Fine sediment offset plan for Gladstone Ports Corporation

October 2023

This report has been prepared by Fitzroy Basin Association Ltd (FBA) and Alluvium Consulting Australia Pty Ltd for Gladstone Ports Corporation.

Authors:	James Teague (Alluvium) and Hannah Kaluzynski (FBA)
Review:	Misko Ivezich (Alluvium)
Approved:	Misko Ivezich (Alluvium) and Elyse Riethmuller (FBA)
Version:	Revised
Date issued:	19/10/2023
Issued to:	GPC
Citation:	FBA and Alluvium, 2023, Fine Sediment Offset Plan for GPC, report prepared by Fitzroy Basin Association Ltd and Alluvium Consulting Australia for the Gladstone Ports Corporation, Gladstone, QLD

Contents

Figures

Tables

1 Introduction

Gladstone Ports Corporation (GPC) completed the Clinton Vessel Interaction Project in August 2020, during which 796,555 m³ of seabed material was dredged using a backhoe dredge and placed within the Western Basin Reclamation Area. The project was executed under an Environmental Protection and Biodiversity Conservation Act 1999 (EPBC) approval (2017/7976), which required that fine sediment returned to the marine environment as a result of dredging be calculated and validated in accordance with a Fine-Grained Sediment Validation Monitoring Plan. It was estimated that 2,010 tonnes of fine-grained sediment were released to the environment because of the dredging activity. As required under Condition 7 of the EPBC approval, GPC must deliver a fine-grained sediment offset strategy to the satisfaction of the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The condition States:

The approval holder must submit an Offset Plan (OP) to the Minister for approval by 31 January 2022. If the Minister approves the OP, the approved OP must be implemented within six months of approval of the OP. The OP must include, but is not limited to:

a) details of offset(s) to compensate for impacts of the amount of fine-grained sediment returned to the marine environment that was not previously available for resuspension before commencement of the dredging activities, calculated and validated in accordance with the Fine-grained Sediment Validation Monitoring Plan;

b) timeframes for delivery and completion of the offset(s);

c) details of how the offset(s) align with the broader strategies and programs for the Great Barrier Reef, including but not limited to the Reef 2050 Long-Term Sustainability Plan;

d) a description of the management measures (including timing, frequency and longevity) that will be implemented to deliver the offset(s);

e) performance and completion criteria for evaluating the success of the management measures and criteria for triggering remedial action (if necessary);

f) a program, including timelines to monitor and report on the effectiveness of the management measures, and progress against the performance and completion criteria; and

g) a description of potential risks to the successful implementation of the management measures and a description of the contingency measures that would be implemented to mitigate against these risks and residual risk ratings.

Fitzroy Basin Association (FBA) have been engaged by GPC to develop the Fine Sediment Offset Plan to meet the requirements of the EPBC approval. FBA have worked with Alluvium Consulting Australia (Alluvium) to develop this plan.

Fine sediment offset project
The overall offset project can be looked at as three key stages including:

1. Stage 1: Fine-grained sediment validation monitoring plan (*complete*)
2. Stage 2: Development of Fine Sediment Offset Plan (*this report*)
3. Stage 3: Implementation of Fine Sediment Offset Plan (*to be completed*)

The stages, key steps required within each stage and approximate time to complete the stage is provided schematically below in Figure 1.

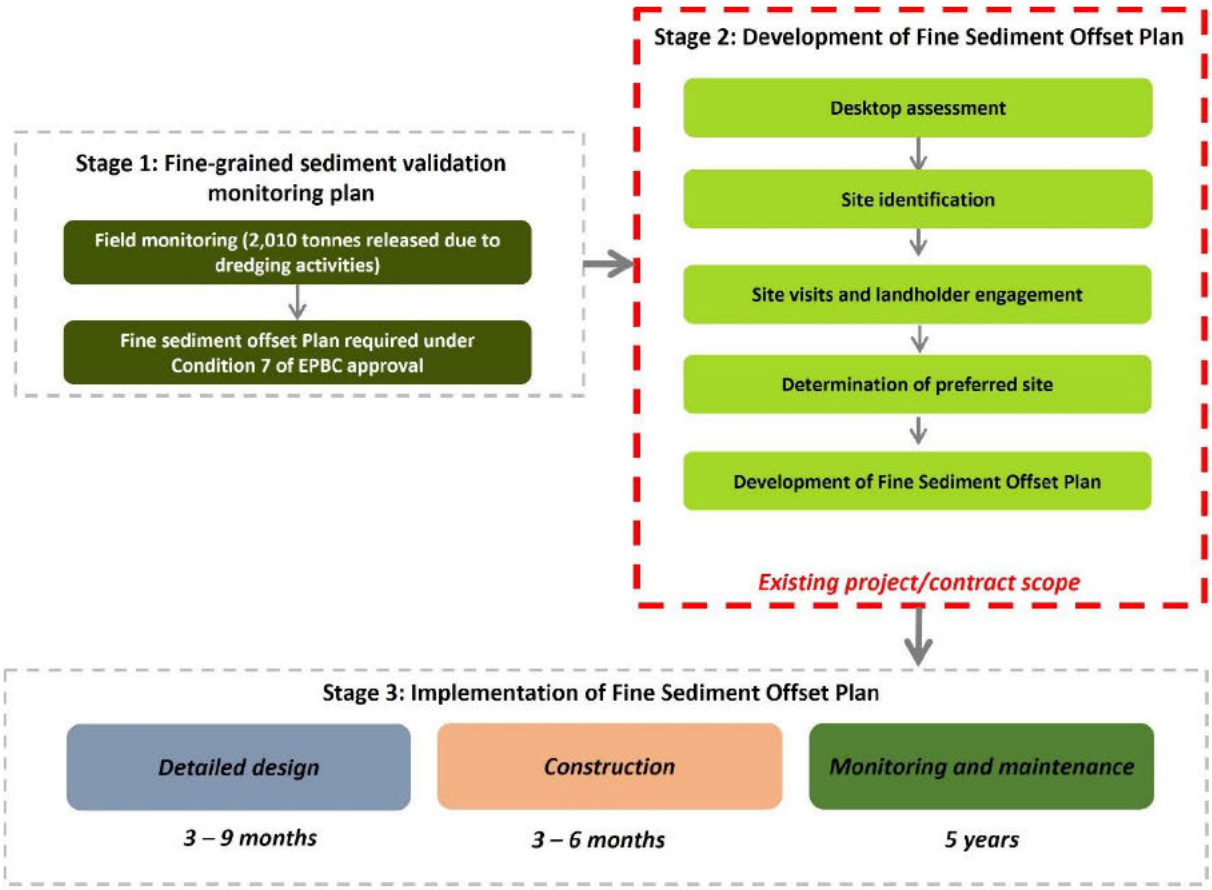


Figure 1. *Schematic representation of the overall Fine Sediment Offset project*

Implementing the following offset strategy in this report not only ensures that Condition 7 of the EPBC approval is met but has wider environmental, social and economic benefits. Work taken to halt actively eroding banks also aligns to additional objectives, targets and strategies of broader programs for the Great Barrier Reef and Queensland environment (Table 1).

Table 1. Description of broader strategies and programs for the Great Barrier Reef that align to the Fine Sediment Offset Project.

	Aligned objectives, targets and or strategies	Contribution of program to strategy
Reef 2050 Plan		
	2.1 Implement the Reef 2050 Water Quality Improvement Plan to meet its targets and undertake a 5-yearly review	This Fine Sediment Offset plan will contribute to 2.1 by preventing sediment run off into the Great Barrier Reef Catchment ultimately aiding in implementing the Reef 2050 Plan.
	5.3 Enhance protection, rehabilitation, and restoration of key coastal and catchment ecosystems	Rehabilitating key coastal and catchment ecosystems will occur through improving riparian vegetation across the site. This will increase habitat for fauna whilst also increasing water quality by reducing sediment run-off.
	A.1 Foster connection, education, and stewardship of the Reef	By being involved in this project the land manager will be made aware of how actions implemented on their property can impact the Great Barrier Reef. Through legacy

	Aligned objectives, targets and or strategies	Contribution of program to strategy
		maintenance of the site past duration of project implementation the land manager will be showcasing stewardship actions, that could potentially extend to other areas of their property as their knowledge and capability increases
Reef 2050 Water Quality Improvement Plan 2017-2022		
	60% reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads	It is expected that through implementing revegetation along the riparian zone, growing plants will absorb some dissolved inorganic nitrogen loads that may occur during flow events. Captured sediment loads from pile fields and plant matter along the site will also allow for dissolved inorganic nitrogen to be absorbed. This will aid in contributing to overall reduction of anthropogenic nitrogen across the Great Barrier Reef Lagoon catchment.
	20% reduction in anthropogenic end-of-catchment particulate nutrient loads	The project will contribute to reducing end of catchment anthropogenic nutrient loads by capturing sediment within pile fields and vegetation. Any nutrients within the soil will also be captured ultimately reducing particulate nutrient loads.
	25% reduction in anthropogenic end-of-catchment fine sediments loads	This project is designed to reduce fine sediment loads entering the Great Barrier Reef by reducing erosion and repairing streambank areas.
	The extent of riparian vegetation is increased	The area where bank stabilisation works will occur and an expanded area along both sides of the streambanks will be revegetated to promote long term bank stability. This project therefore directly contributes to increasing riparian vegetation extent.
	Active engagement of communities and land managers in programs to improve water quality outcomes is increased	Land managers of this property will be actively engaged and educated about water quality outcomes by being involved in this project.
Reef Trust Monitoring and Reporting Plan		
	Outcome 1: Improve the quality of water entering the GBR from broad- scale land use to increase the health and resilience of the GBR.	This project is designed to reduce sediment loads entering the Great Barrier Reef by reducing erosion and repairing streambank areas. Sediment runoff is currently threatening the health and resilience of the reef, and this project directly contributes to this outcome.
	Outcome 2: Improve the health and resilience of coastal habitats.	By reducing the amount of fine sediment entering the Great Barrier Reef catchment

Aligned objectives, targets and or strategies	Contribution of program to strategy
	this project will lessen the negative impacts sediment run off is having across coastal habitats.
National Landcare Program Phase 2 Regional Land Partnerships (2023)	
By 2023, threats to the Outstanding Universal Value of World Heritage Properties listed for natural heritage have been reduced through the implementation of priority actions.	High Sediment loads entering the Great Barrier Reef catchment area is a key threat to the World Heritage area. Reducing these loads is a priority action and will occur through bank stabilisation and revegetation of the area.
By 2023, there is an increase in the awareness and adoption of land management practices that improve and protect the condition of soil, biodiversity, and vegetation.	This objective will be achieved through working with the land manager to improve their knowledge and implement practices that reduce sediment run off, i.e., fencing off the streambank areas and controlling grazing regimes.
Department of Agriculture and Fisheries Strategic Plan 2021- 2025	
Objective 3: A resilient sector with secure production, and value chains that can deal with natural disasters, climate change, biosecurity risks and other emerging challenges.	Restoring degraded areas of the riverbank will help reduce the likelihood of total bank collapse in the event of a flood (natural disaster), ensuring land is not continually lost to erosion.
Objective 4: Ethical and sustainable production of food and fibre that meets consumer and community expectations for food safety, a safe and a sustainable natural environment and animal welfare and management standards.	Improving degraded lands and enabling cattle production and biodiversity to co-exist is becoming a more important factor for communities and food suppliers. This project will see areas of land restored and aid in supporting an environment where cattle production is meeting environmental management standards.
Department of Environment and Science Strategic Plan 2019-2023	
Objective: Protect the Great Barrier Reef	High Sediment loads entering the Great Barrier Reef catchment area is a key threat to the World Heritage area. Reducing these loads is a priority action and will occur through bank stabilisation and revegetation of the area.
Objective: Conserve Queensland's protected areas and biodiversity	Improving riparian vegetation across the site will ultimately increase habitat for fauna, improving biodiversity within the property.
Objective: Protect the health of the environment and our communities	This project by improving water quality will have a direct benefit on the health of the environment. Furthermore, the area where bank stabilisation works will occur will be revegetated to promote long term bank stability.

2 Report structure

There are two main components presented in this report – Site selection and Fine sediment offset management plan. Sections include:

- ***Site selection***
    - **Section 3** provides the system understanding and background to the sediment offset site selection
- ***Fine sediment offset management strategy***
    - **Section 4** provides details of the bank stabilisation works to be undertaken at the preferred fine sediment offset site.
    - **Section 5** Provides details on the fine sediment offset calculations used in the plan
    - **Section 6** Outlines the monitoring and reporting requirements for the offset plan including key performance indicators
    - **Section 7** Provides cost estimates to implement and monitor the offset plan
    - **Section 8** Details the risk assessment undertaken for the fine sediment offset site
    - **Section 9** Provides estimated timelines for implementation of the Fine sediment offset plan
    - **Appendix A** Detailed revegetation design.

3 Site selection

3.1 System understanding

Overview
The Great Barrier Reef is at risk due to run-off carrying sediment from the catchments, making its way to the coast and ultimately into the Great Barrier Reef (GBR) lagoon. Fine sediment lost through stream bank and gully erosion poses the highest threat to GBR ecosystems and has been identified as a major contributor to the decline in water quality across the GBR catchments. Degradation of riparian areas through the removal of vegetation, loss of riparian connectivity and grazing on stream banks has reduced biodiversity and increased delivery of fine sediment to streams.

Stream channels are the primary conduits for the delivery of catchment derived sediments and nutrients to the coast and into the GBR lagoon. Sediments can be derived from hillslopes, gullies and channel erosion. Monitoring and scientific modelling have shown the main source of sediments from the Great Barrier Reef catchments is from agricultural land use, with grazing including gully and hillslope erosion accounting for nearly half of the fine sediment generated by human activity. The second biggest contributor is streambank erosion.

Vegetation plays an important role in these processes. Although erosion is a natural and essential process in alluvial systems, across the Fitzroy, Boyne and Calliope catchments (and the broader Fitzroy Basin) rates of stream bank and gully erosion have increased as a result of land clearing, removal of riparian vegetation and grazing pressure.

Sediment source review
The Dynamic SedNet model is currently used within the GBR Source Catchment Modelling framework to assess end of catchment loads and to estimate pollutant load reductions due to adopted improved management practices. The Dynamic SedNet model is also used to run scenarios to assess efficacy of other proposed practices. The model, and the data inputs currently utilised, is a reasonable tool for estimating the relative contribution of sediment from streambank erosion, gully erosion and hillslope erosion at large whole of catchment scales.

We have undertaken a high-level review of the Dynamic SedNet modelling outputs (used in The Reef Water Quality Report Card - 2019) in the Calliope River, Boyne River and Fitzroy River catchments to provide an understanding of the key contributing processes driving fine sediment generation in each catchment.

One of the key components of the modelling is the delivery ratio which is used to estimate the proportion of fine sediment derived from catchment that is likely to make it out to the GBR receiving waters (Figure 2). The delivery ratio will be an important factor in estimating the fine sediment offset for the strategy. The highest delivery ratios typically occur nearest to the coastal outlet. In the upper Boyne River catchment, the delivery ratios are between 10 - 17 % which is due to the influence of Awoonga Lake. Delivery ratios for the Calliope River catchment and lower Fitzroy River catchment are significantly higher, typically ranging from 60 % to 100 %.

The modelling also indicates that in the Fitzroy River catchment most of the fine sediment generated comes from streambank and gully erosion, while in the Boyne River catchment and Calliope River catchment most of the erosion comes from hillslopes and streambanks (reportcard.reefplan.qld.gov.au). Based on this information and other factors such as likely costs and timing and discussions with GPC it was determined that we would identify potential sediment offset opportunities from either streambank or gully erosion.

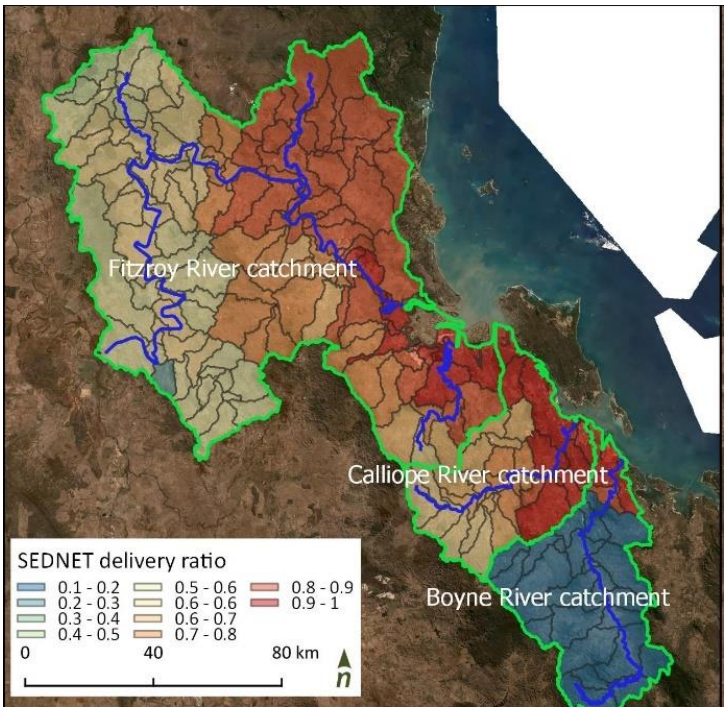


Figure 2. *Dynamic SedNet modelling results showing fine sediment delivery ratio*

Multi-temporal analysis

Within the study area there is partial coverage of publicly available LiDAR data, typically captured in 2008, 2009 or 2014. FBA also has some more recent coverage from 2019 that covers some areas of interest within the Fitzroy River catchment (Figure 3). Where multiple years of LiDAR was available for one location a DEM of Difference (DoD) was created. A DoD identifies changes in ground surface elevation from two LiDAR datasets captured at various temporal scales. From the DoD the volume of sediment eroded from the banks and the dominant erosional process can be assessed (i.e. meander migration, channel widening etc.). Where only a single year of LiDAR data is available, sediment mobilization volumes can be estimated from bank heights derived from LiDAR data and changes to channel alignment assessed from high resolution aerial imagery. Where only one year of LiDAR data was available, erosion volume estimates between each temporal period were estimated by delineating the channel top of banks based on aerial imagery and determining the eroded area of the associated geomorphic unit.

The height of geomorphic units was then estimated from the LiDAR data (note this approach assumes limited adjustment in bed level across the assessment period). The volume was estimated based on the product of the eroded area and the height of eroding geomorphic unit. Where there is no LiDAR data available it is problematic to estimate sediment loss from erosion as it is difficult to determine bank height and morphology.

High resolution aerial imagery availability is highly variable across the three catchments. There is typically more recent imagery available around the coastal areas and regional centres of Gladstone, Calliope and Rockhampton as well as 2019 imagery captured in the 'FBA LiDAR coverage' areas (see Figure 3). Aerial imagery analysis has been used to develop a high-level understanding of the potential areas of erosion where there is no LiDAR coverage, or in conjunction with LiDAR data were available to help further understand landscape features, vegetation extent/condition, and geomorphic process and trajectory.

The multi temporal analysis enabled a first pass identification of sites of significant change through streambank or gully erosion. The erosion sites identified are shown below in Figure 4. It should be noted that analysis of the Fitzroy River catchment has been undertaken in other FBA projects. For the purposes of this project, the analysis identified some potential sites closer to the Gladstone Port catchments in the lower Fitzroy catchment, including Raglan Creek catchment, that may be suitable for offset projects.

Outside of the Fitzroy River catchment, the Calliope River catchment had the highest number of erosion sites identified. These sites included streambank erosion primarily located within the tidal reaches of the Calliope River and Clyde Creek, and gully erosion adjacent to Double Creek and Gravel Creek. Due to the impact of Awoonga Lake on sediment delivery ratios, the Boyne catchment downstream of the lake was the focus. As a result of this, fewer sites were identified in the Boyne catchment, however erosion was identified primarily in the tidal reaches, on the Boyne River and Station Creek, and outside of the tidal area on Coomal Creek.
An example of combined historical aerial imagery and LiDAR analysis from Calliope River catchment, Boyne River catchment and Fitzroy River catchment is provided in Figure 5, Figure 6 and Figure 7 respectively.

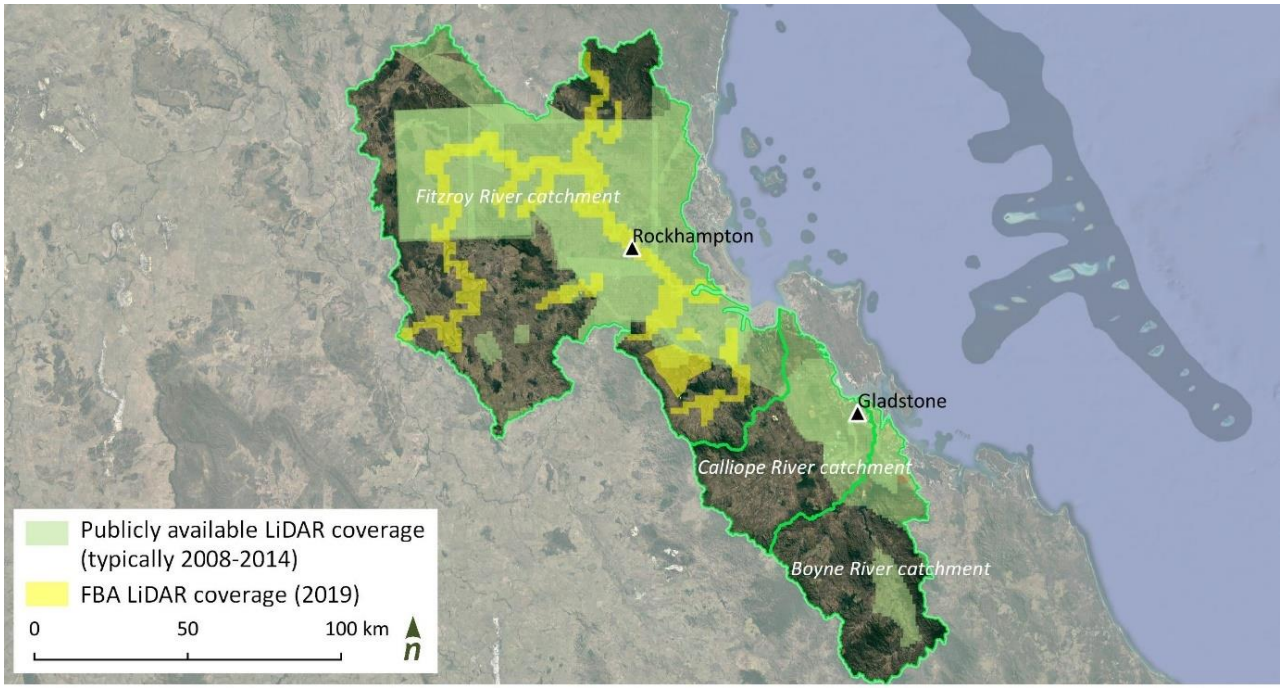


Figure 3. *LiDAR coverage across the study area*

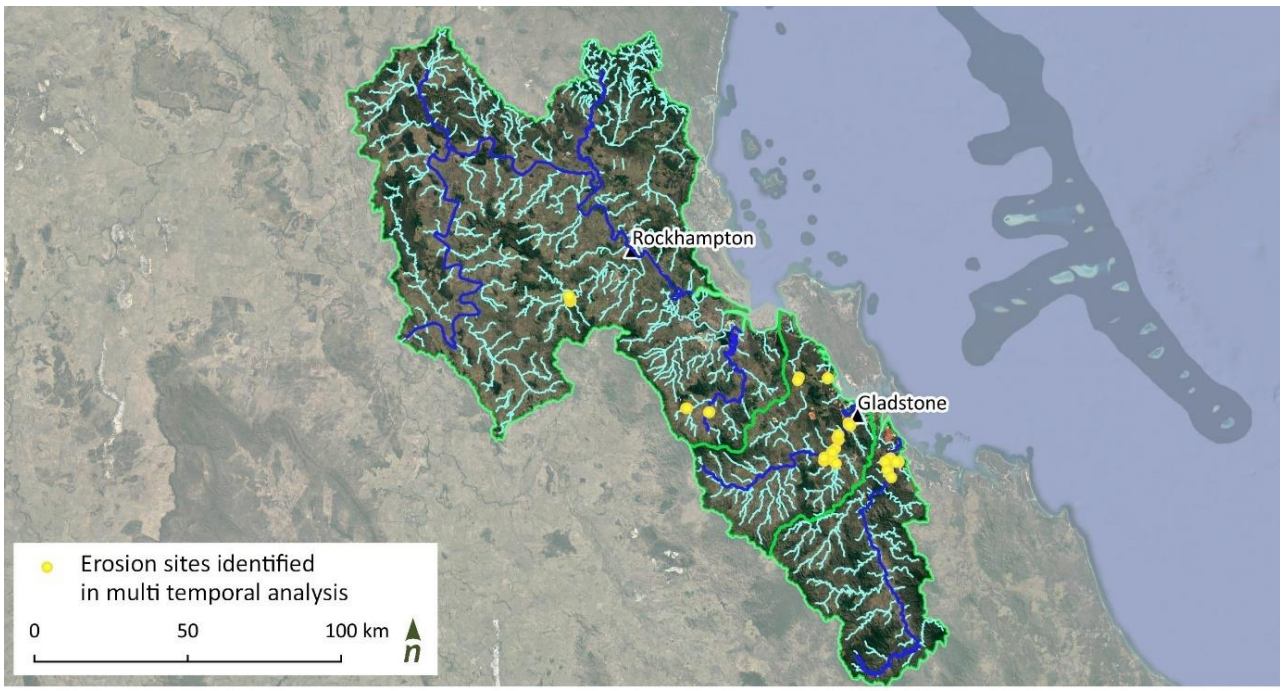


Figure 4**.** *Erosion sites identified in the multi-temporal analysis*

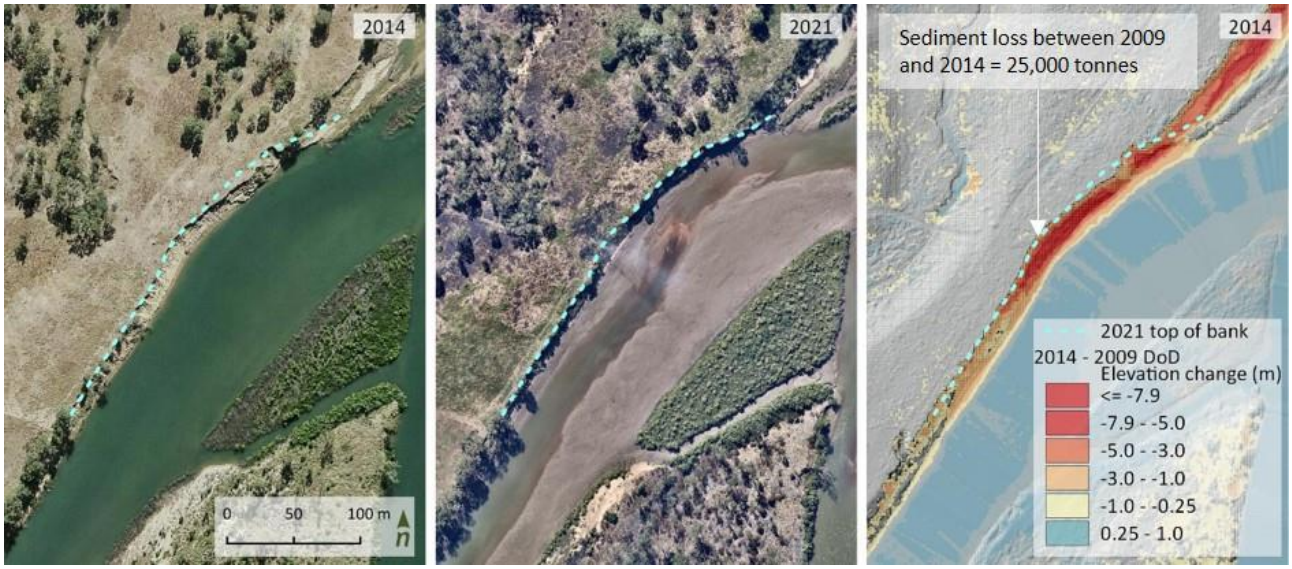


Figure 5. *Multi-temporal imagery and LiDAR analysis example on the Calliope River approximately 10 km upstream of Gladstone*

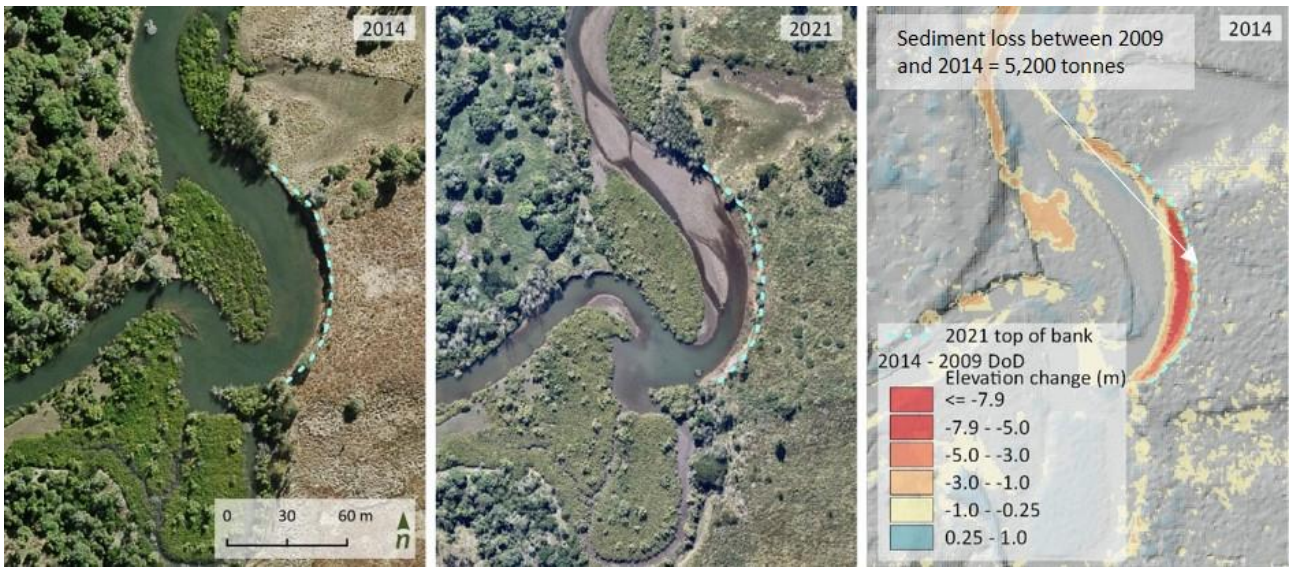


Figure 6. *Multi-temporal imagery and LiDAR analysis example on a Boyne River tributary in Benaraby approximately 10 km upstream of ocean outlet at Tannum Sands*

Figure 7. *Multi-temporal imagery and LiDAR analysis example on Six Mile Creek, (Fitzroy River catchment) app.roximately 70 km upstream of ocean outlet*

Sediment offset opportunities

Based on the multi-temporal analysis six potential sites were identified as potential fine sediment offset sites for further investigation. The following section provides a summary of the preliminary sites identified for further investigation. Locations of the sites are shown in Figure 8, and site maps showing the multi-temporal analysis are provided in Figure 9 to Figure 14. A summary of these sites and their potential offset opportunity is provided in Table 2. An initial prioritisation based on several factors including costs, proximity to port, complexity of likely approvals, potential site constraints and preliminary offset potential was also included.

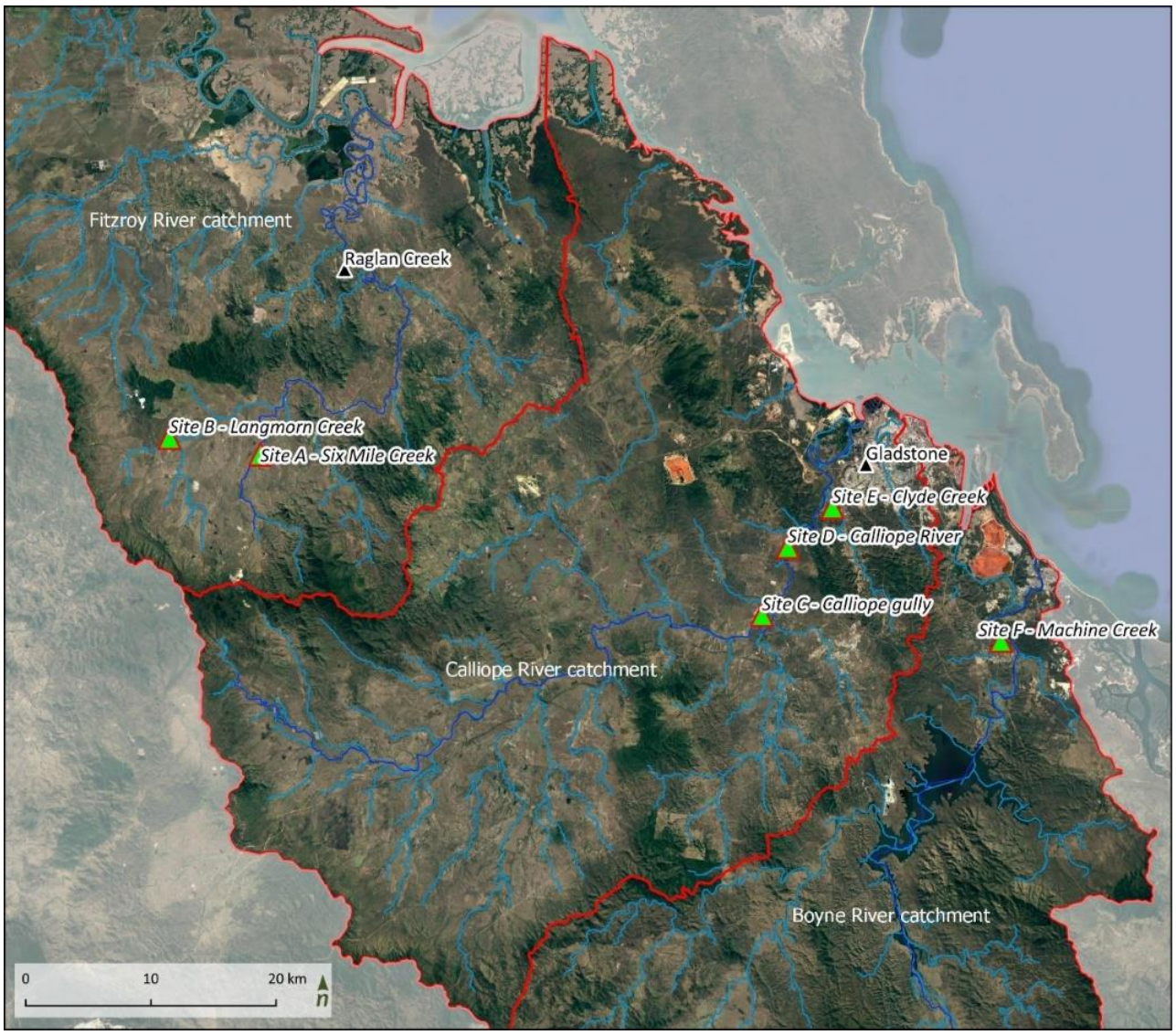


Figure 8. *Potential site location locality map*

Figure 9. *Multi-temporal analysis at Site A - Six Mile Creek - Streambank erosion (meander migration)*

Figure 10. *Multi-temporal analysis at Site B- Langmorn Creek - Streambank erosion (meander migration)*

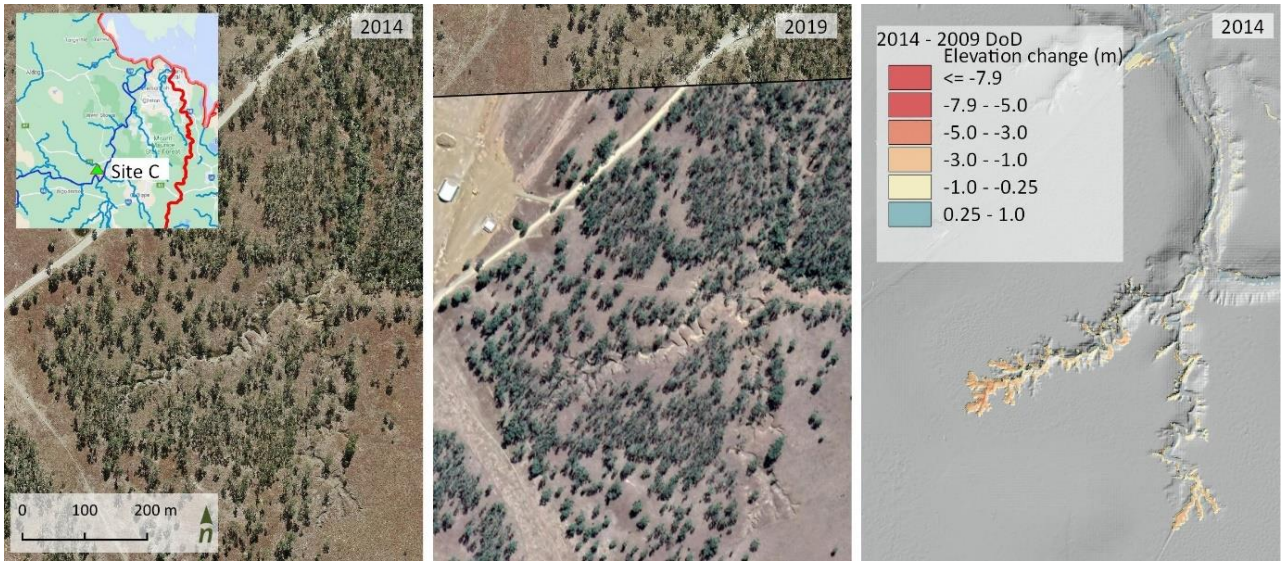


Figure 11. *Multi-temporal analysis at Site C - Six Mile Creek - Gully erosion*

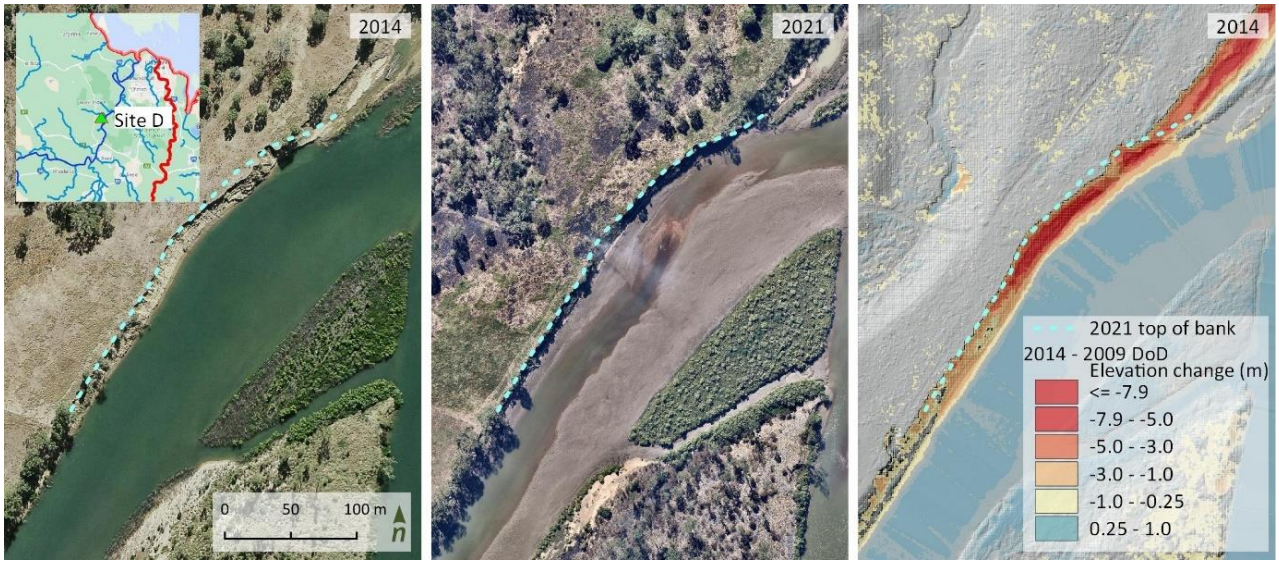


Figure 12. *Multi-temporal analysis at Site D - Calliope River - Streambank erosion (meander migration)*

