homeowners by providing expert witness testimony at mediation hearing.

Expert Witness in the matter RSR Corporation, and Quetmetco, Inc. v Avanti Development, Inc. et al., Court File No. IP 95-C-1359-M/S, United States District Court,

Southern Indiana, Indianapolis Division. The project involved lead contamination of soils in a residential neighborhood from activities conducted at a battery recycling, lead smelter and lead oxide facility. Lead concentrations in the soil surrounding approximately 256 private homes exceeded criteria (>400 ppm) and had to be removed. Responsibilities included reviewing and commenting on testing procedures, analytical data, reports, remedial actions, and response cost allocation for counsel representing a third-party defendant.

Project Director, Remedial Investigation/Feasibility Study, Motor Wheel Superfund Site. Project site was an active gravel mining operation; landfilling of various wastes had taken place in mined-out areas. Efforts included serving as liaison between client and other potentially responsible parties (PRPs) to establish each party's responsibility for the site. Contaminants of concern included chlorinated solvents, numerous inorganic chemicals, and other organic compounds. Represented the client during negotiations with state and EPA personnel regarding a 106 Order and subsequently to define the scope of the investigation and served as overall point of contact for the RI/FS.

Project Director, Contamination Assessment and Site Characterization at a large manufacturing site, Confidential Client. Conducted contamination assessment at facility with numerous potential sources of contamination. Characterization included groundwater, surface water, various areas of fill materials, soils, wastewater impoundments (liquid and sediment sampling and analysis), and in-plant conditions. Represented the client in negotiations with regulatory agencies and associated contractors. Following the contamination assessment activities, a comprehensive risk assessment was conducted at each area of concern to segregate the area of significant impact and to quantify the associated risk. This effort resulted in the prioritization of site with respect to the need to remediate and established remediation criteria at each area of concern.

Project Director, **Remedial Investigation/Feasibility Study at the Verona Wellfield Superfund Site**. Thomas Solvent Company, the duties included direction of court-ordered interim remedial actions and emergency response measures, provided oversight of EPA activities in the RI/FS, proposed remediation contained in the draft Record of Decision (ROD) and throughout the Remedial Action phases. Represented client in community relations with local citizens groups, state and federal litigation, and throughout extensive negotiations and litigation with insurance carriers.

SELECTED BUSINESS EXPERIENCE

R. C. Minning & Associates, Inc. – Treasure Island, Florida

- President - September 1997 to Present

  Environmental consulting and Alternative Dispute Resolution service business, response cost allocation services, specializing in water resource exploration and development, soil and groundwater investigations and remediation, and mediation / arbitration related to environmental issues.

HSA Environmental - Tampa, Florida

- Chief Operating Officer - May 1996 to September 1997

  Responsible for the day to day operations of a multidisciplinary environmental consulting business. Organized the company into operating divisions with profit and loss responsibility, developed middle management, implemented corporate and divisional business planning with budgeting and forecasting, streamlined accounting and finance

operations, negotiated favorable LOC, revised and negotiated favorable rates for all insurance coverage including health, initiated procedures for financial considerations in employee reviews, and developed incentive compensation plan.

R. C. Minning & Associates - Ft. Myers and St. Petersburg, Florida

- President - January 1995 to May 1996

  Developed environmental consulting and alternative dispute resolution business specializing in water resource exploration and development, soil and groundwater investigations and remediation, and mediation / arbitration services related to environmental issues. Developed business plan for startup of a regional engineering and environmental consulting business focused on water resources.

Horizontal Technologies, Inc. - Cape Coral, Florida

- Senior Vice President - October 1993 to January 1995

  Developed and implemented a comprehensive business plan to improve financial performance, increase internal controls, and systemize sales and marketing. Prepared annual business plans and budget, and five-year strategic growth plan, and developed corporate package for presentation to potential investors. Increased revenues over 39 percent, and operating profits by over 200 percent.

Summit Environmental Group, Inc. - Canton, Ohio

- Executive Vice President & Chief Operating Officer - July 1989 to February 1993

  Full responsibility for day to day operations of all Summit Subsidiary companies. Played an integral part in the acquisition and integration, and growth of nine private companies into an $80 million organization with over 1,000 employees, and operating profits in the top ten percent of industry peer group. Participated in planned Initial Public Offering, which due to market conditions did not materialize. Venture capital backers sold company to Earth Tech, Inc. which is in operation as of 1998.

Hunter Environmental Services, Inc. - Gainesville, Florida

- Director - September 1986 to January 1989

  Played a key role in the planning, "Road Show", and initial Public Offering. Member of the Board of Directors of a public company with responsibility for planning and executing growth of the organization and maximizing return to shareholders.

- Senior Vice President - Environmental Operations - March 1988 to January 1989

- President - Environmental Science & Engineering - March 1988 to January 1989

  Directed and responsible for the integration and operations of 25 subsidiary and branch offices with 820 employees providing multi-disciplined environmental and engineering services nationwide. Annualized revenues of $66 million with operating profits in upper quartile of industry peer group.

- Vice President & General Manager - Geosciences Division

  Directed and integrated activities of five geoscience subsidiaries, and full profit and loss responsibility. Participated in the Initial Public Offering of Hunter Environmental

Services, Inc. Increased Division revenues from $13 million to $22 million with consistent profitability.

Keck Consulting Services, Inc. (formerly W. G. Keck & Associates, Inc.) - Williamston, Michigan

- Chairman, Chief Executive Officer & President - January 1971 to March 1988

  Directed the development and growth of a hydrogeological and geophysical consulting services firm. Achieved revenue growth from $20 thousand to over $9 million. Successfully lead the sale of the company to Hunter Environmental Services.

Keck Geophysical Instruments, Inc. - Williamston, Michigan
- Chairman - 1982 to 1986

- Chairman, Chief Executive Officer & President - 1971 to 1982

  Directed to growth and development of a geophysical / electronics instrument manufacturing company from split-off from W. G. Keck & Associates, Inc. to sale to Hunter Environmental Services, Inc.

