The Government of Jersey, Infrastructure, Housing and the Environment
Department of the Environment
Howard Davis Farm
Trinity
Jersey
JE3 5JP

Date: 29th November 2023

Dear

Subject: PFAS Hydrogeological Study - Proposed Budget for 2024

Introduction

Following recent discussions between Arcadis Consulting (UK) Ltd (Arcadis) and Government of Jersey (GoJ), please find below a proposed budget for the PFAS Hydrogeological Study (Contract Reference GOJ/2021/307), which covers works planned within 2024.

Progress to Date (2021-2023)

The Arcadis ITT response and proposal (Provision of PFAS Hydrogeological Studies Jersey) and Fixed Activity Schedule detailed the scope and costs for 2021 – 2023 for undertaking the Phase 1 and Phase 2 of the PFAS Hydrogeological studies. The Item/Task (Tasks) described in this budget relate to the Items in the Fixed Activity Schedule provided as part of the Arcadis ITT tender response. In addition, there have been five Variations to the Contract. To date, the current progress has been highlighted is as below:

- Phase 1 – Completed.
- Variation 1 (March 2022)– Reviewing Existing Available Data - Completed
- Variation 2 (March 2023)- Cultural Heritage Desk Based Assessment - Completed
- Variation 3 (June 2023) - Groundwater & Surface Water Monitoring Round 1 (Q1) – Completed
- Variation 4 (September 2023) - Groundwater & Surface Water Monitoring Round 2 (Q2) – Completed
- Variation 5 –Site supervision (November 2024) -To be completed in December 2023.

Contract update and extension

The current contract, GOJ/2021/307, between Arcadis and GoJ automatically expires on Friday 29th December 2023. In line with Clause 50 of the contract, Arcadis gives formal notice of our request to extend the contract term for a further period 1 year until 29th December 2024.

Clause 26 of the contract details the mechanism of how the price can be adjusted upon extension of the contract. In line with the relevant clause, we have proposed that all works completed as part of the extension, including tasks from the original scope, will have the relevant Retail Price Index (RPI) uplift applied. Arcadis has calculated the RPI uplift at based on publicly available information on the Government of Jersey website.

In addition, in line with clause 7.4 of the contract, we also give formal notification of change of address for the Cambridge Office. Our updated

In summary, this proposed updated budget has been based on the following:

1. **Existing tasks to be completed in 2024 (with RPI uplift).** - Tasks from our existing (2021) scope that will be delivered outside of our existing contract term. These tasks will be delivered under a contract extension (to be delivered by 29th December 2024), with an .
2. **Contract Variation and Extension – Additional tasks** - Variation for new tasks outside of our existing 2021 scope and contract term which will be delivered under a contract extension (by 29th December 2024).

Further details have been provided below:

1. Existing tasks to be completed in 2024 (with RPI uplift)

The following tasks that were scoped at Contract stage (2021) are now proposed to be completed in 2024. These tasks will be completed following the Q4 groundwater and surface water monitoring in May 2024. We therefore proposed to extend our contract term to 29th December 2024.

The scope of these tasks remains the same as set out at Contract stage. However, our fee includes RPI uplift based on the change in RPI between June 2021 and November 2023, which we have calculated at

Task 2.8: Hydrogeological CSM Development

A robust CSM is fundamental to supporting future risk-based decision making and will inform any potential modelling approach and design.

The hydrogeological CSM will be presented as a document summarising all pertinent historical and new data relating to the geology, hydrogeology (including anisotropy/heterogeneity), hydrology, potential PFAS sources, spatial assessment and trend analysis, pathway assessment (including natural or manmade preferential pathways) and subsequent assessment and interpretation in terms of potential source-pathway-receptor linkages. A guiding principle is simplicity, that the level of detail should be appropriate to the objectives, availability of data and complexity of the system.

The CSM will build on the significant knowledge already present for both catchment systems and will also include definition of the hydrogeological domains and system components to make simplifying assumptions for quantitative modelling (subsequent task). Where possible using existing data, it will include defining boundaries and stresses – their geometry, how they change over time. For solute boundaries this should include volumetric flow rates and mass loadings. Recharge is a boundary process as are dry areas and the base of the system. The interaction of groundwater with surface water will be defined and quantified empirically where possible. Catchment specific recharge rates can be calculated using a monte-carlo analytical method called Aquimod, provided by the BGS. Following completion of the CSM, a recommendation as to requirement for modelling, and form of modelling, will be made for agreement with GoJ before progressing to the Task below.

Task 2.9 Waste guidance

Informed by the results of the risk assessment and soil leaching model, the review of PFAS standards and extensive experience dealing with UK landfill operators, Arcadis will liaise with the Department of Environment Waste Licensing team to determine appropriate action levels

for landfill disposal and development with the plume area. Soil leaching and contribution to the groundwater plume will be a key driver for source area soils, soils outside the source area are unlikely to contain significant concentrations. POPs waste and WM3 Haz/Non Haz classifications are unlikely to drive PFAS disposal. Action levels will be pragmatic and robust reflecting cost / benefit and treatment processes (or lack of) at the receiving facility.