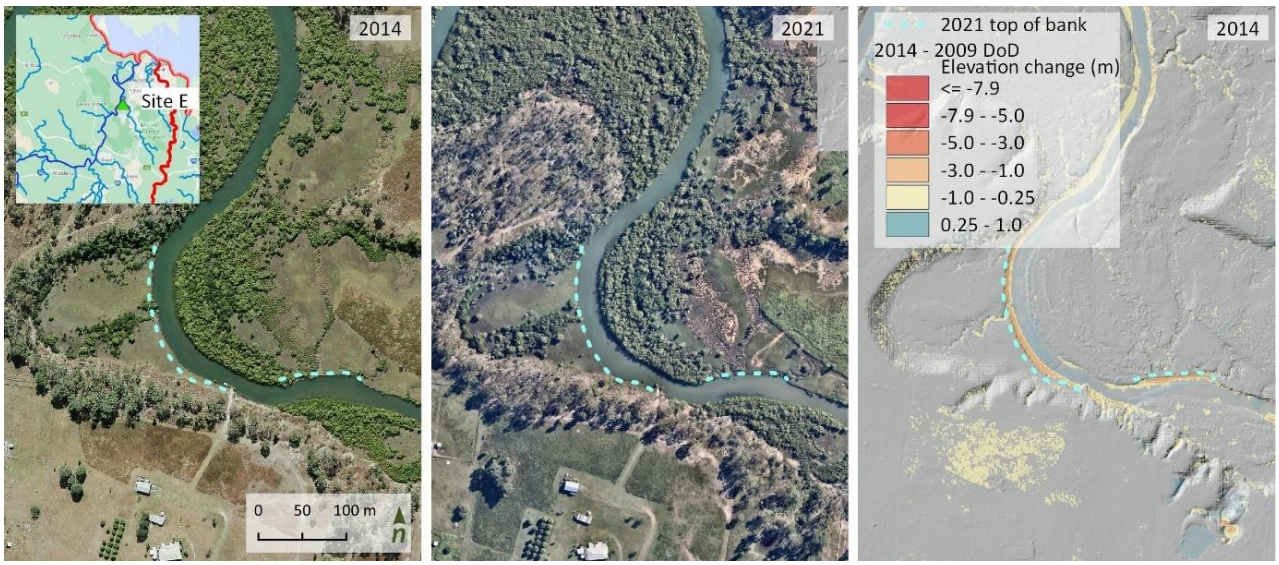


Figure 13. *Multi-temporal analysis at Site E - Clyde Creek - Streambank erosion (meander migration)*

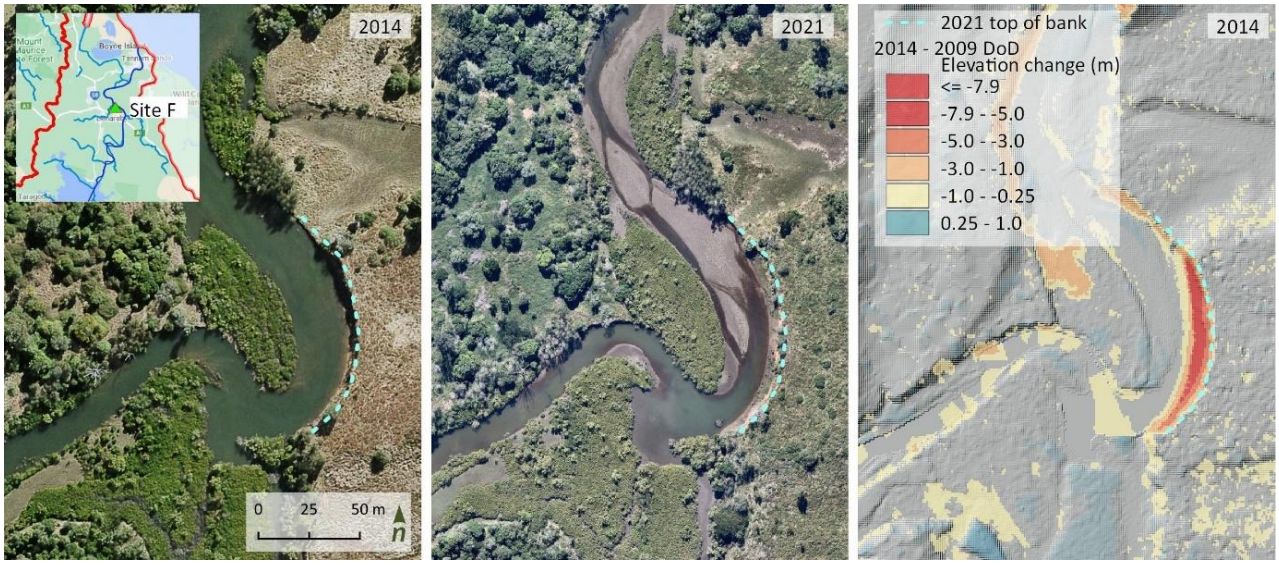


Figure 14. *Multi-temporal analysis at Site F - Machine Creek - Streambank erosion (meander migration)*

Table 2. Initial summary of potential fine sediment offset sites

Site ID	Stream name	Catchment	Data availability	Historic comparison method	Estimated fine sediment abatement (tonnes/year)	Proposed works	Tidal	Other considerations	Initial Proposed priority
A	Six Mile Creek	Raglan Creek	2019 LiDAR, 2019 imagery, 2014 imagery	LiDAR/aerial (2019/2014)	2100	Bank reprofiling, pile fields, stock exclusion, revegetation	no	- Stock exclusion may be limited to immediate works area	1
B	Langmorn Creek	Raglan Creek	2019 LiDAR, 2019 imagery, 2014 imagery	LiDAR/aerial (2019/2014)	300	Bank reprofiling, pile fields, stock exclusion, revegetation	no	- Stock exclusion may be limited to immediate works area. - Limited surrounding riparian vegetation	2
C	Calliope River	Calliope River	2014 LiDAR, 2009 LiDAR, 2012 – 2021 imagery (nearmaps)	DoD (2014/2009)	1074	Gully reprofiling, rock chutes, soil amelioration, revegetation	no	-limited recent data available	3
D	Calliope River	Calliope	2014 LiDAR, 2009 LiDAR, 2012 – 2021 imagery (nearmaps)	DoD (2014/2009)	517	Bank reprofiling, pile fields, stock exclusion, revegetation	Yes, Fish habitat type B	- Large potential sediment reductions but likely complex approvals issues etc. -Potential acid sulfate soils	4
E	Clyde Creek	Calliope	2014 LiDAR, 2009 LiDAR, 2012 – 2021 imagery (nearmaps)	DoD (2014/2009)	524	Bank reprofiling, pile fields, large rootball logs, revegetation	Yes, Fish habitat type B	- Close to town/port, next to boat ramp, highly visible project - Good surrounding veg, - Potential Acid Sulfate Soil risk -	5
F	Machine Creek	Boyne	2014 LiDAR, 2009 LiDAR, 2012 – 2021 imagery (nearmaps)	DoD (2014/2009)	368	Bank reprofiling, pile fields, large rootball logs, revegetation	Yes, no fish habitat	- Close to town/port - Good surrounding vegetation - Fish habitat enhancement - Low sediment offset potential	6

3.2 Land manager engagement

From our initial list of proposed offset sites, Site A, B, C and D were chosen to progress into the initial land manager engagement stage. Land managers were contacted in order to gauge their level of interest and arrange site visits to enable a more detailed site assessment. Land managers were provided with a summary of the project, the aim of works and what would likely be involved for future on ground works.

From this initial contact, land managers from Site B, C and D were willing to progress to the next stage. Of these properties only Site B and D were available for onsite visits. Site C land managers do not reside on property and were unavailable until 2022. These visits enabled a more detailed discussion with land managers, addressing any concerns and questions they had, whilst enabling them to communicate what they envisage as a successful long-term outcome for a project on their property.

3.3 Site visits

Site visits were undertaken by Alluvium and FBA staff on the 2nd and 3rd of December 2021 at two sites, Site D on the Calliope River and Site B on Langmorn Creek (Figure 15). The purpose of site visits was to:

- Understand existing conditions such as bank morphology, bed and bank substrate, vegetation condition, site access, spoil disposal locations and erosional processes
- Detect any infrastructure in the vicinity of the proposed project sites to inform initial land manager and stakeholder discussions
- Determine any other constraints or opportunities to inform land manager and stakeholder discussions, the engagement of site survey and geotechnical investigations and environmental approvals assessments (these are likely to be required as a part of the detailed design process following the development of the Offset Plan).

A summary of the key observations from the site visits is provided below. A high-level concept design for Site D has been included as a part of the summary. Site B was identified as the preferred option for the fine sediment offset plan and as a result the conceptual design and more detailed analysis is provided in Section 4.

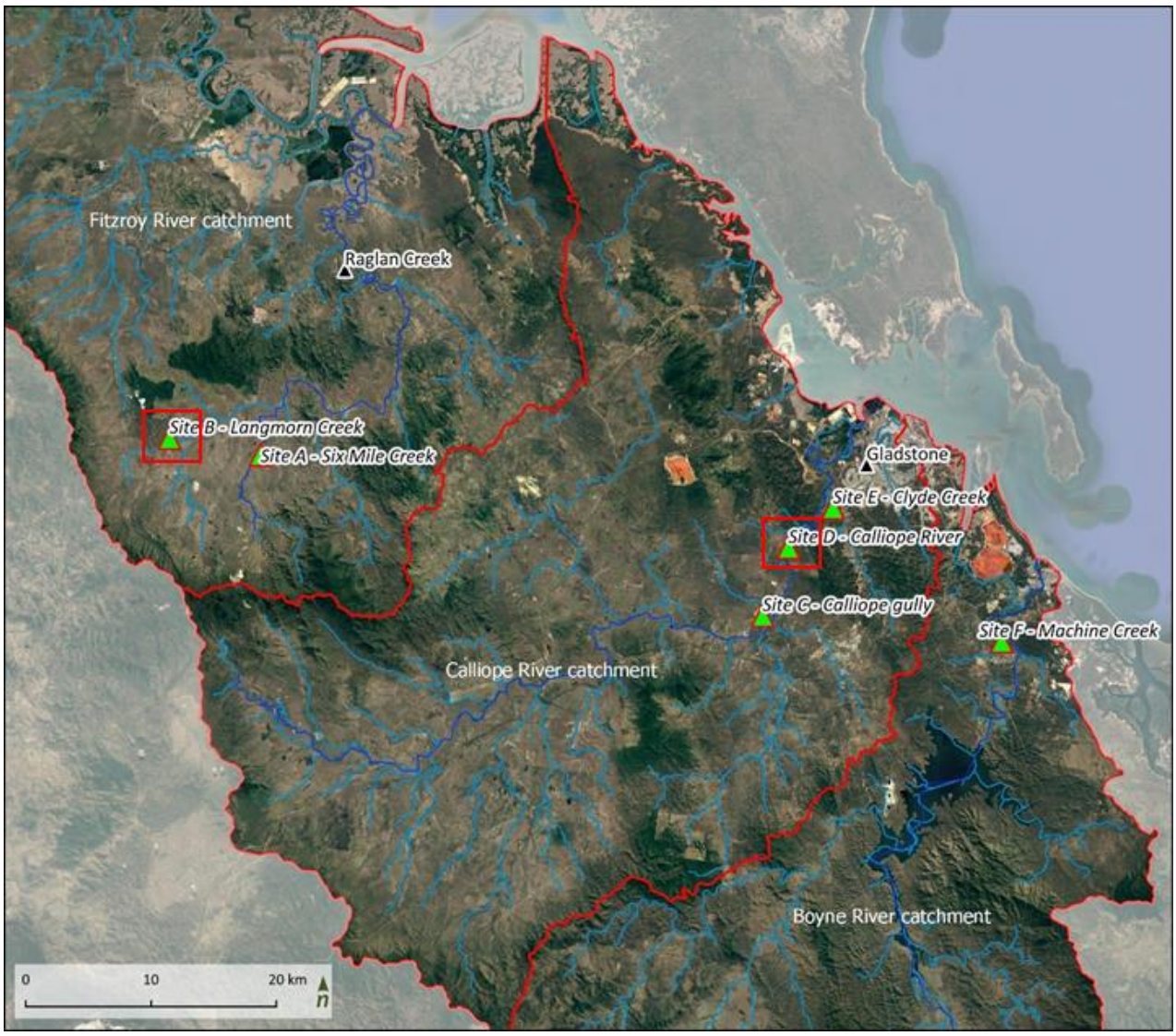


Figure 15. *Potential fine sediment offset site locations with sites inspected in field visits highlighted in red boxes*

3.4 Site D - Calliope River

Site description and offset opportunity

Site D is located on the lower estuarine reaches of the Calliope River approximately 17 km upstream of the Gladstone Port (Figure 16). The site includes an eroding section of the left bank approximately 350 m in length and 11 m high. The banks have experienced significant erosion as a result of meander migration processes. Multi-temporal aerial imagery analysis indicates that the bank has retreated up to 15 m since 2009. Multi-temporal LiDAR analysis indicates that between 2009 and 2014 approximately 27, 000 tonnes was mobilised from the bank during that period (see above in Figure 12). Some key observations from the site visit include:

- Vertical to near vertical banks, undercut in some sections
- The banks are comprised of exposed alluvial sands, of loose to medium density, and clays of soft to firm consistency
- Several trees at the top of bank with exposed roots are likely to fall in the near future which could instigate further bank failure
- Erosion likely a result of a combination of fluvial scour and geotechnical failure
- Accelerated rates of bank retreat are occurring due to loss of deep-rooted floodplain vegetation which provides root reinforcement of the bank which is able to resist mass failure of bank material
- Wave action due to boat wash results in entrainment of bank sediments and limits vegetation recruitment

- Intertidal bench approximately 5 - 10 m wide has formed and mangroves are beginning to establish at the toe of bank
- Upstream of site has significant colonisation of mature mangroves along the bank toe
- Access to site requires crossing a small creek and water storage overflow, would require some works to provide appropriate access for machinery
- Sandy nature of bank material may require a gentle batter to achieve appropriate slope stability (1V:4H) resulting in significant volume of spoil to be removed
- Limited areas for onsite spoil disposal
- Land manager happy to exclude stock from site during vegetation establishment period. Cattle to be allowed back into the site for short periods to control grass growth and reduce fire risk as necessary after the vegetation establishment period.

Figure 16. *Eroding section of bank at Site D - Calliope River (Photos taken December 2021)*

Proposed bank stabilisation works

The recommended works for Site D includes bank reprofiling, pile fields, large wood installation and vegetation establishment. The proposed works to stabilize the eroding bank are presented in Figure 17. The recommended works include:

- Reprofiling the near vertical bank to a gradient of between 1V:3H - 1V:4H (depending on results of geotechnical investigations) which can achieve slope stability and allow the establishment of native riparian vegetation

- Installation of pile fields at the toe of bank to reduce near bank velocity and shear stress
- Installation of large wood, including rootball logs to reduce near bank velocity and enhance fish habitat values
- Establishment of riparian vegetation along the reprofiled bank and overbank zone
- Stock exclusion fencing

These works will provide immediate protection against erosion and help support the establishment of riparian vegetation.

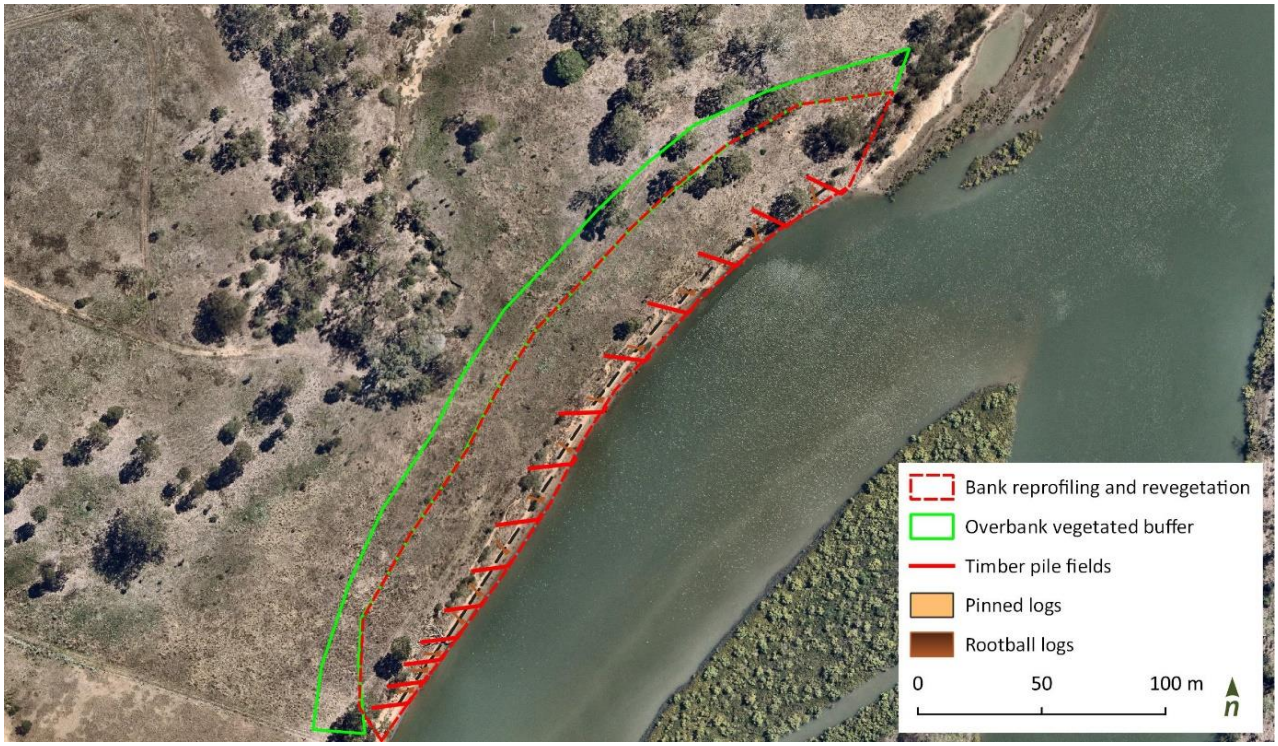


Figure 17. *Conceptual site layout of potential streambank stabilisation works at Site D - Calliope River*

3.5 Site B - Langmorn Creek

Site description and offset opportunity

Site B is located on the upper reaches of Langmorn Creek in the lower Fitzroy River catchment (Figure 15). The site includes an eroding section of the left bank approximately 170 m in length and 5 m high, and an eroding section of the right bank immediately downstream approximately 100 m in length and 5 m high. The banks have experienced significant erosion as a result of meander migration processes. Multi-temporal analysis indicates that the bank retreated up to 50 m between 1999 and 2022 resulting in the mobilisation of approximately 41,500 m^3 of sediment during that period (Fine sediment calculations discussed in more detail in Section 5). Some key observations from the site visit include:

- Vertical to near vertical banks, undercut in some sections
- Bed material largely cobbles gravels and sands
- High variability in bank substrate including sands, sandy clays, clay loams and sandy silty clays
- Presence of a gravel lens at the toe of bank and sections of interspersed gravels through the bank profile
- Several trees at the top of bank with exposed roots, likely to be felled in near future which could instigate further bank failure
- Dominant erosional process is meander migration resulting in erosion of floodplain units
- Erosion likely a result of a combination of fluvial scour and geotechnical failure of undercut banks

- Enough area in the overbank zone to allow for bank reprofiling and significant vegetated buffer
- Closest access via a track directly off Langmorn Road - approximately 2 km from site - track relatively hard given how much rain was received. – *Access track discussed in further detail in 4.4*
- Land manager happy to exclude stock from site during vegetation establishment period. Cattle to be allowed back into the site for short periods to control grass growth and reduce fire risk as necessary after the vegetation establishment period.
- Appropriate spoil disposal locations identified – *Discussed in further detail in Section 4.2*

Figure 18. *Exposed eroding banks at Site B on Langmorn Creek (Photos taken December 2021)*

3.6 Preferred offset opportunity

A summary of potential offset sites inspected including offset opportunity, proposed works, costs, advantages and disadvantages is provided in Table 3. The estimated fine sediment abatement has been calculated using the methodology outlined in the *Reef Trust Gully and Stream Bank Toolbox 3rd Edition* (Wilkinson et. al, 2022) and supporting guidelines provided in the *Stream bank Erosion Control Assessment Tool (SECAT) Survey User Guide, Paddock to Reef Integrated Monitoring, Modelling and Reporting Program* (Humphreys and Wilkinson, 2021). Further details on the estimated fine sediment abatement calculations are provided below in Section 5 page 38 and 39. Based on this information and discussions with GPC, Site B on Langmorn Creek was identified as the preferred fine sediment offset site, with site D as a potential alternative. A fine sediment offset management plan including details on the bank stabilisation works for Site B are provided in the following section.

Table 3. Summary of potential offset sites inspected including offset opportunity, proposed works, costs, advantages and disadvantages

Site	Estimated fine sediment abatement (over 9 year project period - tonnes)	Proposed works	Advantages	Disadvantages
Site B - Langmorn Creek	3,114	Bank reprofiling, timber pile field toe protection, revegetation and stock fencing	- Land manager is engaged and positive about proposed works, including limiting stock access and providing vegetated buffer in overbank zone - Likely much less complex environmental approvals process - Several areas for onsite spoil disposal - Other potential sites on property for potential future offset works	- Most direct and plausible access to site via a 2 km track over the foothills of property. Some track works will likely need to be undertaken before construction works such as grading -*Lantana camara* (Weed of National Significance) present on both sides of bank and will likely require treatment. -Welcome Swallow *Hirundo neoxena* (Marine) nests have been found within the site. A species management plan will need to be implemented to ensure minimum impact on the species in line with legislation requirements.
Site D - Calliope River	3,617	Bank reprofiling, timber pile field toe protection, large wood installation, revegetation and stock fencing	- Close to port - Land manager is engaged and generally positive about proposed works - Land manager is willing to collaborate with local indigenous group for long term monitoring of site.	- Within tidal area, fish habitat area and dugong protection area - Complex environmental approvals process, very difficult to get estuarine works approvals for sediment offset works - Potential for presence of Acid Sulfate Soils (ASS), if found an ASS management plan would be required and treatment of all spoil would be required before disposal which adds costs - Given the height of the bank and sandy nature of substrate, bank reprofiling to stable gradient will result in significant volume of spoil (approximately 36,000 m^3). Limited appropriate areas for onsite disposal of spoil material, some offsite disposal therefore likely which adds costs and becomes difficult for permitting. - Access track will need to be built to divert machinery away from house and some works will be required to improve a creek crossing access. - More costly than Site B

Fine sediment offset management plan

The following sections (Section 4 – Section 9) details the fine sediment offset management plan for 'Site B' situated on Langmorn Creek.

4 Bank stabilisation design

4.1 Design principles

The establishment of remnant standard riparian vegetation will be an essential element in any program to reduce rates of bank erosion on Langmorn Creek. The works aim to create an environment suitable for vegetation to re-establish, to provide natural bank stability and erosion protection in the future.

Vegetation will take time to reach a level of maturity, structural diversity and robustness that allows it to perform its desired erosion control (and other) functions. The change in the function provided by vegetation (e.g. erosion resistance) through time is referred to as its trajectory of change, or trajectory, and is illustrated conceptually in Figure 19. The critical shear stress of the bank surface will increase over time as the vegetation establishes. Initially after the planting works you would expect good groundcover after one year and structural diverse mature vegetation after approximately 10 years.

Based on the geomorphic assessment, there is a risk of failure in the vegetation establishment period, particularly at the toe of the bank, where the hydraulic forces are largest. This risk is minimised through the use of structural protection works.

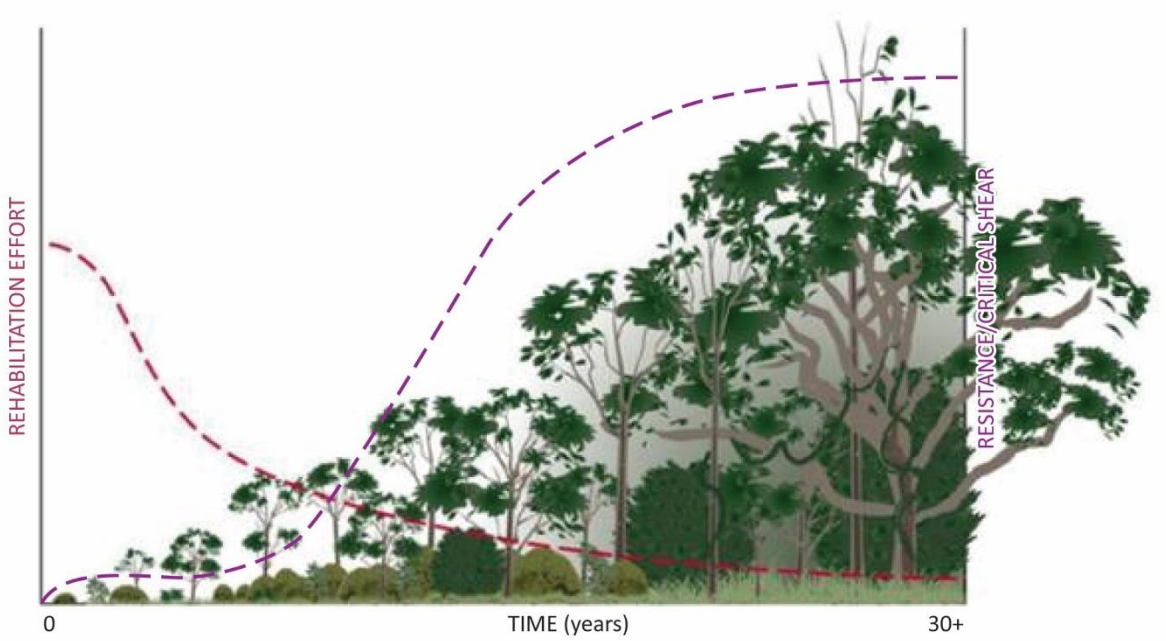


Figure 19. *Progressive long-term improvement in river health and erosion resistance with gradual reduction in rehabilitation effort (source: Department of Sustainability and Environment (2004)*

The structural toe protection works to be utilised at Site B to protect the bank revegetation works during the establishment period are pile field groynes. The pile fields will provide short-term erosion protection by reducing near bank velocity and shear stress which provides an environmental suitable for vegetation establishment. As the piles decay (over 10-15 years) the vegetation and associated root networks can help reduce rates of bank erosion through a range of mechanisms:

- The root networks of riparian trees strengthen bank substrate through structural reinforcement and tend to resist mass failure.

- Vegetation increases hydraulic roughness, which reduces near bank velocities. The shear force exerted against the bank is thus reduced.
- Groundcovers are flattened during flood events which protects the underlying sediments from hydraulic forces.

The current bank erosion processes and trajectory following the implementation of the pile fields and revegetation is shown in Figure 20.

An overview of the bank stabilisation works to be undertaken at Site B on Langmorn Creek are outlined in the following sections.

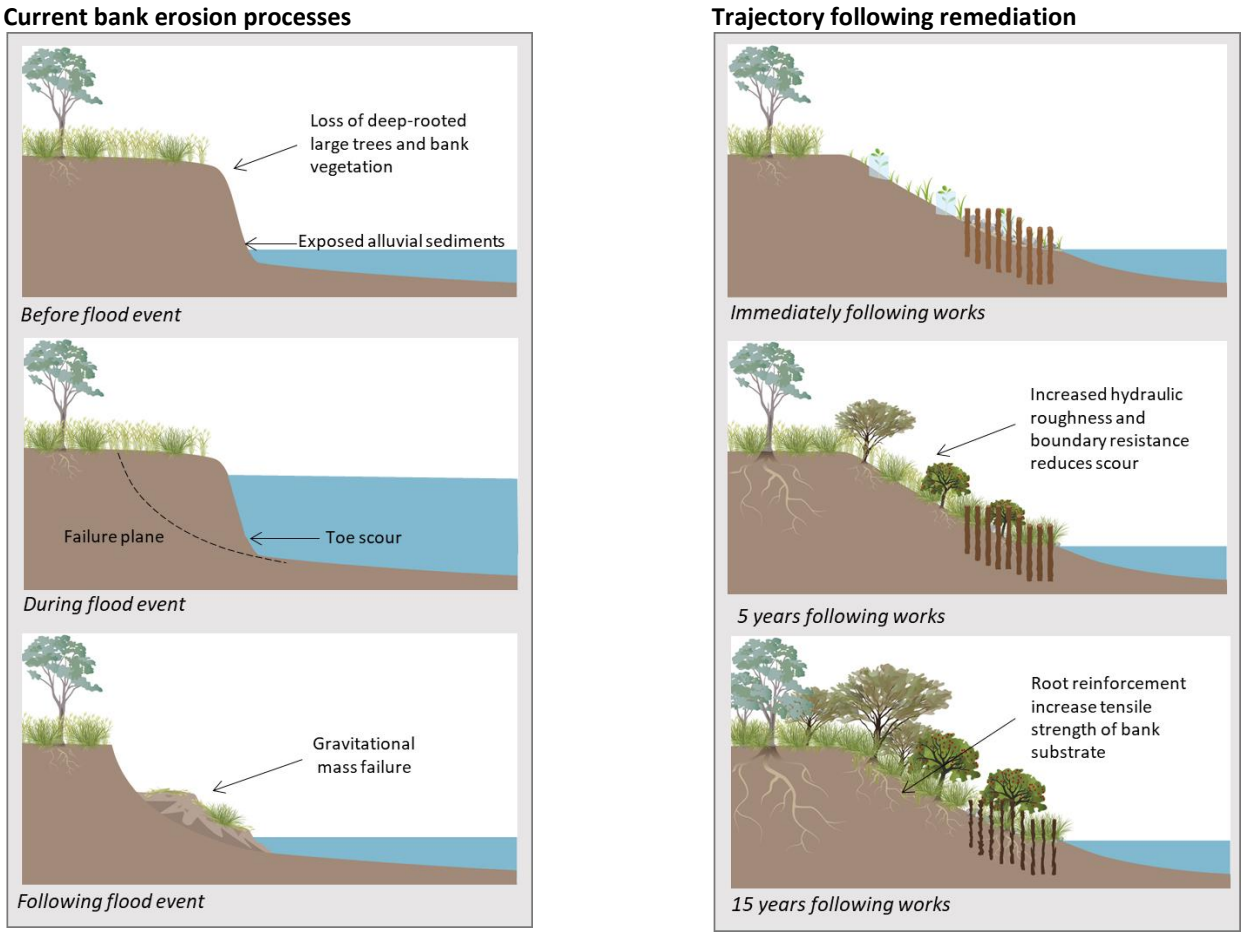


Figure 20. *The current bank erosion processes are shown on the left side, the trajectory of the site following restoration works are shown on the right side*

4.2 Bank stabilisation works

The bank stabilisation works to be undertaken at Site B include bank reprofiling, pile field toe protection, and vegetation establishment. The works are presented in plan view in Figure 21 and conceptual cross section views in Figure 22. The recommended works include:

- Reprofiling the near vertical bank to a gradient of 1V:3H which can achieve slope stability and allow the establishment of native vegetation
- Installation of pile fields at the toe of bank to reduce near bank velocity and shear stress
- Establishment of riparian vegetation along the reprofiled bank and overbank zone, including immediately upstream of reprofiling works to link with upstream corridor of good vegetation

- Facilitated revegetation through the extended reach corridor adjacent to the structural bank stabilisation works (total reach length ≈ 1.5 km). The extended revegetation works aims to reinstate a biodiverse riparian zone that is much more resilient to future flood events providing long term stability to the reach.
- Installation of stock exclusion fencing

These works will provide immediate protection against erosion and help support the establishment of riparian vegetation. The aimed trajectory of the works is shown in Figure 21.

Each component of the works is discussed below.

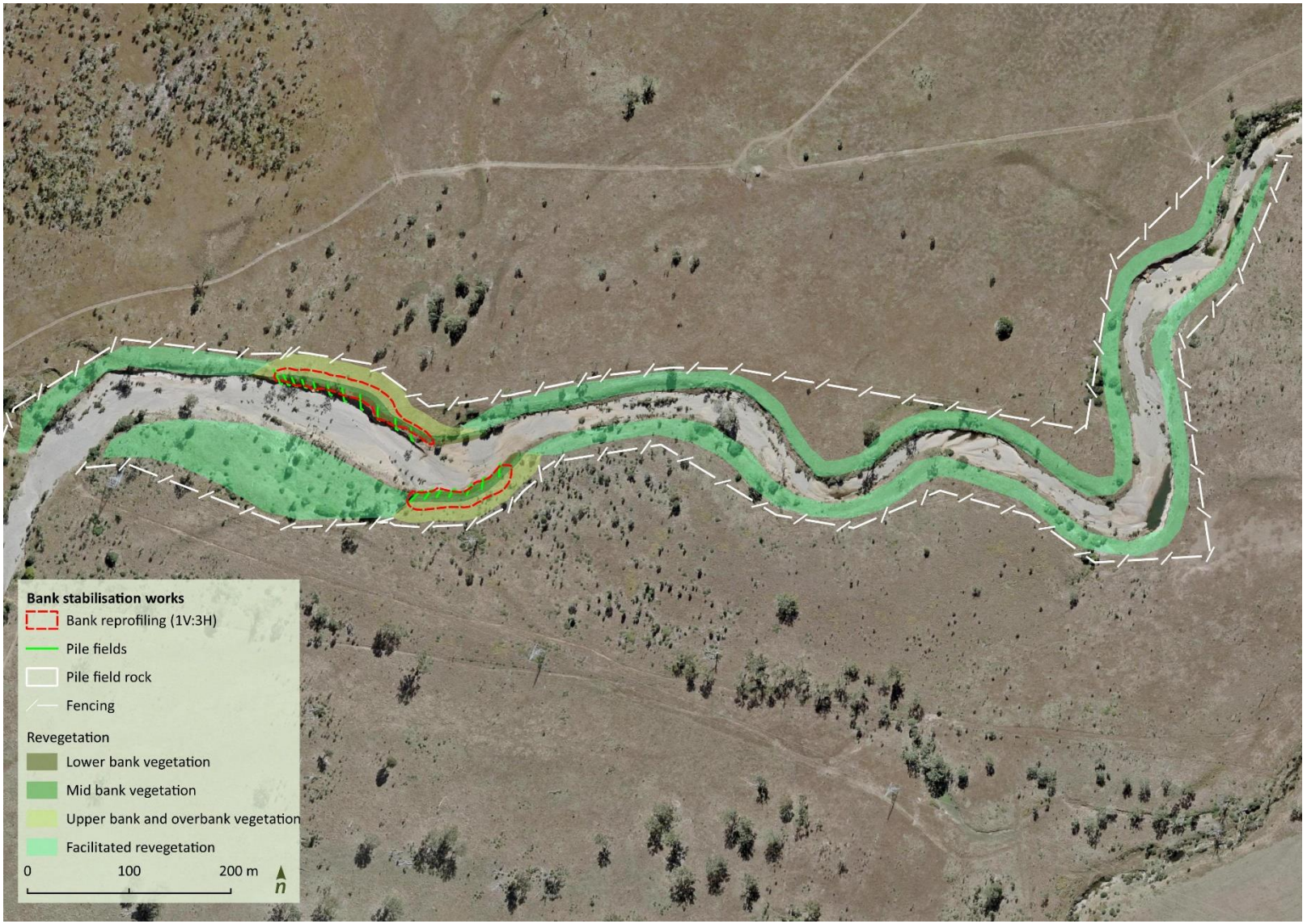


Figure 21. *Stabilisation design plan view – Bank reprofiling, revegetation and pile fields*

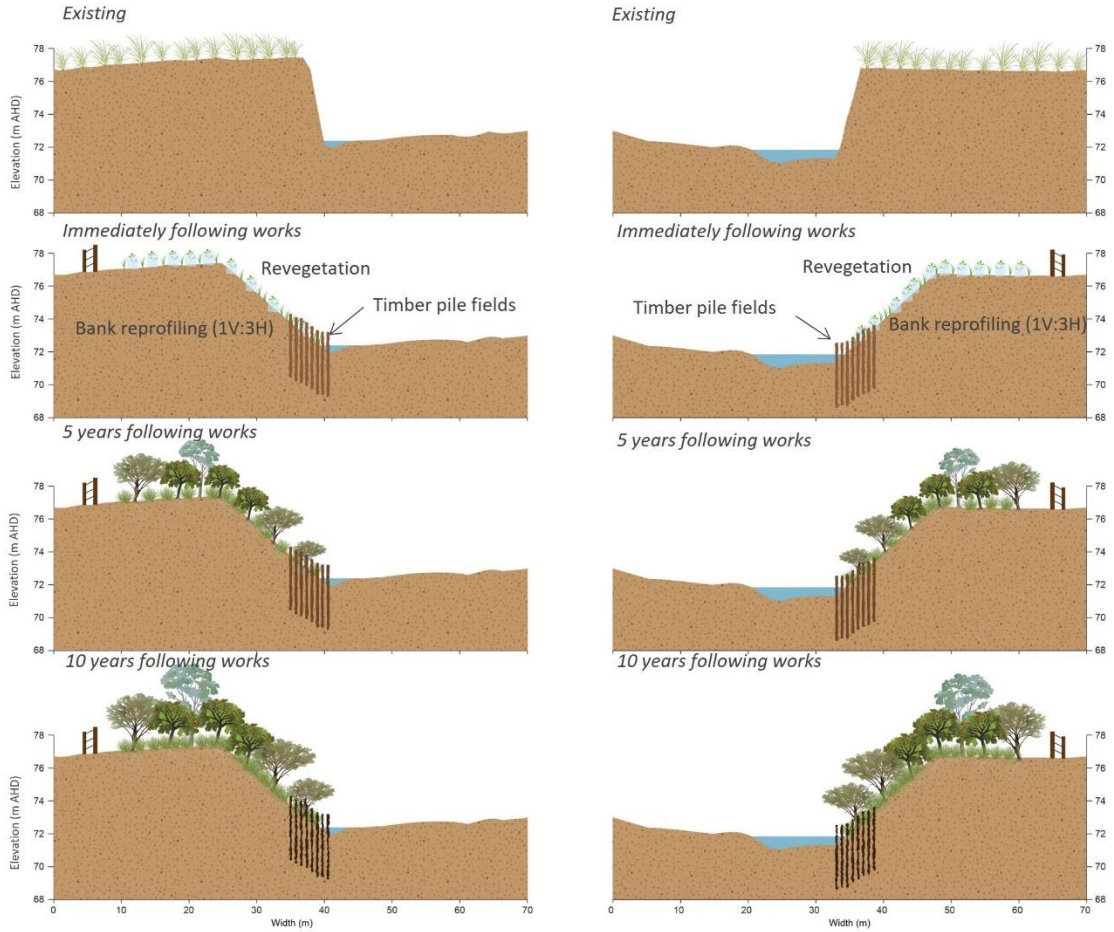


Figure 22. *The current bank, typical section and trajectory following the implementation of the proposed works - Left bank (left) right bank (right)*

Bank reprofiling

Bank reprofiling works are to be undertaken where the existing bank slope is near vertical, exposed and actively eroding. On the left bank, the length of bank reprofiling required is approximately 170 m and approximately 110 m on the right bank (Figure 23). The reprofiled bank has been designed at a slope of 1V:3H which is likely to achieve slope stability and allow the establishment of native vegetation.

An example of a typical reprofiling cross section is presented in Figure 25. It is estimated that a total of 6,760 m^3 of material will be produced as a result of the earthworks from both banks. A suitable location for the disposal of this material has been identified in consultation with the land manager. The spoil is to be placed in a depression either side of an access track that runs east-west approximately 200 m north of the site. The disposal area is approximately 980 m in length and fill will be spread approximately 10 m either side of the track at a depth of approximately 0.3 m (see Figure 24). The existing vegetation in this location is limited to isolated trees that will not be disturbed by the spreading of material The spoil zone will then be grassed. Extensive desktop and field surveys have been completed on site to assess any potential impacts to threatened species and Matters of National Significance (MNES). Whilst squatter pigeons were a potential concern from desktop analysis, field surveys showed no squatter pigeons resided within the project impact area. Further details of these surveys can be found in section 4.6.