SELECTED PROFESSIONAL / BUSINESS ACTIVITIES

City of Treasure Island, Florida

- Commissioner District 3 – March 2007 – March 2009
- Vice Mayor - March 2008 – March 2009
- Mayor – March 2009 – 2018
- Chairperson – Sustainability Committee – 2018-present

Barrier Island Government Council (BIG-C)

- President- 2014-2017
- Vice Chair – 2012 – 2014
- Secretary/Treasurer- 2010-2012

Tampa Bay Regional Planning Council

- Member-2008 – 2018
- Secretary /Treasurer- 2011-2012
- Vice Chair – 2012 – 2013
- Chair-2013-2014

Agency on Bay Management – Tampa Bay Regional Planning Council
- Member-2008-2018
- Chairperson-2013-2015

Madeira Beach Fundamental School – Madeira Beach, Florida
School Advisory Council

- Chairperson – 2009 - 2010
- Vice Chairperson – 2010 – 2011

Southside Fundamental Middle School – St. Petersburg, Florida
School Advisory Council

- Member-2008 to 2009

Pasadena Fundamental Elementary School – St. Petersburg, Florida
School Advisory Council

- Member-2003 to 2008
- Chairperson-2005 to 2008

City of Treasure Island, Florida – Beach Stewardship Committee

- Appointed as Member – 1999 to 2007
- Chairperson – April 2000 to March 2007
- Commission Representative – March 2007 – March 2009

East Lansing - Meridian Water and Sewer Authority, Meridian Township, Ingham County, Michigan

- Appointed as Trustee representing Meridian Township - 1983 to 1988

Ingham County Solid Waste Management Planning Committee, Ingham County, Michigan

- Appointed as Member - 1980 to 1988

Groundwater Monitoring & Remediation

- Member of Editorial Board - 1981 to 1986

Journal of Groundwater

- Member of Editorial Board - 1976 to 1979

The Professional Geologist

- Associate Editor – 2000 to Present

University of Wisconsin-Extension, Madison, Wisconsin

- Instructor in Hydrogeology for Technical Institute of Water Wells Design - 1976 to 1987

Pan American Health Organization / World Health Organization

- Special Consultant in Hydrogeology on projects in Georgetown, Guyana, and in the ten largest cities in Haiti - 1973 to 1977

Indian Health Service, Department of Health Education and Welfare

- Instructor in Geophysics for Short Course in Water Well Construction - 1973 to 1979

JOHN R. BOMBA

EDUCATIONAL AND CAREER SUMMARY

Mr. Bomba obtained Bachelor's and Master's degrees in the Geological Sciences at Ohio University in Athens, Ohio. He was the recipient of a teaching scholarship and the Tarr Award for outstanding achievement. While in graduate school, Mr. Bomba was a teaching assistant for several classes and workshops in geology and hydrogeology.

Mr. Bomba has had considerable experience with respect to groundwater resource evaluations, contaminant investigations, remediation, and property transactional support at underground storage tank, dry cleaner, commercial/industrial chemical, landfill, and manufacturing sites in Michigan, Ohio, Indiana, Georgia, Florida, Illinois, Cayman Islands and the Bahamas. He began his career as a Field Geologist, gradually increasing in experience to Project Director. Mr. Bomba has coordinated projects with budgets ranging from <$1,000 to over $1 Million and is responsible for numerous project investigations and site closures.

In addition to job-related accomplishments, Mr. Bomba maintains active member status in several technical associations and local committees.

EXPERTISE

Geological analyses of soils; hydrogeologic investigation pertaining to water resource evaluation, soil remediation, groundwater contaminant plume delineation and remediation; monitor well installation; groundwater, soil, vapor, and sediment sampling; siting, development, and monitoring of solid waste landfills; interpretation of geophysical logs; evaluation and presentation of field and laboratory data; groundwater modeling; environmental assessments, property transaction support, and technical report preparation.

EXPERIENCE

Coordination and oversight of groundwater resource evaluation and wellhead protection studies and contaminated soil and groundwater contaminant plume delineation and remediation. Project geologist for hydrogeologic investigations of industrial and commercial properties, solid waste landfills, and underground storage tank facilities. Responsible for technical, managerial, and financial aspects of projects.

Analyses and quality control of geologic and geophysical data; coordination and supervision of production and monitor well design and installation; supervision of soil boring construction; collection and preparation of soil samples for laboratory analyses; sampling of groundwater for the purpose of analytical testing; collection of soil vapor and air samples for analyses and assessment; interpretation of analytical data and field observations; determination of hydrogeologic properties, and analytic and numerical modeling using various model codes including Modflow.

Review and presentation of environmental data and information in support of litigation, expert witness testimony, and deposition. Familiar with CAD systems, spreadsheet, and database programs.

Completion of Phase I and II Environmental Site Assessments, Transaction Screen Assessments, Michigan Baseline Environmental Assessments, and Due Care Plans.

BUSINESS EXPERIENCE

4/02-Present KECK Consulting Services, L.L.C.
Battle Creek, Michigan
General Manager/Principal

8/94 -4/02 American Hydrogeology Corporation
Kalamazoo, Michigan
General Manager/Project Manager

8/93 - 7/94 Ohio Petroleum UST Release Compensation Board
Columbus, Ohio
Hydrogeologist/Claims Reviewer

6/91-12/92 WW Engineering and Science
Columbus, Ohio
Staff/Field Geologist (Temporary on college breaks and vacations)

2/90-12/93 US Forest Service (Grant to Ohio University)
Athens, Ohio
Staff/Field Geologist

Academic Background

M. S., Hydrogeology
Ohio University
Athens, Ohio (1994)

B.S., Geological Sciences, Water Resources
Ohio University
Athens, Ohio (1991)