Task 2.10: Risk Assessment

Numerical modelling

Until the CSM is complete, the best modelling approach – if needed – cannot be defined with certainty. Therefore, we will commence with a relatively simple numerical modelling approach based on the available information. The approach comprises the use of the 1D groundwater + fate & transport model, ConSim, to simulate indicator PFAS transport in the aquifer for both catchments, with the relevant outputs them combined with our bespoke hydrological (stream & reservoir) modelling approach, CALM. This allows a simple assessment of the key inputs for PFAS into the catchment system, including for “sinks” such as streams which then play a key role in transport of PFAS towards sensitive receptors.

ConSim is a probabilistic model, which allows for multiple source terms to be assessed over time, to understand plume evolution – as well as simple scenario modelling. The model RTW may also be employed, if necessary, for the purposes of soil source term determination (leaching) informed by airport investigation works. The most relevant / conservative 3 PFAS indicator compounds would be modelled, assumed to be PFOS, 1 short chain PFAS (e.g., PFHxA or PFBA) and 1 additional precursor compound (e.g., cationic PFHxSaAm from 3M lightwater).

The model development will be documented, including the rationale for selection & sensitivity analysis undertaken on key parameters. Where the data allows, the models will be validated based on empirical data to simulate current PFAS plumes and streams quality. Up to 3 relatively simply future scenarios (e.g., increased rainfall / climate change, increased abstraction rates from streams / boreholes and increased storage in reservoirs, source remediation) have been allowed for in the modelling costs, to be agreed with GOJ based on results and aligned with JW 25 year plan.

Risk Assessment

A Site specific risk assessment will be undertaken, building on the results of the CSM and the numerical modelling outputs. Based on the source-pathway-receptor linkage concept, the risk assessment will provide context as to the potential significance of the status quo – as well as the modelled scenarios. Each scenario will include comparison to 3 different trigger levels informed by Phase 1 e.g., DWI 2021 guidelines, EU WFD and one other threshold / standard (e.g. EQS or empirically derived alternative EQS if feasible). Thresholds will be discussed and justified in context of Jersey. The report will also include qualitative discussion of implication to receptor type and sensitivity (e.g., drinking water, versus irrigation BH) and likelihood of risks being released – water supply, use, regulatory trajectories etc, sand pit development, as well as a mass flux assessment (if appropriate) of the indicator PFAS to the sea from groundwater and surface water.

Task 2.11 Recommendations & Final ROA

Assessment of remediation options will focus on relevant SPR linkages where potentially significant risk are identified, including modelled future scenarios. Any strategy would identify the most effective and pragmatic way to safeguard human health and water supplies. Typical approaches to managing risks from large PFAS plumes include soil source remediation, groundwater or surface water interception and treatment prior to off-site migration, drainage improvements or drinking water treatment (at households or water treatment plants (link with WRc review)). It is rare that large scale plume remediation is undertaken but targeted, flux

based options will be reviewed. Technical, operational, commercial and sustainability factors will be systematically ranked and scored against agreed weightings reflecting GoJ priorities. This will provide a clear and defensible rationale to support decision making.

Task 3.3. Provision of GIS data to allow GoJ to upload to ArcGIS.

Following completion of Q4 Monitoring (May 2024), we propose to provide one set of GIS data to GoJ containing data from all four monitoring rounds.

Summary of existing tasks to be completed in 2024 with RPI uplift

Our proposed fee for the above tasks remains as per our ITT response, with the addition of the . An extract from the Pricing Activity schedule is provided below.

Table 1 – Summary of proposed fees for 2024 Contract extension (including 6.6% RPI Uplift)

Item	Description	uantu	Fee in existing contract (2021)	Previously Invoiced (upto November 2023)		Proposed fee for 2024 - including RPI uplift (6.6%)	
				Quantum	Total	Quantum	Proposed fee
	Phase 2						
	Client Requirements*						
2.1	Assessment of the plume(s) in movement and spatial extent, comparison to the trigger levels	1	Included in 2.11			1	Included in 2.11
2.2	Assessment on the water quality over time	1	Included in 2.11			1	Included in 2.11
2.3	Assessment of the plumes in relation to chemistry, breakdown methods,	1	Included in 2.11			1	Included in 2.11
2.4	Assessment of the plumes in relation to abstraction, St Ouen's Pond, Simon Sand, etc	1	Included in 2.11			1	Included in 2.11
2.5	Impact on biota assessments	1	Included in 2.11			1	Included in 2.11
2.6	Rainwater assessments	1					
2.7	Household treatment systems review	1					
2.8	CSM	1		0%	£ -	1	
2.9	Soil/Waste guidance levels	1		0%	£ -	1	
2.10	Risk Assessment	1		0%	£ -	1	
2.11	Recommendations	1		0%	£ -	1	
	Contract / Data Management						
	Client Requirements*						
3.3	Provision of Data to allow GoJ to upload to ArcGIS	5		1.00		1.00	
						Total	

2. Contract Variation 6 and extension – additional tasks

The following tasks are a variation to the original scope set out in the contract (GOJ/2021/307) which are proposed to be undertaken outside the original contract term (i.e., after 31st December 2023). This forms an extension to the existing contract by one year to 29th December 2024.

Task 6.1 – Task Monthly GoJ / Arcadis project steering group meetings, provision of meeting minutes and completion of relevant actions.