Topsoil will be separated and stockpiled during the earthworks. A 300 mm layer of topsoil will then be placed on the reprofiled bank prior to the installation of erosion matting. It is estimated that topsoil demand at

300mm across the reprofiled surface is 1,100 m^3. There is approximately 4,000 m^2 of intact topsoil within the designed disturbance footprint at an average depth of 200mm. Ripping and stripping of this topsoil will yield approximately 800 m^3 of the required demand. The balance required to meet the demand will be sourced from the upper 150 mm of subsoil. Soils analysis indicates nutrient deficiencies, and it is therefore recommended a fertilizer blend be incorporated into the topsoil following placement (refer to Section 3.2 in Appendix A for fertilizer blend requirements and application rates).

During and immediately after the clearing and earthworks stages of construction there is risk of short-term erosion of the exposed banks either from overland flow or high channel flows. The first way to manage this risk is through appropriate sediment and erosion control measures and undertaking construction at the appropriate time of year where the risk of significant rainfall is at its lowest. The '*Best Practice Erosion and Sediment Control*.' Guidelines developed by the International Erosion Control Association (IECA, 2008) provides an erosion risk rating procedure for ephemeral channels where flow is directly related to rainfall (such as Site B) based on average monthly rainfall. Rainfall data accessed from the Bureau of Meteorology (BOM) at the nearby rainfall gauge at Bajool (39002, gauge data from 1912 - 2021) was used to provide an erosion risk rating for the site. Based on these results (Table 4 and Table 5) and experience in constructing similar works in the region the lowest risk months to undertake the construction phase will be between July and September.

The earthworks will ensure drainage from the local catchment is not conveyed across the reprofiled bank. This may require small earth bunds to redirect runoff to the river away from the proposed works (i.e. downstream of the works). No ponding of water is allowed within 15 m of the top of the reprofiled bank. Once topsoil is laid, erosion matting such as coir mesh or equivalent will be installed to the manufacturer specifications prior to revegetation works (example shown in Figure 26) to further reduce risk of short-term erosion.

Figure 23. *Approximate extent of proposed bank reprofiling works*

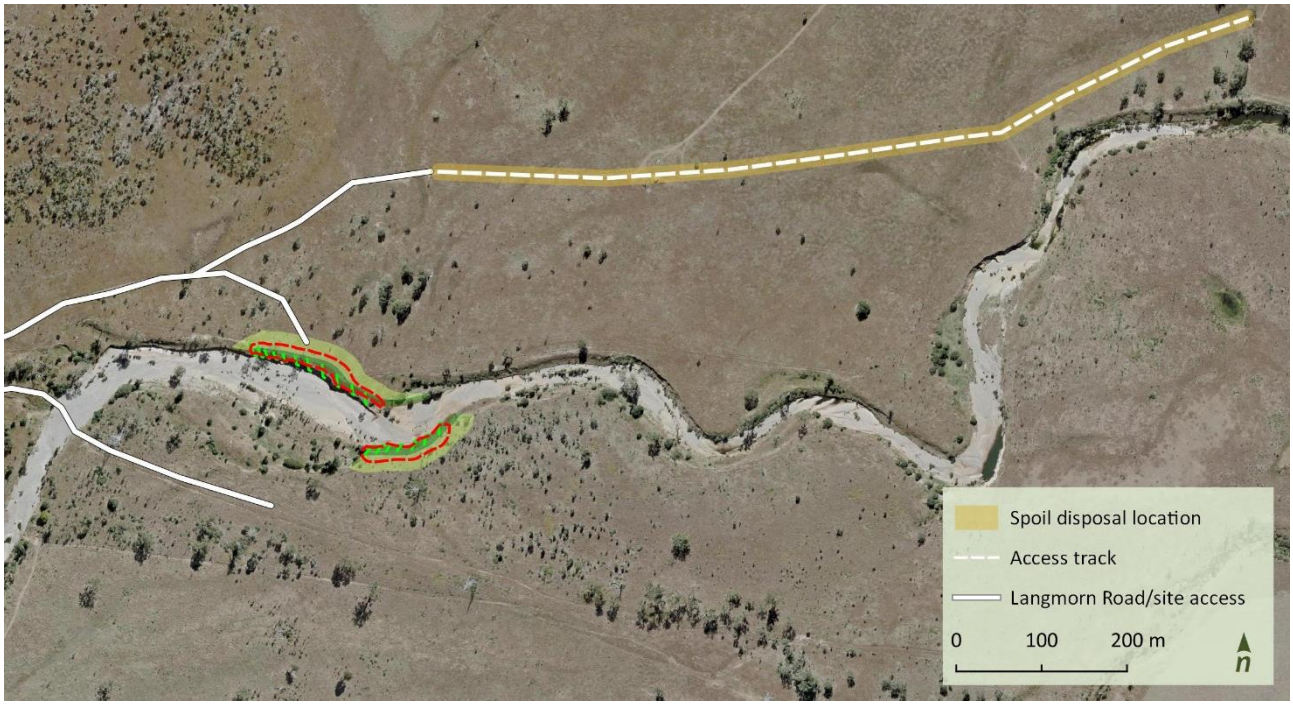


Figure 24. *Spoil disposal location*

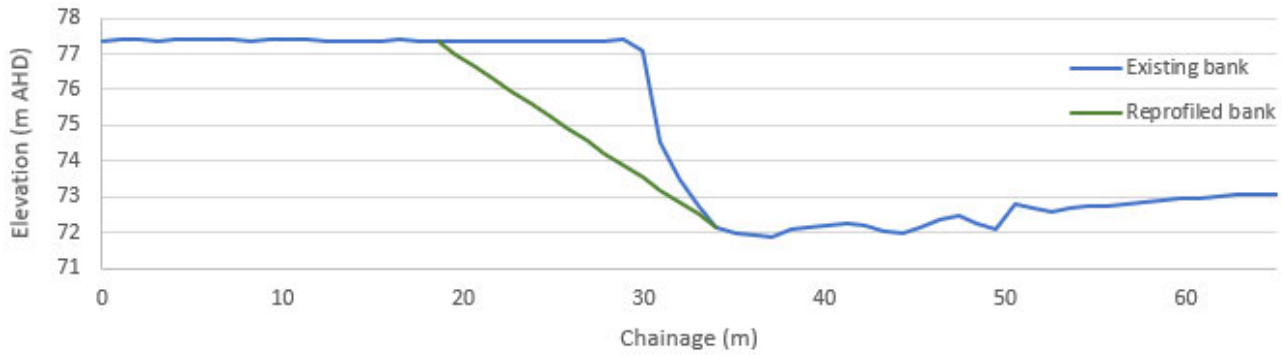


Figure 25. *An example of a typical cross section of the bank reprofiling works required at Site B*

Figure 26. *Example of coir mesh installation on the Mary River*

Table 4. Erosion risk rating based on average monthly rainfall (adopted from IECA, 2008)

Erosion risk rating	Average monthly rainfall
Very low	0 to 30 mm
Low	30 to 45 mm
Moderate	45 to 100 mm
High	100 to 225 mm
Extreme	> 225 mm

Table 5. Erosion risk rating based on average monthly rainfall at Bajool (IECA, 2008)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	138	139	90	40	39	40	34	24	22	52	71	107
Erosion risk	High	High	Moderate	Low	Low	Low	Low	Very low	Very low	Moderate	Moderate	High

Pile fields

Pile field toe protection will assist in reducing the likelihood of scour along the lower bank and provide protection to the vegetation establishment along the lower bank. The pile fields will reduce shear stress in the lower bank zone which will promote sediment deposition and provide favourable condition for vegetation establishment (Figure 27).

Figure 27. *Example of pile field groynes protecting revegetation works*

Pile fields have been designed using the notional lines of attack approach outlined in the *Technical Guidelines for Waterway management (*DSE, 2007). The pile fields are spaced 7.5 m apart at the upstream end and 20 m at the downstream end and have a length ranging from 8 to 18 m. The first two pile fields extend higher up the bank to reduce the risk of outflanking.

The individual piles will have a minimum length of 6 m and maintain a minimum embedment depth of 3 m below the design surface. The length of the last four piles (bank side) can be reduced to 3 m in length as the reduced height tapers to the design surface from 1.5 m. All piles will have a minimum diameter of 300 mm. The maximum exposed pile length is 1.5 m.

Once the piles have been installed a 1 m wide, 900 mm deep layer of rock protection will be placed on both sides of each of the first four pile fields to protect against scour. The scour risk is greatest for these upstream pile fields, beyond the fourth pile field the shear stress will be reduced sufficiently to limit the scour risk. For the subsequent pile fields, scour protection rock will be installed at 1m wide on both sides to a depth of 300 mm.

The piles will have a short life span (approximately 10 years) however within 10 years they will have allowed vegetation establishment along the lower bank which can provide the long-term protection against erosion. An example of the typical pile field arrangement is presented in Figure 28.

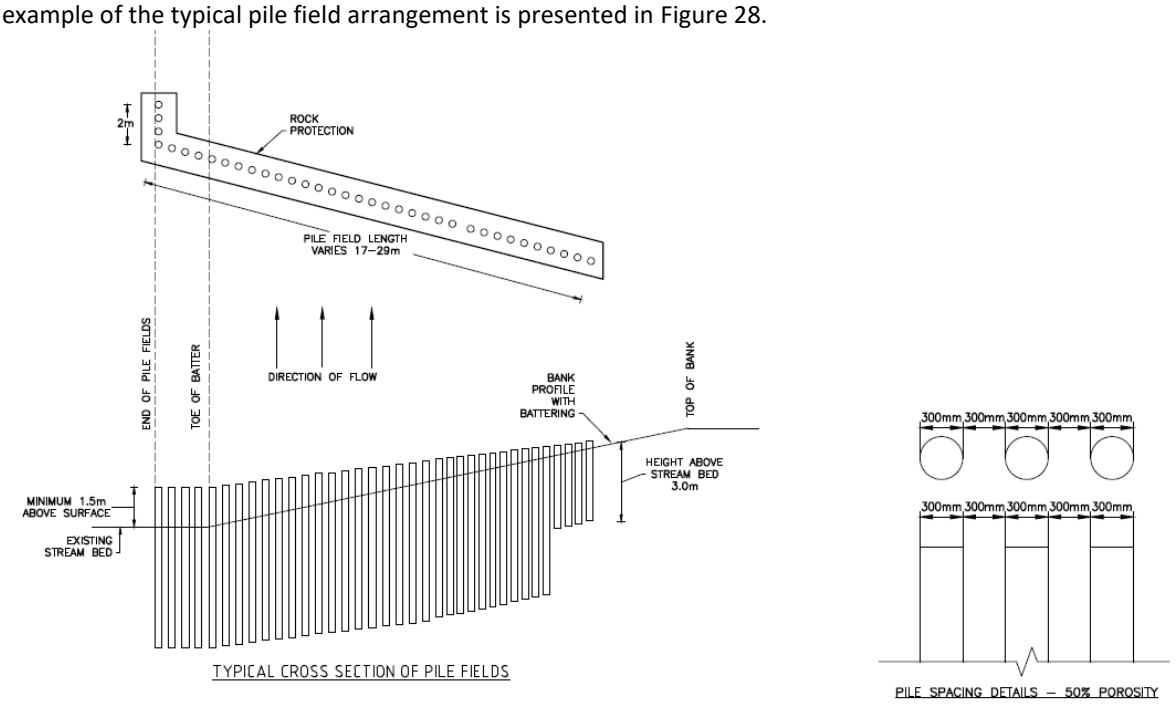


Figure 28. *Typical pile field arrangement and cross section*

4.3 Revegetation works

Revegetation of the reprofiled surface, between the pile fields and along the top of bank is a key component to ensure the long-term success of the works at all sites. The reprofiling and revegetation will further reduce the risk of outflanking of the pile fields and hence increase the likelihood of success of the works. A gradient of 1V:3H is a suitable slope for the establishment of native vegetation including groundcovers, shrubs, and large trees.

A detailed revegetation design/plan has been developed for the site is included in Appendix A and is summarised below. The revegetation aims to encourage the rapid establishment of a vegetation community that contributes to bank stability, and a stable landscape that can tolerate creek flows and periodic inundation from Langmorn Creek and is representative of the surrounding riparian community. Revegetation planting works will proceed as soon as practical after civil works are completed. However, the revegetation contractor/project manager will work with the civil works contractors in the revegetation planning (including soil management and amelioration), procurement (of seed, seedlings etc.) and management to ensure effective delivery of revegetation works.

Revegetation management zones have been delineated into seven discrete zones as outlined below in Figure 29, Figure 30 and Table 6. The soil preparation and management, fertilizing requirements, seeding and planting species/rates/methods and watering requirements have been developed for each zone and are outlined in detail in Appendix A.

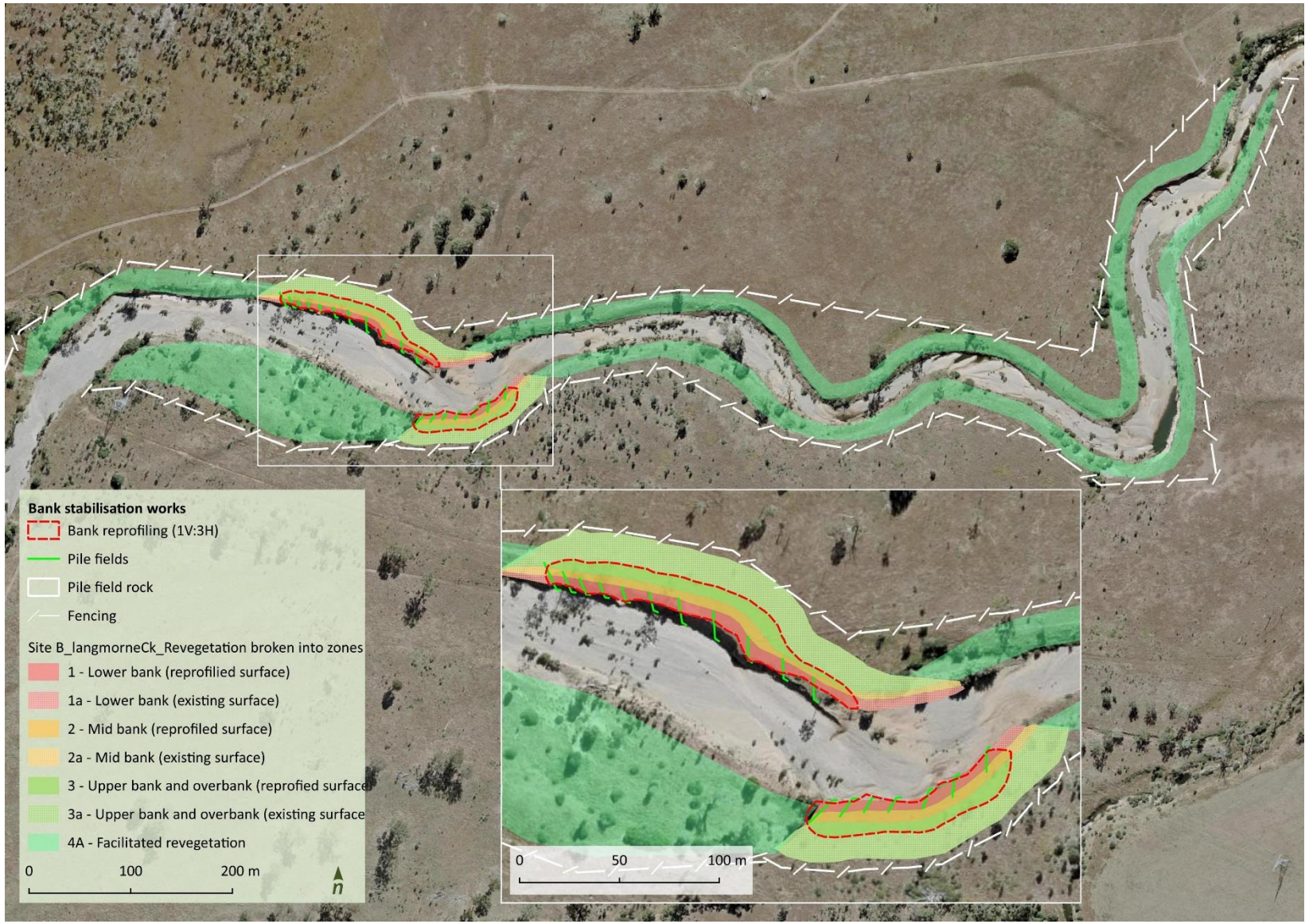


Figure 29. *Revegetation management zones*

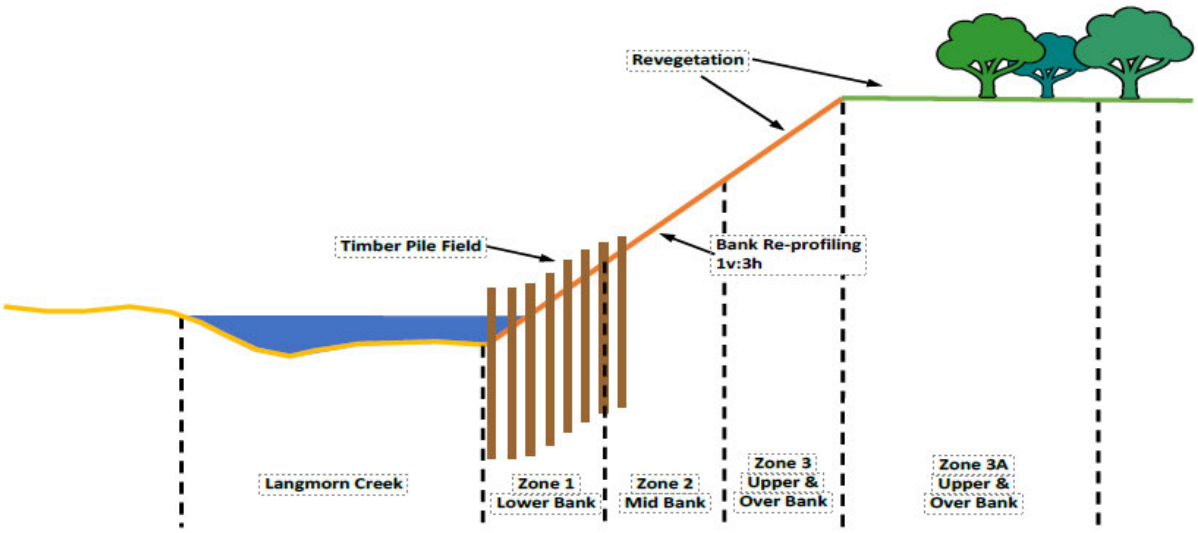


Figure 30. *Typical section schematic showing the revegetation management zones*

Table 6. Revegetation management zone areas

Zone	≈ Area (m²)
1 – Lower bank (reprofiled surface – gradient 1V:3H)	1,300
1a – Lower bank (existing surface)	400
2 – Mid bank (reprofiled surface - gradient 1V:3H)	1,300
2a - Mid bank (existing surface)	100
3 – Upper bank and overbank (reprofiled surface – gradient 1V:3H)	1,300
3a – Upper bank and overbank (existing surface)	5,300
4a – Facilitated revegetation	56,700

The intent is to reinstate a biodiverse riparian zone that is resilient to future flood events. A detailed revegetation maintenance and monitoring program has been developed and is outlined in Appendix A and is included in the overall monitoring strategy provided in Section 6. With implementation of the maintenance program a good coverage of the bank would be expected in the first one or two-years following establishment. Stock exclusion will also be enacted to allow for successful establishment of vegetation. Discussions with the land manager indicate no issues with stock exclusion from the site during and potentially beyond the project life (9 years following construction). When vegetation is well-established, and there is no longer a risk to the engineering structures, short periods of dry-season grazing may occur within the fenced area to manage fire risk or vegetation composition. Stock exclusion conditions will be included within formalised agreements with the land managers. These agreements are formal contracts outlining duration of the agreement specified by GPC and DCCEEW, land manager responsibilities and site conditions needed to uphold for river stablisation work to be funded on the property. A copy of the approved fine sediment offset plan will be provided to the land manager and included within the signed contract document.

4.4 Site access

The most direct and appropriate site access for further site assessments and construction extends from the western extent of the property boundary at Langmorn Road and is approximately 2 km to the site (Figure 31). A site inspection and constructability assessment was undertaken by FBA and Alluvium staff, and civil works contractor on the 30th of August, 2022. The track appears to be largely in a moderate to good condition, site visits coincided with a significant rainfall event and the track base remained firm (examples of track condition

are presented in Figure 32). The access track is suitable for access of all the required equipment in and out of the site with some minor maintenance work to be undertaken including:

- Light grading for daily use during construction
- Line the main hill (highlighted in blue) with fresh gravel to reduce risk of light vehicles getting stuck if heavy rain occurs
- Installation of 'Whoa-boys' on the main hill at completion of project to divert road runoff to stable location

Figure 31. *Existing access to site from Langmorn Road*

Figure 32. *Photos showing the condition of the existing access track to the site from Langmorn Road*

4.5 Construction management

The works have been designed to limit hazards during construction and post implementation works. The works can be constructed safely providing the risks of working adjacent to a shear bank and working in and near water are accounted for. This includes limiting slopes to those which are safe to operate machinery and monitor and maintain vegetation. Minimum safety standards for working within these site conditions include:

- A recommendation that no personnel or plant work within 5 m of the crests of the riverbanks. It is envisaged that any material required as fill would likely to be 'pushed' to the toe from above, with all spoil 'pulled' back.

- Excavations within the natural soils are expected to be achievable using conventional earth moving equipment such as tracked excavators with toothed buckets or small dozers. The proposed permanent bank batters of 1V:3H need to be confirmed as acceptable from a geotechnical viewpoint as a part of detailed designs.

The development and implementation of a safe work method statement will ensure the safety of contractors during the construction phase. It is recommended that the contactors and the engineer agree on a safe work method statement prior to commencement of the works. A Safety in Design report will be prepared for the works as a part of the detailed design. In addition, guidance by the design engineer will be provided during the construction of the proposed works. Note that it is the contractor's responsibility to ensure all underground services have been located prior to the commencement of works.

4.6 Additional Stakeholder and traditional custodian engagement

Additional stakeholders identified as necessary for project engagement in the initial planning stage were the Port Curtis Coast Trust (PCCC) and Gladstone Regional Council (GRC).

PCCC represents the traditional owners of the First Nations Bailai, Gurang, Gooreng Gooreng, Taribelang People Native Title Claim Group and provides administrative and operational support for the Registered Native Title Prescribed Body Corporate (RNTPBC or PBC). Their region includes traditional country spanning across the Bundaberg, Gladstone and North Burnett regions, and covers all properties identified as offset opportunities in this plan. Engagement with PCCC took place to discuss cultural values present on potential offset sites, provide the opportunity for the Traditional Custodians to gain an understanding of the project, and convey need for their involvement in future on-ground cultural assessments.

GRC is the relevant local government authority body for the proposed area of sediment offset works. FBA provided council with an overview of the project, to ensure project awareness and knowledge of the environmental benefits. The opportunity was also provided for council to raise any issues they felt may impact offset works. Involving as many relevant stakeholder groups as possible in the early planning stage of the offset builds foundations for strong relationships that aid in achieving sustainability, longevity, quality, and effectiveness of project outcomes. It also provides the opportunity for offset project works to be considered from a variety of social, cultural, and legislative angles, decreasing likelihood of issues that could impact works being overlooked.

4.7 Approvals

All environmental approvals necessary for on ground works will need to be determined through the State Assessment Referral Agency (SARA) of the Queensland Government. This will require the project to be lodged on their online system with approvals potentially taking up to 6 months.

Information required for this approval process will be location and description of works, and evidence of any potential impacts to;

- Stream connectivity (i.e barriers in fish habitats)
- Protected Wetlands and watercourses
- Threatened species
- Essential habitat of native species (e.g removal of nests or trees with hollows)
- Regulated vegetation (Category B, C, R and Riverine)
- Critical fish habitat
- Any other Matters of State or National Significance
- Sites of Cultural Heritage

A desktop analysis was performed to check for any impacts to those listed above. The desktop assessment included a cultural heritage database assessment (See Appendix C), reviews of State and Commonwealth databases and map layers to identify records or potential occurrences of species of conservation significance including Least concern and special Least concern animals, vegetation type, areas of remnant vegetation, threatened ecological communities, wildlife habitat and any other biodiversity value. From desktop analysis the likelihood of vulnerable squatter pigeon *Geophaps scripta scripta* occurrence promoted site environmental assessments to determine any potential impacts (full survey methodology can be found in Appendix B). On-ground cultural heritage surveys were also completed, to provide as evidence in preparation for the lodgement with SARA.

No Squatter Pigeons were identified as present on the project site and all other species were listed as Least Concern. Welcome Swallows *Hirundo neoxena* listed as Marine were found within the site and their nests found within the bank of the eroding riverbank wall in two sections on the construction site (Figure 33). Due to this species being listed as Special Least concern and a colonial breeder, specific actions (outlined in Table 7) will need to be implemented to ensure as minimal as possible disturbance to the species and/or safe relocation of active nests. The location and position of the nests on an undercut of the bank wall suggests that if remediation activities did not occur these nests would likely be lost during the next high rainfall event. It is therefore highly likely that the nests may no longer be present on the riverbank when construction activities are to take place. No other MNES were identified during field surveys.

Cultural Heritage assessments were completed on the 20th of September 2022 by PCCC's Senior Cultural Heritage Field Officer. No objects or places of cultural heritage significance were located during the inspection of the project area streambank and streambed (Langmorn Creek, Lots 11 and 42 DT40168) (See Appendix C).

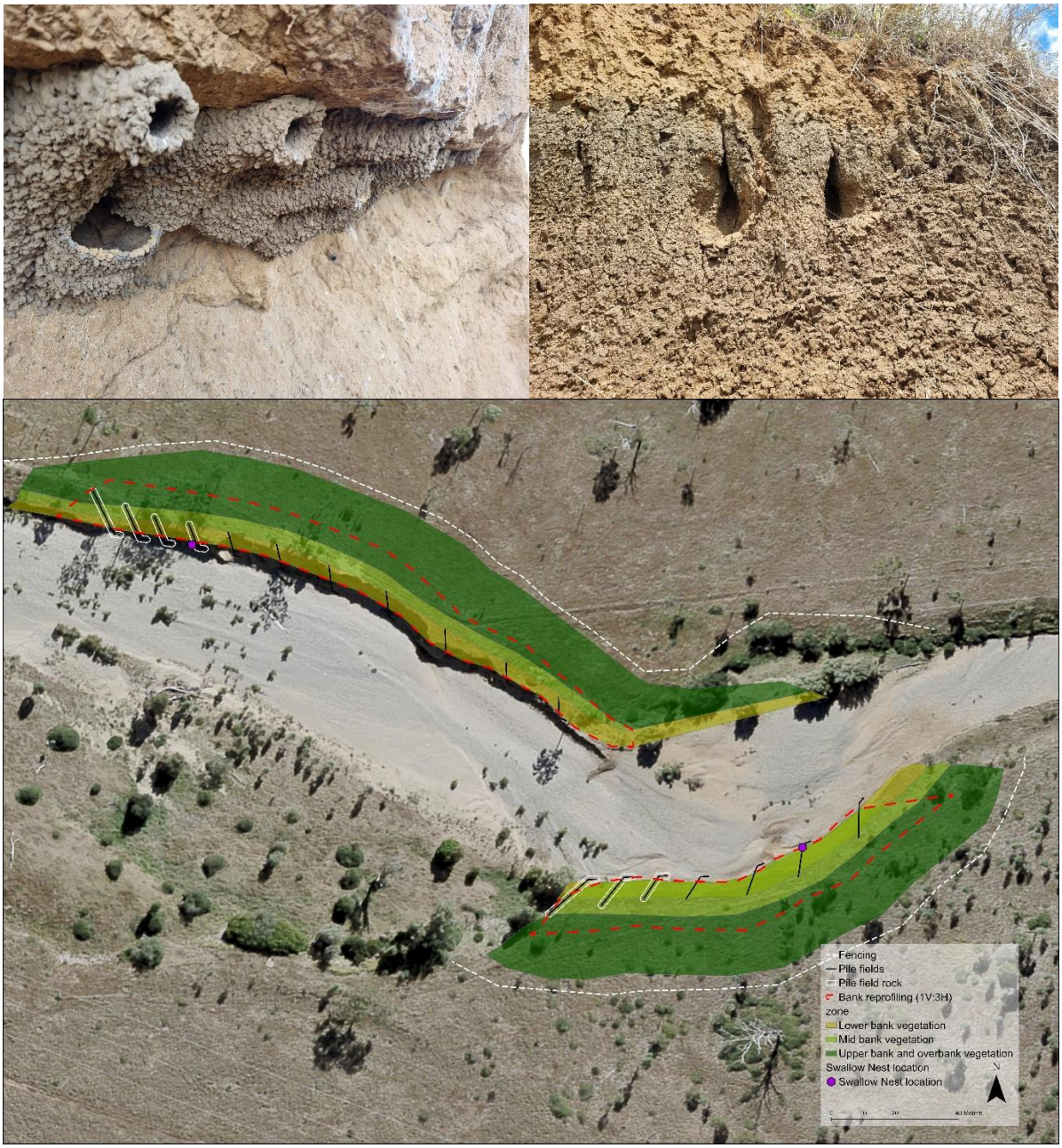


Figure 33: Location and Images of Welcome Swallow *Hirundo neoxena* nests taken during fauna surveys completed on the 15th (top left) and 29th (top right) of September. Mud structures were found on the northern bank with large undercutting bank walls predicted to collapse with the next high rainfall event. Nests dug into the side of the southern bank were not present at the beginning of fauna surveys but appeared within the week between the fifth and final survey.

Table 7. Management actions to limit disturbance to any animal breeding places at riverbank restoration works at Site B.

Management Actions	Responsibility
Construction Site Access Management Actions	
During all stages of preconstruction planning, construction and maintenance access to the construction site vehicle speed will be limited to 15km/h within 300m of the site to minimise the risk of vehicle strike to fauna.	GPC, FBA and all Contractors and subcontractors
All vehicles entering the site will be washed prior to entry in accordance with FBA policies. Details of all vehicles entering the site to be recorded in the visitors record book.	GPC, FBA and all Contractors and subcontractors
To minimise noise disturbance and the risk of wildlife strike by vehicles accessing the site construction will be limited to the hours between 6.00am and 6.00pm.	GPC, FBA and all Contractors and subcontractors
Construction Site Management Actions	
Welcome Swallow *Hirundo neoxena* nest mitigation actions are carried out in the following order. 1. A pre-construction site inspection to be conducted by a suitably qualified ecologist to re-confirm nest locations and ensure any new nesting sites are captured. These sites will be recorded in an Animal breeding place register 2. Just before construction begins a fauna spotter /catcher is to check nesting sites for any active nests. These will then be relocated to a suitable location on the property. Only designated and trained personal will be allowed to handle fauna. 3. Peak construction activity to occur between May and July to avoid the breeding period of August to March. 4. A fauna spotter /catcher will be present on-site during construction activity to ensure nests are not rebuilt within the construction area and monitor relocated nests. 5. Post project monitoring to determine species recolonises area once works are complete. 6. All records are provided to DES on project completion and/ or as requested during project implementation	GPC, FBA, FBA Ecologist, Fauna Spotter Catcher and all Contractors and subcontractors
Locate temporary and permanent structures or laydown areas within cleared or non-remnant vegetation areas to avoid disturbance to remnant vegetation.	GPC, FBA and all Contractors and subcontractors
A pre-construction site inspection to be conducted by a suitably qualified ecologist to identify habitat features (e.g. tree hollows, logs, rock piles) that may be impacted by construction. If located in the construction area they will be; a) clearly marked and not interfered with or b) or carefully moved to suitable adjacent habitat.	FBA Ecologists

Management Actions	Responsibility
Peak construction activity to occur between May and July to avoid the breeding season for the majority of animals that are likely to breed in the area. Limited activity pre and post site inspections or watering of revegetation areas will occur outside of these months.	GPC, FBA and all Contractors and subcontractors
Construction will include the targeted removal of up to 25 trees which will be identified by the Site Engineer and inspected by FBA Ecologists prior to removal. A fauna spotter /catcher will be present during all tree removal operations.	Site Engineer, FBA Ecologist and Fauna Spotter Catcher.
If any animal or animal breeding place is detected during any phase of construction a fauna spotter /catcher will relocate the animal / breeding place if required.	Site Engineer, FBA Ecologist and Fauna Spotter Catcher.
An Animal breeding place register will be maintained by FBA for the duration of the project and any post-construction activities. This register will be made available to DES on request and will be updated if any animal breeding is located or tampered with.	GPC, FBA and FBA ecologists
Only designated and trained personal will be allowed to handle fauna under a limited range of circumstances. This may include assisting any native animal trapped/stranded within the construction area. Any animal requires care or treatment a veterinarian or licenced wildlife carer will be contacted. Suitable records of any incidents with native wildlife will be kept by FBA.	Fauna spotter Catcher, FBA and FBA Ecologists
To minimise the risks of weed introduction and spread site weed assessment will be conducted before construction commences. Where appropriate weeds will be chemically treated or manually removed where appropriate before commencing construction.	GPC, FBA and all Contractors and subcontractors
Management of waste to discourage fauna entering the construction site.	GPC, FBA and all Contractors and subcontractors
Ensure that the construction work area does not provide nesting or shelter sites (e.g. material stockpiles).	GPC, FBA and all Contractors and subcontractors
Disturbed areas will be stabilised as soon as possible, including wetting down to minimise dust generation. Site to be revegetated as soon as practical after construction in accordance with the site revegetation plan (Veterra 2022).	GPC, FBA and all Contractors and subcontractors
Sediment impacts from construction to adjacent habitat areas to be avoided with appropriate construction techniques.	GPC, FBA and all Contractors and subcontractors
Management Actions for Adjacent Areas	
The site will be cleaned up and rehabilitated to a high standard including replanting in riparian areas (trees and understorey species). Areas disturbed by machinery will be raked and all unused materials and equipment will be removed from the works site.	GPC, FBA and all Contractors and subcontractors

Management Actions	Responsibility
Construction to occur between April and July to avoid the breeding season for the majority of animals that may occur in the area.	GPC, FBA and all Contractors and subcontractors
A buffer zone (of at least 20m) will be maintained around identified breeding habitat. All buffer zones will be identified to construction personnel prior to the commencement of works.	GPC, FBA and all Contractors and subcontractors
Noise and activity at work locations adjacent to breeding places is to be kept to a minimum. Construction work to occur between the hours of 6.00am and 6.00pm.	GPC, FBA and all Contractors and subcontractors

5 Fine sediment abatement

The estimated fine sediment abatement has been calculated using the methodology outlined in the *Reef Trust Gully and Stream Bank Toolbox 3rd Edition* (Wilkinson et. al, 2022) and supporting guidelines provided in the *Stream bank Erosion Control Assessment Tool (SECAT) Survey User Guide, Paddock to Reef Integrated Monitoring, Modelling and Reporting Program* (Humphreys and Wilkinson, 2021). The key steps involved in the methodology and a summary of the data used, source of data and key assumptions are summarised below.

1. Determine historic erosion rate
2. Determine baseline erosion rate
3. Calculate sediment yield
4. Calculate total fine sediment reduction at the coast

Historic erosion rate

There are two methods outlined in the SECAT user guide to determine the historic rate of erosion at a streambank site – the ''Recent period method'' and the ''Catchment modelled'' method. The Recent period method is considered a more accurate approach and will be utilised when appropriate data is available. The recent period method (as outlined Pg 10 of SECAT user guide) assesses the erosion rate (change in stream bank location) over a set period (ideally between 20-30 years) using either a digital elevation model (DEM) or historical aerial imagery, or a combination of the two.

At Site B, high resolution LiDAR data (0.2m resolution), captured in August 2022, was compared with aerial imagery from 1999. To determine the historic erosion rate. The erosion volume was estimated by delineating the top of bank from each dataset and determining the change in bank location between 2022 and 1999 (23-year period). The height of the eroded bank was estimated by taking the average stream bank height across the erosion site which was calculated across regular cross sections (every 1 m) taken from the 2022 LiDAR. When calculating the left bank erosion site the bank was split into two zones to account for transition to lower bank height. The historic comparison, including an example of a typical cross section, is presented in Figure 34. The volume was estimated based on the product of the eroded area and the average height of eroding bank. The total volume of sediment mobilised between 1999 and 2022 is estimated to be 41,595 m^3 or an annual average sediment loss of 1,808 m^3/year.

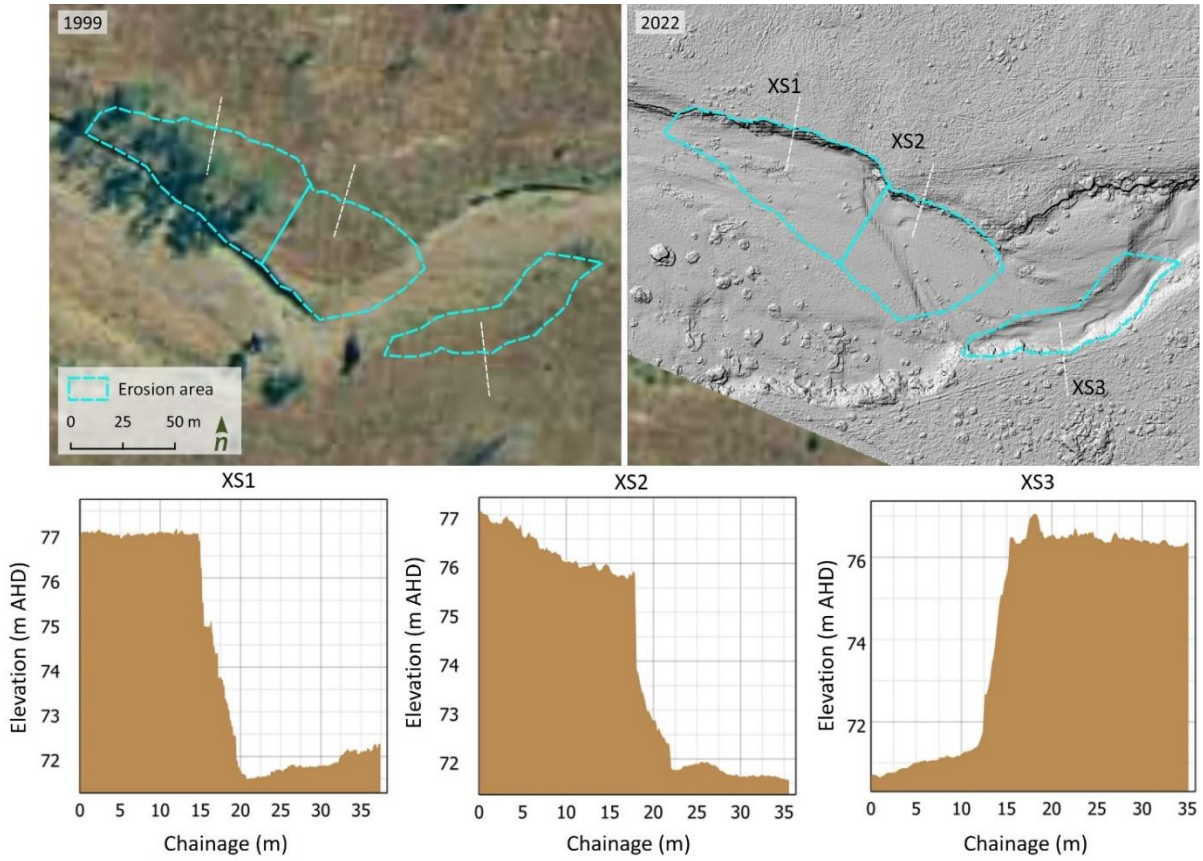


Figure 34. *multi-temporal analysis used for historic erosion rate calculations*

The current bank condition at the site consists of steep, near vertical outside meander banks with exposed sandy loams to sandy clay alluvial sediments. As a result, in the absence of management intervention, ongoing bank retreat would be expected through a process of toe scour and subsequent gravitational mass failure.

Baseline erosion rate

The baseline erosion rate is defined as the rate of erosion that would likely occur in future years in the absence of any management intervention (Humphreys and Wilkinson, 2021). The baseline erosion rate is derived from the historic erosion rate and a suitable adjustment for climate variability using a climate correction factor. The climate correction factor for stream bank erosion is derived by considering the ratio between long term average streamflow conditions and the average streamflow conditions over the historic erosion period used in calculating the historic erosion rate.