Certifications/Affiliations/Memberships

HAZWOPER Site Worker Training
Certified Professional Geologist, State of Indiana (#1920)
Certified Professional (CP), State of Michigan (#1021)
Certified Michigan Wastewater Treatment Plant Operator (A-2b, A-2d, B-2c, and B-3b)
Certified Michigan Industrial Stormwater Operator
National Groundwater Association
Michigan Ground Water Association
American Water Works Association
Calhoun County Solid Waste Management and Planning Committee
Calhoun County Local Emergency Planning Committee
Columbus, Indiana "Design Team" 1997-98 - Developing a Comprehensive Land Use, Economic, and Social Plan for the Future
Columbus, Indiana Chamber of Commerce - Environmental Issues Subcommittee
ASTM Risk-Based Corrective Action and RBCA Toolkit Training
ITRC – Vapor Intrusion and other related training
EDR "Due Diligence at Dawn" Seminars

Publications/Presentations

"Financial and Technical Considerations for Wellhead Protection Programs," Training session presented at the Indiana Water and Wastewater Association 16th Annual Conference, April 9, 1998, Jasper, Indiana

Important Considerations for Completing Wellhead Protection Programs in Indiana a Companion Guide to the "Financial and Technical Considerations for Wellhead Protection Programs" Training session presented at the Indiana Water and Wastewater Association 16th Annual Conference, April 9, 1998, Jasper, Indiana

Numerous "brown bag" meetings regarding Hydrogeology, Water Resources, Environmental Issues and Property Transactions, Environmental Management Systems, Septic Systems, and Physical Hydrogeology

"The ABC's of AAI - A Practitioner's Perspective of the new All Appropriate Inquiry Standard for Environmental Due Diligence." AIPG National Conference, September 27, 2006, St Paul, Minnesota.

Dr. BRIAN JONES,

Distinguished University Professor, University of Alberta
Fellow Royal Society of Canada
P. Geol.

General background

Geologist with 45 years of experience working with carbonate Sedimentary rocks, including work on oil, gas, water reservoirs. Extensive fieldwork experience throughout the world, including work in the Cayman Islands, Arctic Canada, China, New Zealand, Iceland, Bermuda, Barbados, Chile, and many other locations.

Cayman Islands

Dr Jones is the pre-eminent authority on the Geology of the Cayman Islands. Extensive experience working on the geology of the Cayman Islands. Since 1981, Dr Jones has visited the islands twice a year (on average) in order to undertake fieldwork on all aspects of the geology of the islands. To date, this work has resulted in 90 peer-reviewed papers on the geology of the islands that have been published in various journals, and 8 Ph.D. and 22 M.Sc. theses dealing with the islands' geology have been completed under my supervision. At present 2 Ph.D. and 1 M.Sc. students are working on the geology of the islands. This research has established a comprehensive understanding of the modern carbonate sediments around the islands and a thorough knowledge of the bedrock successions.

Although the publications and theses are largely academic in nature, they provide the practical framework for understanding the nature of the rocks on the island. This practicality has been amply demonstrated by various projects that Dr Jones have been involved with on the islands. Specific examples, include the following.

Over the last 25 years, he have actively worked with the Water Authority of the Cayman Islands; undertaken the geological work that was needed as they developed the Reverse Osmosis Water Plants in Lower Valley, Red Gate, and the North Side location. Development of those water-producing plants relied heavily on knowledge and interpretation of the subsurface rock successions. Similar work was also done for the development of a new Sewerage Processing Plant in George Town for the Water Authority.

Over the last several years, while working with APEC Consulting Engineers Ltd. (Cayman Islands), Dr Jones has been involved with a proposed Waste Management Facility site near Bodden Town, the Kimpton Hotel resort and the proposed beachrock removal project on Seven Mile Beach. In each project, Dr Jones provided the documentation and interpretations of the subsurface geology of those sites.

CURRICULUM VITAE

Name:	**Ronan O'Keeffe** BE MSc CEng MIEI
Birth/Citizen	1982/Irish
Disciplines:	Civil & Structural
Position:	Project Engineer
Academic Qualifications:	Educated at Trinity College Dublin, Dublin, Ireland Masters of Science in Civil Engineering, 2008 Educated at the Dublin Institute of Technology, Dublin Ireland – Bachelor of Structural Engineering, 2005
Registration:	Chartered Engineer, Registration #047284 Engineers Ireland
Design Software:	Autodesk Civil 3D www.autodesk.com AutoCAD www.autodesk.com Autodesk Revit www.autodesk.com ETABS 3D Structural Modeling www.csiamerica.com MapInfo, www.mapinfo.com TEDDs Structural Analysis www.cscworld.com TRL Modelling Software, www.trl.co.uk

Ronan is a Chartered Civil / Structural Engineer with 13 years post qualified experience in civil and structural projects. Ronan has completed several engineering projects since he started working with APEC in 2011. Recent structural projects have focussed on BIM Revit design collaboration. Ronan has also been responsible for construction observation services for several large projects including the Kimpton Grand Cayman Hotel development and Camana Bay Block 5 mixed use buildings.

Experience:

2011 – present, APEC Consulting Engineers Ltd

Cayman International School Major Expansion 2016 – present
www.camanabay.com/times/cis-expansion-plans-revealed
Cost KYD$ 50 million
Project engineer on a multi-disciplinary team for a 100,000 SF multi-structure school expansion project. Delivering the project through BIM Revit through design consultancy collaboration.

Fosters Food Fair Camana Bay
Project engineer on a large, 50,000 SF grocery store with ancillary structures and surface carparks. Project design & drawings delivered through BIM Revit collaboration.

National Roads Authority projects 2011 - present
www. caymanroads.com
Project engineer for several projects on behalf of the National Roads Authority including design for reconstruction of public roadways and traffic impact assessments of several public and private developments

Camana Bay Phase 2.1 Development 2014 – present
www.camanabay.com
Cost KYD$ 250 million
Project engineer for a multi-disciplinary team responsible for the design of the advance civil engineering enabling works. Includes the widening and realignment of the Esterley Tibbetts Highway construction of two air-right underpass structures and diversion of utilities.

