

## **Appendix 1: Product Descriptions**

### **Product 1: Skeletal sub-sample**

- Purpose: identifies the individuals whose remains will be sampled for isotope and trace element analysed. Required before initiation of sample analysis at Stage 2.
- Composition: Dataset of human remains for analysis
- Derived from: Consultation of osteological assessment and DDT records from the HIA project and physical access to skeletal dataset.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Project Team meeting to review selected sub-sample. Quality will be assessed against required skeletal elements and preservation criteria outlined in the methods statement, and guidance given in Mays *et al.* (2023).
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive and Project Board
- Planned completion date: 2026 (after HIA project closure)

### **Product 2: Raw Isotope Dataset**

- Purpose: Provides raw measurements from isotope and trace element analysed to be interpreted at Stage 3.
- Composition: Dataset of values from carbon, nitrogen, strontium, oxygen, and lead isotope analysis and trace element analysis.
- Derived from: Sample preparation undertaken by AIPRL and analysis at internal and external laboratories at Stage 2.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Isotope and trace element analyses are carried out in line with recognised standard procedures (e.g. O'Connell *et al.* 2001; Font *et al.* 2008) and resulting measurements are compared against international standards and quality criteria (e.g. DeNiro 1985; van Klinken 1999).
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive
- Planned completion date: early 2027

### **Product 3: Interim Assessment**

- Purpose: To assess the research potential of the dataset produced in Stage 2 through preliminary analysis. Required for sign-off of R4.

- Composition: Sets out preliminary findings, basic comparison with results from HIA project and relevant work elsewhere.
- Derived from: Review of dataset produced during Stage 3.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Review against initial project design's business case and expected research potential of the dataset.
- Quality assurance responsibility: Project Manager and Project Executive
- Approval responsibility: Project Executive and Project Board
- Planned completion date: mid-2027

#### **Product 4: Updated Project Design**

- Purpose: To review project progress and make recommendations for further analysis and publication based on interim assessment report. Required for sign-off of R4.
- Composition: Sets out updated research approach, reviews aims and objectives, and presents suggestions for future work.
- Derived from: Review of dataset produced during Stage 3 and review of interim assessment report.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Review against initial project design's business case and expected research potential of the dataset.
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive and Project Board
- Planned completion date: mid-2027

#### **Product 5: Data Visualisation Products (isoplots/graphs)**

- Purpose: To visually represent data from isotope and trace element analyses. Required for production of final report in Stage 5.
- Composition: Isoplots and graphs
- Derived from: Analysis of isotope and trace element data
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Graphs and plots will be produced in accordance with AIPRL's standard practice for specialist reports, and will be suitable quality for publication.
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive
- Planned completion date: late 2027

### **Product 6: Comparative dataset**

- Purpose: identifies relevant comparative data from scientific publications studying contemporaneous or geographically-related burial populations that the LHL data can be combined with.
- Composition: Dataset of comparative isotope and trace element analysis results.
- Derived from: Analysis of isotope and trace element data
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Dataset will be compiled from publications within peer-reviewed journals and recognised databases.
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive
- Planned completion date: late 2027

### **Product 7: Final report**

- Purpose: Specialist report compiling all data and interpretations produced during the scientific analysis programme to be published before project closure.
- Composition: Presents detailed discussion of aims and objectives, methodology, results, and interpretations of the scientific analysis programme for publication during Stage 5.
- Derived from: Analysis of the isotope and trace element analysis data and compilation with HIA project results and comparative data.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Check against initial research design to ensure report meets aims and objectives and proposed outputs.
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive and Project Board
- Planned completion date: early 2028

### **Product 8: Dissemination outputs**

- Purpose: Enables dissemination of project results to wide-ranging audiences. Required to achieve aim 5 of the project.
- Composition: Outreach programme including, but not limited to: dedicated LHL project webpage within DigVentures' Lindisfarne project website, presentations to local community groups, submission of isotope data to open-access database, and educational resources for primary to university ages.