To calculate the climate correction factor two erosivity measures based on streamflow metrics were considered based on the nearest available stream gauge recording station.

1. ***The Mean-annual discharge (m^3/s)*** : Climate correction factor = Long-term mean annual discharge/historic erosion period mean annual discharge
2. ***Rate of events above a threshold discharge*** : Climate correction factor = Number of events with peak discharge > 3 yr ARI for long term record/ Number of events with peak discharge > 3 yr ARI for historic erosion period record

The closest stream gauge to Site B is the Raglan Creek at Old Station gauge (130004A), which is approximately 17 km downstream on Raglan Creek (Langmorn Creek is a major tributary of Raglan Creek). The stream gauge has streamflow data dating back to 1963 – 59 years of record. Climate correction factor calculated using the mean annual discharge method and rate of events above threshold method was 1.04 and 0.57 respectively. A climate correction factor of 0.8 was used at Site B based on the average of these two erosivity measures.

Fine sediment yield

The fine sediment yield is an estimate of the amount of fine sediment generated from the erosion site and the expected abatement resulting from bank stabiilisation works. The proportion of fine sediment is calculated based on the estimated silt/clay content and bulk density. The efficacy of works is based on the effectiveness of common erosion control activities listed in Table 1 (pg.23) of the Gully toolbox 3rd edition (Wilkinson et. al, 2022).

The following ratios were applied to the baseline erosion rate to determine the fine sediment yield:

- Bulk density of soil – Soil properties obtained from the Australian Soil Resource Information System, ASRIS (http://www.asris.csiro.au)(As outlined Pg 16 of SECAT user guide) – value: 1.4 mg/m^3
- Percentage of fine sediment – The total fine proportion of soil (clay+silt) was estimated based on the soil sampling and lab analysis provided in Appendix 2 of Attachment A – *Revegetation plan*. will be ~10% higher than the clay content (as outlined Pg 16 of SECAT user guide). – value: 37 %
- Efficacy of works – The effectiveness of the works at reducing fine sediment volumes is estimated at 70% based on Erosion control treatment 10 and the implementation of 9 years of monitoring and maintenance of the site. "Engineered stream bank protection and revegetation" from Table 1 (Pg 23) in the Gully toolbox 3rd edition (Wilkinson et. al, 2022). Value – 70 %

Fine sediment reduction at the coast

The fine sediment reduction at the coast is calculated by multiplying the Total fine sediment yield at site (t/y) by the Fine sediment delivery efficiency to coast (Delivery ratio). The delivery ratio to GBR Lagoon –is determined from values adopted within the Source - Paddock to Reef catchment modelling - Data provided in June 2021 by Robin Ellis (Paddock to Reef catchment modelling, DES). Site B is in Source modelling sub-catchment SC#1772 which has a delivery ration of 66%.

A summary of the fine sediment offset calculations due to the proposed project activities is presented below in Table 8. It is estimated that following the implementation of the works at Site B - Langmorn Creek an annual fine sediment saving of 300 tonnes/year will be achieved. Over a proposed nine-year project period it is estimated that the proposed works could result in a fine sediment offset of 3,114 tonnes.

Table 8. Fine sediment abatement calculations due to project activities at Site B – Langmorn Creek

Parameter	Site B - Langmorn Creek
Total sediment loss (between 1999 - 2022)(m^3)	41,595
Annual average sediment loss - *Historic erosion rate* (m^3/yr)	1,808
Climate correction factor	0.8
Baseline erosion rate (m^3/yr)	1,462
Bulk density (ASRIS soil mapping) (g/cm^3)	1.4
Percentage fine fraction (Source: Soil sampling analysis)	37%
Efficacy of works (Gully toolbox Table 1 pg 23)	70%
Fine sediment yield at site (tonnes/yr)	525
Delivery ratio (Source: Paddock to Reef)	66%
Fine sediment reduction at the coast (tonnes/yr)	346
***Fine sediment reduction at the coast over 9 yr project period* (tonnes/yr)**	**3,114**

6 Monitoring and reporting

Monitoring and maintenance of the stream stabilisation works is required to evaluate and ensure the success of the works. Monitoring of these stream stabilisation works requires an assessment of riparian condition, including structural works and vegetation works, and sediment loss. The monitoring and evaluation of works is required not only to enable sediment abatement (and associated fine sediment offset) calculations but also to evaluate and ensure the success of the works.

An overview of each component, triggers for remediation and relevant performance criteria is summarised below.

Structural works monitoring
Structural works including bank reprofiling, pile fields and associated rock will be routinely inspected following RPEQ sign off of construction works. Structural monitoring will occur every six months and following high flow events (described below) during the vegetation establishment period (24 months). Following this stage, an inspection will also be undertaken at the end of each subsequent wet season (between March and May) and following any specific high flow events. A high flow event that would trigger an inspection will be determined by:

1. Stream gauge monitoring from the Raglan Creek at Old Station stream Gauge (#130004A) located approximately 15 km downstream. When a flow exceeds a 2 yr event then that triggers monitoring (Figure 35). Assessment of stream gauge data will occur every three months during the vegetation establishment period and every 6 months following.
2. Anecdotal evidence from the property owner that significant flows have occurred (where water levels exceed the top of pile field height) will also be used as a secondary supplementary measure.

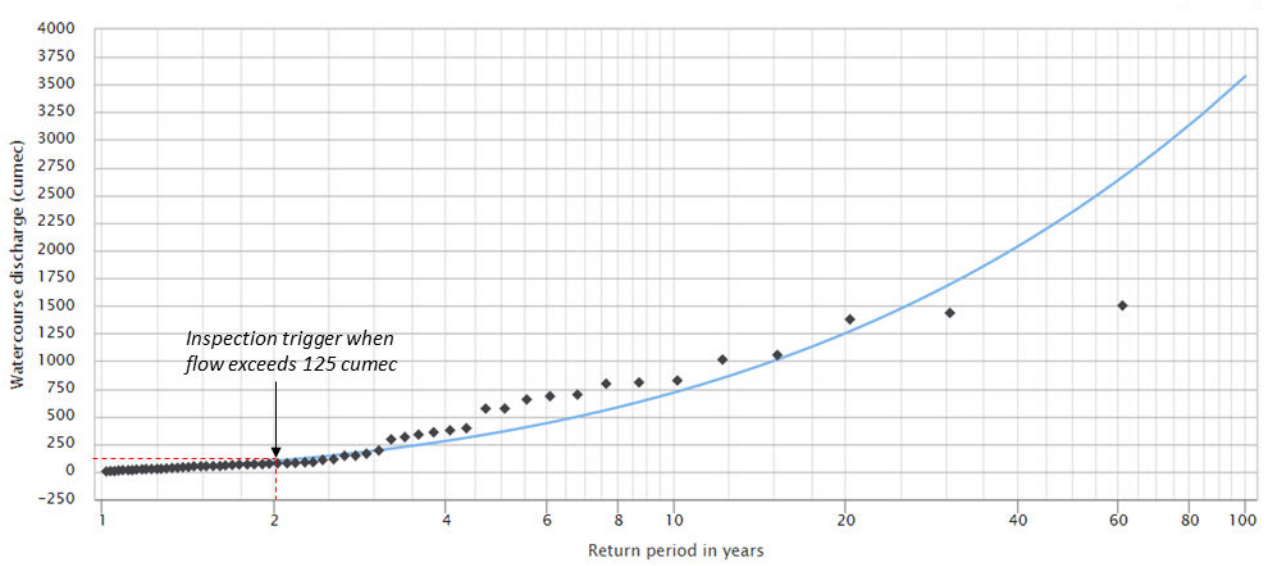


Figure 33. *Flood frequency analysis from the Raglan Creek stream gauge highlighting the flow that will trigger an event driven inspection (Source: Water Data Online: Water Information: Bureau of Meteorology (bom.gov.au))*

Structural works inspections will assess the key criteria described below. Remediation measures are also included in these descriptions. The performance criteria, including whether remediation works are required are outlined in Table 9. Maintenance/rectification measures will be carried out as required for the project life (9years).

1. Indications of scouring, rilling or tunnelling of the bank batter surface. If significant (i.e., deeper than 0.3m for greater than 2 m) then determine cause of erosion and remediate accordingly. If remediation works are required, an engineering inspection will be undertaken to determine required works. Works may require preventing runoff concentration through contouring or diversion or installation of batter chute if there are no alternative flow paths. If tunnel erosion is found (unlikely at this site due to non-dispersive soils) then dig out, fill, and compact to surrounding soil bulk density.
2. Indications of toe of bank scour. Some minor scour of the toe in between the pile fields is acceptable, if scour has resulted in a near vertical toe scarp and has retreated more than 1 m then remediation may be required.

This will require an engineering inspection to determine appropriate remedial action (i.e., additional toe protection).

3. Any indication of stock entry to site (i.e., cattle tracks or broken fencing. If stock getting in determine the cause and rectify (i.e., fix broken fencing etc.))
4. Significant voids, surface irregularities or loose rock around the pile fields. If required additional or existing rock can be placed where necessary to repair works.
5. Whether debris has become lodged in pile fields or whether any vegetation has become established on the works in a location which may cause flow to accelerate around it or cause damage to the works if it is dragged out during a high flow event. Debris and/or inappropriate vegetation will be carefully removed.

Table 9. Structural works monitoring performance indicators

Performance indicator		Successful	Moderately successful	Unsuccessful (Remediation required)
1.	Bank surface erosion (rilling, tunnelling etc)	Minimal to no signs of erosion Sediment saving estimations are achieved within the predicted time period	Moderate surface erosion typically < 0.3m in depth or very isolated	Erosion >0.3m deep and >2m in length
2.	Toe scour	Minimal to no signs of toe scour	Moderate toe scour <1m	Significant scour – vertical scarp with >1m toe retreat
3.	Stock entry	Stock entry is controlled to ensure soil and vegetation disturbance is not impacting offset site,	Stock entered but have since been excluded (i.e., fence fixed)	Site accessible to stock
4.	Rock movement	Limited to no signs of irregularities in rock movement	Isolated rock movement	Voids in rock or significant movement
5.	Debris in pile fields	Limited to zero debris found in pile fields	Isolated small debris caught in ways that still impact flow	Large or widespread small debris lodged – likely to influence flow

Photo point monitoring will also be adopted as a broad and easy to interpret indicator of site condition and to assist reporting and communication. The bank end of each pile field can serve as a standard photo point location and one photo is to be taken looking upstream, looking downstream, looking toward top of bank, and looking toward the toe of bank (see Figure 36). Along with fixed photo points, other photos relating to the inspection and performance criteria listed above will be taken at the point of interest.

The structural works monitoring frequency is outlined in Table 10. Monitoring is more frequent during the vegetation establishment period (first 12-24 months), after which the risk of erosion is lower.

Table 10. Structural works monitoring program

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9			
Monitoring type	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Structural works monitoring																																				

* *Additional event based monitoring may be required – Stream gauge assessment to occur every quarter during year 1 and 2 and biannually through to yr 9.*

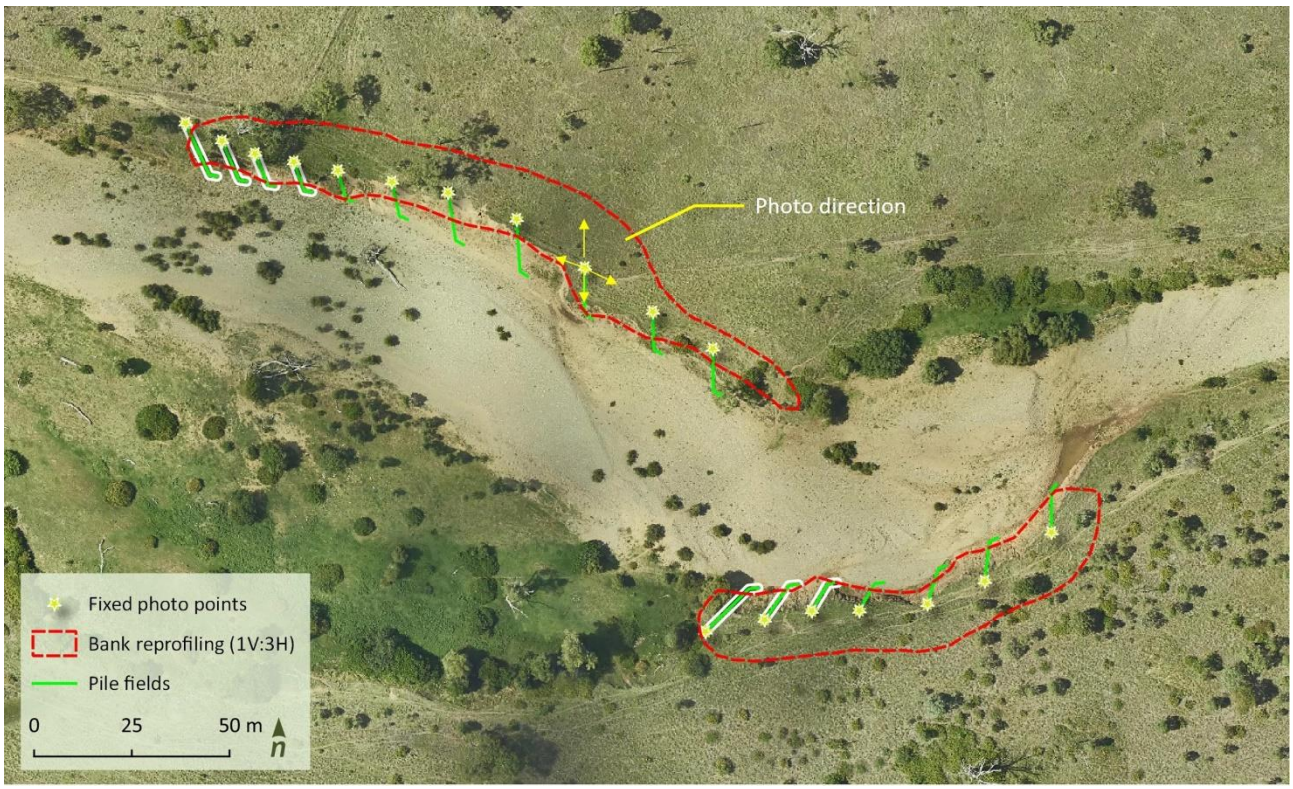


Figure 36. *Fixed photo monitoring point locations for structural assessments*

Vegetation monitoring

The monitoring approach and key performance indicators are described below. A vegetation maintenance program has been developed for the site and is outlined in the detailed revegetation plan in Appendix A. The monitoring program is designed to quantify success and identify actions to be implemented for the project life (9 yrs) to track progress and inform timely mitigation interventions.

A summary of the key monitoring terms used are outlined in Table 11.

Table 11. Monitoring terms

Term	Definition
Groundcover	All grass, shrub, legume, and pasture less than 1m height.
Seedlings	Planted native tree and shrub species 0-6m.
Trees	Native species greater than 6m.
Weeds	All species listed in the *Biosecurity Act 2014* plus local environmental weeds.
Litter	Any dead "on-ground" vegetation matter (including spread mulch).
Rock	Observed surface stone, gravel, or rock.
Bare ground	Land that is free of live vegetation and includes Rock and Litter.

Monitoring approach

The revegetation monitoring considers each of the vegetation management zones independently.

Vegetation Management Zones 1- 3 are narrow linear shapes by design. The following linear transect sampling approach will be adopted to monitor species for these Zones.

Timber pickets will be installed every 60m along the Zone's central axis and a GPS location recorded for each picket. Commencing from the picket at 0m, walk 10m recording each planted seedling 2.5m either side of the centreline. At 10m install a temporary 1m x 1m sample and assess ground cover percentage for all vegetation <1m high. Repeat the process for successive 10m sectors until 30m is completed. Step up to the next timber picket and repeat the procedure until the zone has been traversed. The linear sample format is demonstrated conceptually in Figure 37. Photos are to be taken in North, East, South and West directions at the centre of each quadrat.

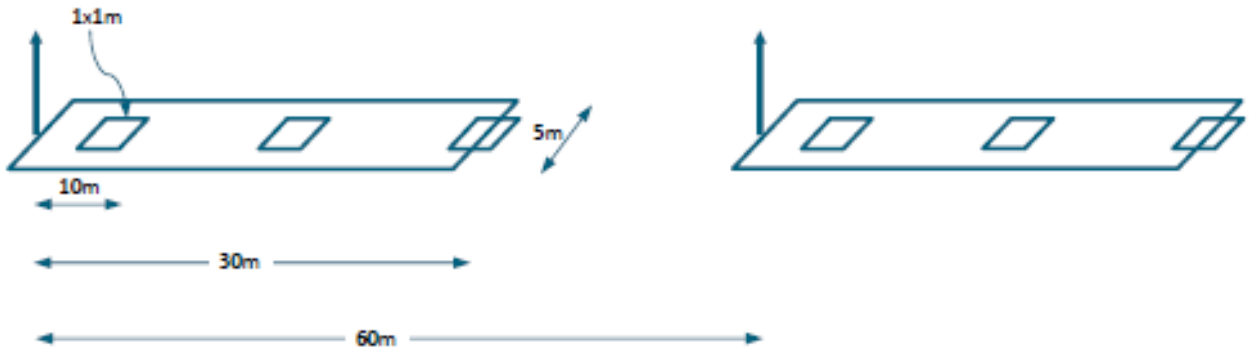


Figure 37. *Linear transect sampling approach*

Sampling of the overbank zone (Zone 3a and Zone 4A) is likely to include areas of non-cleared vegetation and large individual trees, linear sampling is less likely to be appropriate. A traverse (an informal, unmarked route along which data is collected) can be adopted for gathering vegetation performance data. This method allows for meandering amongst remnant vegetation, surveying 5m either side of the traverse centreline.

It is suggested that a traverse running for the full length of Zone 3A and Zone 4A be undertaken, with quadrats surveyed at 25 m intervals. Groundcover below 1 m height will be recorded as a percentage in 1 x 1m quadrats. Photos are to be taken in North, East, South and West directions at the centre of each quadrat. Seedling survival, seedling species, seedling height and regeneration (natural regrowth of tree species) will be recorded along the full length of the traverse.

The following parameters will be captured in the two subplots:

- 5m x 30m transect plot
    - Seedling survival
    - Seedling species
    - Seedling height
    - Regeneration (natural regrowth of tree species)
- Three 1x1m quadrats - Reported ground cover percentage will be the average of:
    - Grass & Pasture%
    - Legume%
    - Litter%.

Indications of any stock access will also be assessed and reported during all monitoring and maintenance visits.

Performance criteria and monitoring frequency

The vegetation monitoring frequency is outlined in Table 12. Monitoring is more frequent during the establishment period (first 12 – 24 months). It should be noted that while monitoring may tie in with the scheduled maintenance program, the monitoring frequency varies from the maintenance frequency which is outlined in Appendix A. The vegetation maintenance will occur as described in the revegetation plan (Section 8.2 of Appendix A) for the project life (9 yrs).

Table 12. Vegetation monitoring program

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9			
Monitoring type	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Vegetation monitoring																																				

key performance criteria to be assessed during the monitoring program have been developed for each vegetation management zone and is outlined in Table 13.

Table 13. Key vegetation performance indicators

Vegetation management zone	Monitoring period	Ground cover	Seedling survival
Zone 1 and 1a - Lower bank, and Zone 2 and 2a - Mid bank	Yr 1 - Week 1	Sowing complete	Seedlings planted at prescribed rate 1,000 sph trees 2,000 sph sedges
	Yr 1 - Week 12	70%	95% survival
	Yr 1 -Month 12	85%	85% survival Average tree height 0.8m
	Yr 2 - Month 18	85%	85% survival (tree survival becomes key indicator)
	Yr 2 - Month 24	85%	85% survival (tree survival becomes key indicator)
	Yr 3 - Month 36	85%	85% survival (tree survival becomes key indicator)
	Yr 4 - Month 48	85%	85% survival (tree survival becomes key indicator)
	Yr 5 - Month 50	85%	85% survival (tree survival becomes key indicator)
	Yr 6 – Month 62	85%	85% survival (tree survival becomes key indicator)
	Yr 7 – Month 74	85%	85% survival (tree survival becomes key indicator)
	Yr 8 – Month 86	85%	85% survival (tree survival becomes key indicator)
	Yr 9 – Month 98	85%	85% survival (tree survival becomes key indicator)
Zone 3 and3a - Upper bank and over bank	Yr 1 - Week 1	Sowing complete	Seedlings planted at prescribed rate 750 sph trees 750 sph sedges
	Yr 1 - Week 12	70%	95% survival
	Yr 1 -Month 12	85%	85% survival Average tree height 0.8m
	Yr 2 - Month 18	85%	85% survival (tree survival becomes key indicator)
	Yr 2 - Month 24	85%	85% survival (tree survival becomes key indicator)

	Yr 3 - Month 36	85%	85% survival (tree survival becomes key indicator)
	Yr 4 - Month 48	85%	85% survival (tree survival becomes key indicator)
	Yr 5 - Month 50	85%	85% survival (tree survival becomes key indicator)
	Yr 6 - Month 62	85%	85% survival (tree survival becomes key indicator)
	Yr 7 - Month 74	85%	85% survival (tree survival becomes key indicator)
	Yr 8 – Month 86	85%	85% survival (tree survival becomes key indicator)
	Yr 9 – Month 98	85%	85% survival (tree survival becomes key indicator)
Zone 4A	Yr 1 - Week 1	nil	Seedlings planted at prescribed rate 334 sph trees 166 sph sedges
	Yr 1 - Week 12	nil	95% survival
	Yr 1 -Month 12	nil	85% survival Average tree height 0.8m
	Yr 2 - Month 18	nil	85% survival (tree survival becomes key indicator)
	Yr 2 - Month 24	nil	85% survival (tree survival becomes key indicator)
	Yr 3 - Month 36	nil	85% survival (tree survival becomes key indicator)
	Yr 4 - Month 48	nil	85% survival (tree survival becomes key indicator)
	Yr 5 - Month 50	nil	85% survival (tree survival becomes key indicator)
	Yr 6 - Month 62	nil	85% survival (tree survival becomes key indicator)
	Yr 7 - Month 74	nil	85% survival (tree survival becomes key indicator)
	Yr 8 – Month 86	nil	85% survival (tree survival becomes key indicator)
	Yr 9 – Month 98	nil	85% survival (tree survival becomes key indicator)

Independent of any monitoring survey outcomes, seedling refill and seed re-sow will be required on all planted areas up to the end of Revegetation Maintenance Year 1 within any Zone when the following conditions exist:

- Any bare area greater than 5m^2 (for zones 1-3) and 10m^2 (for Zone 4A)
- Any contiguous area of 20m^2 with less than 50% groundcover.
- Any row length of planted seedlings greater than 15 m where seedlings have failed.

The above thresholds provide guidance for vegetation management on all Zones. If these requirements are not met, it will be considered failed, and will undergo remedial revegetation to achieve:

- A minimum ground cover of 80%; and/or
- A minimum tree survival in line with Table 13 above.

.

Topographic monitoring

Successful vegetation establishment will be the key indicator of project success. Topographic monitoring will be used in conjunction with the structural works and vegetation monitoring to identify any erosion issues that may not have been picked up due to dense vegetation coverage, and help ensure project success.

By comparing two digital elevation models (DEM) over a period of time a DEM of Difference (DoD) can be developed. A DoD identifies changes in ground surface elevation from two DEMs captured at various temporal scales. From the DoD the volume of sediment eroded from the bank can be assessed. Topographic survey is to be undertaken using repeat high-resolution aerial LiDAR survey (minimum 50 points/m^2) – a drone LiDAR survey is appropriate for capture across the site.

A limit of detection will also be applied to the DoD to account for uncertainty in the accuracy of the DEMs due to potential vertical accuracy errors, misalignment, surface roughness and vegetation differences. The limit of detection will be set to a level where there is no erosion shown outside of the streambank or channel. Typically values between -0.15 m and 0.15 m will be excluded from the DoD analysis, although this will vary depending on the data quality. A histogram of volume loss can be utilized to justify the limit of detection applied in any case.

The DoD will pick up any significant surface changes due to erosion and will trigger a response as per performance indicators provided above in Table 9.

Topographic monitoring will need to occur immediately after the completion of the bank stabilisation works to establish the baseline for monitoring. Repeat surveys will be undertaken each year following the wet season (March to May) and then compared with the baseline survey (DoD).

Where significant repair/maintenance works are undertaken (i.e. earthworks were required to reshape bank or repair tunnelling) additional topographic surveys will be done immediately following the repair as this will act as the updated baseline surface for future monitoring.

Successful vegetation establishment will be the key indicator of project success. This will be monitored and maintained as described above (structural works monitoring and vegetation monitoring) to ensure success.

The Topographic monitoring frequency is outlined in Table 14.

Table 14. Topographic monitoring program

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9			
Monitoring type	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Topographic monitoring*																																				

Reporting

A milestone reporting program has been developed for the site and is required to ensure the plan achieves the erosion control and revegetation outcomes identified. Performance Reports should be submitted by the contractor for the duration of the nine (9) year monitoring program following each monitoring event and summarised in a yearly progress update report. The information to be provided in the monitoring reports is summarised below. A report should be provided following each monitoring event and a yearly progress update report.

A completion report will be provided to the department at the end of the project detailing the results, learnings and overall outcome of the project. This report will include all performance and monitoring reports mentioned above.

Structural monitoring report:

- Photo records from fixed monitoring sites and other areas of interest
- Performance against key performance indicators
- Any remedial actions required including further engineering inspections
- Other issues/recommendations

Vegetation monitoring report:

- Photo records from fixed monitoring sites and other areas of interest
- Sampling results summary including ground cover percentages, seedling/tree heights, survival rates etc.
- Performance against key performance indicators
- Any recommended remedial actions
- Identification of other potential issues and recommendations

Topographic monitoring report:

- Data capture information including date, resolution, vertical and horizontal accuracy, any alignment shifts required, limit of detection applied
- Mapping of DoD completed for comparison period
- Any recommended remedial actions
- Performance against key performance indicators

Progress update report:

- Summary of the overall offset site performance based on monitoring reports
- Trajectory of sediment offset project (i.e., is it on target to meet required fine sediment savings)
- Identification of any issues that may result in inability to achieve offset and any associated recommendations

A summary table outlining the required monitoring timing/frequency for each type of monitoring is provided in Table 15.

Table 15. Summary of required monitoring frequency

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9			
Monitoring type	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Structural works monitoring*																																				
Vegetation monitoring																																				
Topographic monitoring*																																				

*[1] *Additional event-based monitoring may be required; *[2]Additional topographic survey may be required if remediation works requiring earthworks is required on site.*

7 Costs

8 Risk management

This Strategy has considered the risks that may inhibit achieving the completion criteria for the offset site, including risks that may be wholly outside the approval holder's control. The risks have been assessed against the Risk Matrix below, supplied by the Department of Climate Change, Energy, the Environment and Water. The risk analysis:

- Identifies events and threats that will, may, or are likely to impact the attainment of the completion criteria
- Assesses the likelihood and consequences of those events and threats eventuating, both before and after risk controls are applied, and assesses residual risk levels
- Identifies levels of uncertainty in mitigating the risks, with appropriate trigger criteria for corrective actions should risks and threats eventuateThe risk assessment is provided below in Table 17.

RISK MATRIX	
Likelihood (L): A qualitative measure of likelihood how likely is it that this event/circumstances will occur both before and after management activities are implemented	
Highly likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances
Consequence (C): Qualitative measure of what will be the consequence/result if the issue does occur	
Minor	Minor incident of environmental damage that can be reversed (*e.g. short-term delays to achieving strategy objectives, implementing low-cost, well-characterised corrective actions*)
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts (*e.g. short-term delays to achieving strategy objectives, implementing well-characterised, high cost/effort corrective actions*)
High	Substantial instances of environmental damage that could be reversed with intensive efforts (*e.g. medium-long term delays to achieving objectives, implementing uncertain, high-cost/effort corrective actions*)
Major	Major loss of environmental amenity and real danger of continuing (*e.g. strategy objectives are unlikely to be achieved, with significant legislative, technical, ecological and/or administrative barriers to attainment that have no evidenced mitigation strategies*)
Critical	Severe widespread loss of environmental amenity and irrecoverable environmental damage (*e.g. strategy objectives are unable to be achieved, with no evidenced mitigation strategies*)

Final Risk Rating (R): A function of multiplying Likelihood (L) and Consequence (C)

		Consequence				
		Minor	Moderate	High	Major	Critical
Likelihood	Highly Likely	Medium	High	High	Severe	Severe
	Likely	Low	Medium	High	High	Severe
	Possible	Low	Medium	Medium	High	Severe
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Low	Medium	High

Table 17. Risk assessment

Risk Event	Risk Description	Initial Risk Rating*			Management Measures / Actions	Residual Risk Rating*			Performance Criteria	Management Triggers	Corrective Actions	Monitoring Mechanism
		L	C	R		L	C	R				
Force Majeure Events												
Mining of the offset site.	Offset site is not effective due to mining activities implemented at site.	Rare	Major	Medium	Currently no mining resource authority has been granted over the property. An exploration permit has been granted for a larger area that includes the offset property, but activity is focused on Magnetite and is extremely unlikely to be within the offset site or completed within the time required for accomplishment of sediment savings. This exploration permit does expire in 2025. Adjacent exploration permits for nearby properties also record coal and gas exploration but is also extremely unlikely for this activity to impact offset site.	Rare	Major	Medium	Mining company approaches landholder to make them aware of their intent to explore mining of offset site.	Lodgment of an intent to mine.	Seek legal advice of what actions are recommended in this situation.	Mining lease records, land tenure, mineral resources mapping.
Drought.	Inclement weather conditions prevent successful regeneration of vegetation after civil works have been completed.	Unlikely	High	Medium	Installation of a successful watering regime.	Unlikely	Moderate	Low	Zone 1 and Zone 2 - Ground cover.	<50% groundcover. Any bare ground >10m^2.	Remedial revegetation (refill seeding) to achieve a minimum ground cover of 50%.	Vegetation monitoring program.
Cyclones/ Severe tropical lows / flooding.	Extreme weather events during or after completion of project works result in offset failure due to bank collapse.	Unlikely	High	Medium	Civil works completion within dry season. Prioritise sowing fast growing cover crop on completion of civil works.	Unlikely	Moderate	Low	Sediment loss.	Bank Failure or Rill erosion.	Remedial batter works.	Post event site assessment.
Catastrophic Bushfire.	Contingency planning is unable to address the impacts of extreme weather events.	Rare	Major	Medium	Develop and/or revise the project plan and contingency options based on realistic expectations of delivery and previous experience. Plan to undertake works outside of times of expected extreme weather events. Prepare and implement strategies and optional activities and outcomes.	Rare	Moderate	Low	Fire damage to offset site.	Vegetation and/or infrastructure destroyed or badly damaged.	Work with the land manager to correct the loss of vegetation and/or site infrastructure and change future fire management by updating plans. Clearly define adaptive management tasks that protect the project area.	Land manager and project manager observations. Photo monitoring points.
Standard Risks												
The Offset failing (regardless of cause).	The offset fails to achieve the sediment saving outcome.	Unlikely	Critical	High	Implement all identified risk management measures in this table.	Rare	High	Low	Annual erosion rate.	Erosion rate is greater than 585 m3 in a year.	In the event of total failure of the offset, the Department will require, and the approval holder commits to providing, a replacement offset. That replacement offset must be agreed with the Department within twenty-four months of the failure of the offset becoming apparent.	Topographic Monitoring program.

Risk Event	Risk Description	Initial Risk Rating*			Management Measures / Actions	Residual Risk Rating*			Performance Criteria	Management Triggers	Corrective Actions	Monitoring Mechanism
		L	C	R		L	C	R				
Offset Funding Shortfall.	The Budget allocated for the Program by the proponent does not have the capacity to deliver the outcomes required.	Rare	High	Low	Monitor expenditure and ensure actual expenditure remains in alignment with planned expenditure.	Rare	High	Low	Financial.	Financial reporting.	Progressive financial review as part of the design of the individual project actions, revision of expenditure commitments, engagement of contractors or use of co-funding by the land manager for contractors.	Financial system and project expense delegations.
Impacts from incompatible land management practices on adjacent properties.	Site works are impacted from incompatible land practice on neighbouring properties preventing vegetation establishment or success of bank restructuring.	Unlikely	Minor	Low	Stakeholder Member engagement ongoing. Staff trained and supported in relationship management and in identifying potential issues early. Board Directors connection to regional stakeholders an important communication conduit. Staff are recruited for their strong communication skills and supported through training and professional development. FBA Engagement plan guides efforts to maintain engagement and connection.	Unlikely	Minor	Low	Project Land managers do not identify neighbouring actions impacting the offset site.	Neighbouring property actions impacts.	On identifying impacting actions from neighbouring properties communication with neighbouring land managers occurs to address the underlying issue.	Land manager's and project manager's observation.
Erosion.	Individual erosion risks at site outlined in more detail below.	Possible	Moderate	Medium	Implement bank stabilisation design as outlined in offset plan.	Unlikely	Moderate	Low	Erosion rate.	Rill erosion or bank Failure.	Remedial batter works. Revegetation of cover crop	Topographic Monitoring program
Timber harvesting/collection.	Site is impacted from timber harvesting activities.	Unlikely	Moderate	Low	Stake holder relationship with land manager to include awareness of the benefit of retaining vegetation and best management practices for riparian areas. Land manager agreement to specify no timber harvesting to be undertaken at the site.	Rare	Moderate	Low	Vegetation extent. Number of large trees retained.	Loss of vegetation.	Work with the land manager to correct the loss of habitat and change future plans. Clearly define adaptive management tasks that protect the project area.	Vegetation monitoring program.
Unplanned clearing.	Site is impacted from clearing of vegetation not related to planned activities.	Unlikely	High	Medium	Stake holder relationship with land manager to include awareness of the benefit of retaining vegetation and best management practices for riparian areas. Land manager agreement specifying clearing cannot be undertaken on site.	Rare	Moderate	Low	Vegetation extent. Number of large trees retained.	Loss of vegetation.	Clarify areas available for clearing and no-go zones for protection. Promote understanding of the benefit of retaining vegetation and best management practices for riparian areas.	Vegetation monitoring program.
Unplanned or not controlled fire in offset area.	Loss of vegetation and other support structure on project site due to small fires.	Possible	High	Medium	Review and follow current fire management plans, appropriate buffer zones and control of undergrowth.	Unlikely	Moderate	Low	Fire damage.	Land management practice failure.	Work with the land manager to correct the loss of habitat and change future fire management by updating plans. Clearly define adaptive management tasks that protect the project area.	Bio-condition assessments, weed density surveys and review of planned actions through property records.
New infestations of invasive weed species in the offset area.	New infestations of invasive weed species in the project area.	Possible	Moderate	Medium	Weed management is to be undertaken prior to civil works and as a part of ongoing vegetation maintenance. Implement weed management plans, work with land managers to control weed outbreaks.	Unlikely	Moderate	Low	Weed presence and density.	New weed species are identified on site.	Revise biosecurity plan, identify source of outbreak and manage accordingly, change land management practices to reduce future outbreaks. Control weed species according to DAF best practice guidelines.	Bio-condition assessments, weed density surveys and review of planned actions through property records.

Risk Event	Risk Description	Initial Risk Rating*			Management Measures / Actions	Residual Risk Rating*			Performance Criteria	Management Triggers	Corrective Actions	Monitoring Mechanism
		L	C	R		L	C	R				
Expansion of existing infestations of declared weed species in the offset area.	New infestations of invasive weed species in the project area.	Possible	Moderate	Medium	Weed management is to be undertaken prior to civil works and as a part of ongoing vegetation maintenance.	Unlikely	Moderate	Low	Weed presence and density.	Widespread weed coverage.	Revise biosecurity plan, identify source of outbreak and manage accordingly, change land management practices to reduce future outbreaks. Control weed species according to DAF best practice guidelines.	Bio-condition assessments, weed density surveys and review of planned actions through property records.
Increased population of feral animals in the offset area.	Increased population of feral animals in the project area.	Possible	Moderate	Low	Implement pest management plans, work with land managers to control pest numbers.	Unlikely	Moderate	Low	Pest animal presence and population density.	Pest animal damage to project site.	Coordinated local pest management as well as education of land managers to reduce pest sanctuaries.	Land manager reports, survey data, seasonal records.
Unauthorised or inappropriate grazing in offset area.	Grazing activity damages or prevents vegetation establishment at offset site.	Possible	High	Medium	Sock exclusion in land manager agreement. Monitoring including fence inspections as a part of structural and vegetation works program.	Rare	High	Low	Stock entry and evidence of stock damage to site.	Site accessible to stock.	Remove stock and rectify access issues i.e fencing.	Structural works monitoring and vegetation monitoring programs.
					Additional risks identified							
Vegetation failure (ground cover) due to hydraulic forces.	Risk of failure in the vegetation establishment period due to hydraulic forces, toe scour and/or erosion.	Likely	Moderate	Medium	Installation of pile fields and rock surrounding pile fields reduces the hydraulic forces along lower bank.	Unlikely	Moderate	Low	Zone 1 and Zone 2 – Ground cover.	<50% groundcover. Any bare ground >10m^2.	Remedial revegetation to achieve a minimum ground cover of 50%; and/or a minimum tree survival in line with survival rates outlined in performance criteria.	Vegetation monitoring program.
Vegetation failure (seedlings) due to hydraulic forces.	Risk of failure in the vegetation establishment period due to hydraulic forces, toe scour and/or erosion.	Likely	Moderate	Medium	Installation of pile fields and rock surrounding pile fields reduces the hydraulic forces along lower bank.	Unlikely	Moderate	Low	Zone 1 and Zone 2 – Seedling survival.	<95% survival at week 12. <85% survival at month 12 and beyond. Any row of seedling where >15m have failed.	Remedial revegetation to achieve a minimum tree survival in line with survival rates outlined in performance criteria.	Vegetation monitoring program.
Erosion risk at clearing and earthworks stages.	During and immediately after the clearing and earthworks stages of construction there is risk of short-term erosion of the exposed banks either from overland flow or high channel flows.	Possible	Moderate	Medium	Construction during driest period of year (July/September). Ensure local drainage conveyed away from reprofiled bank surface. Erosion matting installation following completion of earthworks.	Possible	Minor	Low	Bank surface erosion.	Erosion >0.3m deep and >2m in length.	Engineering inspection – actions likely to include remedial earthworks and rectifying any flow conveyance issues.	Construction supervision.

Risk Event	Risk Description	Initial Risk Rating*			Management Measures / Actions	Residual Risk Rating*			Performance Criteria	Management Triggers	Corrective Actions	Monitoring Mechanism
		L	C	R		L	C	R				
Rill erosion on bank surface.	Scouring or rill erosion over bank surface following construction.	Possible	Moderate	Medium	Ensure local drainage conveyed away from reprofiled bank surface. Erosion matting installation following completion of earthworks. Maintaining ground cover through vegetation maintenance practices.	Possible	Minor	Low	Bank surface erosion.	Erosion >0.3m deep and >2m in length.	Engineering inspection – actions likely to include remedial earthworks and rectifying any flow conveyance issues.	Structural works monitoring program.
Debris lodgement in pile fields resulting in scour.	Debris getting lodged in pile fields and causing a concentration of flow for long periods resulting in scour.	Possible	Moderate	Low	Ongoing structural works monitoring.	Possible	Minor	Low	Debris in pile fields.	Large or widespread small debris lodged – likely to influence flow.	Remove debris.	Structural works monitoring program.
Land manager withdrawing from participation.	Land manger withdraws from participating in project, preventing site works from occurring.	Unlikely	High	Major	FBA engages with many land managers who are keen to make changes to their land management practices that will deliver significant offsets given a level of support. Other properties of less priority can be used as an alternative site to meet offset obligations.	Unlikely	Moderate	Low	Targeted Engagement.	Land manager withdrawing from project.	Direct land manager engagement, call to action campaign, and land manager meetings. Other properties approached in the beginning stage to be used as the offset site.	Land manager engagement.
Topsoil deficit.	Not enough topsoil to cover desired depth, resulting in lower rate of germination.	Possible	Minor	Low	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Allowance for additional ripping of subsoil and amelioration to provide additional volume. Apply topsoil to reprofiled surface first as this is highest priority. Modify seeding rates for areas with less soil cover if required.	Unlikely	Minor	Low	Amount of topsoil.	Topsoil being returned to site is not the amount needed.	Source topsoil from a reputable source.	Structural works monitoring program.
Weed invasion prior to seeding.	Introduction of weeds.	Possible	Minor	Low	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Chemically control weeds prior to seeding and repeat if required after 2 weeks.	Unlikely	Minor	Low	Weed presence and density.	Widespread weed coverage.	Revise biosecurity plan, identify source of outbreak and manage accordingly, change land management practices to reduce future outbreaks. Control weed species according to DAF best practice guidelines. Source seeds from a reputable provider.	Revegetation Hold points provided in Revegetation plan.
Seed quality.	Introduction of weeds.	Possible	Minor	Low	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Seed certificates to be provided with supplied seed. Undertake seed germination testing.	Possible	Minor	Low	Weed presence and density.	New weed species are identified on site.	Revise biosecurity plan, identify source of outbreak and manage accordingly, change land management practices to reduce future outbreaks. Control weed species according to DAF best practice guidelines. Source seeds from a reputable provider.	Revegetation Hold points provided in Revegetation plan.