The project team ( ) will attend 1 hourly project steering group meetings to update GoJ on the progress of the project, present interim findings and outputs from key deliverables, resolve issues and assign actions. We will provide meeting minutes with actions for GoJ/ Arcadis every month during 2024.

Task 6.2 & 6.3 - Q3 and Q4 Groundwater and Surface Water Monitoring

We propose to undertake the third (Q3) and fourth (Q4) round of groundwater and surface water monitoring in January and April/May 2024 respectively.

Scope of Works

To provide GoJ with support for the third and fourth rounds of monitoring, Arcadis propose to the following scope of works/Tasks:

Health & Safety Planning and Project Planning/Data Management

The monitoring works will be undertaken in line with the PFAS sampling protocols developed by Arcadis to minimise data quality issues. For the Q3/Q4 sampling works, Arcadis will update the existing Health and Safety Plan, taking into consideration any changes to scope / conditions and the potential risks associated with the works and how to mitigate appropriately. The team includes specialists with experience working in comparable environments, who would help to support the planning and implementation of this project. Specific measures for this project, which involves working on and adjacent to water courses, would include additional PPE (Life Jackets), preceding weather and river flow assessment, safe access checks (each location and each visit) and avoidance of lone working. Arcadis will submit all H&S documentation to GoJ prior to the works being carried out.

Groundwater Sampling & Provision of Field Support to GoJ

The works will be undertaken by an experienced Arcadis consultant and will include the monitoring and in-field refresher training / support to GoJ on groundwater monitoring and sampling. It is anticipated that our consultant will be the same person who was present during the Q1 and Q2 sampling, however we reserve the right to vary the resources should the situation require.

The proposed sampling dates (and Arcadis Consultant) for Q3/ Q4 are as follows:

Q3 – January 2024

- Week 1: Monday 8th – Friday 12th January 2024
- Week 2: Monday 15th to Friday 19th January 2024

This comprises 10 working days (Monday 8th – Friday 19th January) .

It is anticipated that therefore accommodation/subsistence costs will be incurred over the full 14 days of stay.

Q4 – April/ May 2024

- Week 1: Monday 22nd – Friday 26th April 2024

- Week 2: Monday 29th April to Friday 3rd May 2024.

This comprises 10 working days, plus 2 days travel time. Accommodation/subsistence costs will be incurred over the full duration of stay.

Methodology

The Q3/Q4 monitoring programme will aim to sample three groundwater sites per day to allow additional time for preparation (of equipment, sample containers and sample dispatch etc.) at the beginning/ end of each day.

The proposed groundwater monitoring methodology is as follows:

- Prior to sampling groundwater at each location, depth to groundwater, depth to base, visual/ olfactory evidence of contamination, well condition, diameter and presence of existing monitoring infrastructure will be recorded for each monitoring well location.
- January 2024 (Q3): Collection of groundwater samples at up to 30 locations. This includes the 29 locations monitored during Q1 and Q2, plus ARC003 which is proposed to be drilled in December 2023.
- April/May 2024 (Q4): collection of groundwater samples at up to 34 locations. This includes the 30 locations monitored during Q1, Q2 and Q3, plus four additional holes (ARC001, ARC002, ARC004 and ARC005) which are proposed to be drilled in February/ March 2024 (exact dates tbc).
- Collection of 8 Quality Control/ Quality Assurance samples (QA/QC). This includes the 6 QA/QC samples collected in Q2, plus two additional QA/QC samples to test for potential impacts to the data from sample tubing.
- Wherever possible, groundwater will be sampled using low flow sampling techniques (peristaltic pumps or bladder pumps). This will be possibly in the majority of locations except where the well condition/ diameter requires the use of submersible pumps, Wattera tubing or disposable bailers.
- Dedicated, disposable sampling tubing and equipment will be used for low flow sampling. Tubing will be changed where practical to do so. In some locations where tubing is stuck or difficult to install, tubing will remain in situ over the monitoring period. Equipment such as bladder pumps will be decontaminated after use, before being used on the next location.
- To retrieve groundwater samples, hydrogeochemical parameters (including pH, conductivity, temperature, salinity, redox, total dissolved solids, and dissolved oxygen) will be measured using a multi parameter probe during low flow purging. This will continue until such a time as the field parameters stabilise indicating that the water in the monitoring well is now representative of that within the ground.
- Arcadis will carry out the sampling based on PFAS-specific protocols which are critical to ensure the highest sample and data quality.
- The requirement for development / desilting of existing monitoring wells was assessed during Q1 and this was decided not to be necessary going forward. It is understood that if required, desilting of the 5 new boreholes will be undertaken by the drilling contractor and will not be undertaken during the Q3 sampling run.
- Rising head tests will be undertaken in 3 (or 4, if time allows) groundwater boreholes during Q3 to determine aquifer permeability data that is needed for the numerical modelling. Rising head tests in 4 additional locations (new boreholes) will be completed in Q4 (April/May 2024). Further details are provided below
- Passive samplers will be installed in 7 Stream/ Surface water locations in Q3 and 7 groundwater locations in Q4. The passive samplers will provide a longer term indication of PFOS/PFAS concentrations and confirm that the quarterly snapshots of data collected are consistent over a longer period of time. Further information is provided below.