Kimpton Grand Cayman Hotel & Condominium, 2013 – present
www.kimptonhotels.com/stay/seafire-resort-and-spa
The project works include providing the structural design and construction monitoring for a large multi-use development incorporating a 10 storey hotel, 10 storey condo block, beach bungalows and associated structures and facilities. Responsible for structural modelling of the both main structures, involved in civil design and directly responsible for construction monitoring.

Esterley Tibbetts Highway Extension, 2011 – 2013
Cost KYD$ 25 million
The road improvement works include providing a new roundabout junction and providing an additional on the existing alignment, extending the road through green field land to open up potential development land, provisions of new drainage, sidewalks, curbing, etc on behalf of the National Roads Authority. Directly responsible for the preparation of preliminary design drawings, developing 3D alignment model and specifications.

Site Investigation Monitoring, Cayman Islands. 2011 - present
Project Engineer responsible for the monitoring several site and ground investigations throughout Grand Cayman.

2011 – 2011, Opus International Consultants UK Ltd (London, UK)

Rochester Bridge Trust Infrastructure Management, 2011 - 2011
Opus managed all assets associated with three bridges across the Medway River. Improvement works included designing new street lighting, upgrading the drainage network and undertaking bridge inspections and assessments. Directly responsible for scheduling work and managing staff working on the project and implementing new QA procedures to improve project management.

2006 – 2011, J.B. Barry and Partners Ltd (Ireland)

Stage I Structural Assessment of Bridges
This project involved the inspection and detailed assessment of 76 bridges along the National Road Network throughout the province of Leinster. Responsibilities included:

- Undertaking bridge inspections to record key dimensions and report any defects
- Calculating load carrying capacity of the bridge structures
- Management of junior staff, third parties and sub-consultants
- Preparation of detailed bridge assessment reports and scoping / costing remedial works

Motorway Service Areas
This project incorporated the selection of suitable locations for Motorway Service Areas (MSA) and the Site Monitoring and Administration, as Authority's Representative, of the first MSA to be constructed in the Republic of Ireland. Responsibilities included:

- Undertaking site selection studies and subsequently producing EISs for each site
- Attending and assisting at Planning Authority Oral Hearings
- Site supervision of construction works, including liaison between design & site teams

CURRICULUM VITAE

Name:	**Denis Murphy** BE CEng MIEI
Birth/Citizen/Status:	1978 / Caymanian / Married
Disciplines:	Civil & Structural
Position:	Senior Engineer
Academic Qualifications:	Educated at the University College, Dublin Ireland – Bachelor of Engineering, 2000
Registration:	Chartered Engineer, registration #039239 Engineers Ireland

Denis has worked with APEC since 2003. He is a Senior Civil/Structural Engineer and chartered with The Institution of Engineers of Ireland since 2004. Denis has worked on numerous civil & structural engineering projects in the Cayman Islands and Ireland over the last 19 years. Recent projects include a vertical expansion study for the Westin Resort in 2015, civil engineering design services for the Westin Redevelopment 2016-2017 and civil engineering design services for the Ritz Carlton Grand Cayman.

Experience:

2003 – present, APEC Consulting Engineers Ltd

The Westin Hotel Redevelopment 2015-2017
Completed an initial structural feasibility study for a 2 storey vertical expansion to the hotel in 2015. Later provided the civil engineering design services for the improvement works 2016-2017

National Roads Authority projects 2011 - present
www. caymanroads.com
Project Manager for several projects on behalf of the National Roads Authority including design for reconstruction of public roadways and traffic impact assessments of several public and private developments

Camana Bay Phase 2.1 Development 2014 – present (www.camanabay.com)
Cost KYD$ 250 million
Project manager for a multi-disciplinary team responsible for the design of the advance civil engineering enabling works. Includes the widening and realignment of the Esterley Tibbetts highway construction of two air-right underpass structures and diversion of utilities.

Port Authority Marina, Dragon Bay 2012 – 2013
Cost KYD$ 4.5 million
Project Manager for the construction phase of the marina advance earthworks, construction of docks and onshore facilities. Providing full construction administration services and site monitoring. To be complete January 2014

Esterley Tibbetts Highway Extension 2011-2013
Cost circa. KYD$ 25 million
Project Manager of a multi-disciplinary team for the design of a two mile extension of a four lane urban arterial road, three roundabout intersections, one overpass structure and several access roads. Full construction documents completed for Dart Realty (Cayman) Ltd and Cayman Islands National Roads Authority. Provided construction observations duties, inspections, responding to site queries, submittals review, etc.

Waste Management Facility and George Town Landfill 2009-2013
Full build-out cost circa. KYD$ 120 million
Project Manager for the preliminary design and environmental impact assessment of a new waste management facility and the remediation of the existing George Town Landfill. The assessment included a full traffic impact assessment which was completed in-house. Participated in negotiations with Cayman Islands Government, its regulatory authorities and Dart Realty (Cayman) Ltd

Camana Bay Residential Phase 2A, 2009
Completed a traffic impact assessment for the proposed residential development at Camana Bay to National Roads Authority standards.

Airport Connector Road, 2008-2009
Estimated cost CI$ 19 million
Project Manager of an international multi-disciplinary team for the design of a four lane urban arterial road from Owen Roberts International Airport to Camana Bay. Full construction documents were completed for the Cayman Islands National Roads Authority

Dorcy Drive Road Improvement Works. 2008
Cost KYD$ 1.2 million
The road improvement works included improving the vertical alignment of the roadway, provisions of new drainage, sidewalks curbing, etc on behalf of the National Roads Authority. Directly responsible for the preparation of construction drawings, specification, tender documents and cost estimate. Managed the tendering process on behalf of the NRA.