Risk Event	Risk Description	Initial Risk Rating*			Management Measures / Actions	Residual Risk Rating*			Performance Criteria	Management Triggers	Corrective Actions	Monitoring Mechanism
		L	C	R		L	C	R				
Seed quantity.	Not all seeds available.	Possible	Minor	Low	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Engage multiple seed collection groups.	Unlikely	Moderate	Low	Seed availability.	Not enough seeds.	Revegetation designer to review seed list of species and quantities and source alternatives within approved species groups.	Revegetation Hold points provided in Revegetation plan.
Seed viability.	Seeds are not viable at the time of spreading and therefore do not germinate	Possible	Minor	Low	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Manage seed acquisition to avoid prolonged storage. Seed storage sit to meet Australian guidelines. Engage experienced seed collectors. Installation of irrigation. Fertiliser added prior to seeding at prescribed rates. Seed certificates required. Undertake seed germination testing.	Unlikely	Moderate	Low	Germination rate. Zone 1, Zone 2 and Zone 3 ground cover.	% Of seed germination. <50% groundcover. - Any bare ground >10m^2.	Source seed from different supplier. Remedial revegetation (refill seeding) to achieve a minimum ground cover of 50%	Revegetation Hold points provided in Revegetation plan.
Vegetation establishment – Ground cover.	Non-establishment of native vegetation including cover crops	Possible	Moderate	Medium	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Installation of irrigation. Installation of coir mesh following civil works to reduce soil erosion. Livestock exclusion. Implement prescribed vegetation maintenance program.	Unlikely	Moderate	Low	Zone 1, Zone 2 and Zone 3 ground cover.	<50% groundcover. Any bare ground >10m^2.	Remedial revegetation (refill seeding) to achieve a minimum ground cover of 50%	Vegetation monitoring program.
Vegetation establishment – Seedlings/trees.	Non-establishment of native vegetation including seedlings/trees.	Possible	Moderate	Medium	Adhere to recommended hold points and QA outlined in Appendix 4 of Appendix A (Detailed revegetation plan). Installation of irrigation. Installation of coir mesh following civil works to reduce soil erosion. Livestock exclusion. Implement prescribed vegetation maintenance program.	Unlikely	Moderate	Low	Zone 1, Zone 2 and Zone 3 seedling survival.	<95% survival at week 12. <85% survival at month 12 and beyond. Any row of seedling where >15m have failed.	Remedial revegetation to achieve a minimum tree survival in line with survival rates outlined in performance criteria.	Vegetation monitoring program.

9 Timelines for delivery

As identified in Section 1, the overall offset project is comprised of three key stages:

5. Stage 1: Fine-grained sediment validation monitoring plan (*Complete*)
6. **Stage 2: Development of Fine Sediment Offset Plan (*This project*)**
7. Stage 3: Implementation of Fine Sediment Offset Plan (*to be completed*)

The stages, key steps required within each stage and approximate time to complete the stage are provided in Figure 30. It should be noted that as a part of our risk management strategy the civil construction phase will only take place during the dry season, ideally between July and September which also aligns well with recommended seeding timing of September/October. A schematic representation of the overall fine sediment offset project is shown in Figure . A Gant chart including the key project components and monitoring timing for the project life (9 years following construction) is also provided in Table 18. Note there is also a detailed maintenance schedule provided in Sect 8.2 of Appendix A.

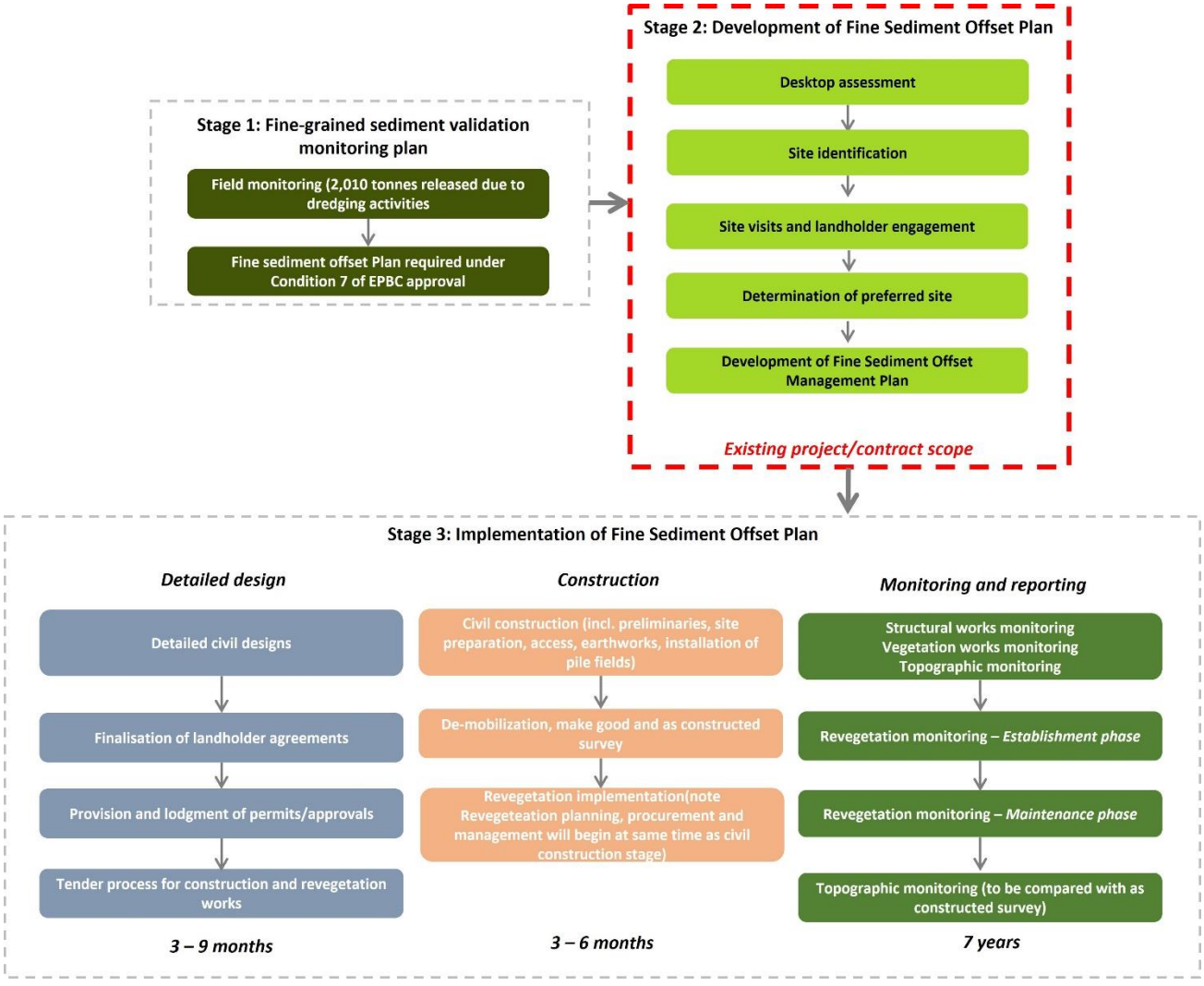


Figure 38. *Schematic representation of the overall Fine Sediment Offset project*

Table 18. Key project components and timing

	Contract Tender				Construction				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detail design to tender																																											
Detailed design																																											
Approvals																																											
Tender process																																											
Construction																																											
Civil construction works																																											
Reegetation works (including procurements)																																											
Monitoring																																											
Structural works monitoring*																																											
Vegetation monitoring																																											
Topographic monitoring*																																											

*[1] *Additional event-based monitoring may be required; *[2]Additional topographic survey may be required if remediation works requiring earthworks is required on site.*

References

Alluvium, 2018, “Annualised estimates of sediment loss’ undertaken for Fitzroy Basin Association (FBA) as a part of the Lower Fitzroy River design package, Rockhampton, QLD.

Boon, Marinus & Tesfamichael, Solomon. (2017). WETLAND VEGETATION INTEGRITY ASSESSMENT WITH LOW ALTITUDE MULTISPECTRAL UAV IMAGERY. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. XLII-2/W6. 55-62. 10.5194/isprs-archives-XLII-2-W6-55-2017.

Department of Sustainability and Environment (DSE), 2007, ‘Technical Guidelines for Waterway Management’, Department of Sustainability and Environment, Victoria.

Humphreys P1, Wilkinson S2. 2021. Stream bank Erosion Control Assessment Tool (SECAT) Survey User Guide, Paddock to Reef Integrated Monitoring, Modelling and Reporting Program, version 1.0.0, State of Queensland, Brisbane, Australia.

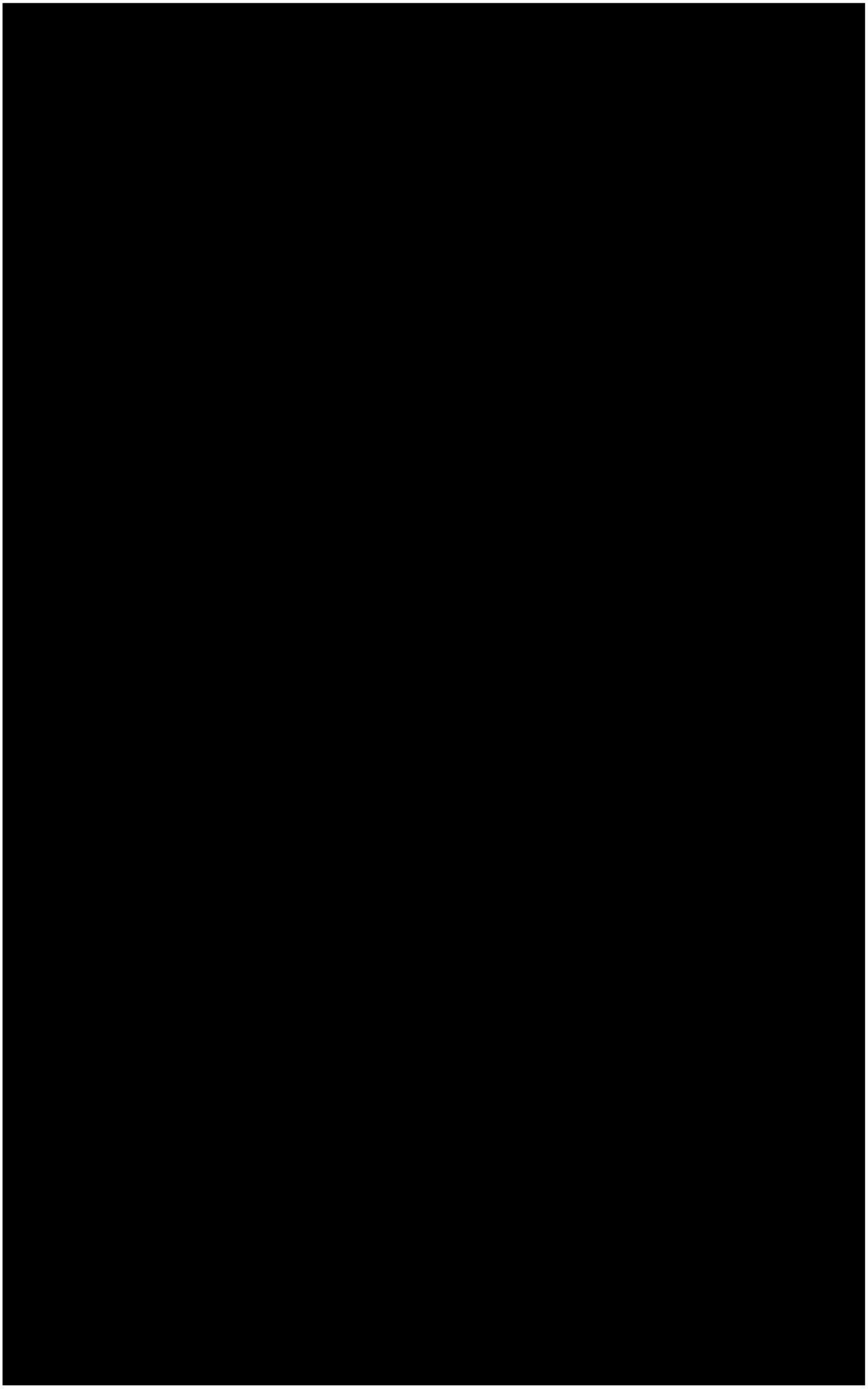
1. Rural Economic Development – Paddock to Reef Evaluation, Queensland Department of Agriculture and Fisheries.
2. Reef Trust Gully and Stream Bank Erosion Control Program, Landscape Evaluation - Commonwealth Scientific and Industrial Research Organisation.

IECA, 2008, ‘*Best Practice Erosion and Sediment Control*.’ International Erosion Control Association (Australasia), Picton NSW.

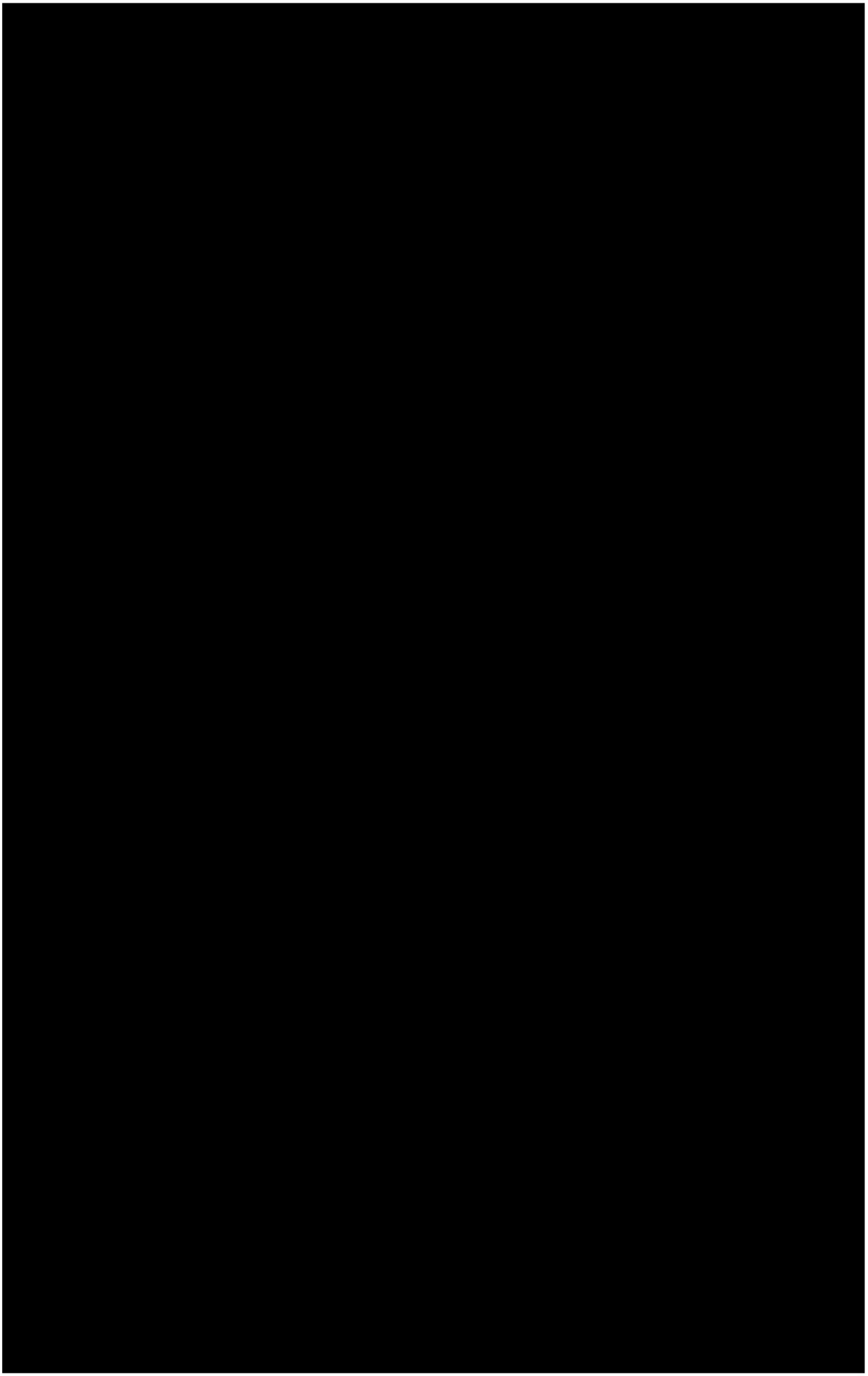
Wilkinson S, Hairsine PB, Bartley R, Brooks A, Pietsch T, Hawdon A, Shepherd R. 2022. *Gully and Stream Bank Toolbox. A technical guide for gully and stream bank erosion control programs in Great Barrier Reef catchments. 3rd Edition.* Commonwealth of Australia.

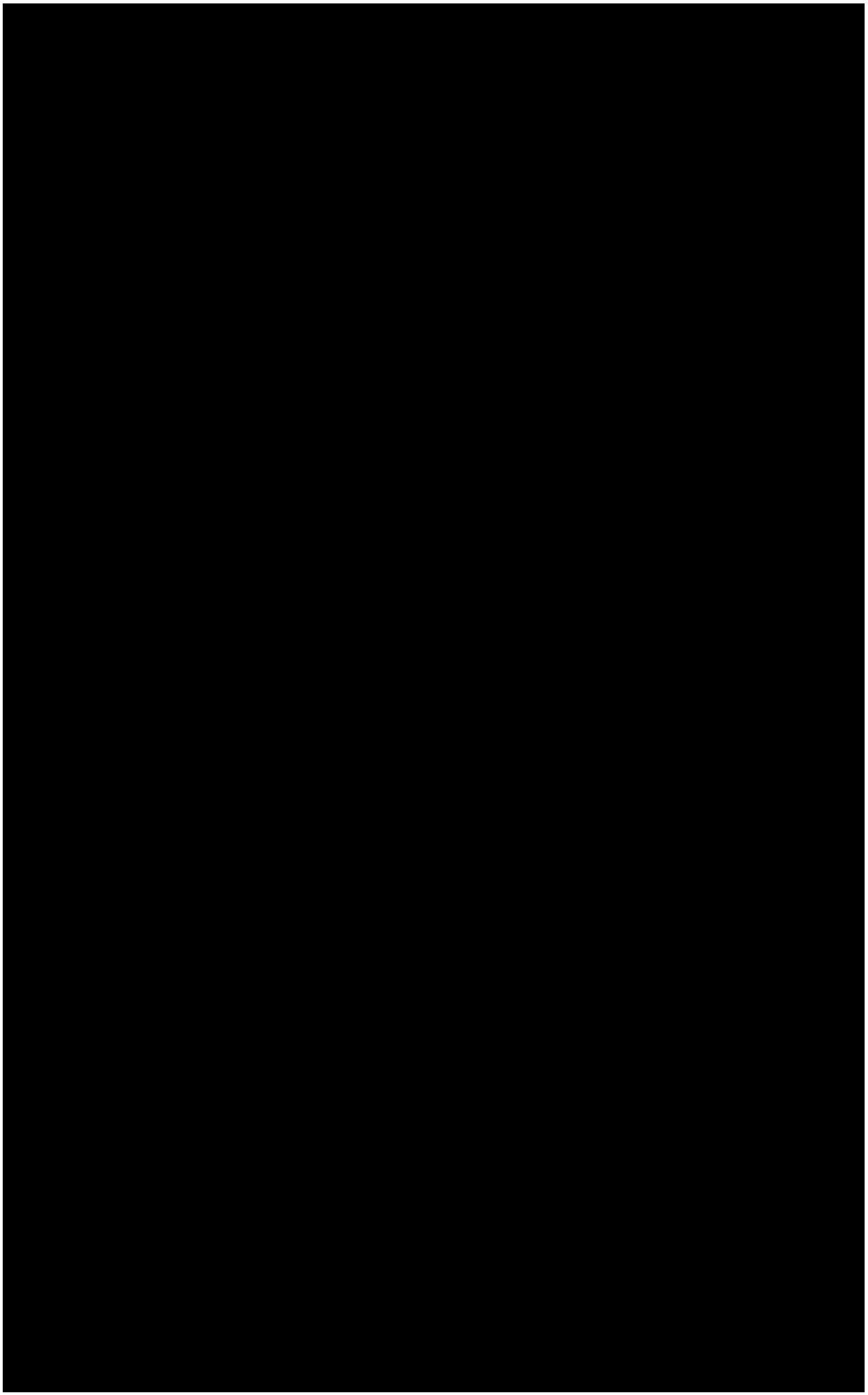
Reef Trust, 2022. Gully and Stream Bank Toolbox 3rd Edition – A technical guide for gully and stream bank erosion control programs in the Great Barrier Reef catchments.

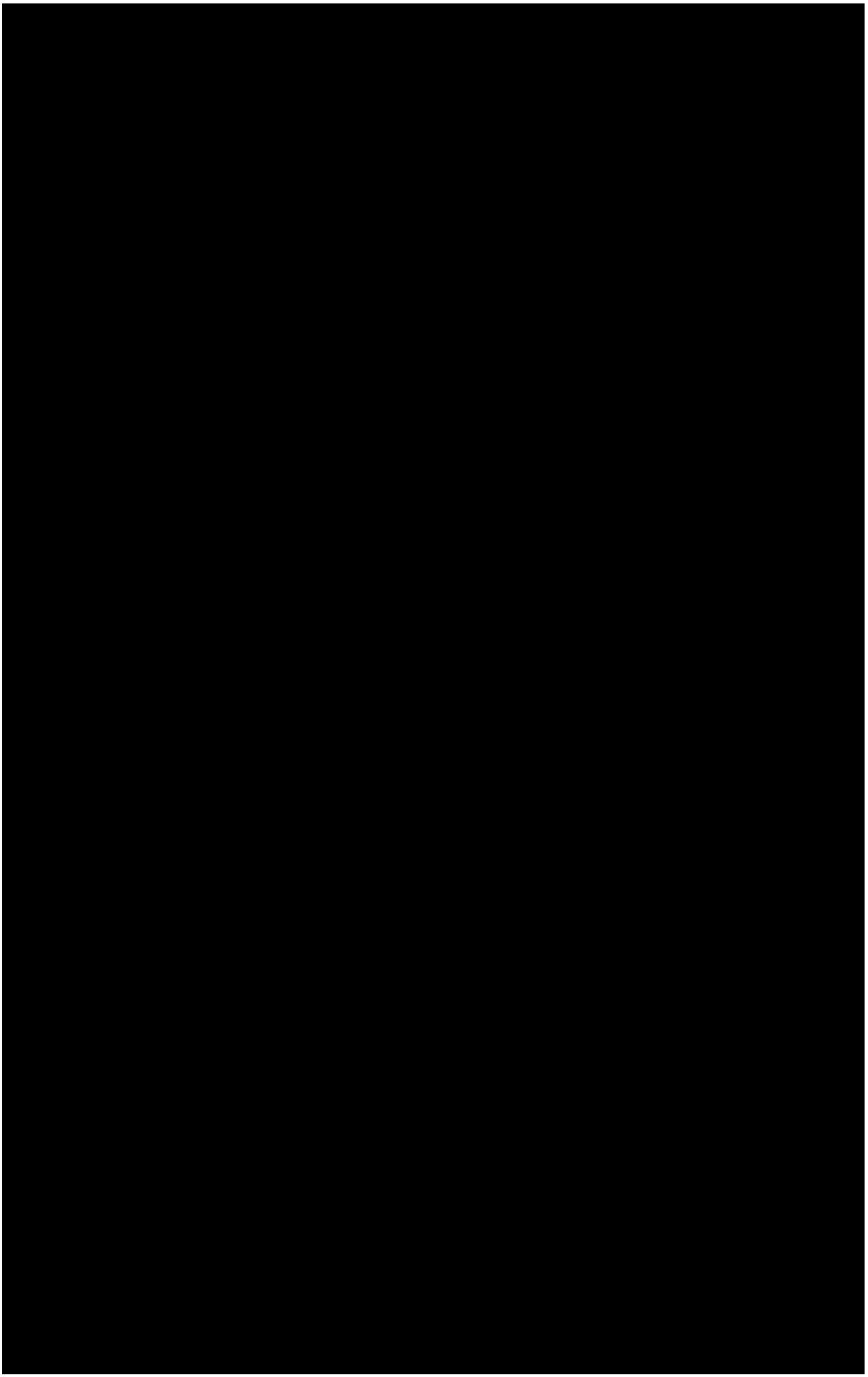
Appendix A: [redacted]

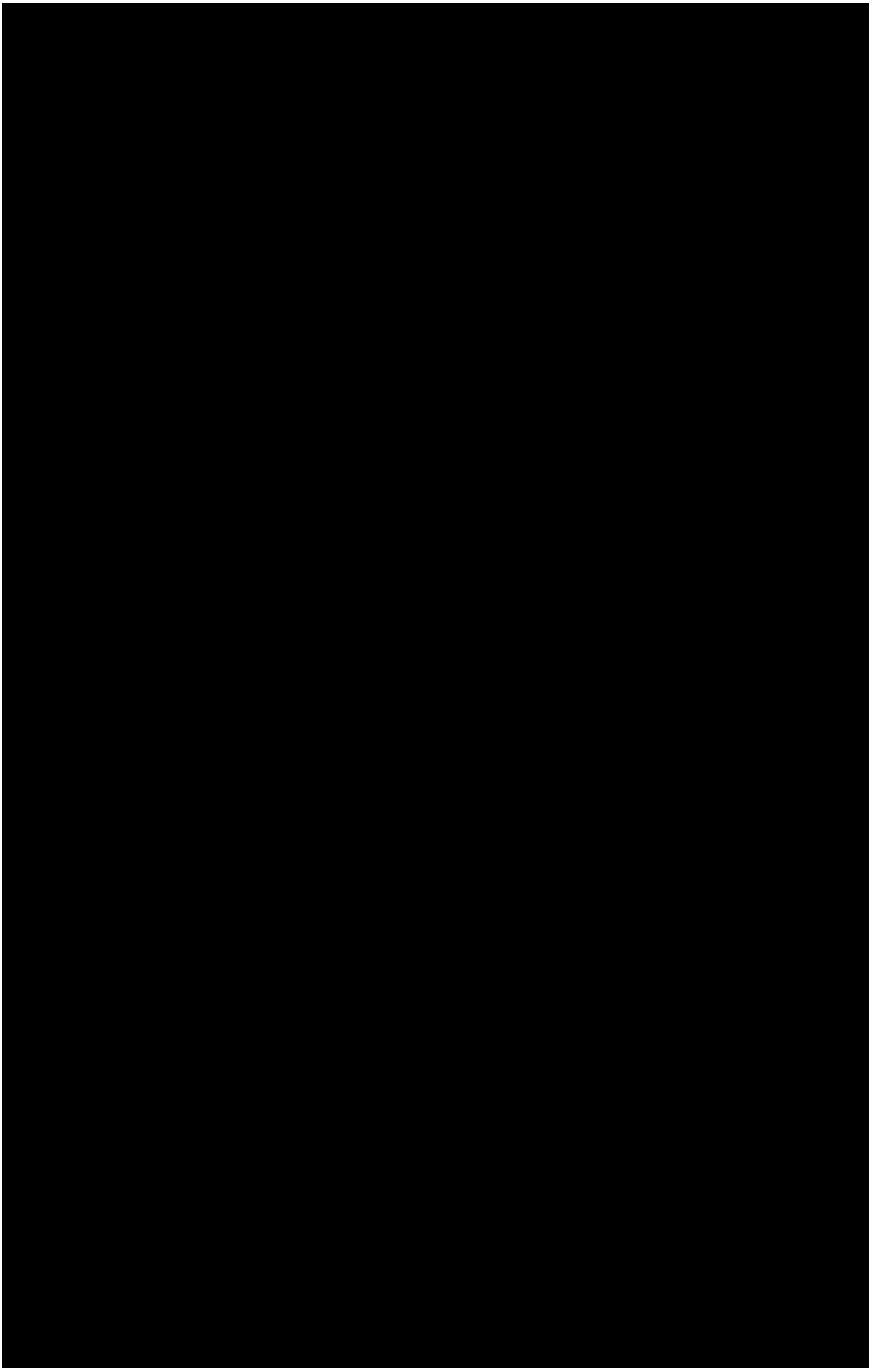


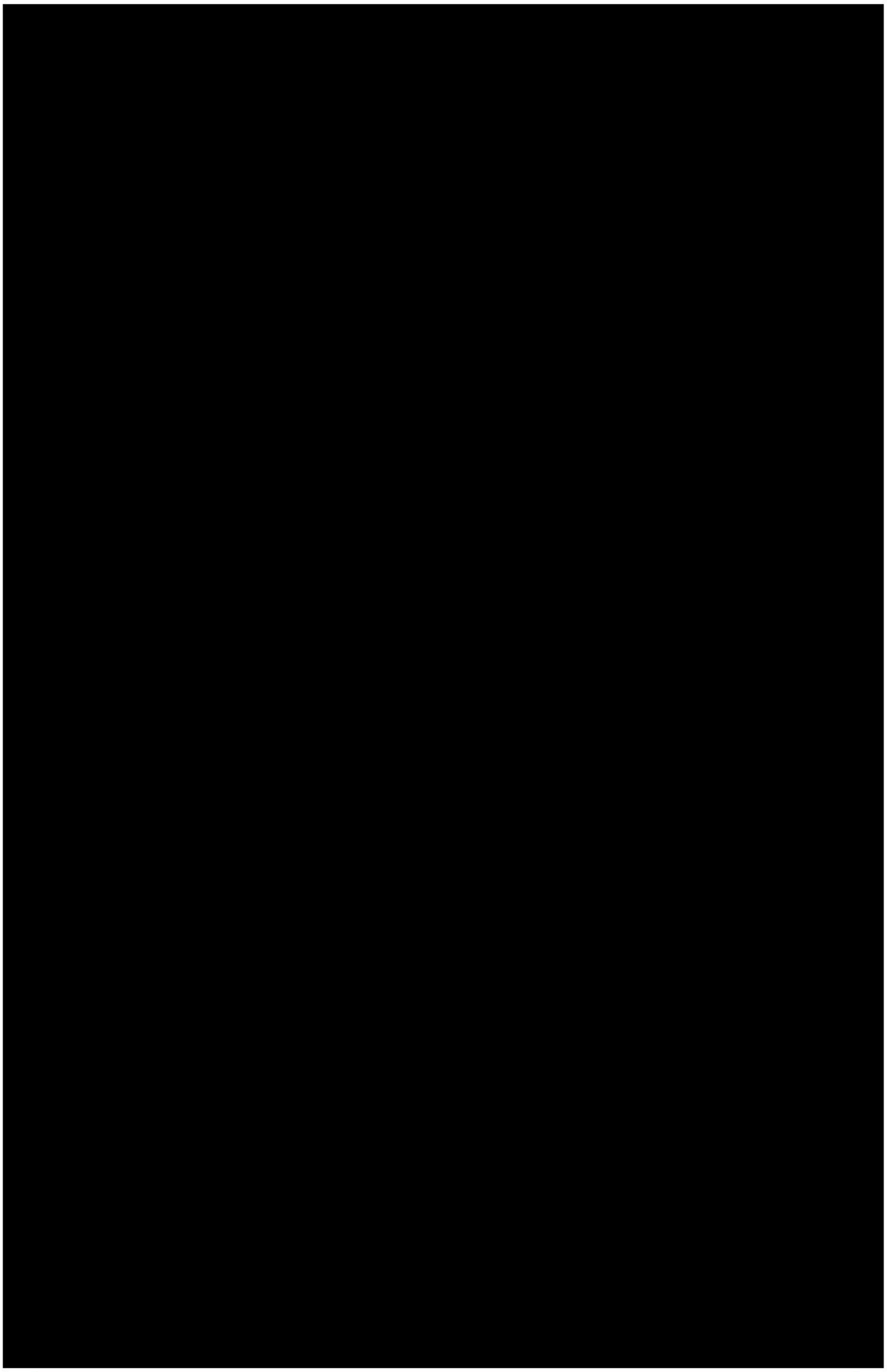
[redacted]