- Derived from: Community-based nature of preceding HIA project and project's aim to continue public outreach within LHL project.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: All dissemination outputs will be reviewed by the Project Executive and Project Board before dissemination, and will be created through liaison with appropriate experts.
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive and Project Board
- Planned completion date: early 2028

### **Product 9: Project Archive**

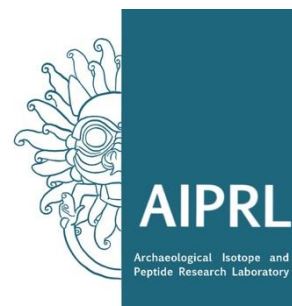
- Purpose: To archive all project documentation and data
- Composition: Deposition of project design, interim assessment report, updated project design, final report and data spreadsheets to ADS.
- Derived from: Production and publication of final report and preparation for project closure after Stage 5.
- Allocated to: Project Manager and Expert Team
- Quality Criteria and Method: Deposition will follow relevant ADS guidance (ADS 2024b; ADS and Digital Antiquity 2013)
- Quality assurance responsibility: Project Manager
- Approval responsibility: Project Executive and Project Board
- Planned completion date: early 2028

## Appendix 2: Risk Log

| Risk # | Description                           | Probability | Impact                                                                                                                                           | Countermeasures                                                                                                                                                                           | Estimated time/cost                                                         | Owner            |
|--------|---------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|------------------|
| 1      | Absence of key Project Team member    | Low         | High<br><br>Delay to planned works; additional cost to bring new staff in                                                                        | Ensure staff availability before initiation; reallocate responsibilities; bring alternative staff in                                                                                      | Minimal if adjustments made                                                 | PM/PExec         |
| 2      | Equipment failure                     | Low         | High<br><br>Delay to planned works; additional cost to purchase new equipment                                                                    | Ensure all equipment in good working order before initiation; locate potential alternative equipment in case of failure                                                                   | 1 month+ delays and potential £10,000+ cost if equipment has to be replaced | PM/PExec         |
| 3      | Analysis failure                      | Medium      | Medium<br><br>Reduction of dataset of results available for analysis; potential implications on interpretations from insufficient data retrieval | Some samples will inevitably fail but sample preparation and analysis standards must be adhered to at all stages                                                                          | Minimal if adjustments made                                                 | PM/PExec         |
| 4      | Project over allocated time or budget | Medium      | High<br><br>Project closure or reduction of planned scope; reputational damage; stakeholders and sponsors removing support for the project       | Regular review of project progress against budget and timeline; monitoring and managing risks throughout project; identify contingency plans in advance                                   | Medium time/financial impacts if contingencies put in place                 | PM/PExec /PBoard |
| 5      | Comparative data not available        | Medium      | Low<br><br>Reduction of dataset available for combination with LHL results; unable to situate LHL project within wider research context          | Interpretations adapted to focus more on comparison with HIA results; identify potential comparative data in advance of analysis stage; adapt project scope within updated project design | Minimal if adjustments made                                                 | PM/PExec         |
| 6      | Lack of public interest               | Low         | Medium<br><br>Lower financial contribution from crowdfunding; lower                                                                              | DigVentures' to promote project through audiences established during HIA project; project                                                                                                 | Minimal if adjustments made                                                 | PM/PExec /PBoard |

|          |                                                                   |     |                                                                                                                                                                   |                                                                                                                                                           |                             |          |
|----------|-------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------|
|          |                                                                   |     | impact of research project                                                                                                                                        | to be promoted by Durham University; social media outreach to gain interest                                                                               |                             |          |
| <b>7</b> | Internal or external laboratories at capacity for sample analysis | Low | High<br><br>Reduction of dataset of results for interpretation; potential implications on interpretations from insufficient data retrieval; delay to planned work | Capacity of laboratories to be enquired before initiation; alternative laboratories identified in advance                                                 | Minimal if adjustments made | PM/PExec |
| <b>8</b> | Injury during sample preparation                                  | Low | Medium<br><br>Delay to planned work; reputational damage; key staff absence                                                                                       | Risk assessments and H&S guidance for laboratory work to be consulted before reviewed and consulted regularly; allocation of new staff in case of absence | Minimal if adjustments made | PM/PExec |

## Appendix 3: AIPRL Quote Template



### Date:

### Estimate prepared by:

Prof. J. Montgomery / Dr. J. Moore  
AIPRL  
Durham University  
Archaeology Department  
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South Road  
DH1 3LE

### Estimate prepared for:

### Site/location:

### Samples:

Possible and suggested types of analysis are given in the table below. We can tailor the analytical programme to your budget and questions.