West Indian Club Garden, George Town 2007 – 2008
Cost circa. KYD$ 5 million
Project Engineer for the design and construction of earthworks, access roads, a lake and culvert bridge. Responsible for the preparation of construction documents, bill of quantities and tendering of works. Project manager for the construction phase of the works.

Camana Bay, West Bay Road. 2003 – 2008 (www.camanabay.com)
Camana Bay is a 500 acre mixed-used development. Direct involvement in Phase 1 included the following:

- Project Engineer for marina with reinforced concrete promenade deck, sheet pile seawall, pedestrian bridge and small craft docks.
- Project Engineer for preliminary design of 120 FT single span post-tensioned concrete vehicular bridge. Performed geometric design of approach lanes. Detailed design of bridge expected in phase 2 of works.
- Project Manager for four earthworks and canal formation construction contracts (construction cost circa. $12 million). Responsible for ensuring the works were completed per design drawings, preparation of payment certificates and final completion certificates, liaison with several contractors during the progress of the works.
- Part of construction monitoring team performing engineering inspections, responding to site queries and reviewing submittals.

CURRICULUM VITAE

Name:	Daniel McCarthy BEng., MSc.
Birth/Citizen	1982/Irish
Disciplines:	Civil & Structural
Position:	Engineer
Academic Qualifications:	Educated at Edinburgh Napier University, Scotland Masters of Science in Project Management, 2018 Educated at the University of Edinburgh, Scotland Bachelor of Civil Engineering, 2005
Design Software:	AutoCAD www.autodesk.com CSC Fastrak -Building Designer www.tekla.com ETABS 3D Structural Modelling www.csiamerica.com MapInfo, www.mapinfo.com TEDDs Structural Analysis www.cscworld.com SIDRA

Experience:

2016 – present, APEC Consulting Engineers Ltd

Camana Bay Block 5 South 2015-2017
www.camanabay.com
Project engineer responsible for overseeing a team of reinforced concrete detailers for a five storey multi-use reinforced concrete development. Responsible for the site monitoring and design compliance of the development.

Camana Bay Phase 2.1 Development 2015 – 2017
www.camanabay.com
Cost KYD$ 250 million
Project engineer responsible for overseeing a team of reinforced concrete detailers for a six lane divided urban arterial road underpass structure. Responsible for the site monitoring and site compliance of the structure, roadway and infrastructure works.

Cricket Square Phase 6 2016 - present
Project engineer responsible for overseeing a team of reinforced concrete detailers for a five storey multi-use reinforced concrete development.

Cayman Enterprise City
Project engineer for a traffic impact statement (TIS) for a mixed-use development plan. Completed a TIS in accordance with National Roads Authority (NRA) requirements as part of the Planned Area Development which was approved in 2017

2013 – 2015, Structerre Consulting Engineers Ltd (Perth, Australia)

West End Apartments, Yokine 2014- 2015
www.structerre.com.au/projects/west-end-apartments-wa
Structural Design Engineer responsible for the design of 2 mixed-use complexes comprising 3-storey buildings containing 36 residential apartments and retail space.

Danmar Developments, Perth 2013
Structural Design Engineer responsible for the design of numerous developments across Western Australia for one of Australia's top residential developers.

2006 – 2013, Harley Haddow LLP Consulting Engineers (Edinburgh, UK)

Harbour Green, Portobello 2012-2013
Lead Project Engineer responsible for the structural design of a deep basement underground car park and steel support structure for a 5 storey residential beachside development comprising 45 apartment units.

Salamander Place, Edinburgh 2011 – 2013
Lead Project Engineer responsible for the design of two 5 and 6 storey apartment blocks comprising 145 units with underground piled retaining wall car parking. Other responsibilities included undertaking a geotechnical and geochemical audit of the site, assessing tenders and managing a team of sub-contractors.

Eshields Depot, Peebles 2012
Lead Project Engineer responsible for the design of a 15,000 square foot steel portal framed industrial building.

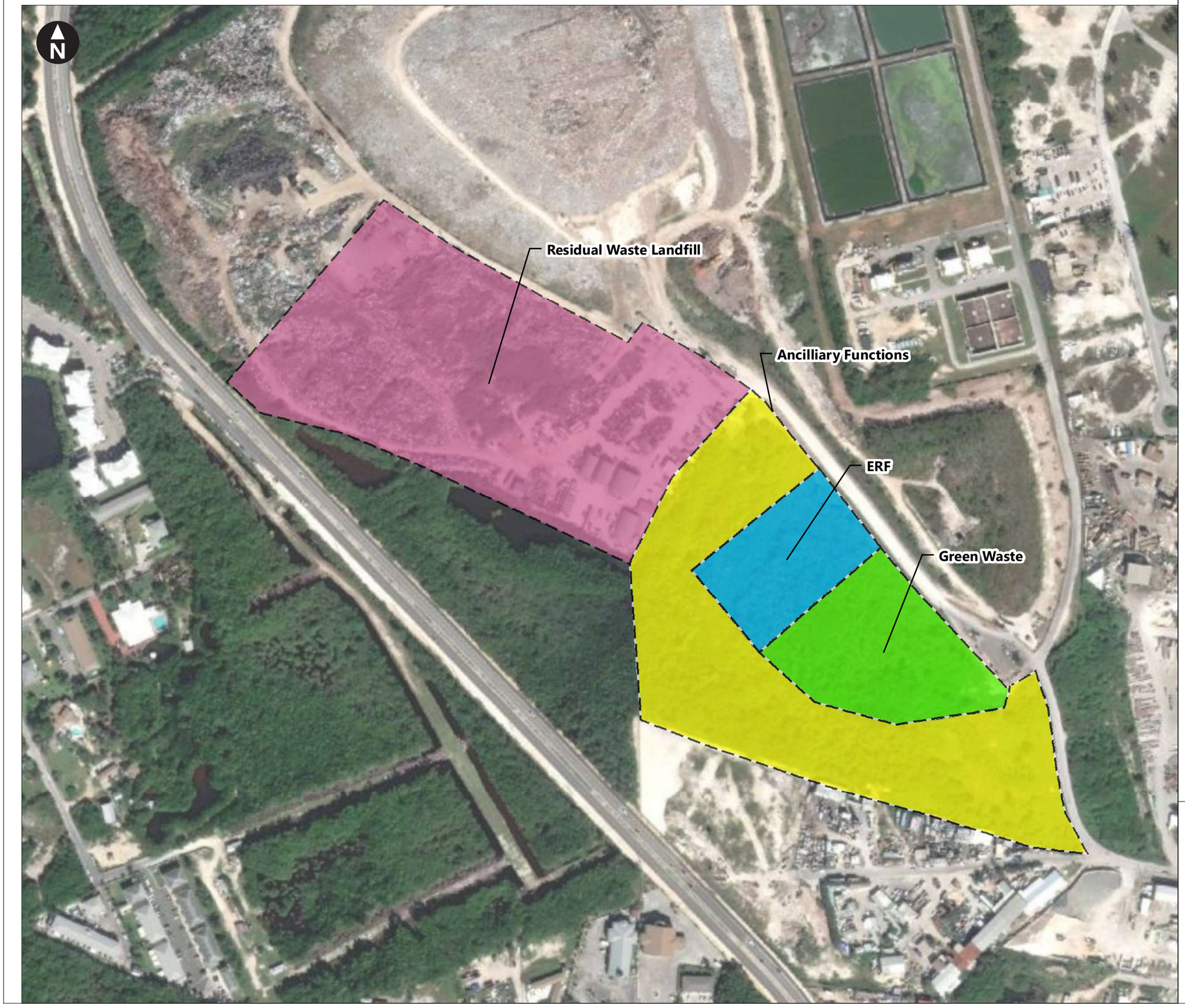
Newhaven Road, Edinburgh 2009-2011
Project Engineer responsible for the design of two 6 storey mixed-use steel framed buildings in Edinburgh city centre. Development comprised 120 apartment units, office and residential spaces.