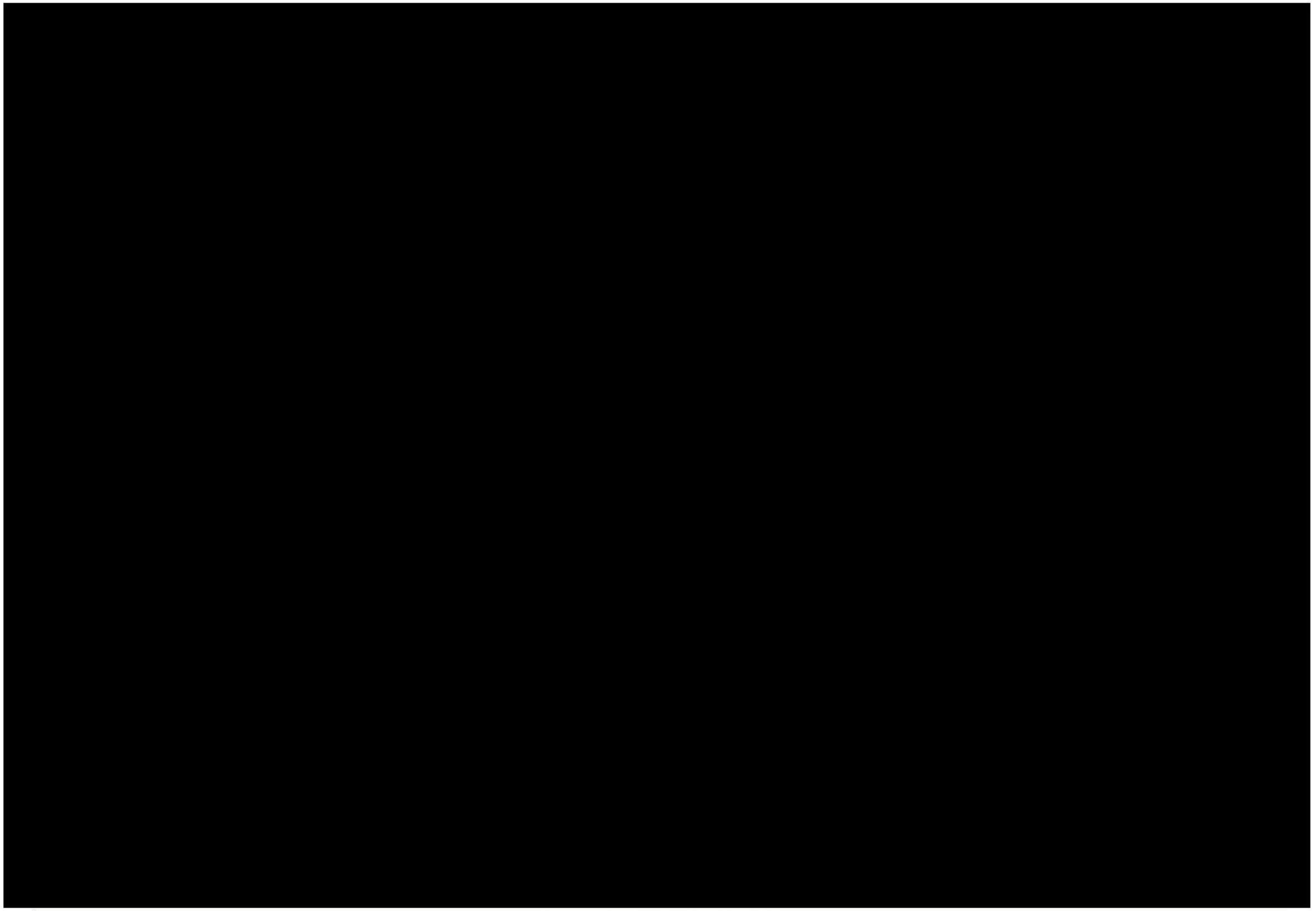


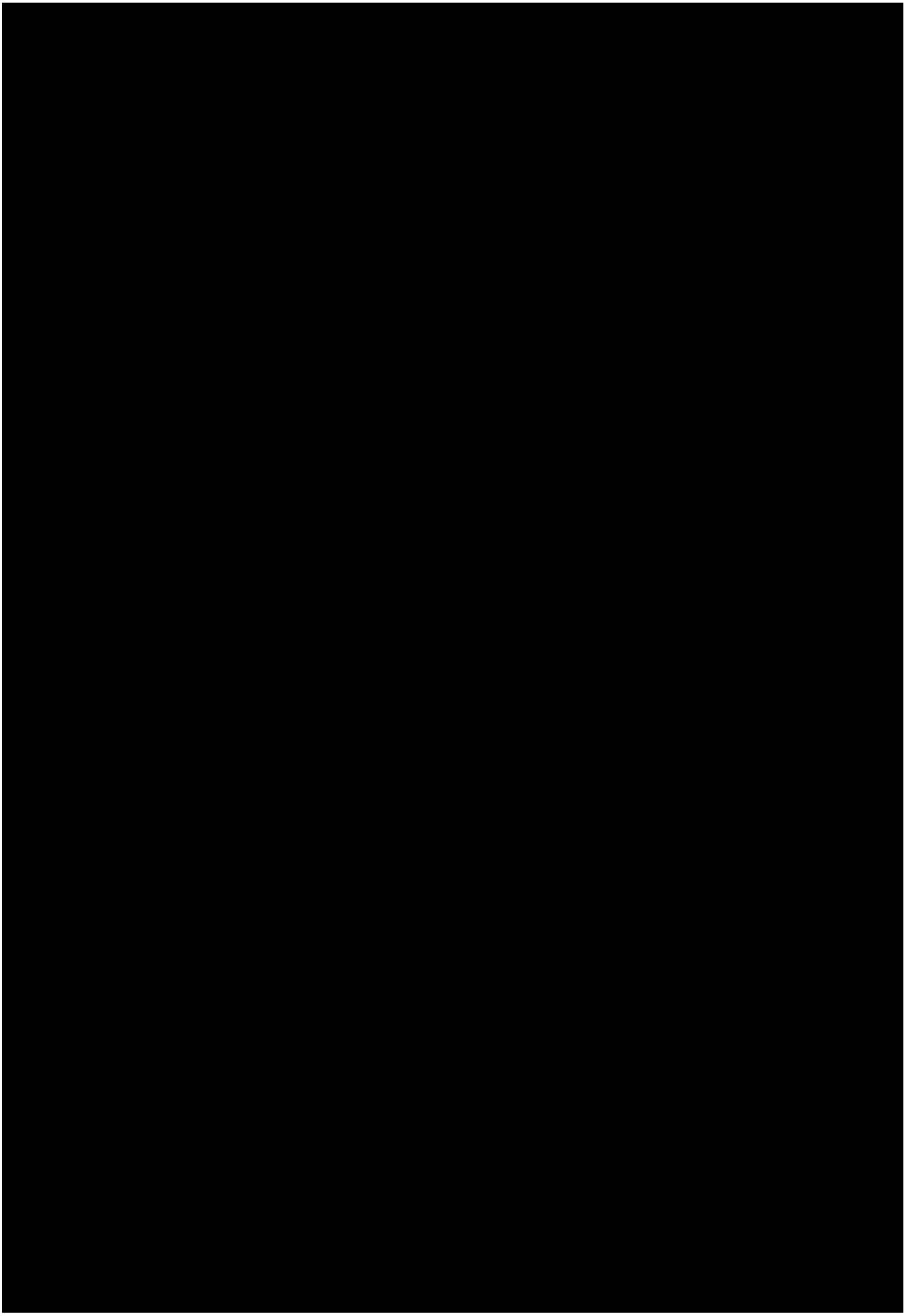




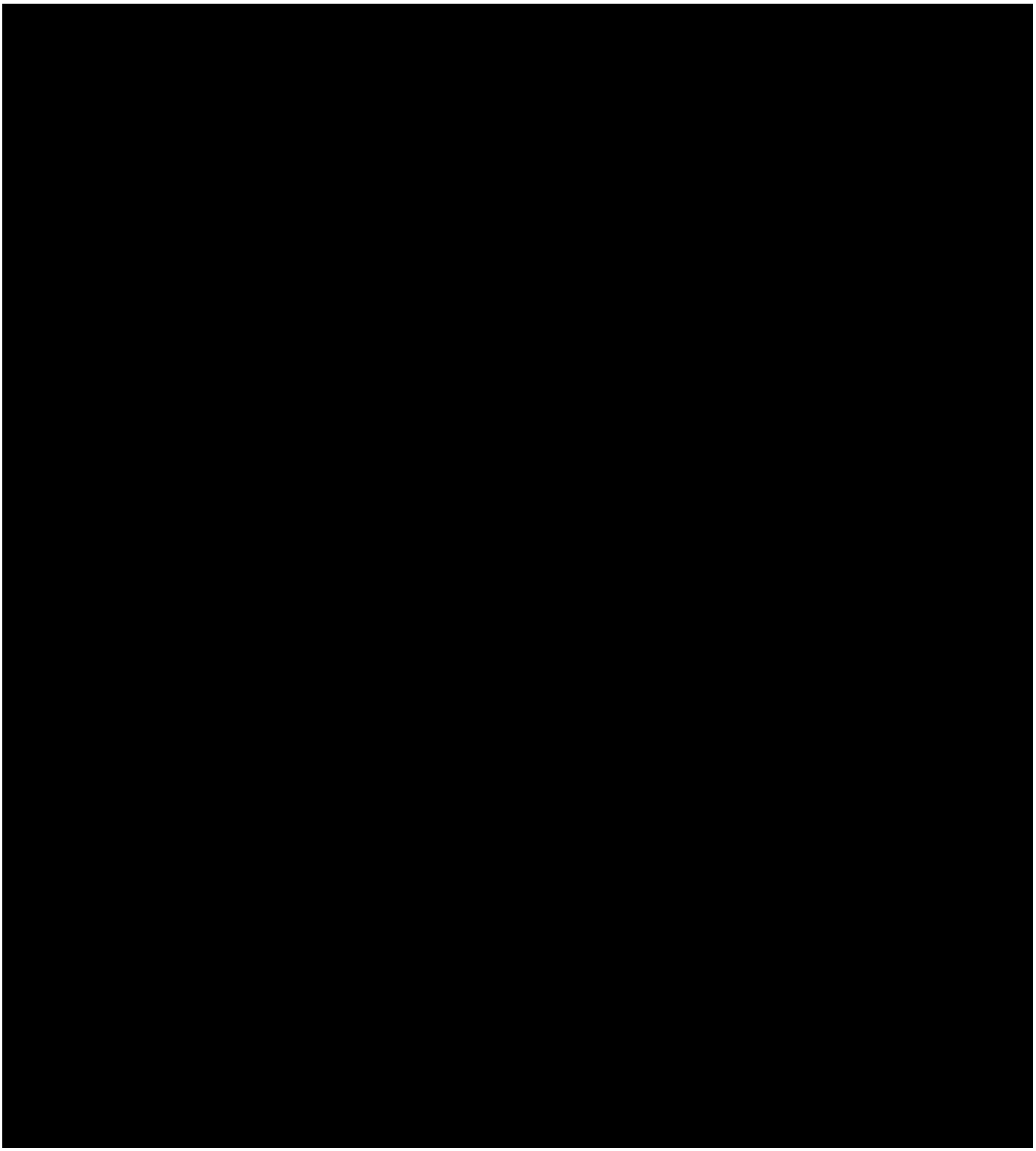


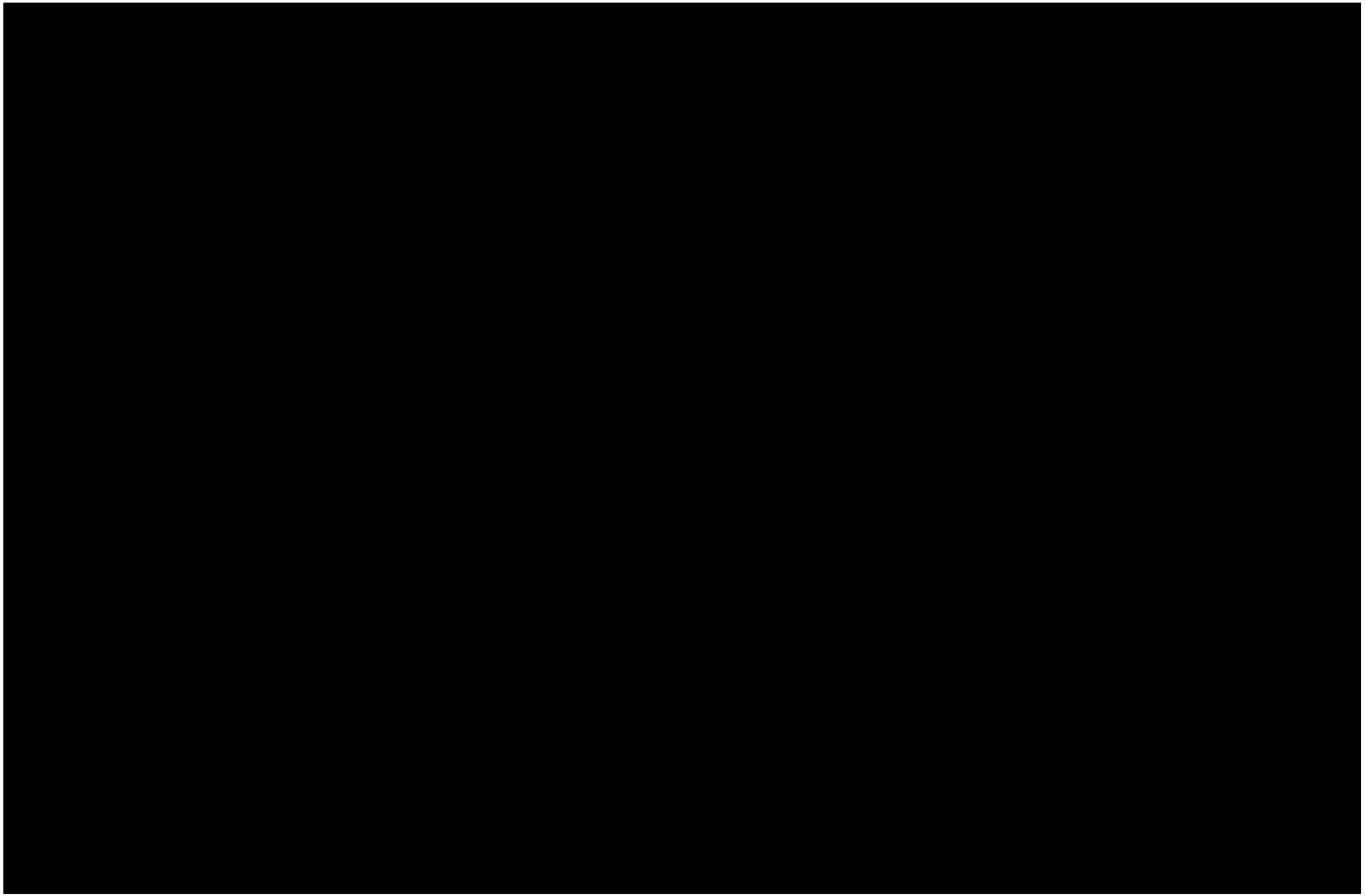


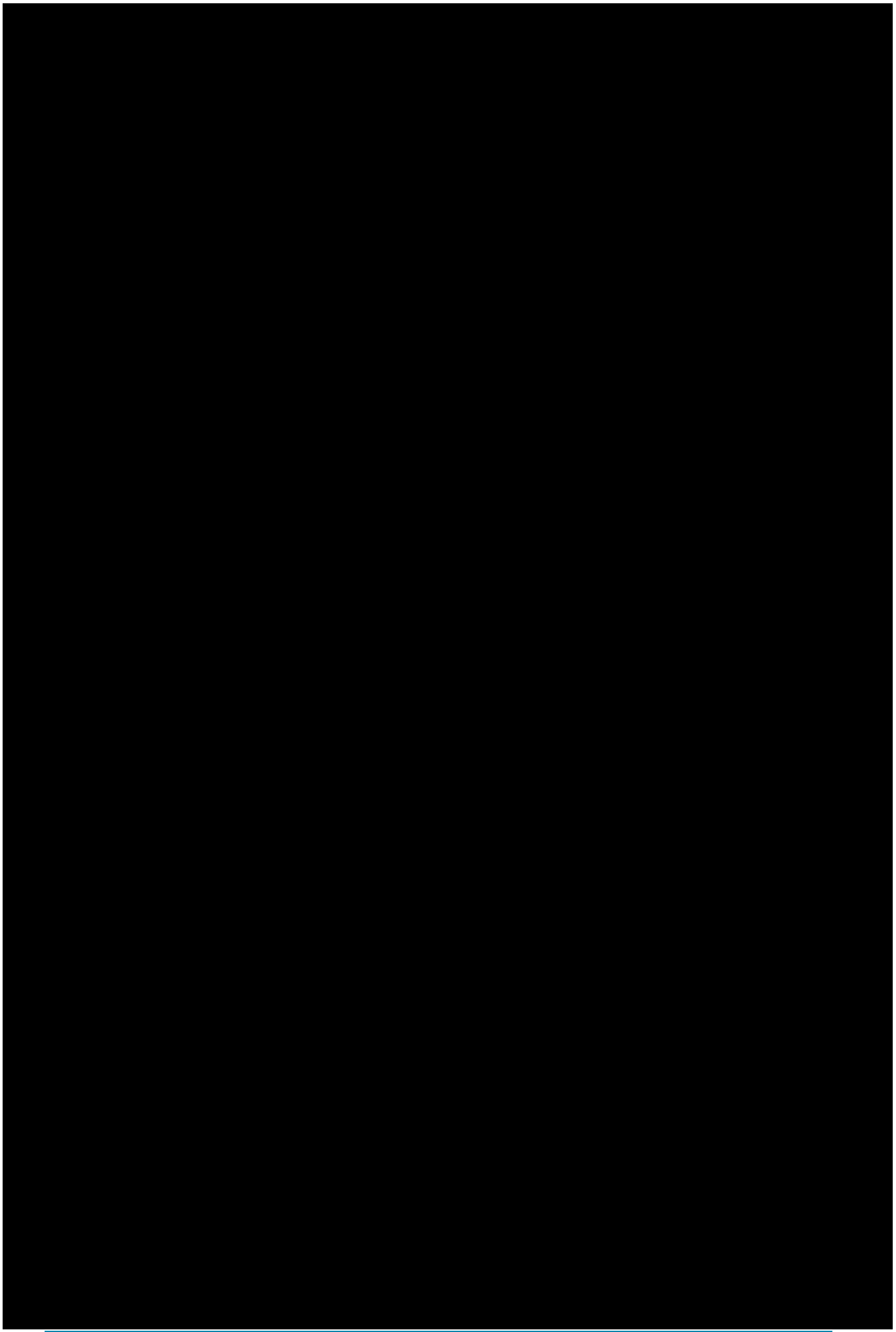


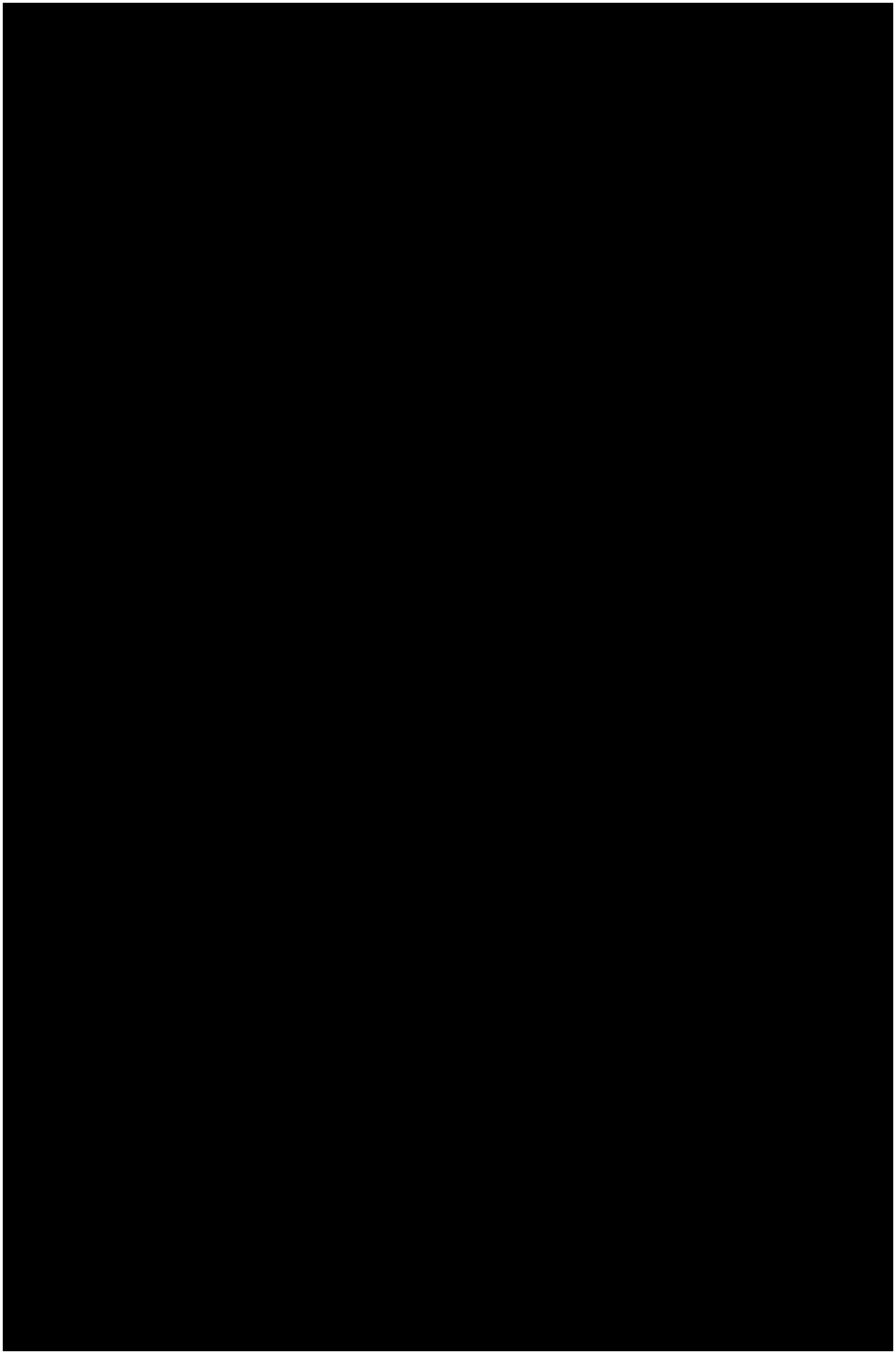


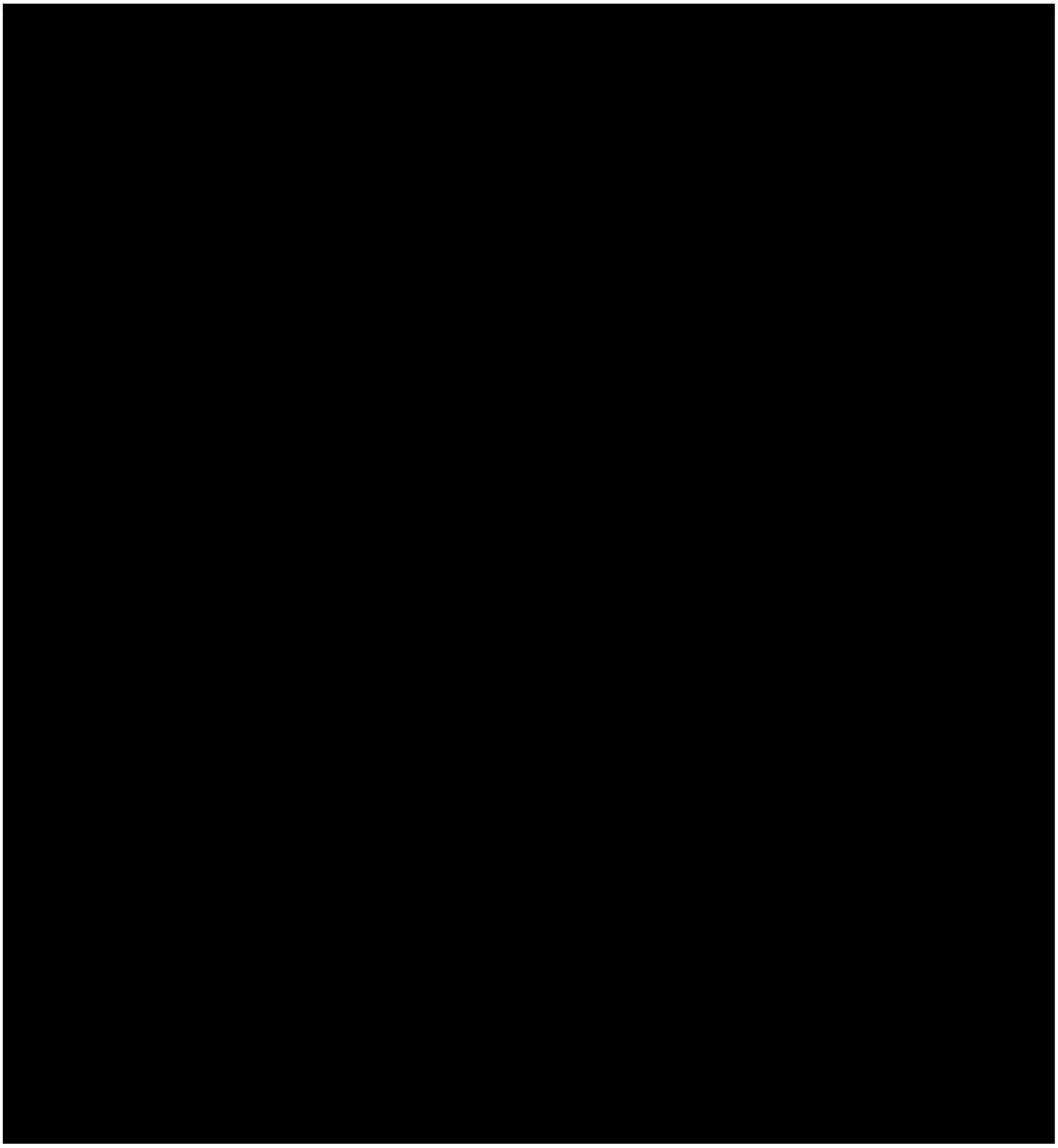
F

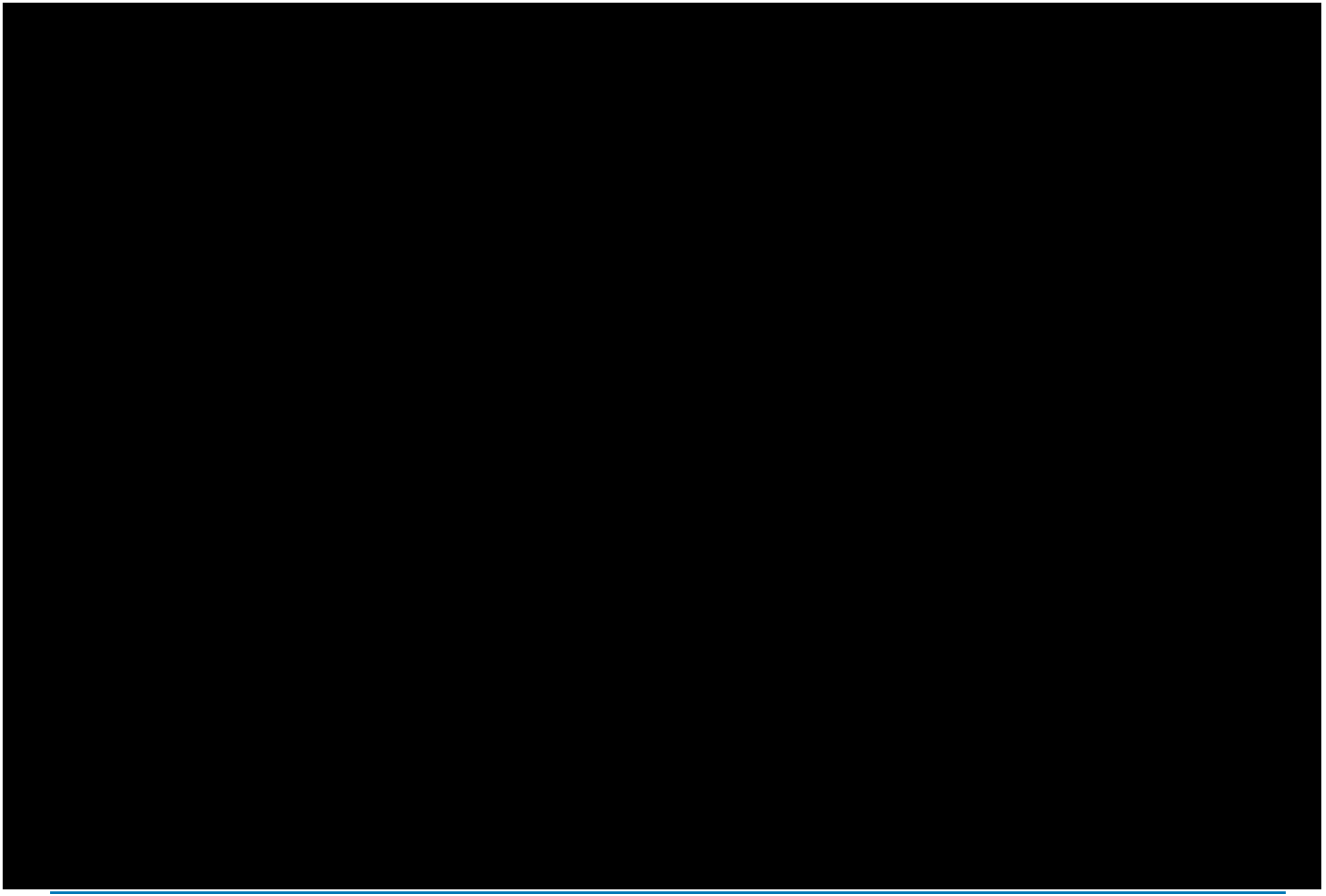


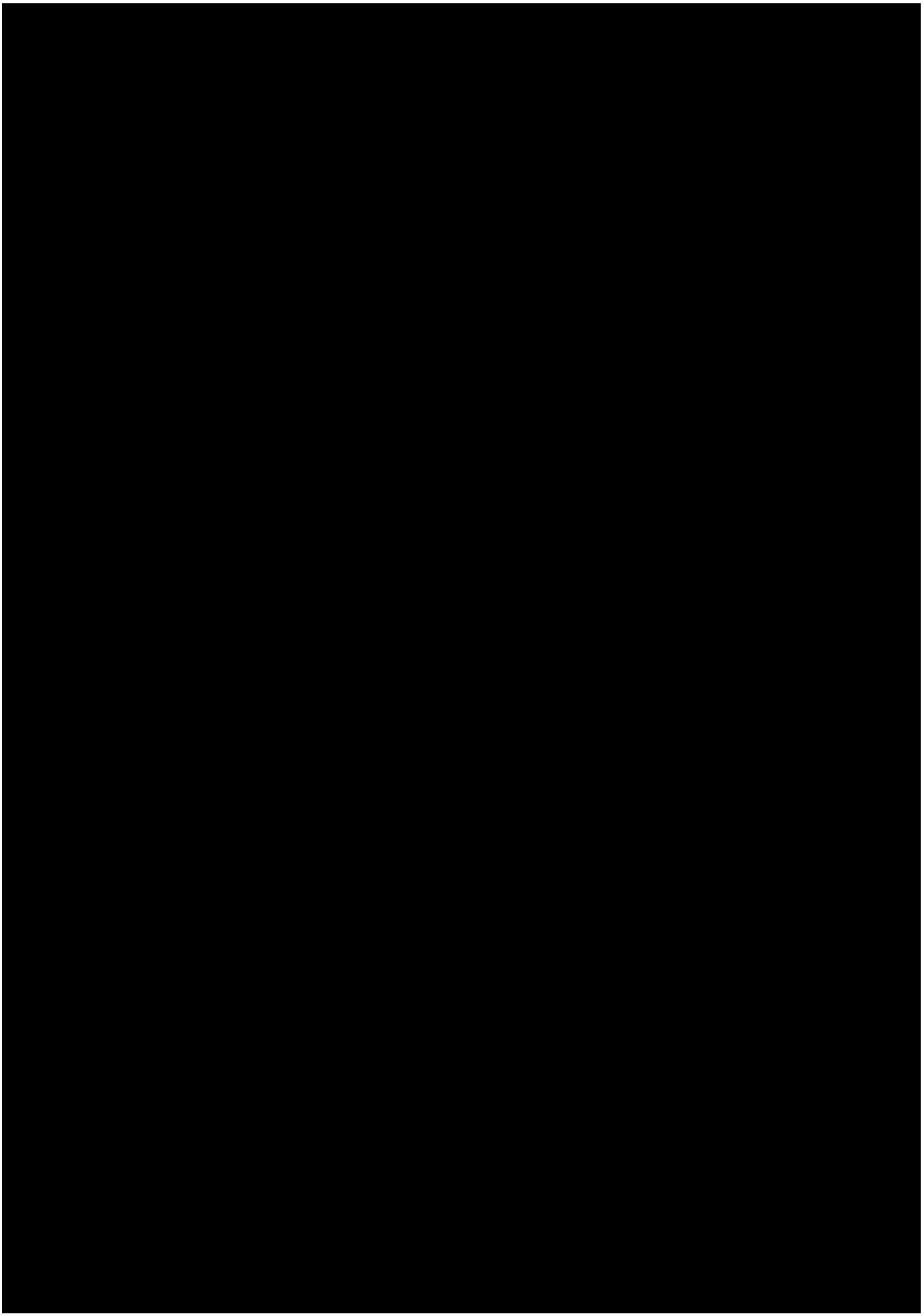


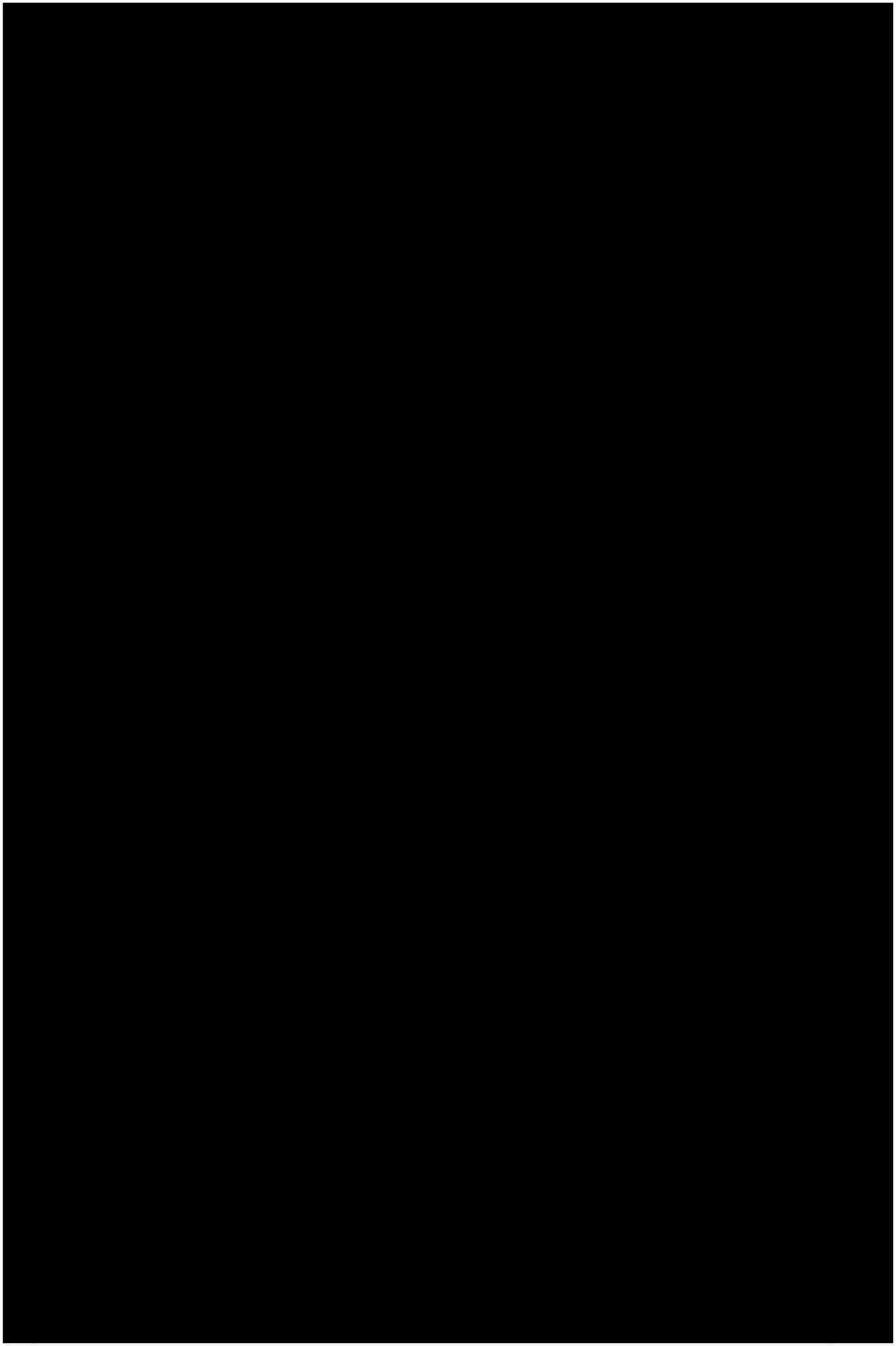


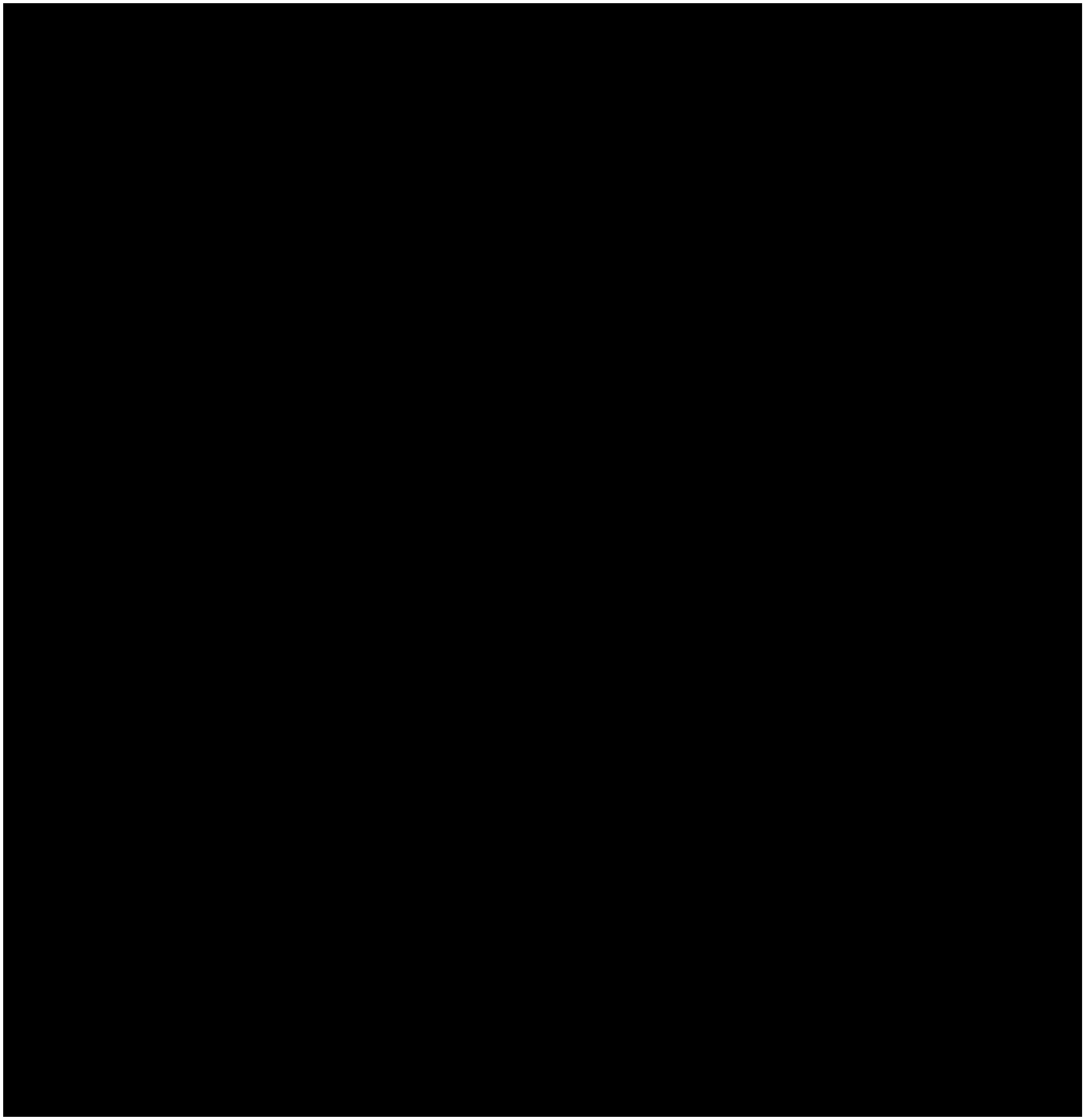




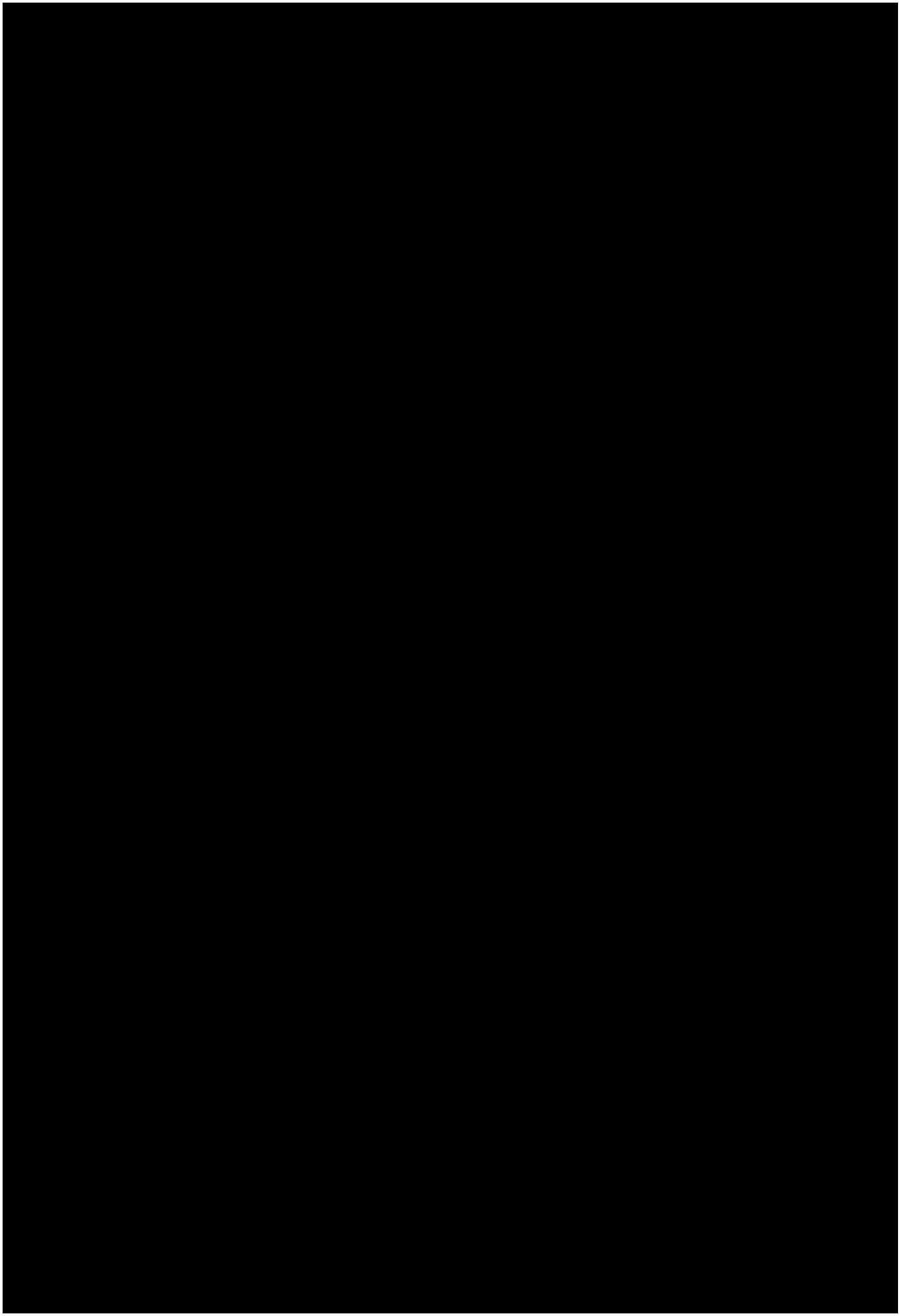


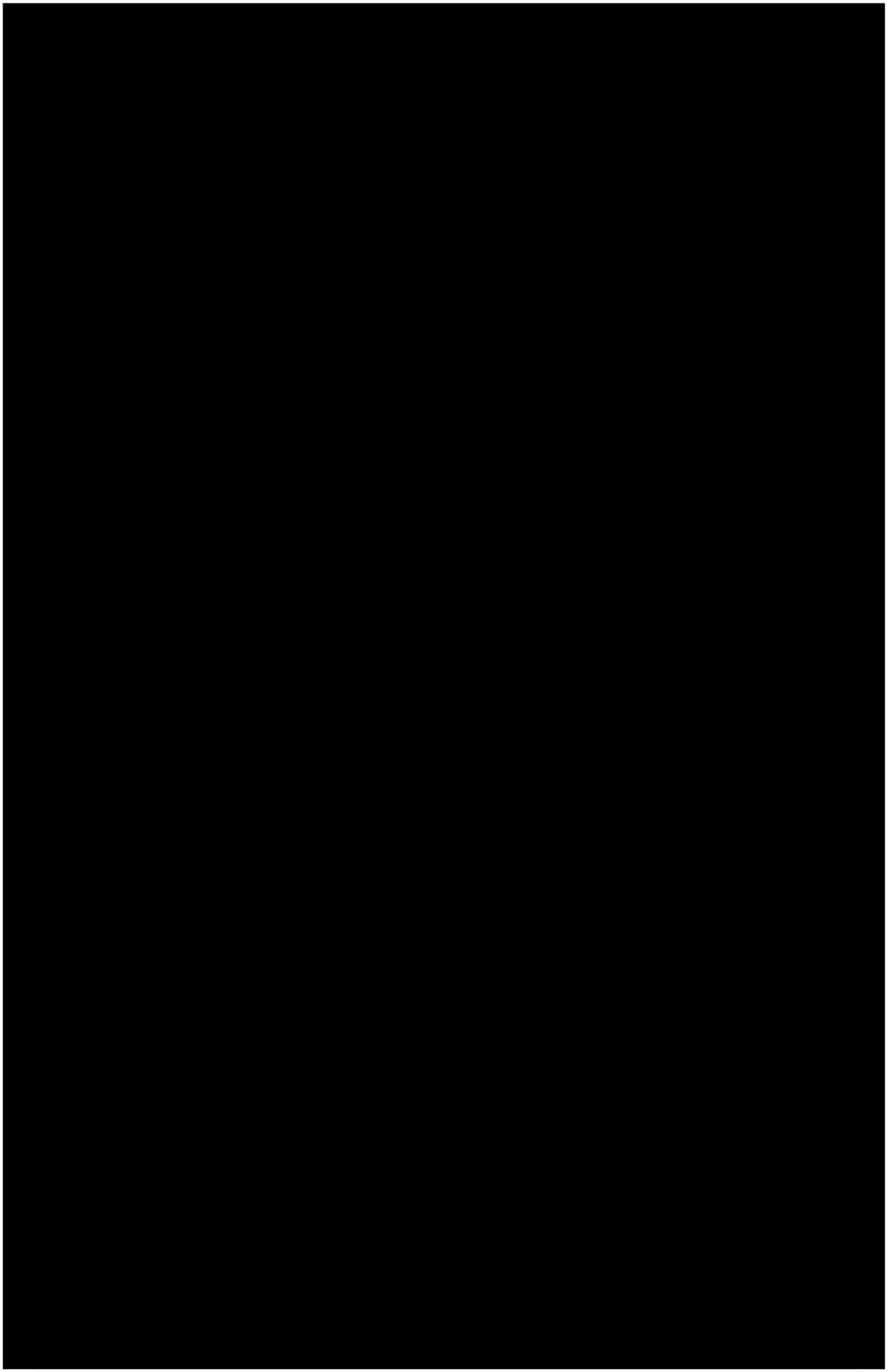


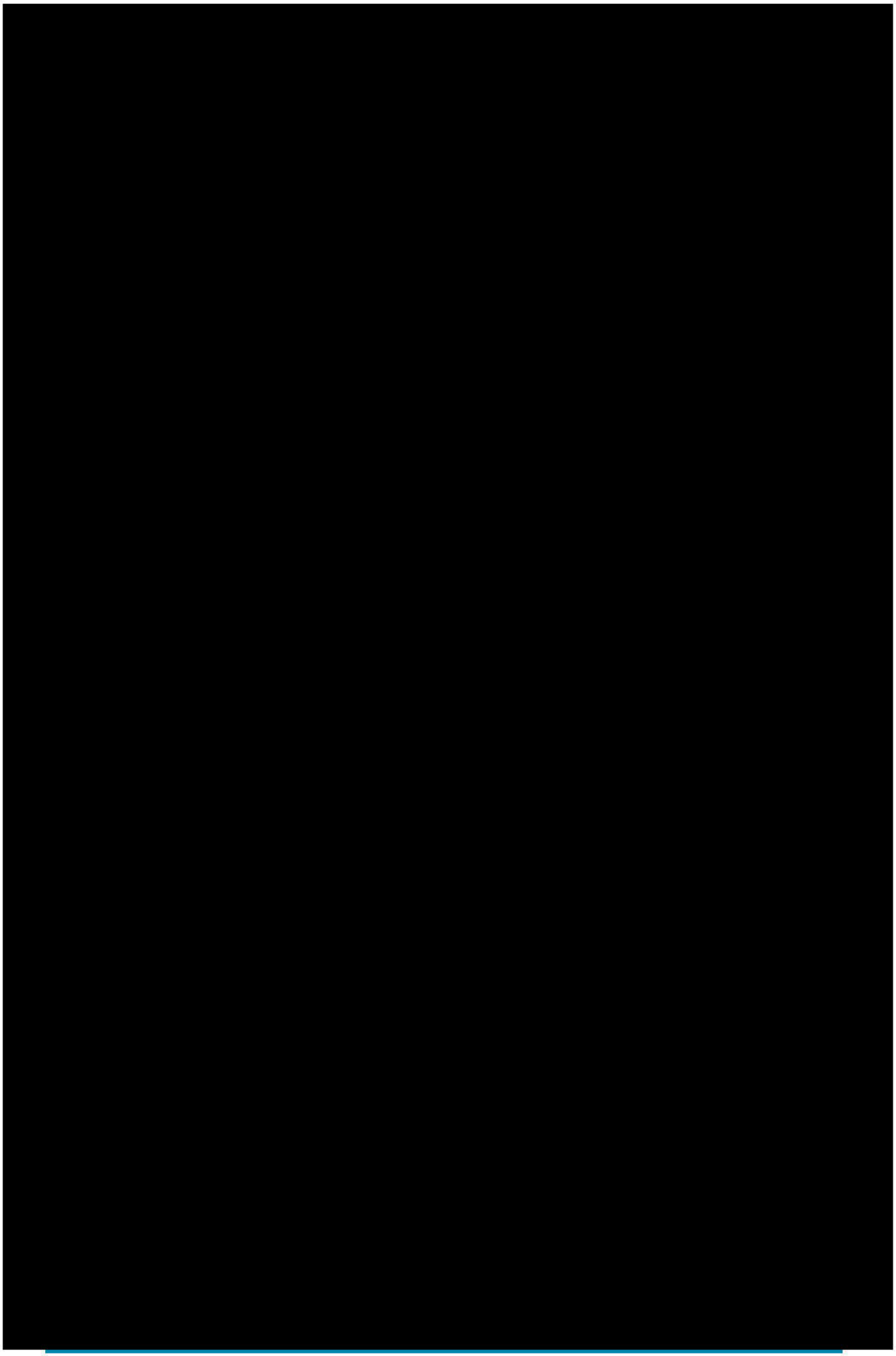


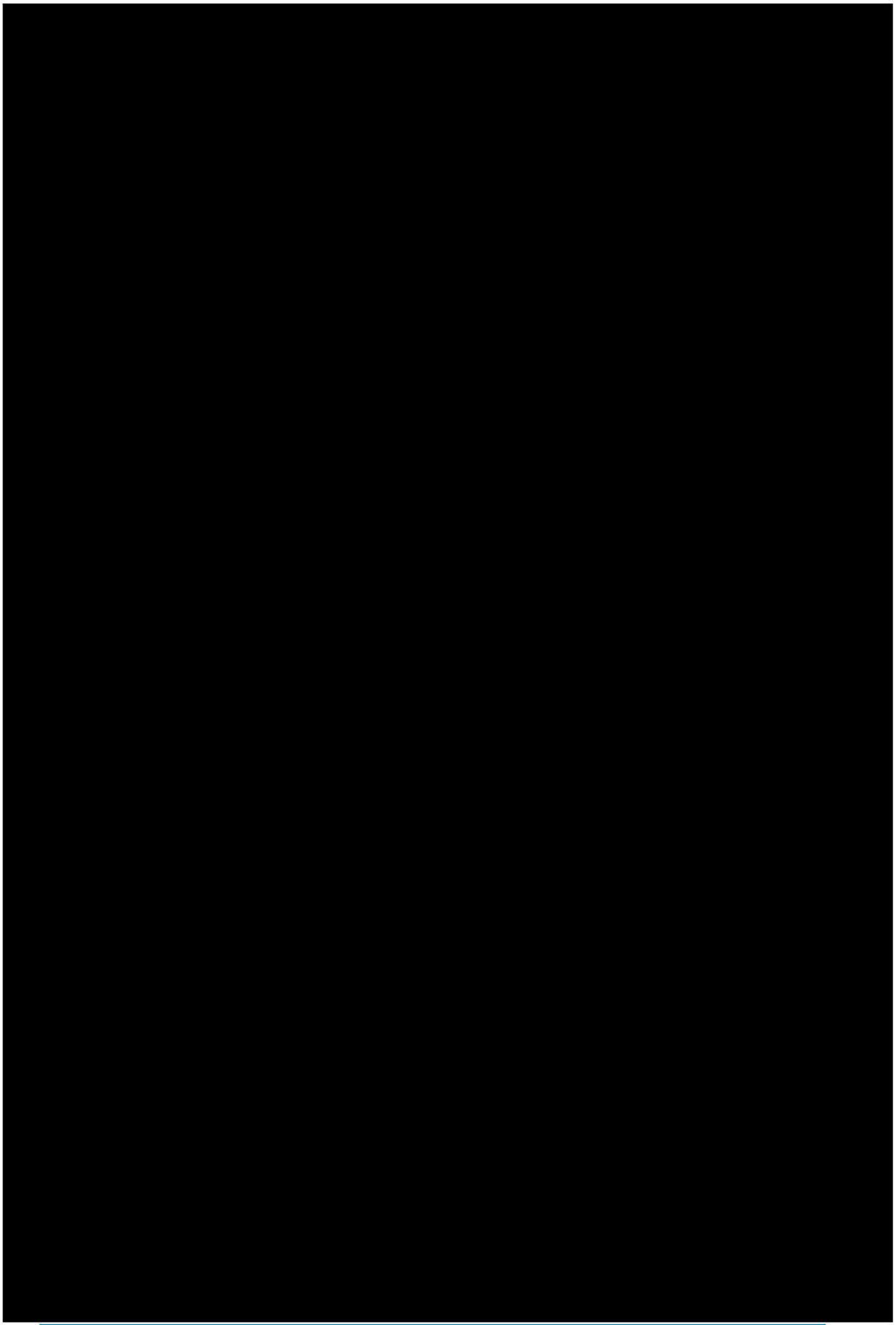


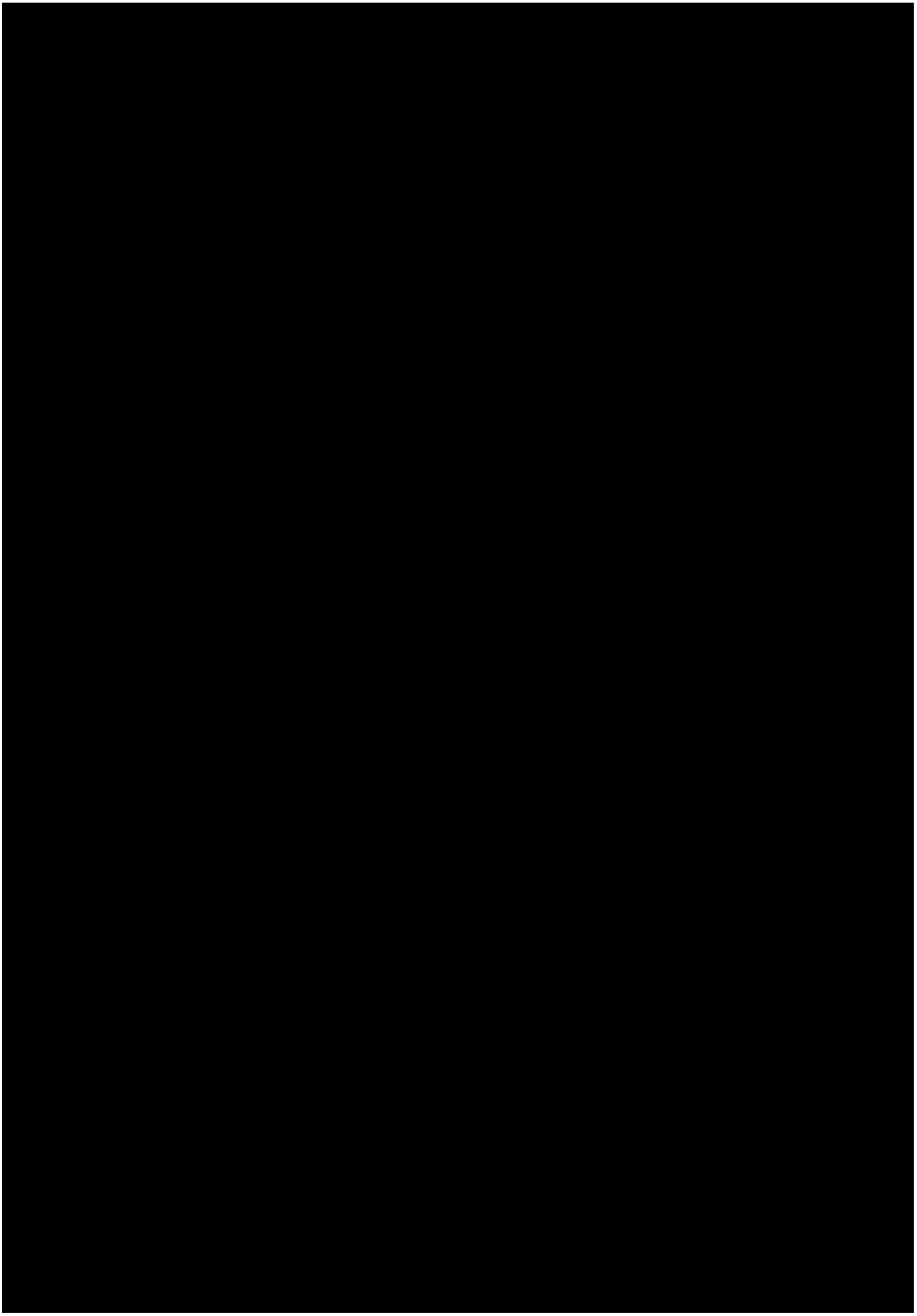
[redacted]