- Samples will be transported in dedicated sample boxes provided by the laboratory. Sample details will be recorded on the laboratory chain of custody form, prior to dispatching to an UKAS and MCertS accredited laboratory for analysis.
- All data will be collected in Fulcrum and managed electronically to enable incorporation within the existing Arcadis EsDAT database and GIS model. We have included additional time in the budget for processing field and laboratory data and providing this to GoJ.

Surface Water Sampling & Flow Monitoring

Arcadis will provide assistance to GoJ in undertaking Stream flow monitoring and sampling as required, as part of the sampling team. It is understood that training in undertaking stream flow sampling/ monitoring is not required, however we will provide our expertise and full Standard Operating Procedures (SOPs), including H&S documentation prior to the works. These protocols include sampling to avoid the air:water interface (where PFAS accumulate), PFAS-free sampling equipment, PPE and container materials, PFAS-free plastic sampling containers (not glass which can sorb PFAS) and the avoidance of cross contamination through dedicated sampling equipment and decontamination of non-dedicated equipment with PFAS-free cleaning solutions. The Sampling method will be dependent on location and safe access and is expected to be via dedicated tubing and/or direct sampling methods including the use of extendable poles. Surface water samples will be collected minimising sediment disturbance which may affect sample quality.

Laboratory Analysis

Samples will be transported in dedicated sample boxes provided by the laboratory. Sample details will be recorded on the laboratory chain of custody form, prior to dispatch to the laboratory for analysis.

All samples will be submitted to ALS Environmental Ltd, a UKAS and McertS accredited laboratory and Arcadis approved provider. A summary of the estimated Laboratory Analysis has been provided below for indicative purposes. This is subject to change and will be revised based on the number of samples collected each round (for example, if a borehole is dry, no sample would be collected).

A summary of the proposed chemical testing suites (including QA/QC samples) and breakdown of costs for Q3/Q4 is provided in Tables 2 & 3 below. This has been based on the analysis undertaken for Q2 for indicative purposes. We will review the previous Q2 and Q3 data to inform the actual analytical scope prior to each subsequent monitoring round

It should be noted that the total number of samples will increase in Q3/Q4 (compared to Q1 and Q2). This is because in Q3, it is proposed to sample from the additional borehole ARC003 that will be drilled in December 2023. In Q4, it is proposed to sample from the additional 4 boreholes (ARC001, ARC002, ARC004 and ARC005) that will be drilled in February/ March 2024), plus ARC003.

Table 2 – Summary of estimated analysis costs for Q3 (January 2024)

Analysis	Rate per sample	Number of analyses for Groundwater & Surface water	Estimated cost for Q3
PFAS Standard Suite		38	
Water Quality Suite*		37	

Analysis	Rate per sample	Number of analyses for Groundwater & Surface water	Estimated cost for Q3
Top Assay		21	
TPH CWG		4	
PFAS Standard Suite (QA/QC samples only)		10	
Sample disposal		70	
Metals prep		37	
Shipment of sample containers to Jesey (Q3 only)	-	-	
Total Q3			

***Water Quality Suite includes:** Alkalinity (Bicarbonate), Alkalinity (Total), Calcium, Chloride, Dissolved Organic Carbon, Iron Filtered, Magnesium Filtered, Potassium Filtered, Sodium Filtered, Sulphate Soluble, Total Suspended Solids.
** Estimate only. Actual courier fee based on volumetric weight. Shipment of containers will be charged at cost.

Table 3 – Summary of estimated analysis costs for Q4 (April/May 2024)

Analysis	Rate per sample	Number of analyses for Groundwater & Surface wate	Estimated cost for Q4
PFAS Standard Suite		37	
Water Quality Suite*		41	
Top Assay		25	
TPH CWG		4	
PFAS Standard Suite (QA/QC samples only)		10	
Sample disposal		74	
Metals prep		41	
Total Q4			

***Water Quality Suite includes:** Alkalinity (Bicarbonate), Alkalinity (Total), Calcium, Chloride, Dissolved Organic Carbon, Iron Filtered, Magnesium Filtered, Potassium Filtered, Sodium Filtered, Sulphate Soluble, Total Suspended Solids.

Note: Lab rates may increase for Q4 for analysis undertaken after April 2024. Any lab fee increased will be passed to GoJ.

Rising Head Tests

Rising head tests using automatic water level / pressure loggers (data loggers) will be undertaken in 3 boreholes (or up to 4 if time allows), to assess the aquifer hydraulic conductivity in that location. This will generate site-specific parameters for use within subsequent numerical modelling and risk assessment. The following locations are proposed for rising head tests in Q3:

- 61 (FTA Source well, shale)
- 52 (mid plume, shale)
- WR4162 (mid plume, blown sands)
- 1509 (potential option to be completed if time allows)

In addition, the following rising head tests will be undertaken in April/May 2024 (after the new boreholes are drilled in Feb / March 2024)

- ARC001 (proposed Arcadis borehole within blown sands near drinking water abstraction)
- ARC002 (proposed Arcadis borehole within shale near drinking water abstraction)
- ARC004 (proposed Arcadis borehole within shale, near source)
- ARC005 (proposed Arcadis borehole within blown sands, near source)

To undertake a rising head test, an automatic data logger is first lowered into the well to a designated depth below the water table and secured in place. A bailer or 'solid slug' is then lowered into the borehole to remove or displace a 'slug' of water. The groundwater recharge rate back into the well is then measured using the data logger. A dip tape will also be used to manually check the progress of aquifer recharge in real time. Once the groundwater has returned to pre-test levels, the test is completed. The data logger is removed, and data will be downloaded for interpretation, post monitoring.
A dedicated bailer will be used per each location any solid slugs will be decontaminated. Water removed from the borehole will be collected within purge water containers and disposed of within GoJ provided IBCs. The rising head tests are anticipated to take approximately 1 hour per location.