Taylor Wimpey, 2009 House Range, Scotland 2007-2008
Project Engineer responsible for the complete structural design and structural supervision of 13 sites; totalling over 2,100 plots throughout Scotland for one of Britain's largest residential developers. Foundation solutions across the sites included Cast in-situ & Precast Driven Piles, CFA Piling, and Rotary techniques. Ground improvement techniques included Vibro Compaction and Lime Stabilisation.

2005-2006, The Rooff Group Ltd. (London, UK)

Hylands Park Estate, Chelmsford, Essex 2005
Site Engineer/Assistant Project Manager for the redevelopment of. £3.2m historic building restoration and refurbishment together with major estate Civil Engineering including the complete draining and relining of the original lake and extensive culvert fed drainage system. Responsibilities included setting out of new access roads, lake realignment, and drainage systems. Site engineer responsible for ensuring Environmental Control Procedures adhered to on site. Financial control, ensuring compliance with budget, production of monthly claims and forecasts.

Appendix B
Figures



Key

- Residual Waste Landfill
- ERF
- Ancilliary Functions
- Green Waste

0 50 100 150 m

Scale at A3: 1:3,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

George Town
Integrated Waste Management Solution

Figure 2.1
EIA Terms of Reference site plan

April 2021

wood.

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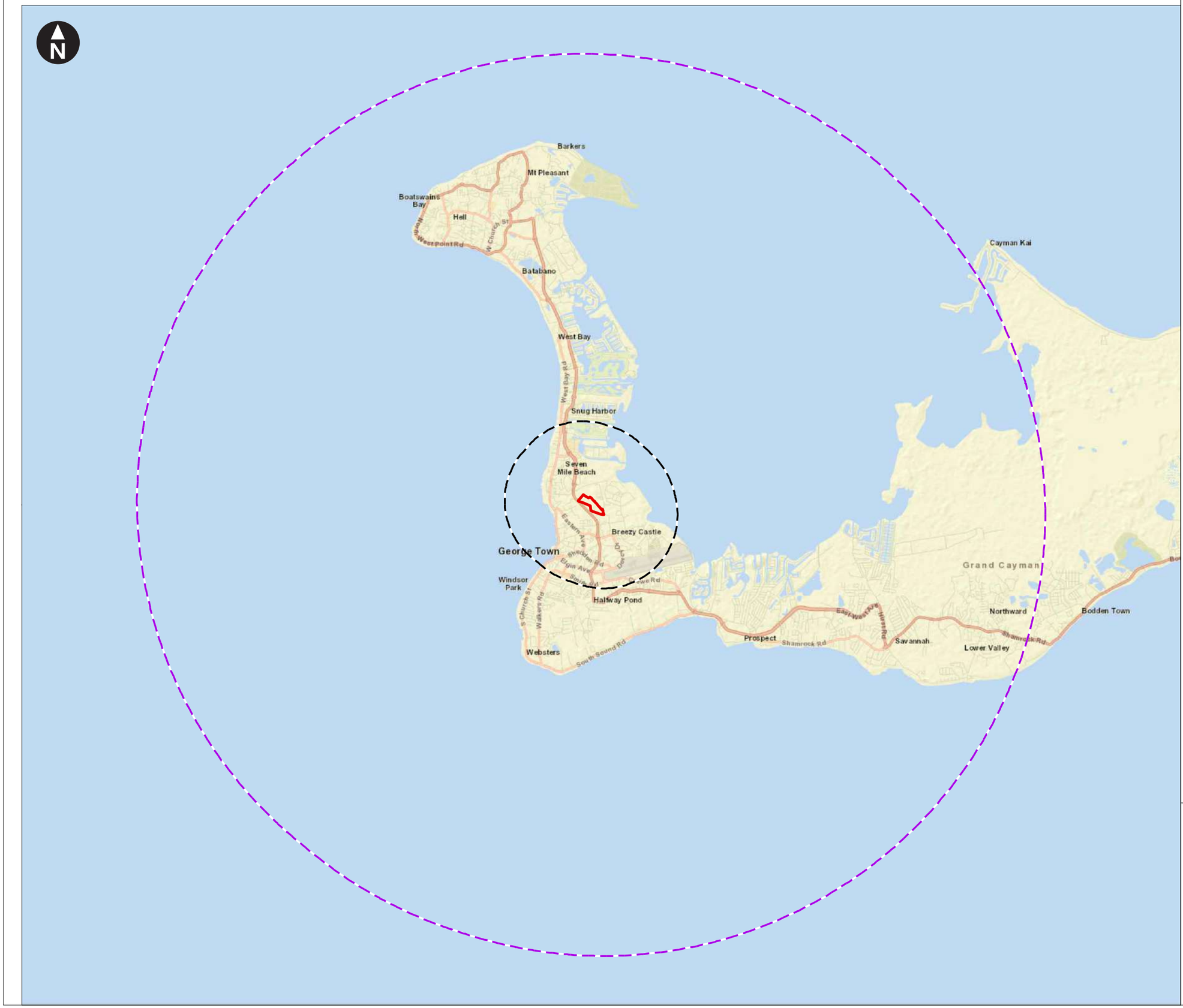