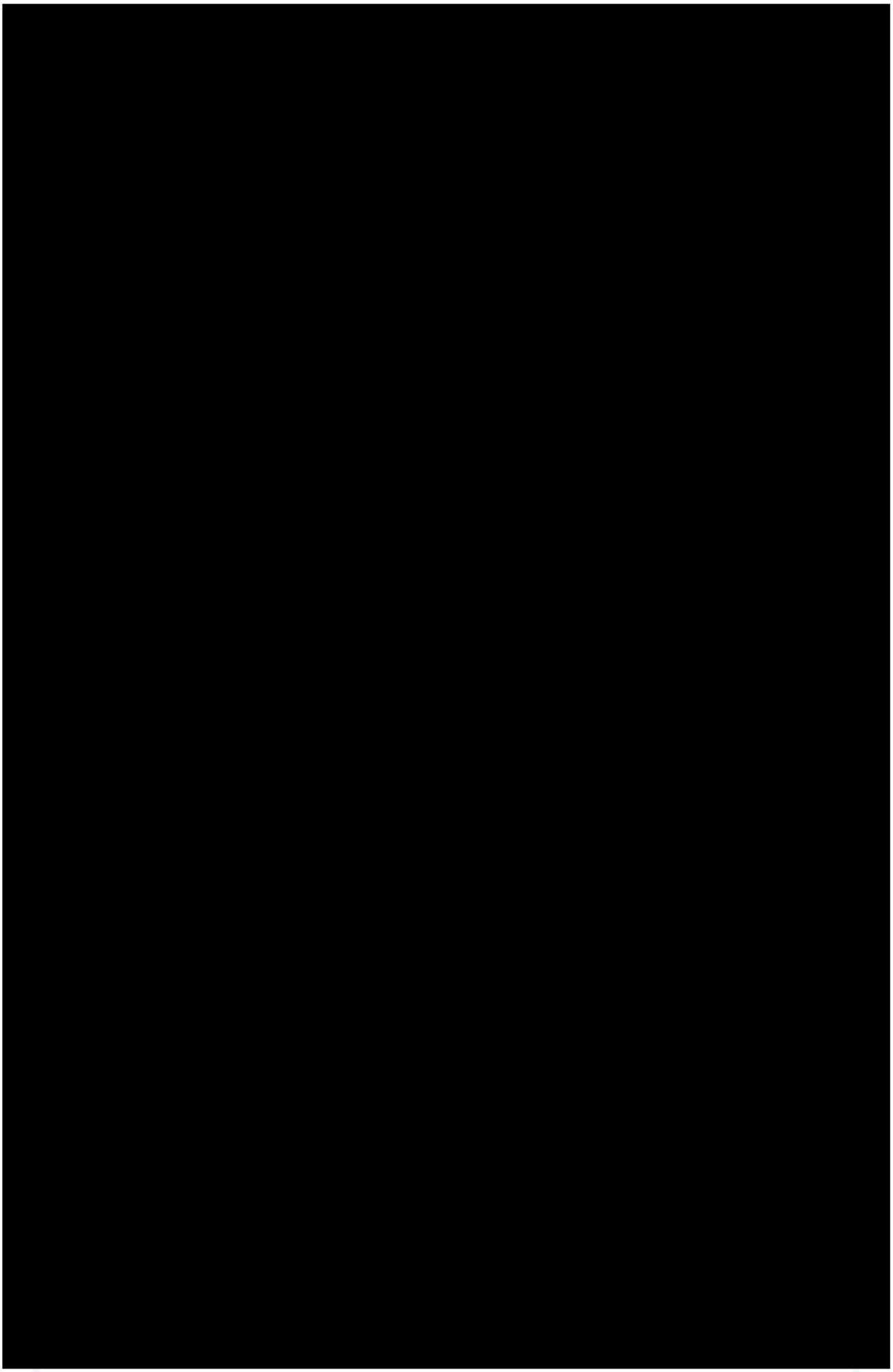


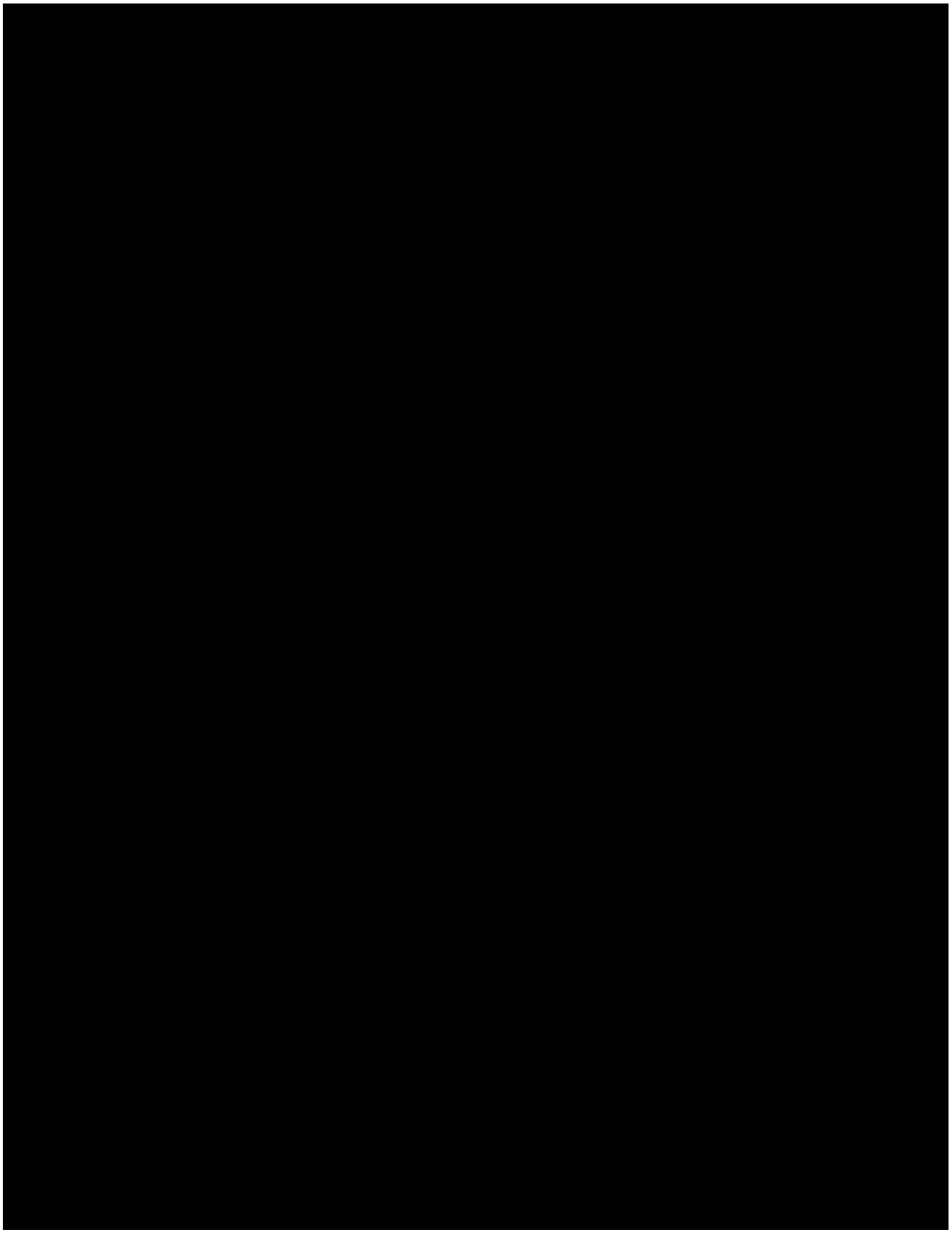


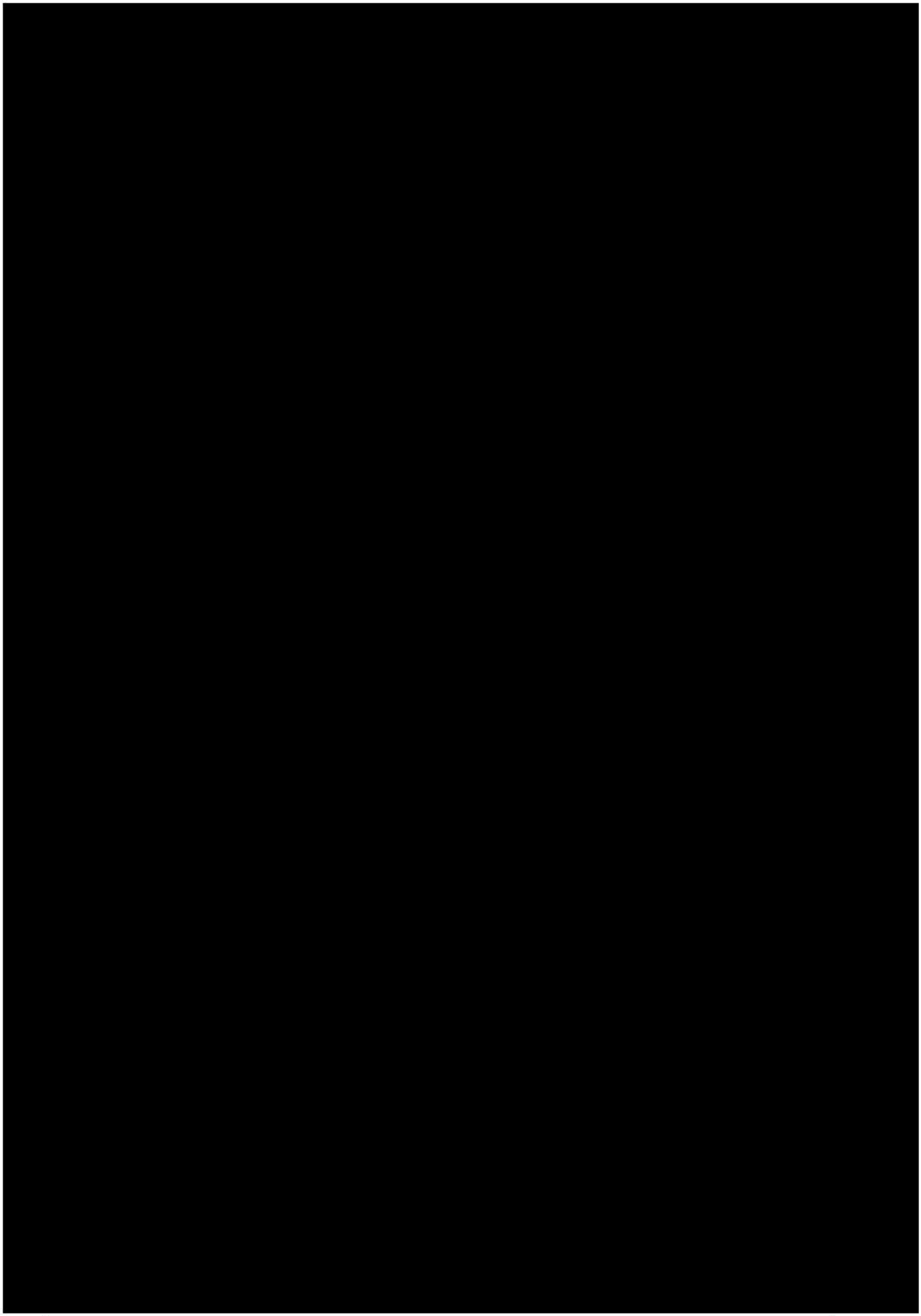


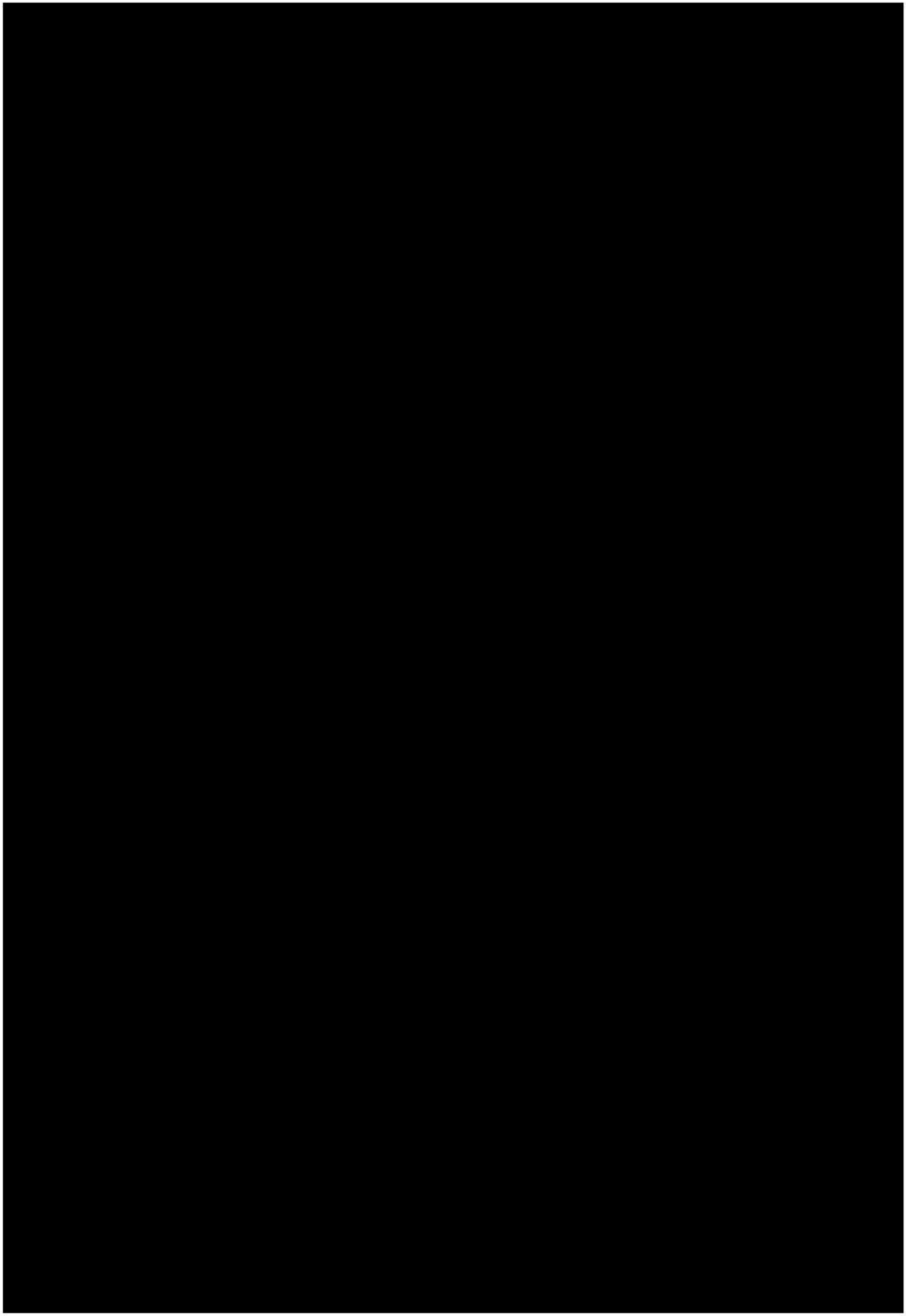


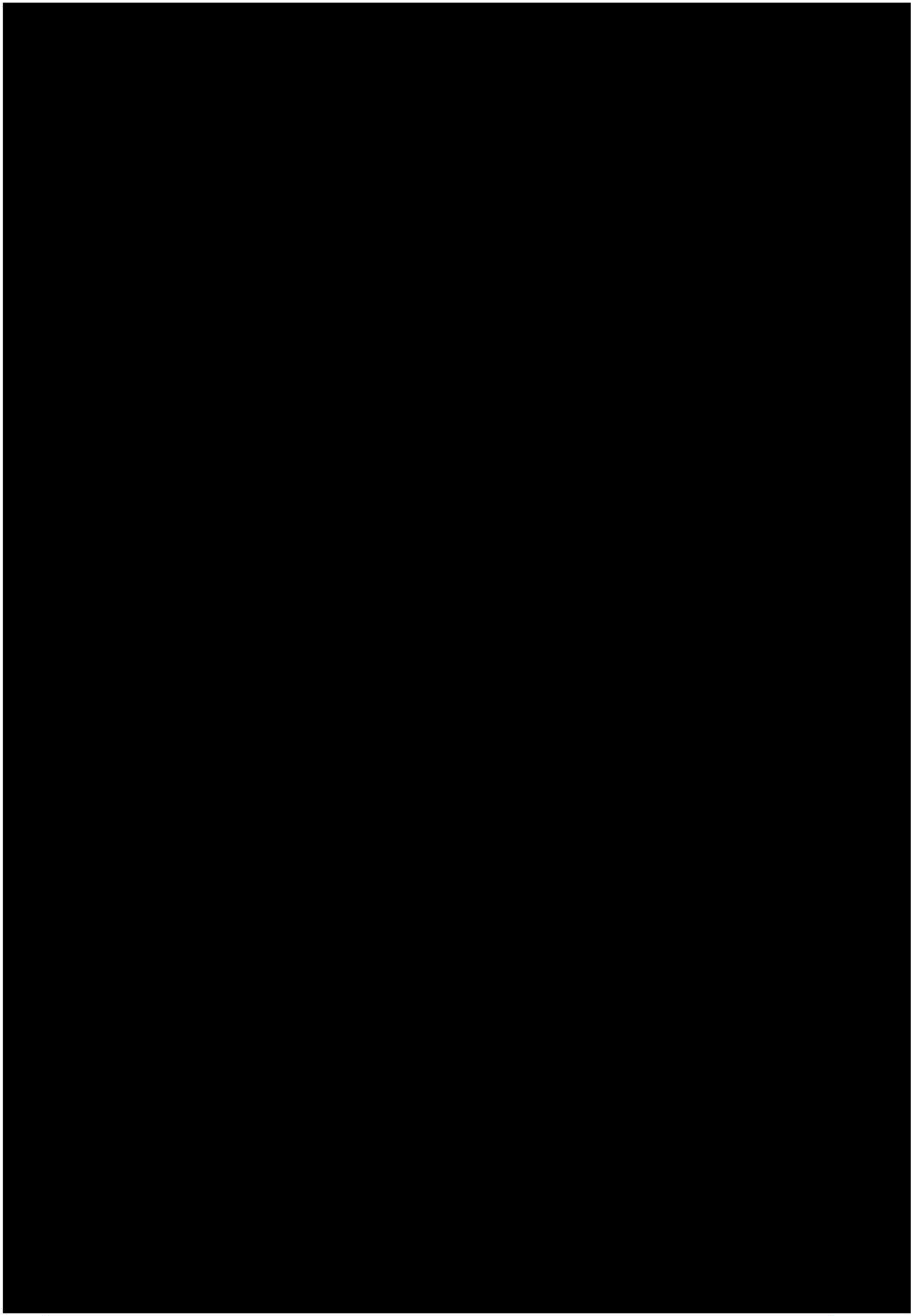


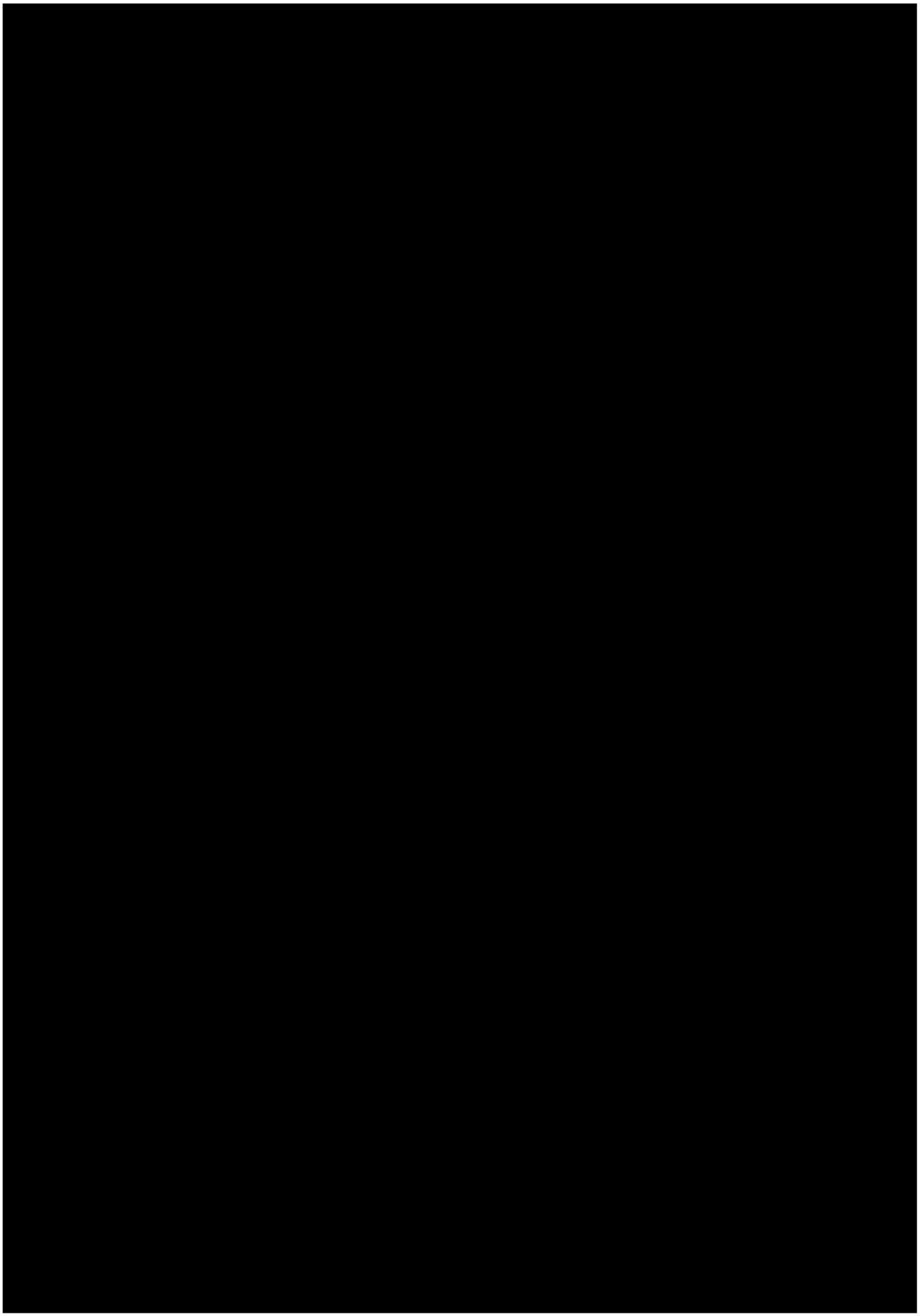


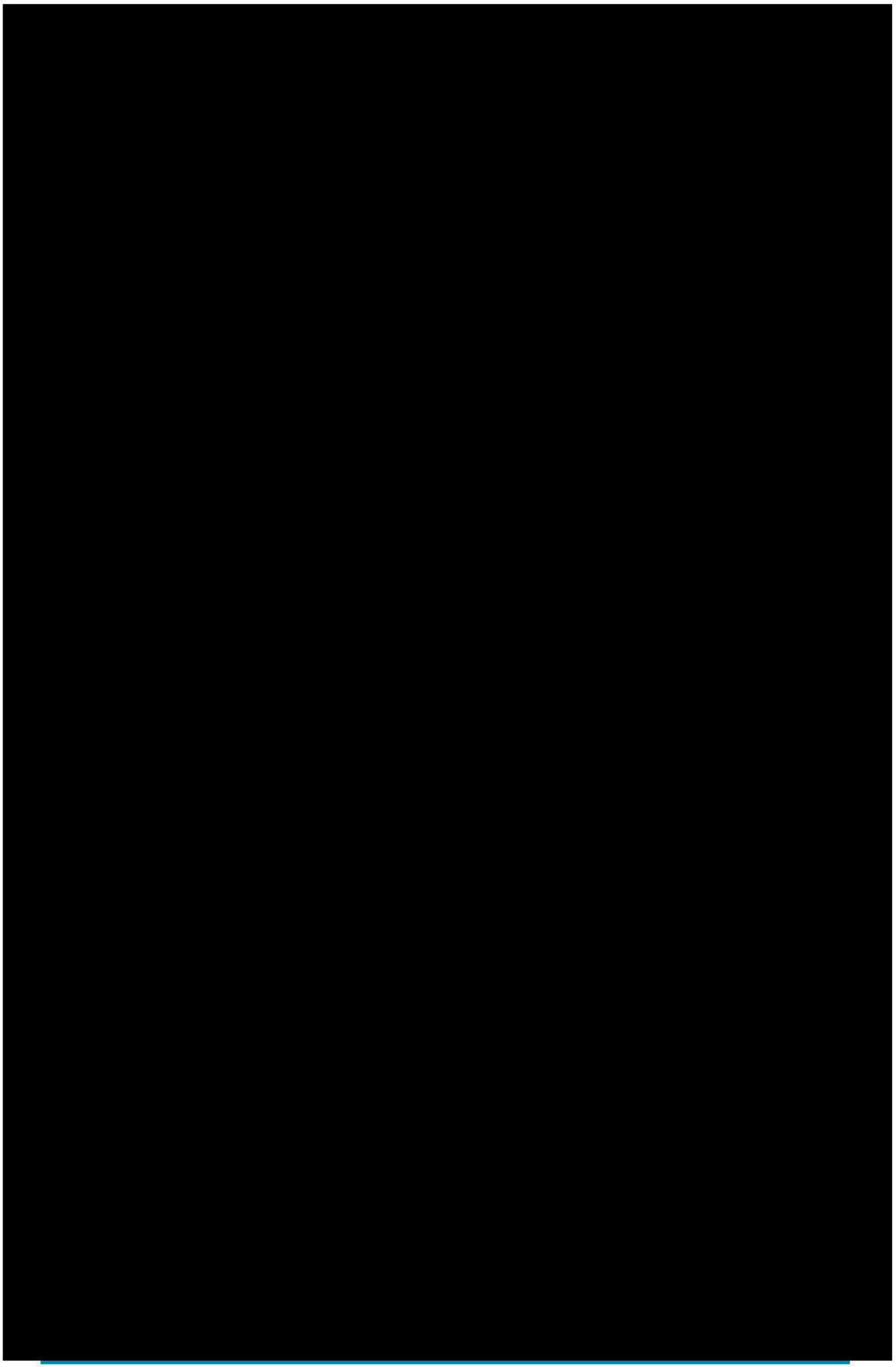


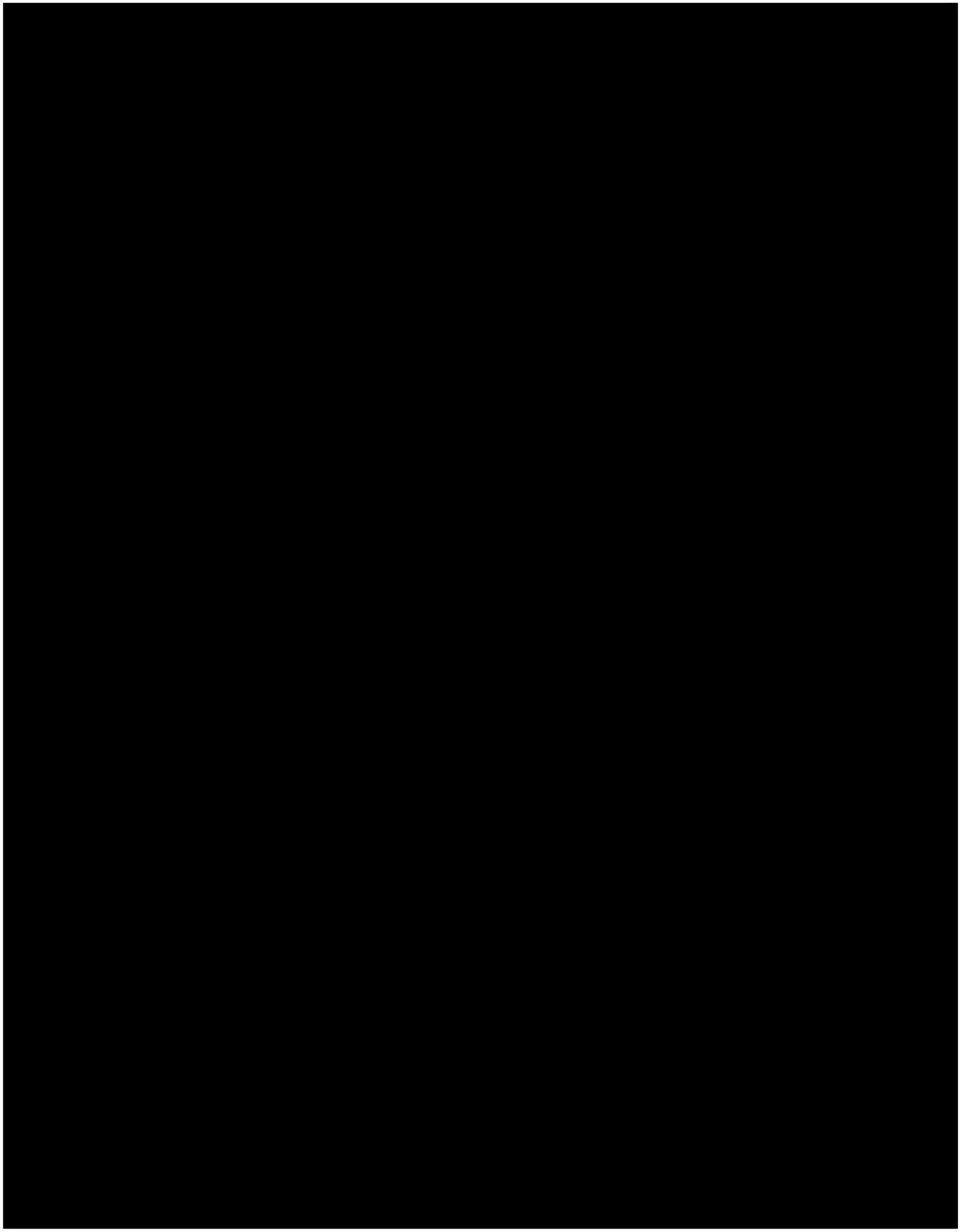


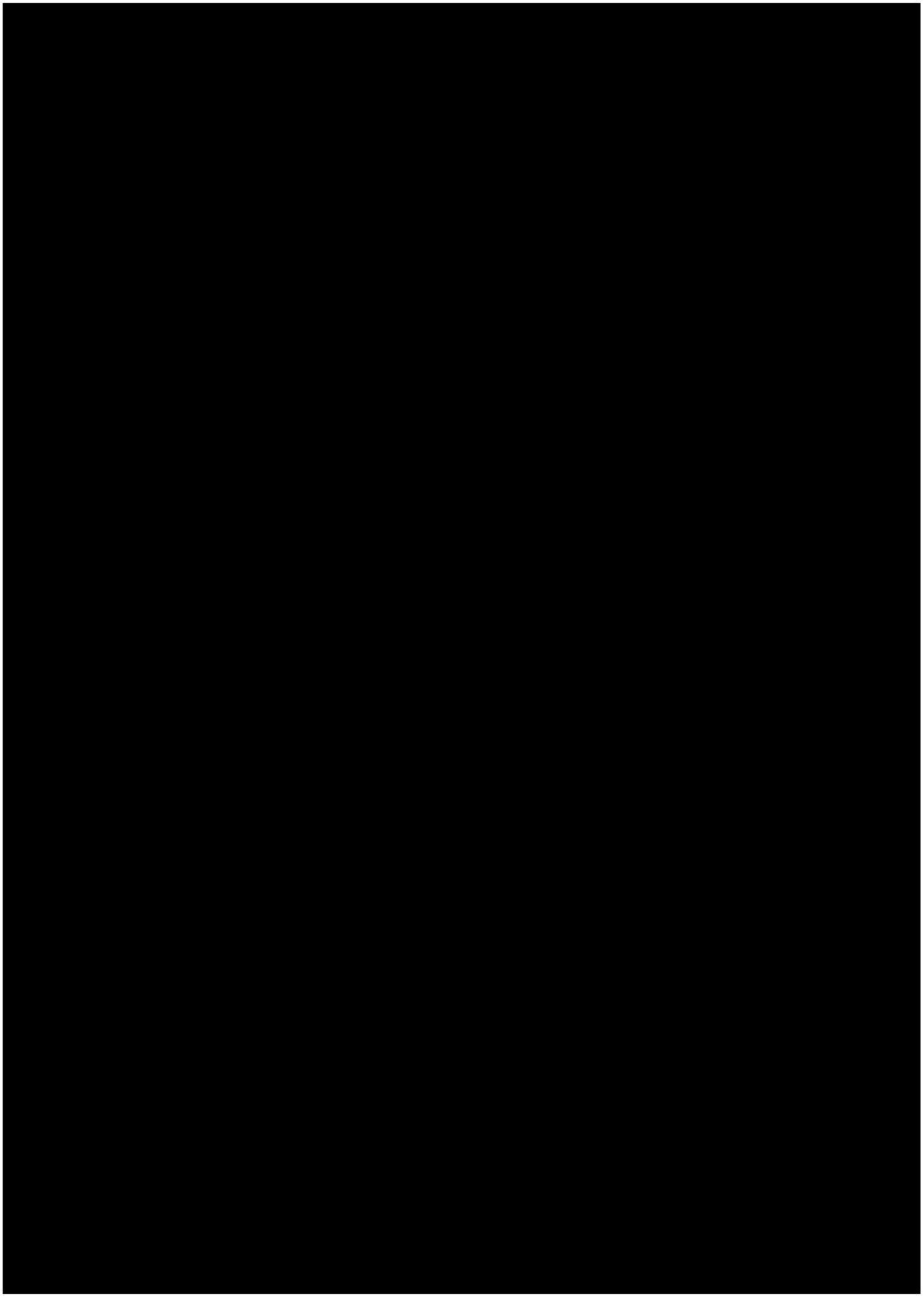