Task 6.4 - Passive PFAS Samplers

PFAS passive samplers are proposed to be installed within 7 groundwater and 8 surface water locations (including airport stormwater outfalls) to provide a longer term measurement of PFAS concentrations and inform mass flux. This data will be used to confirm that the quarterly data is representative of groundwater surface water conditions over a longer period of time.

It is proposed to deploy Sentinel™ Passive Samplers which have been developed through a partnership between Arcadis and The College of Wooster (USA). Sentinel™ Passive Samplers use an organosilica sorbent media, Osorb®, to sorb PFAS over a desired timeframe. Over 200 samplers have been deployed in groundwater, surface water, and sediment, and the results of detailed laboratory validation and field testing are presented in Appendix A. A key advantage of these samplers is that they are small and can be flexibly deployed within outfalls, small streams and groundwater monitoring wells which are all relevant for the project.

Sentinel™ PFAS passive samplers are single use passive sampler which are used to detect long term PFAS concentrations. They will provide a time weighted average of contamination levels which is especially valuable in monitoring low levels of concentrations and/or within

variable flow regimes. The Sentinel™ samplers comprise a 2.5 cm by 4.5 cm by 2mm 'body' comprising an adsorbent media which is designed to sorb and retain PFAS molecules and can achieve accurate and precise measurement of short and long chain PFAS, at concentrations ranging from low nanograms per litre (ng/L) to high micrograms per litre (µg/L). Further information is provided in Appendix A.

In addition, iFlux™ cartridges will be deployed in two groundwater locations in Q4 (likely 61 and ARC001). Two cartridges per location will be deployed, to measure groundwater mass flux and PFAS concentrations. iFlux™ cartridges contain pre-processed sorbents that capture PFAS to determine contaminant flux through adsorption and recovery processes as well as inorganic tracer cartridges to assess groundwater flux. These cartridges can only be deployed within groundwater wells not in surface water locations.

The locations have been carefully selected to target source, pathway and receptor areas at locations in which the existing well construction / stream condition will allow the use of passive samplers. Groundwater locations with the presence of existing pumps / infrastructure have been excluded. Stream locations with inadequate flow have also been excluded.

Table 4 – Proposed Passive sampler locations

Proposed locations	Passive sampling technique	Note/ potential deployment
Q3 Monitoring Round (January 2024)		
2016	Sentinel™ Passive Sampler	East Outfall
2020	Sentinel™ Passive Sampler	St Peters Culvert
SE Outfall	Sentinel™ Passive Sampler	
S Outfall	Sentinel™ Passive Sampler	South Outfall
ARC011	Sentinel™ Passive Sampler	Near SW abstraction. Install before sluice gate
SSW Outfall or ARC007	Sentinel™ Passive Sampler	If unable to accurately measure flow at SSW outfall, then could swap for Arc007, immediately downstream
N Outfall	Sentinel™ Passive Sampler	Deploy by granite gate post.
2003B	Sentinel™ Passive Sampler	Deploy by granite gatepost & wooden bridge
Q4 Monitoring Round (April/May 2024)		
61	Sentinel™ Passive Sampler and iFlux™ cartridges	FTA Source well (150mm diameter) Existing pump will need to be removed
52	Sentinel™ Passive Sampler	Mid plume, shale (125mm diameter)
WR4162	Sentinel™ Passive Sampler	Mid plume, blown sands (49mm inner diameter)
ARC001	Sentinel™ Passive Sampler and iFlux™ cartridges	Proposed Arcadis BH within blown sands near drinking water abstraction (50mm inner diameter)
ARC002	Sentinel™ Passive Sampler	Proposed Arcadis BH within shale near drinking water abstraction (50mm inner diameter)
ARC004	Sentinel™ Passive Sampler	Proposed Arcadis BH within shale, near source (50mm inner diameter)
ARC005	Sentinel™ Passive Sampler	Proposed Arcadis BH within blown sands, near source (50mm inner diameter)

Deployment

For the surface water locations, the Sentinel™ passive samplers will be deployed using weights and/ or cable ties and simply dropped into their respective locations or fixed in place. For the groundwater locations, the Sentinel™ and iFlux™ samplers will be weighted and hung at specific pre- determined depths (aligned to low flow groundwater sampling depths) within the wells and secured in place to the well cap or casing.

The passive samplers will be installed in the locations shown above by Arcadis during the relevant Q3 / Q4 monitoring rounds, and left in situ for approximately 1 to 2 weeks, when they will be retrieved by GoJ and shipped to the analytical laboratory for analysis.