Key

- Site boundary
- Study area for nationally designated sites, habitats and species
- Study area for internationally designated sites

0 1,000 2,000 3,000 4,000 5,000 6,000 m

Scale at A3: 1:100,000

George Town
Integrated Waste Management Solution

Figure 5.1
Study areas for ecology

February 2021

wood.

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Key

Site boundary

Proposed Ramsar Sites

Barkers Wetland

Central Mangrove Wetland, Little Sound, Ponds and associated Marine Zones

0 1,000 2,000 3,000 4,000 m

Scale at A3: 1:80,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

George Town
Integrated Waste Management Solution

Figure 5.2
Environmental context plan

February 2021

wood.

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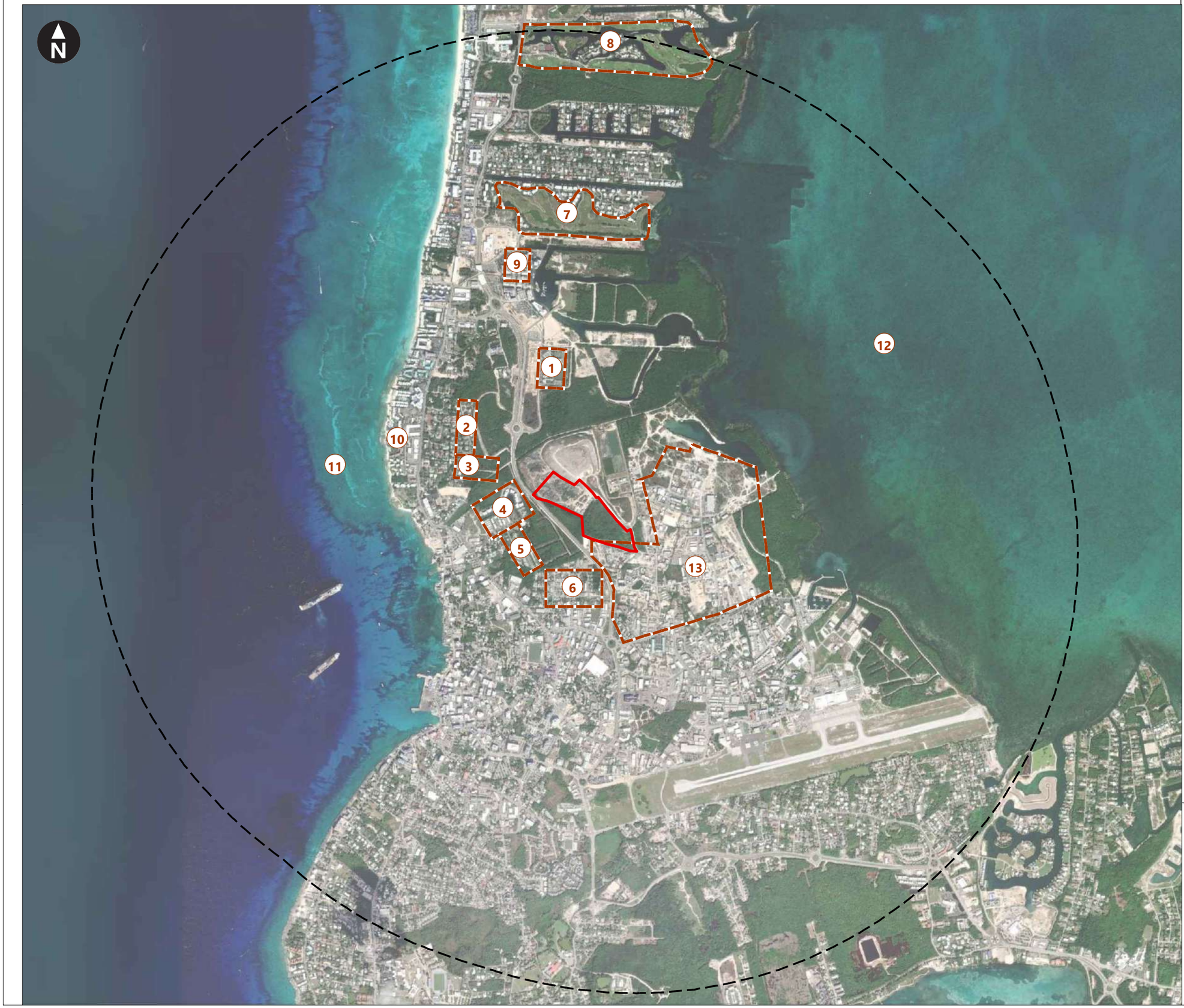

Key

- Site boundary
- Seascape, landscape and visual assessment study area
- Visual receptor group

1. Cayman International School
2. Properties on Parkside Drive
3. Properties on Marbel Drive
4. Lakeside Villas
5. Properties on Spruce Lane
6. Properties on Woodpecker Close, Bushy Avenue and Woodlake Drive
7. Brittania Golf Club
8. Blue Top Golf Club
9. Camana Bay Observation Tower
10. Hotels and Tall Residential Blocks on Seven Mile Beach
11. Cruise Liners anchored off Seven Mile Beach
12. Recreational boats in North Sound
13. Employees in H.I. Zone

0 250 500 750 1,000 1,250 1,500 m

Scale at A3: 1:25,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

George Town
Integrated Waste Management Solution

Figure 5.3
Landscape and visual assessment strudy area

February 2021

wood.