| Analyses                                              | Sample                                                                                                                                                                                                                                                                                              | Unit cost* | Total cost*         |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------|
| Combined strontium and lead isotope ratios            | Enamel phosphate – one per individual to investigate geographical childhood origins and exposure to anthropogenic pollution, samples taken from a tooth forming in early childhood (e.g., a canine) - <i>lead is particularly helpful for Roman period and 19<sup>th</sup> century individuals.</i> | £350       | £<br><b>samples</b> |
| Strontium $^{86}\text{Sr}/^{87}\text{Sr}$             | Enamel phosphate – one per tooth to investigate geographical childhood origins                                                                                                                                                                                                                      | £250       | £<br><b>samples</b> |
| Lead isotope ratios                                   | Enamel phosphate – one per tooth to investigate geographical childhood origins (must include trace element analysis)                                                                                                                                                                                | £250       | £<br><b>samples</b> |
| Trace elements (e.g. As, Ba, Ca, Hg, Pb, Sr, Zn etc.) | Enamel calcium phosphate – one per tooth to establish level of exposure to pollution, bedrock contribution to diet and medicinal treatments for disease (e.g. Syphilis).                                                                                                                            | £50        | £<br><b>samples</b> |
| Oxygen & Carbon                                       | Enamel carbonate – one per individual to investigate geographical childhood origins                                                                                                                                                                                                                 | £60        | £<br><b>samples</b> |

|                                                                                     |                                                                                             |      |           |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------|-----------|
| $^{18}\text{O}/^{16}\text{O}$<br>$^{13}\text{C}/^{12}\text{C}$                      |                                                                                             |      |           |
| Carbon & Nitrogen<br>$^{13}\text{C}/^{12}\text{C}$<br>$^{15}\text{N}/^{14}\text{N}$ | Bulk dentine or bone collagen to investigate diet                                           | £50  | £ samples |
| Carbon & Nitrogen<br>$^{13}\text{C}/^{12}\text{C}$<br>$^{15}\text{N}/^{14}\text{N}$ | Incremental dentine collagen - to investigate dietary change throughout childhood per tooth | £350 | £ samples |
| Sulphur<br>$^{34}\text{S}/^{32}\text{S}$                                            | Dentine or bone collagen to investigate geographical origins                                | £60  | £ samples |
| Amelogenin peptides                                                                 | Enamel peptide – one per tooth to determine sex if unknown                                  | £165 | £ samples |
| Specialist report                                                                   | With plots and interpretation (including data provided by SUERC) to publication standard    | £    | £         |
| <b>Total:</b>                                                                       |                                                                                             |      | <b>£</b>  |

**\*All prices are exclusive of VAT**

Turnaround is usually a minimum of 12 months for each type of analysis, but it depends on scheduling and machine backlog *at the point the order is made*. All forms of analysis are done separately. We will supply data tables. Errors and methods with the data. We can provide a basic PowerPoint with plots of the data and first order interpretation, e.g. for a museum display depending on your requirements.

All work will be carried out at the University of Durham in internationally recognised laboratory facilities using international standards and published protocols or when necessary at comparable approved laboratories. All data will be of publishable quality.

#### Notes:

This is an **estimate** of the likely costs and is not a quote.

The notes on pages 2 and 3 provide some background for the estimate.

#### *Oxygen carbonate versus phosphate*

For oxygen, prices have been given for duplicate (recommended but not essential) enamel carbonate analysis. Some research projects employ phosphate analysis, the suggestion being that the phosphate is more resistant to post-mortem alterations; it is, however, a more difficult and expensive technique. Data from carbonate analysis have been shown to be

robust in British contexts and comparisons of phosphate and carbonate data have shown a relatively consistent offset which allows the comparison of carbonate and phosphate data from the literature – conversions will be given. Carbonate analysis also allows the production of carbon isotope ratio data from the tooth enamel simultaneously, providing an additional set of data for incorporation into the interpretation. If phosphate analysis is preferred, a separate price estimate will be required.

### ***Animal bone for carbon and nitrogen***

Carbon and nitrogen isotope ratios are related to the environment in which the plants at the base of the food chain are grown. They will show differences according to that environment due to factors such as rainfall levels, temperature, soil salinity and manuring practices. If human dietary resources are likely to have been obtained from the burial region, it is helpful to have animal samples, particularly herbivores, for analysis as a 'baseline' for the location. If such samples are available, they should be dated as closely to the humans being analysed as possible. If none are available or there is no budget it may limit interpretation if there is no useful published data.