QA/QC

The following QA/QC samples will be undertaken:

- 1 Duplicate sample per monitoring round. This will comprise installing two Sentinel™ passive samplers in the same location. The duplicate passive sampler will be tested for comparison with the 'actual' sample.
- 1 Trip Blank per monitoring round. A Sentinel™ sampler will be obtained and kept within its packaging (i.e. not deployed in a stream or groundwater location) over the monitoring period. This will be sent to the laboratory for analysis along with the other samples for analysis.

Estimate for Sentinel™ samples

The Sentinel™ samples will be sent to ALS laboratory for analysis. The equipment and analytical suite and costs are provided below.

Table 5 – Estimated equipment and laboratory analytical costs for Sentinel™ Samplers

Analysis / Equipment	Rate per sample	Number of analyses for Groundwater & Surface water	Estimated cost
Sentinel™ samplers			
PFAS Standard Suite		15 (7 groundwater and 8 surface water locations)	
PFAS Standard Suite (QA/QC samples)		4 (2 QAQC samples per round)	
Sample disposal		19	
Shipment of sample containers to Jesey (Q3 only)*	-	-	
Sentinel™ sampler devices/ equipment**		14	
Delivery of equipment from USA to Jersey***	-	-	
Total			

* Shipment of sample containers to Jesey (Q3 only). Containers for April/May 2024 monitoring (Q4) will be brought over in the Arcadis van in January 2024 to avoid shipment costs.
** Cost for the Sentinel™ samplers includes the device, attachment equipment and steel weights.
*** Delivery costs have been estimated and will be charged at cost.

Estimated costs for iFlux™ samplers

The iFlux™ cartridges are priced from the supplier on a flat rate basis which includes for design, data analysis and reporting, plus PFAS sorbent cartridge and waterflux cartridge (which includes their analysis). Therefore, we estimate

that costs associated with deployment of two iFlux™ cartridges would be up . The iFlux™ cartridges will be shipped to the iFlux Europe lab for analysis.

Note: Following the analysis of data from the Q3 monitoring, the deployment of IFlux™ samplers may not be considered to be necessary, and therefore will not be deployed. In this case, costs would not be incurred.

Table 6 - Estimated equipment and laboratory analytical costs for IFlux™ Samplers

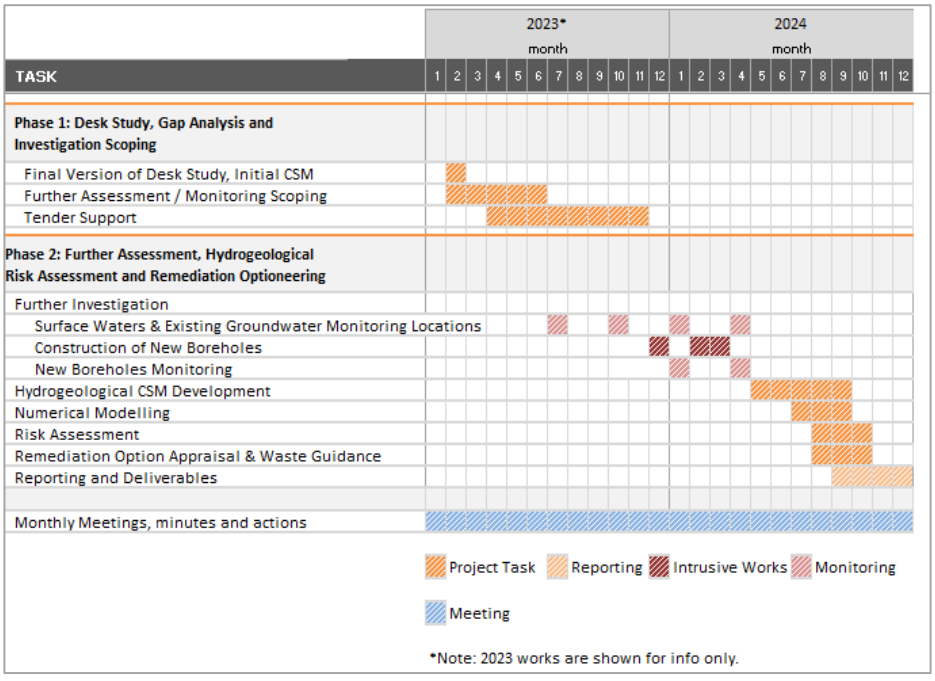
Analysis / Equipment	Rate per sample	Number of analyses for Groundwater & Surface water	Estimated cost
IFlux™ Cartridges			
IFlux™ cartridges (includes the equipment, deployment and analysis)*		2	
iFlux™ project design, data interpretation and reporting (flat rate)		1	
Courier costs for shipping samples to IFlux Europe**		1	
Total			

* This is an estimated costs for information purposes. The actual cost will be charged to GoJ at cost.
** Delivery costs have been estimated and will be charged at cost.

Data processing and analysis of passive sampler data
We have included additional labour costs associated with processing the passive sampler data and including it within our modelling and associated CSM assessment and reporting.