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Key

- Site boundary
- Seascape, landscape and visual assessment study area
- Townscape character area
- Landscape character area
- Seascape character area

A: Industrial and commercial development Townscape Character Area

B: Low height, medium density residential Townscape Character Area

C: Medium height, residential, tourism and commercial Townscape Character Area

D: Relic, semi-natural, low-lying coastal Landscape Character Area

E: Intensively managed recreational Landscape Character Area

F: Lagoon Seascape Character Area

G: Seven Mile Beach Seacape Character Area

0 250 500 750 1,000 1,250 1,500 m

Scale at A3: 1:25,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Integrated Waste Management Solution

Figure 5.4
Seascape, landscape and townscape character areas

February 2021

wood.

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Key

Site boundary

Air quality study area

0 500 1,000 1,500 2,000 m

Scale at A3: 1:40,000

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Figure 5.5
Study area for air quality

February 2021

wood.

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Key

- Site boundary
- Noise sensitive receptor
- Ambient air H2S monitoring station

0 100 200 300 400 m

Scale at A3: 1:8,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan,

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Integrated Waste Management Solution

Figure 5.6
Proposed noise sensitive receptors

March 2021

wood.

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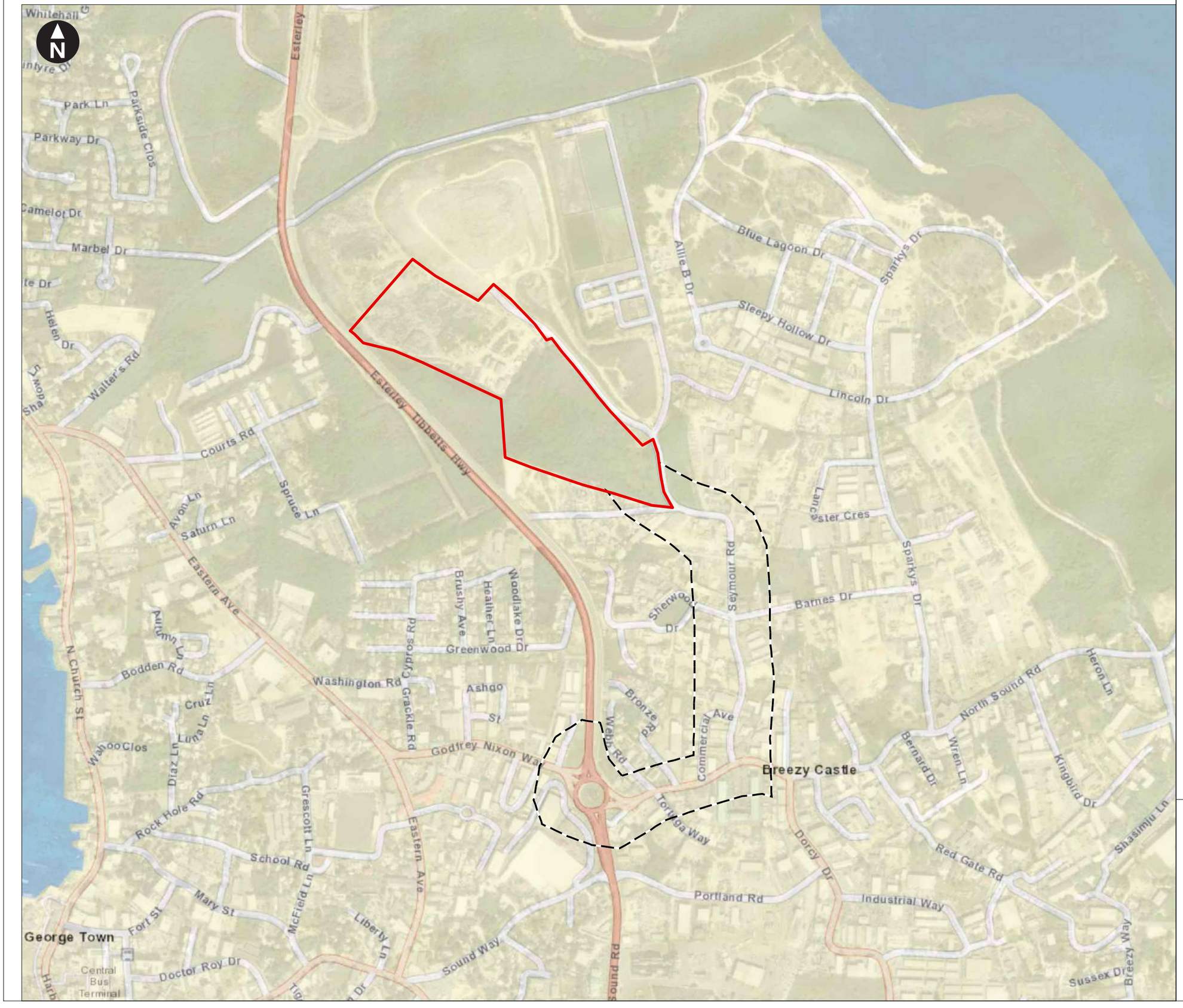

Key

Site boundary

Transport study area

0 100 200 300 400 m

Scale at A3: 1:8,000

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan,

George Town
Integrated Waste Management Solution

Figure 5.7
Study area for transport assessment

February 2021

wood.

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