### ***Traded dietary resources***

The trading of foodstuffs will affect the data. Historic individuals may have lived all their lives in the general region of their burial, but may have eaten foods which have been imported from elsewhere. Strontium isotope data from human tooth enamel generally reflect plant resources much more strongly than animal products, so that if an individual as a child was consuming significant quantities of imported plant foods, this may give them a strontium isotope profile which reflects the source of these foods rather than the place inhabited.

### ***Childhood versus adulthood***

Enamel and dentine data reflect the period of tissue formation for teeth which form mainly during childhood. Strontium and oxygen data from tooth enamel, together with carbon and nitrogen data from dentine samples, therefore reflect childhood resource consumption. Bone collagen turns over during life, but at different rates for different bone fractions. For instance, long bone cortical shaft will reflect an average lifetime dietary carbon and nitrogen signal, probably weighted towards adolescence; rib and trabecular bone turn over faster and are more likely to reflect a period closer to the point of death than cortical long bone.

By comparing carbon and nitrogen isotope signals from different fractions (e.g., dentine, cortical long bone, rib) it can be possible to see changes over an individual's life which may relate to a change in dietary resources, changes in location (i.e. mobility), or to other factors which can affect the body, such as dietary or health stresses. Such comparisons can add value to a study of mobility based on strontium and oxygen isotope analysis of tooth enamel.

### ***Strontium analysis of dentine***

Tooth enamel is the preferred skeletal fraction for strontium and oxygen isotope analysis because it is resistant to post-mortem alteration, whilst bone and dentine are not. Because dentine is likely to take up strontium from the burial environment, strontium isotope analysis

of dentine can provide an indication of the 'baseline' for the location. It is recommended, therefore, to include a small number of such analyses in a strontium study for comparison with the enamel data unless sufficient biosphere data are already available from other published studies. We can advise on this.

### ***Serial and incremental analyses***

Advances in techniques now allow serial and incremental analyses of dental tissues so that a number of samples from the same tooth can be analysed to provide a timeline showing changes in isotopic data over the period of tooth formation (largely childhood, but depending on the tooth chosen this can range from before birth through to around 23 years of age). Strontium isotope data can be obtained from serial enamel samples (micromilling is suggested here rather than laser ablation); carbon and nitrogen isotope data can be obtained from incremental sections of a tooth root. In both cases, a series of around 15 data points might be expected. These serial data sets for individuals can provide a much more precise understanding of mobility and diet. They do, however, increase the budget substantially and can rarely be included for a large number of individuals. The estimate is for single analysis of each increment to avoid the cost of duplication, which is unlikely to be necessary for serial analysis across a single tooth.

### ***Sample requirements***

The strontium and oxygen isotope analysis will destroy c. 100mg of tooth enamel, e.g. usually less than one quarter of a molar crown depending on extent of wear. The bulk bone and dentine analysis will require c. 200mg of bone or dentine. The incremental dentine analysis normally destroys half of a canine tooth root bisected longitudinally – but can be done on the tooth of your choice depending on what period of life you wish to focus on. We can in some cases do two teeth from a single individual, e.g. a canine and a third molar which will produce a combined profile from around birth up to c. 23 year of age. The number of samples is flexible and can vary between isotopes, e.g. you may wish to do 60 bone samples for carbon and nitrogen isotopes only or sub-sample 20 of these individuals for more detailed incremental dentine analysis. We are happy to advise on sampling strategy prior to selecting samples from the individuals.

Unused teeth and bone samples and excess collagen will be returned by courier once data is obtained.

### ***Deadlines and lead times***

No deadline has been specified for this project at the time of raising the estimate. Lead times for analysis will vary according to a number of factors, including the facility used, demand for their services, holiday periods and absence of key technical staff, and maintenance requirements for equipment which are often unforeseen even at the time of sample provision and initial sample processing. The timing of data provision is therefore usually difficult to predict. A reasonable expectation in most circumstances would be a period of six months from the point at which samples have been provided to the production of a report on the data, but this period usually cannot be precisely determined in advance.