Programme

Our proposed programme is provided below:



Summary of contract variation fees 2024

Table 7 – Summary of proposed costs for 2024 Contract Variation (additional tasks)

Task number	Task description	Proposed fee
6.1	Monthly Arcadis/ GoJ project update meetings, minutes and actions (X 12)	
6.2	**Groundwater/ Surface water monitoring Q3 – January 2024**	
	Labour including monitoring works (based on 10 hour day), travel time, update to H&S documentation, planning, project management, demobilisation and data processing/ presentation	
	Estimate for travel/ accommodation and subsistence expenses	
	Equipment hire (groundwater and surface water, including rising head tests)	
	Estimated laboratory analysis costs	
	Sub total task 6.2	
6.3	**Groundwater/ Surface water monitoring Q4 – April/May 2024**	
	Labour* including monitoring works (based on 10 hour day), travel time, update to H&S documentation, planning, project management, demobilisation and data processing/ presentation	
	Estimate for travel/ accommodation and subsistence expenses	
	Equipment hire (groundwater and surface water, including rising head tests)	
	Estimated laboratory analysis costs	
	Sub total task 6.3	
6.4	**Passive samplers**	
	Sentinel™ samplers (including equipment, deployment, lab analysis, shipping cost estimate	
	IFlux™ samplers (including equipment, deployment, lab analysis, data analysis and reporting)	
	Labour costs associated with additional data interpretation, modelling and reporting	
	Sub total task 6.4	
	Total Task 6	

*Note our hourly rate increase for post April 2024 has been included.

Fee Summary

Arcadis proposes to complete the requested scope of work outlined above for a fee of This includes labour, site equipment and an allowance for expenses and laboratory analysis. All costs quoted exclude VAT. A breakdown of the costs has been summarised below:

Contract task description	Proposed fee
Tasks (2.8, 2.9, 2.10, 2.11 and 3.3) from our existing (2021) scope that will be delivered under a contract extension (by 29th December 2024), with an RPI uplift of	
Variation for new tasks (6.1, 6.2, 6.3 and 6.4) outside of our existing 2021 scope which will be delivered under a contract extension (by 29th December 2024).	
Total proposed budget for 2024	

Assumptions

The fees provided by Arcadis for completion of the scope of works detailed above have been based on the following assumptions:

- Laboratory analysis costs may increase for Q4 (for analysis undertaken on or after 1st April 2024). Any lab fee increases will be passed on to GoJ.
- All costs provided for travel, accommodation and subsistence are estimated costs at the time of writing. We will charge GoJ the actual costs upon completion of each associated task(s). We will provide a breakdown the actual costs in our invoice.
- Achieving any access agreements to locations (including Jersey airport) and communications with landowners regarding access during the works would be the responsibility of GoJ.
- Standard laboratory turnaround times for the PFAS suites are 10 working days from receipt of samples. Expedited laboratory results can be sought at increased cost.
- Any purge groundwater will be collected in an IBC provided by GoJ and disposal (and associated costs) will be the responsibility of GoJ.
- The fee is provided on the basis of working hours being Monday to Friday 0800- 1800 (excluding bank holidays), except where stated. Should a requirement to complete works outside of these hours be identified then additional costs may apply.
- Shipping of samples to the analytical laboratory has not been included in the costings. We have included an estimation of costs for shipping of empty containers to Jersey for Q3 monitoring. Containers for Q4 monitoring round will be brought over in the Arcadis Van in January. Delivery of any additional containers will be charged at cost.

We hope that you are satisfied with the level of service, experience and value that Arcadis has brought to this commission. If this budget and scope does not fit with the expectations of the GoJ, then Arcadis would be happy to assist GoJ in amending the scope to meet the GoJ expected requirements.

Yours sincerely

Appendix A – Sentinel™ Passive Sampler information Sheet

Sentinel™ Passive Sampler for PFAS

A cost-saving, resilient option

The Sentinel™ Passive Sampler reduces monitoring costs by decreasing sample collection time, sample volume and shipping costs.

- **Accurate, low-cost, PFAS passive sampler** for aqueous systems, including groundwater, surface water, and stormwater
- Designed for **rapid uptake** using an Osorb®-based adsorbent modified for optimal PFAS adsorption
- **Small** (2.5 cm x 4.5 cm x .2 mm) and **durable** (HDPE) sampler body
- Measures a **wide range of PFAS analytes**

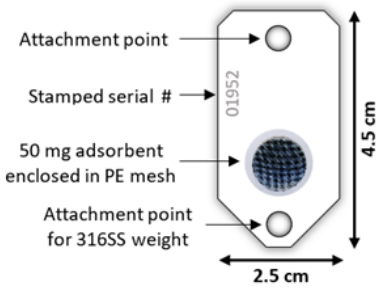
Passive sampling tends to reduce time spent in the field and reduces the volume of investigation derived waste, providing health and safety and sustainability benefits, as well as cost savings. The small size of the Sentinel™ passive sampler further reduces sample shipping weight, which saves cost and reduces the carbon footprint.

The Sentinel™ passive sampler is designed to be flexible, for use in a variety of water types and range of PFAS concentrations, from low ng/L to high µg/L levels. A successful pore water passive sampler for PFAS will also allow measurement of the freely dissolved PFAS concentration in sediment. Measurement of this fraction will improve decision-making for site investigation, risk assessment and remediation, focusing on the bioavailable fraction of PFAS in sediment.

- Flexible deployment times, from <1 day to >4 weeks
- Can reliably measure concentrations of a 6+ order of magnitude range
- Highly repeatable
- Largely insensitive to water ionic strength, pH, and TOC
- Inexpensive to manufacture
- Analytical steps are straightforward and compatible with conventional methods at commercial laboratories

Advantages Over Alternatives

The device's small size with high durability allows for easy installation and shipping, lowering costs.
Its consistent and fast uptake rates show applicability to a wide range of environmental water types.
The integrative sampling nature is useful for providing concentration values that are time-averaged.
The Sentinel™ uses isotopically labeled surrogates for QA/QC evaluation.

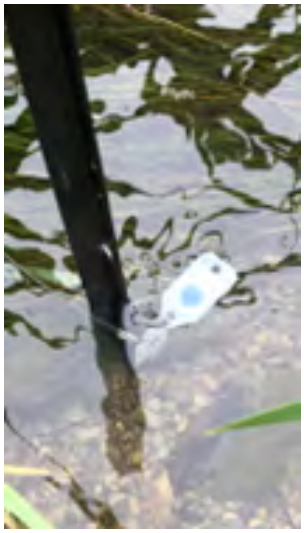


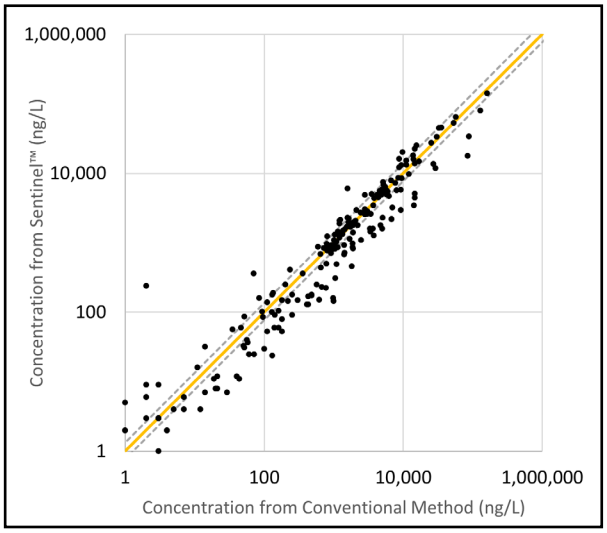
About Arcadis

Arcadis is the world's leading company delivering sustainable design, engineering and consultancy solutions for natural and built assets. Our focus is on maximizing our impact in support of our mission to improve quality of life. Harnessing the power of technology and data, we develop solutions to address important societal challenges faced in resilience, places, mobility and intelligence. We are more than 36,000 people, active across 70 countries. We support UN-Habitat with knowledge and expertise to improve the quality of life in rapidly growing cities around the world.

.

www.arcadis.com





The Sentinel™ passive sampler body is constructed of either high-density polyethylene (HDPE; for water sampling) or stainless steel (for sediment porewater sampling) with a 1-cm through-hole (shown on previous page). Adsorbent (60 mg) is placed between mesh screens. The adsorbent is an organosilica Osorb® resin modified with cross-linked amine polymer and copper ion. The adsorbent is pre-wetted with glycerol allowing the samplers to be placed in the environmental water without any pre-treatment steps. The samplers have two 0.635-cm (1/4-in) attachment points and are sized and tapered at one end to fit into a standard 50 mL centrifuge tube, allowing minimal handling during sample collection, transport, and analysis. If removal of the adsorbent resin is needed, the mesh windows can readily be removed. Passive sampler uptake rates are relatively constant, even under condition of extreme ionic strength and natural organic matter concentrations, indicating potential applicability to a wide range of environmental water types (Hartmann et al. 2021). Over 200 samplers have been deployed in groundwater, surface water, and sediment, and the results of detailed laboratory validation and field testing are presented in Edmiston et al. (2023a, b).

Additional Resources

Commercially available www.aquanexusa.com

Publications

Edmiston, Hill, Hershberger, Hartmann, Carter, Divine, 2023a. Laboratory validation of an integrative passive sampler for per- and polyfluoroalkyl substances in water. Env. Sci.: Wat. Res. Tech. doi: 10.1039/d3ew00047h

Edmiston, Carter, Toth, Hershberger, Hill, Versluis, Hollinden, Divine, 2023b. Field Evaluation of the Sentinel™ Integrative Passive Sampler for the Measurement of Perfluoroalkyl and Polyfluoroalkyl Substances in Water Using a Modified Organosilica Adsorbent. GWMR, doi: 10.1111/gwmr.12574

Hartmann, Hefner, Carter, Liles, Divine, Edmiston, 2021. Passive Sampler Designed for PFAS Using Polymer-Modified Organosilica Adsorbent. AWWA Water Science, 3(4) doi.org/10.1002/aws2.1237.

Contact us

E

E

Kevin Toth
Staff Scientist
E Kevin.Toth@arcadis.com

Arcadis. Improving quality of life

Connect with us

@ArcadisGlobal Arcadis @ArcadisGlobal @ArcadisGlobal