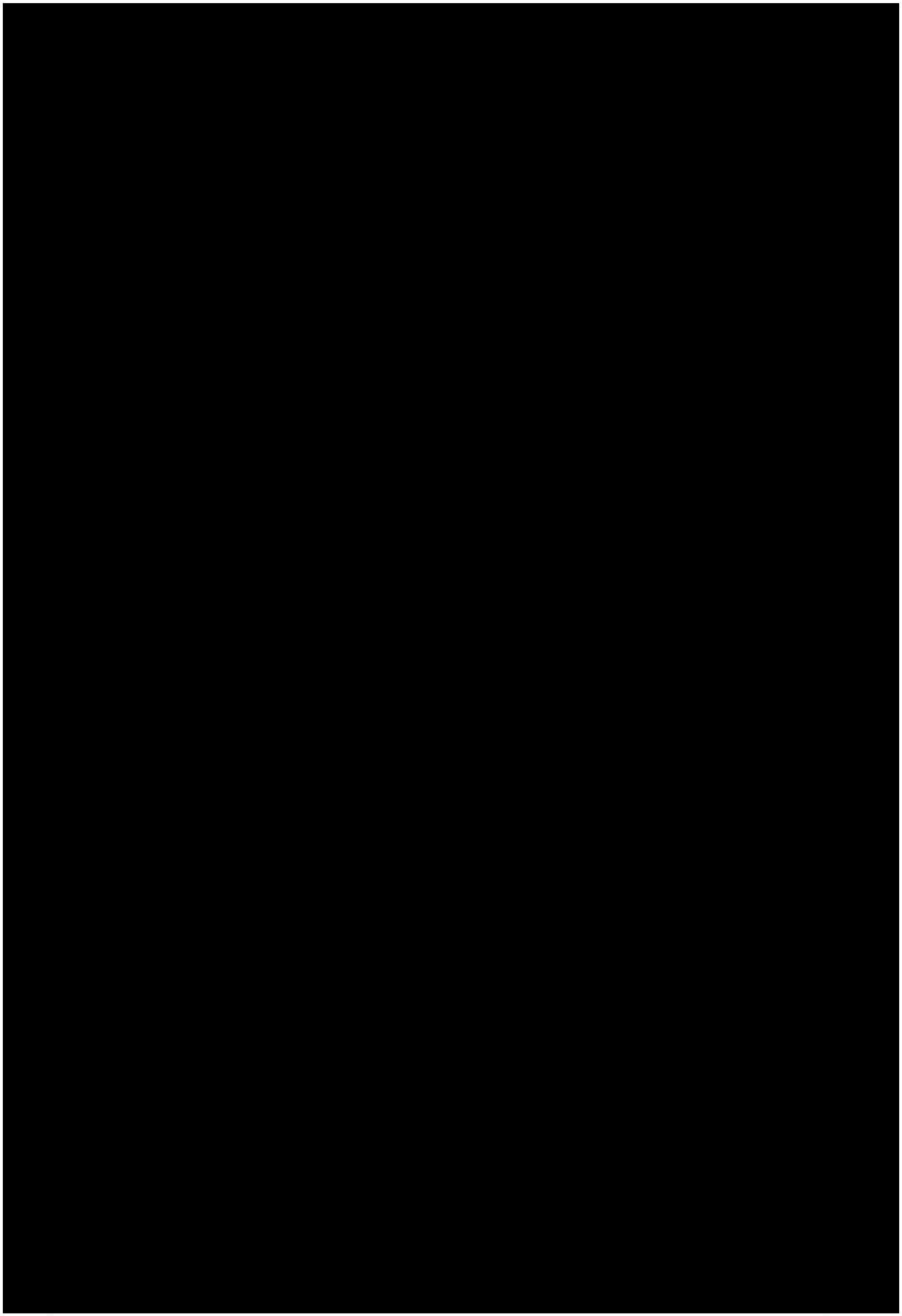


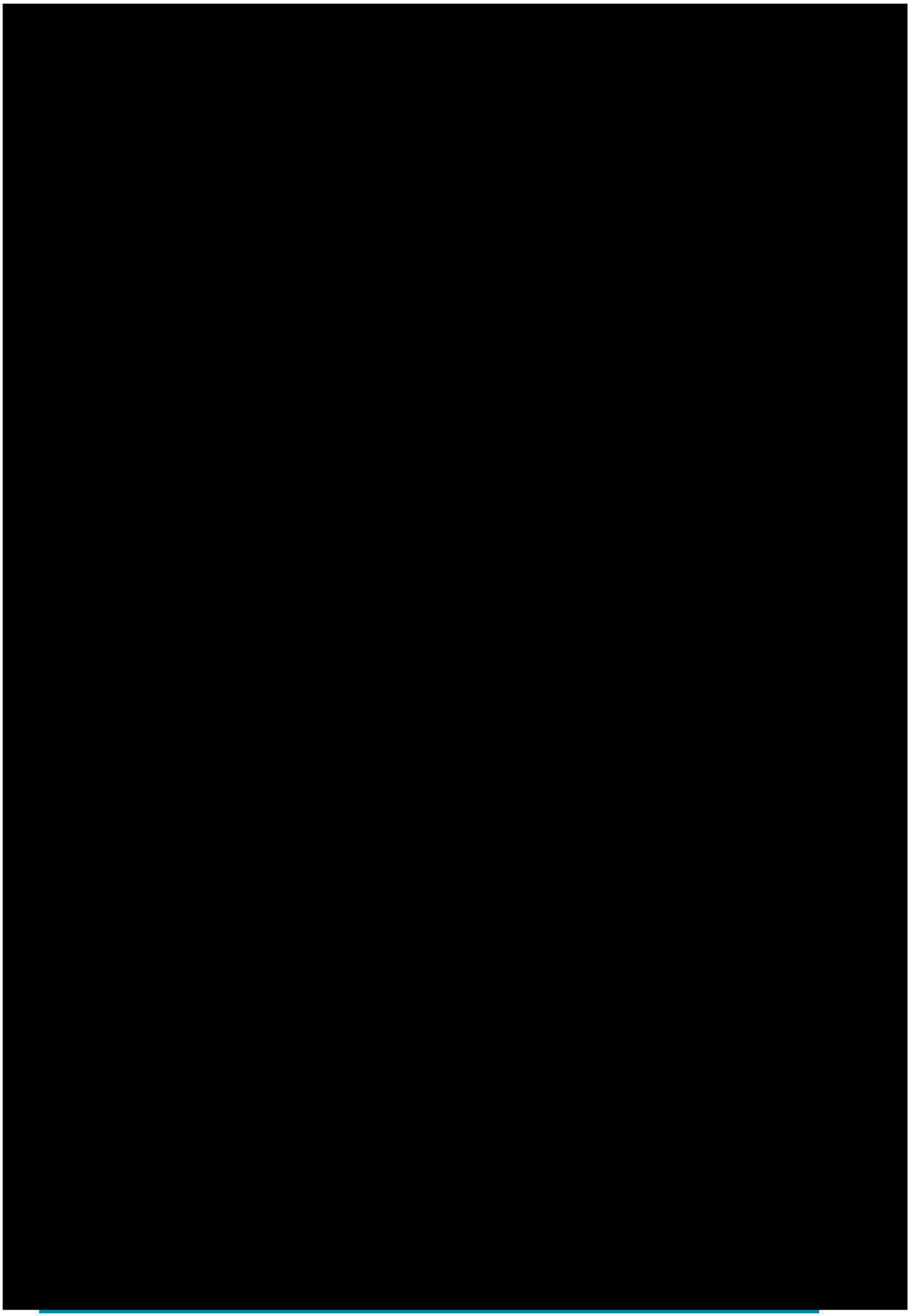


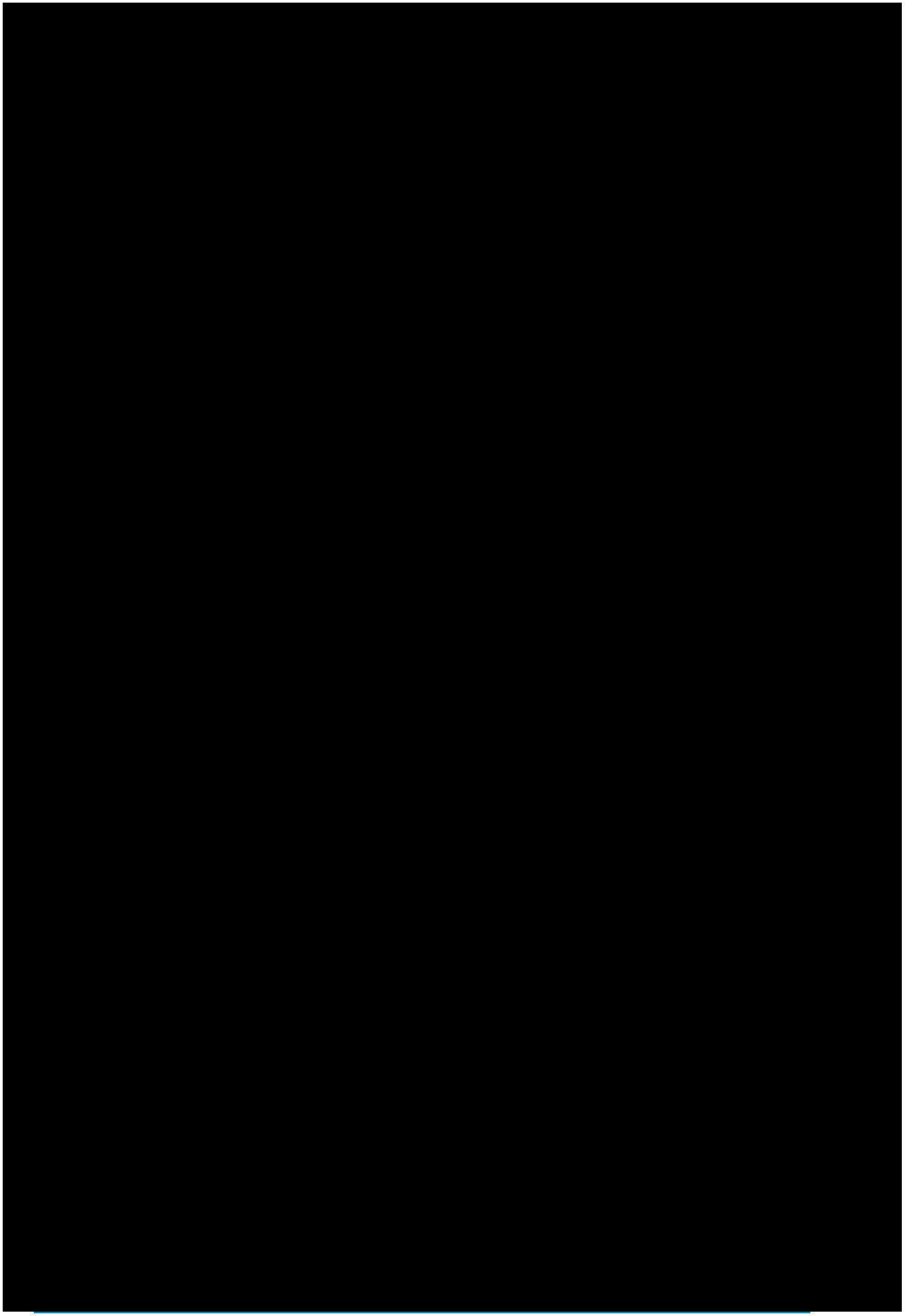


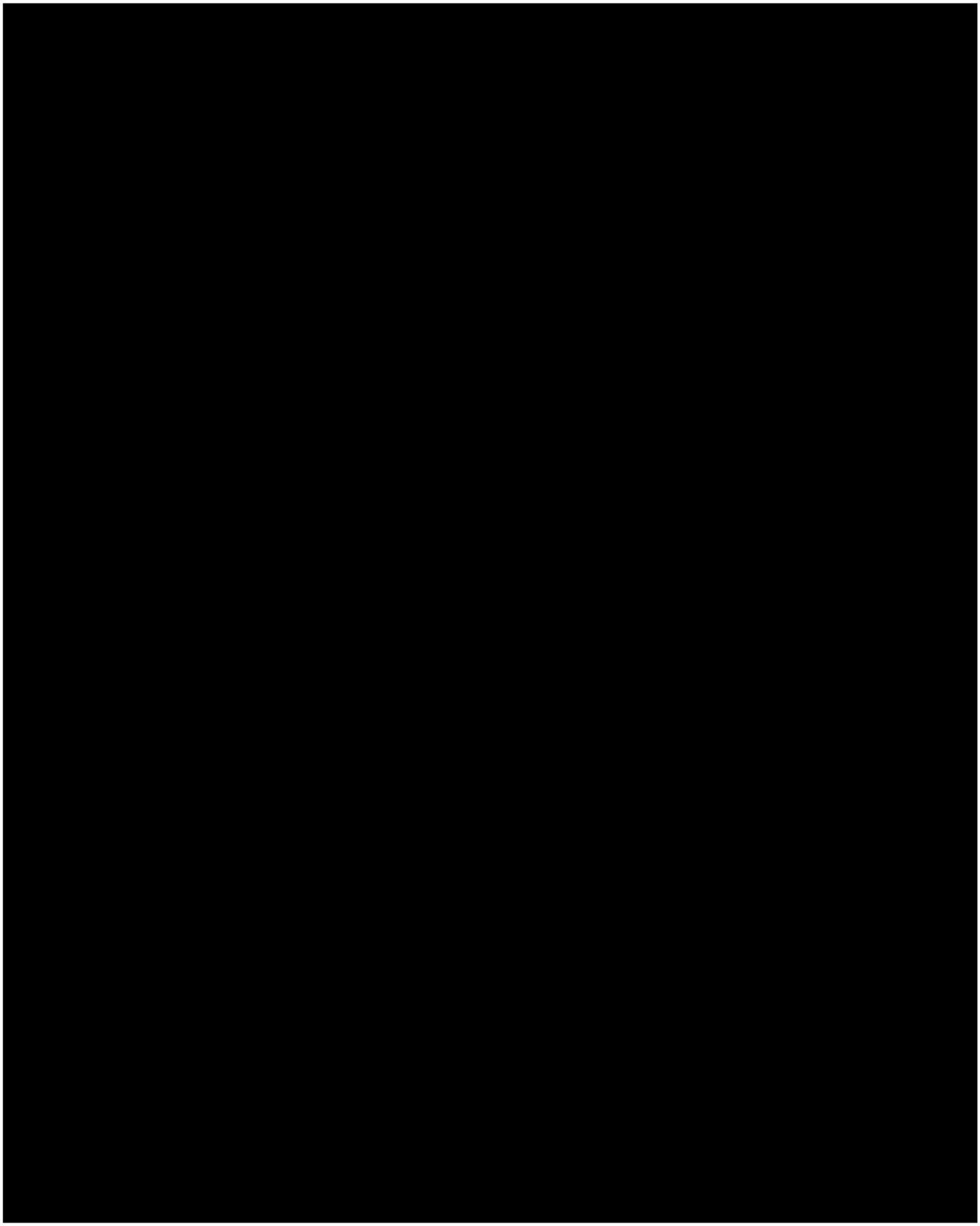


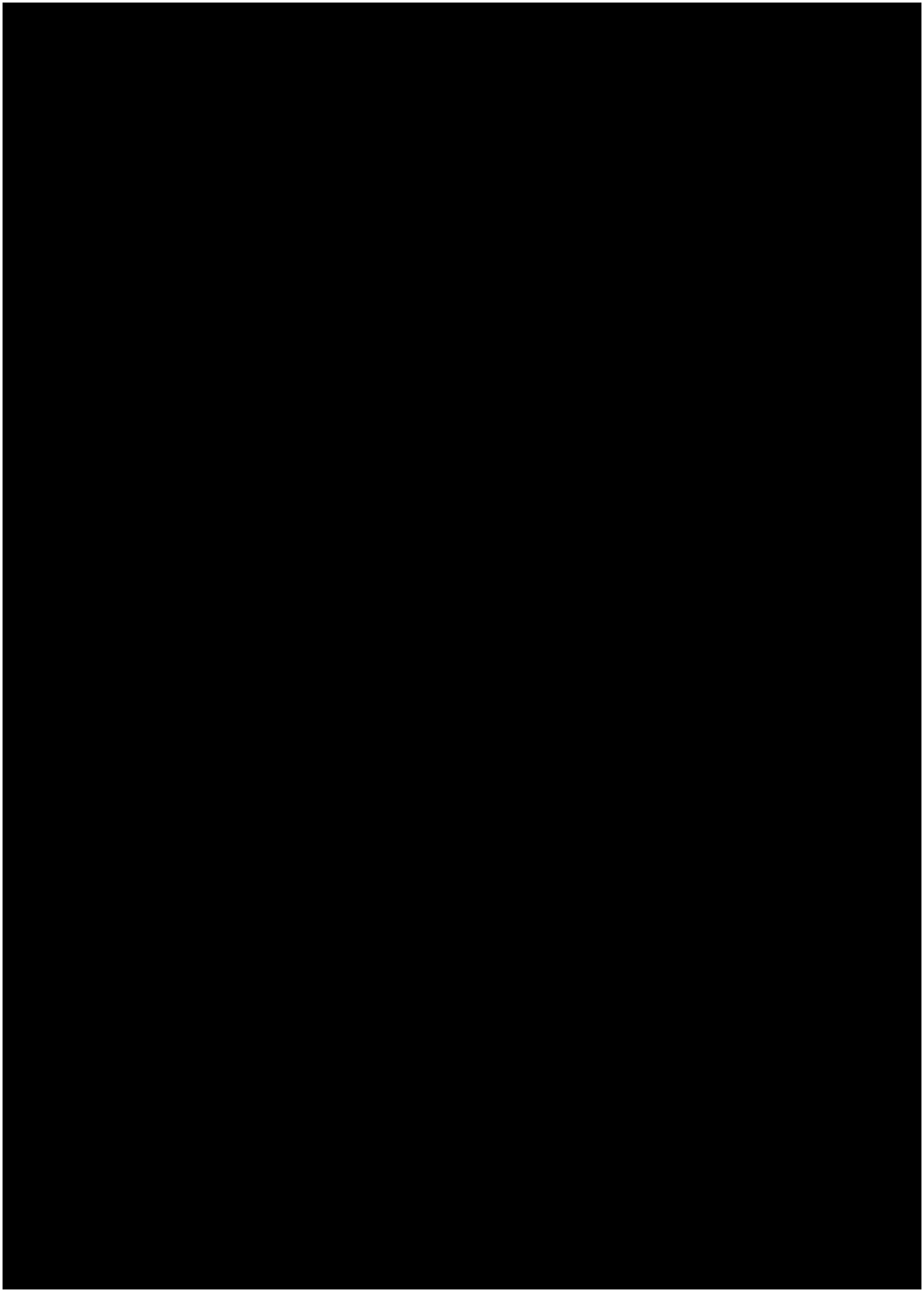




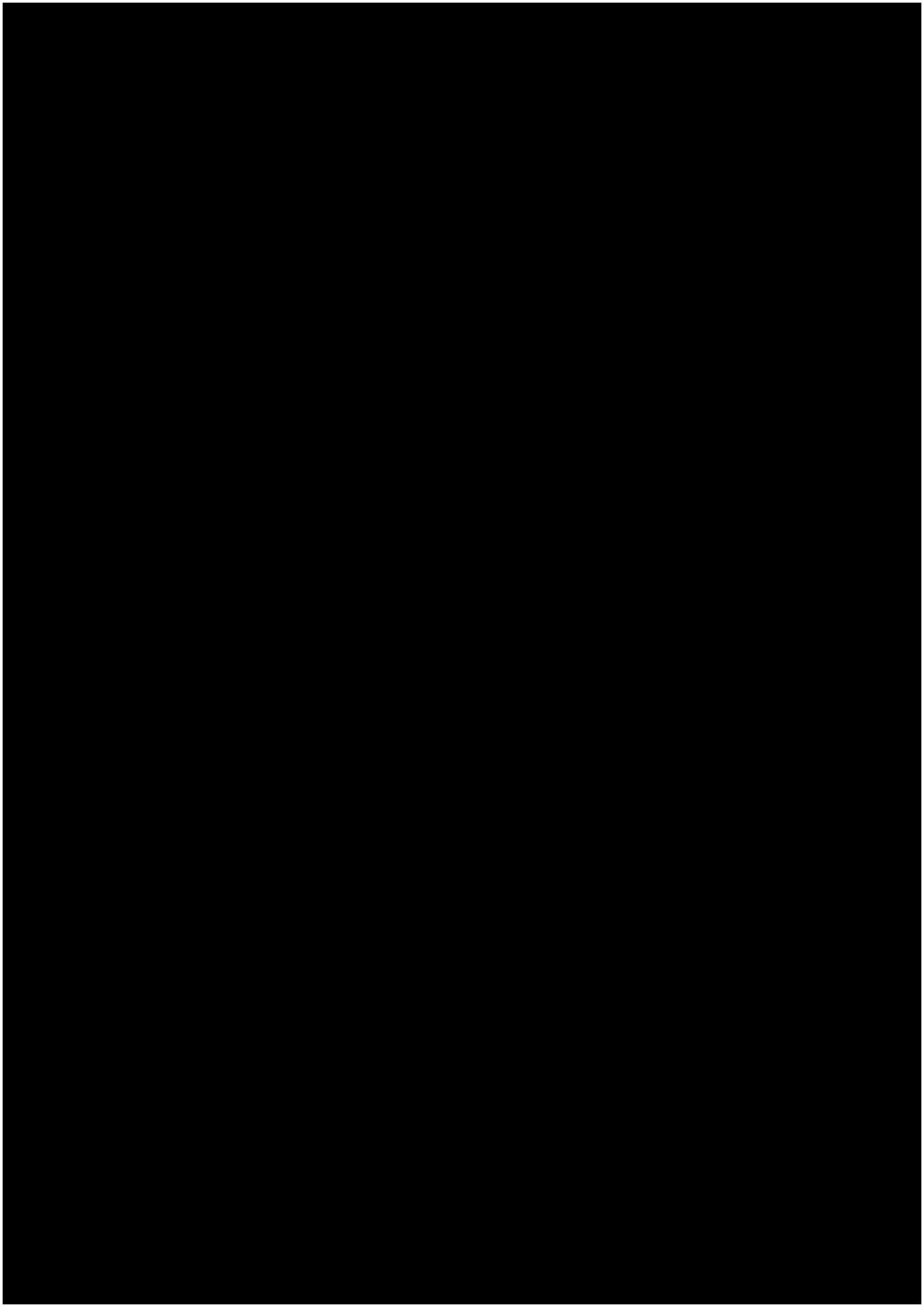


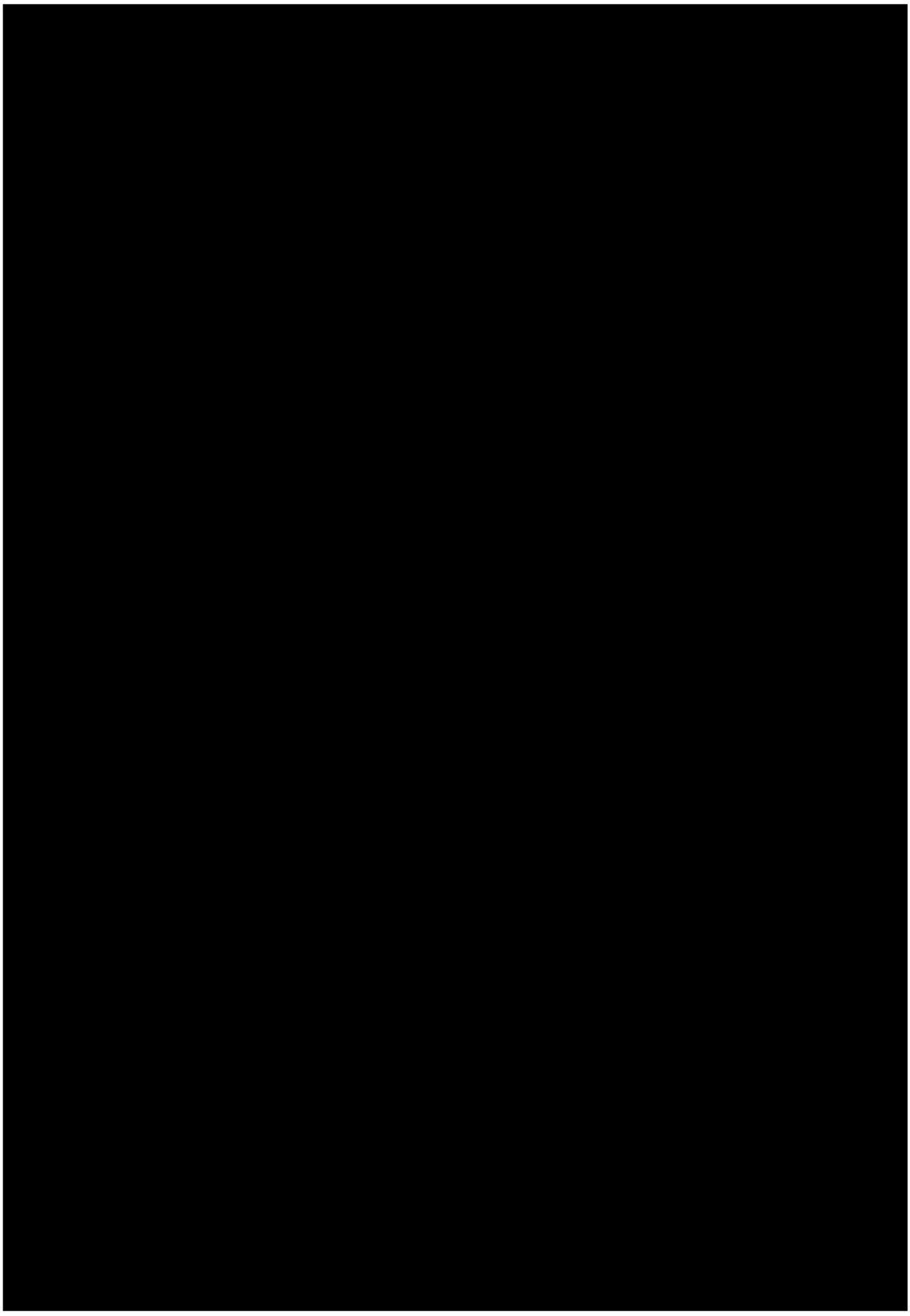


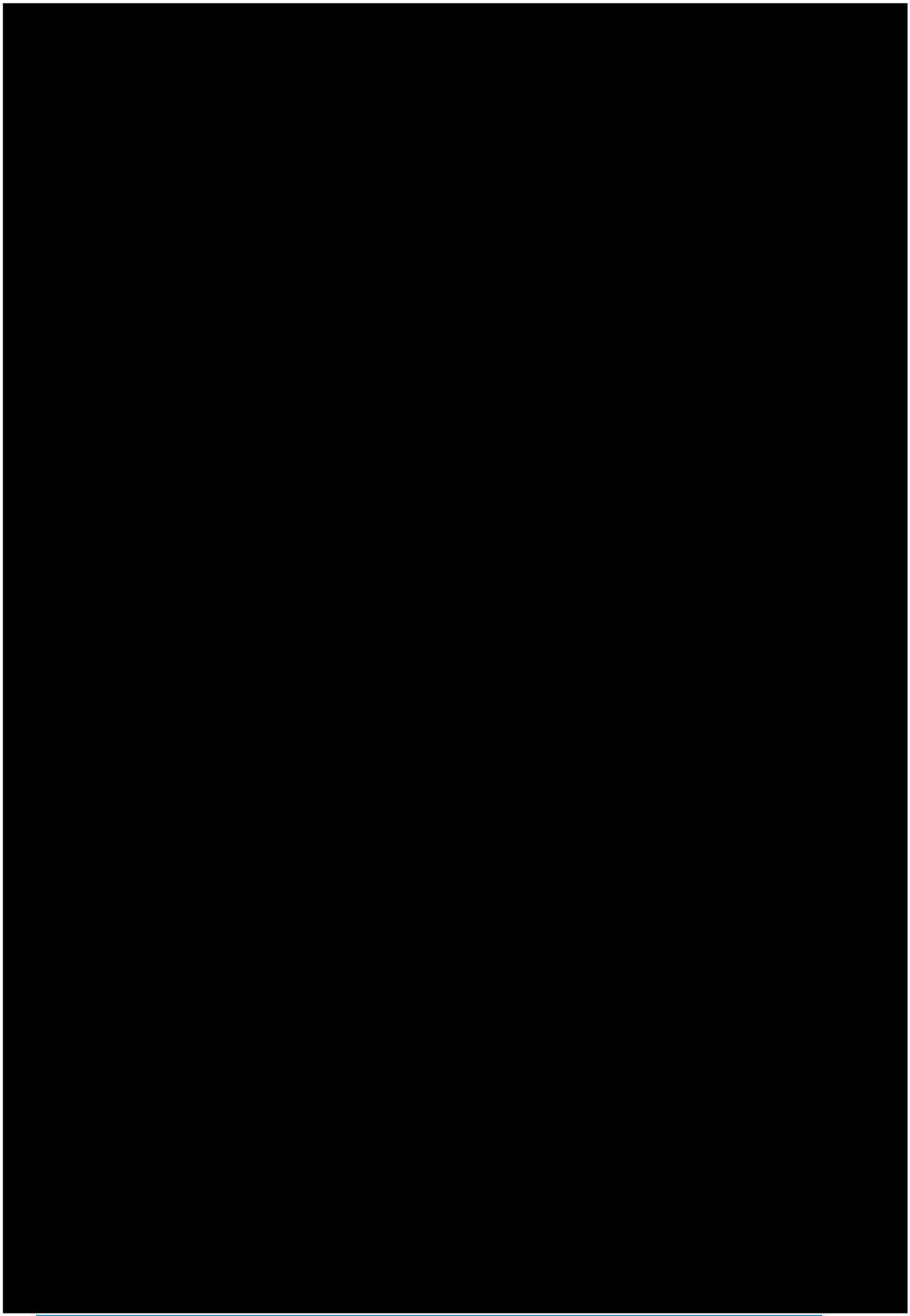


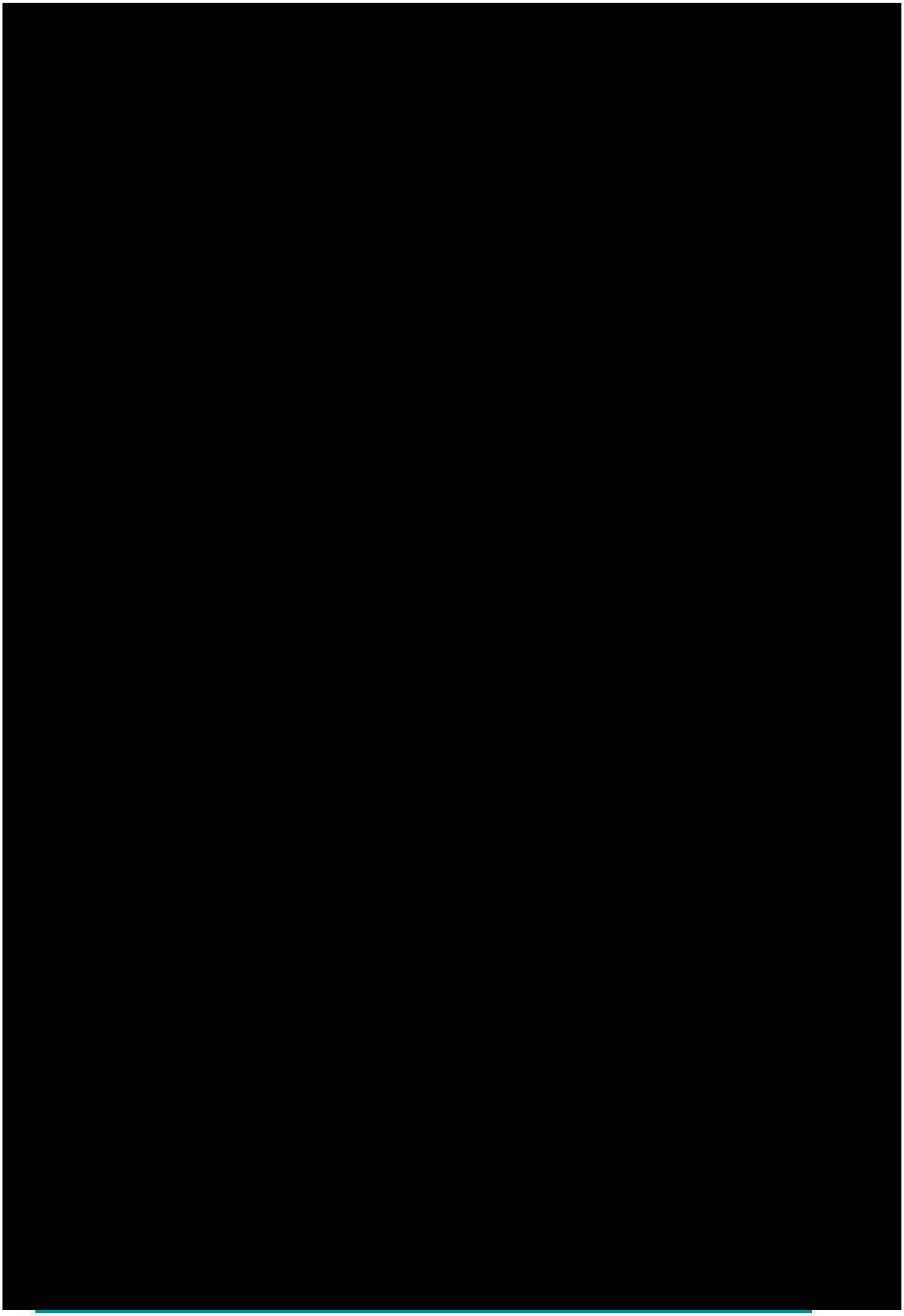


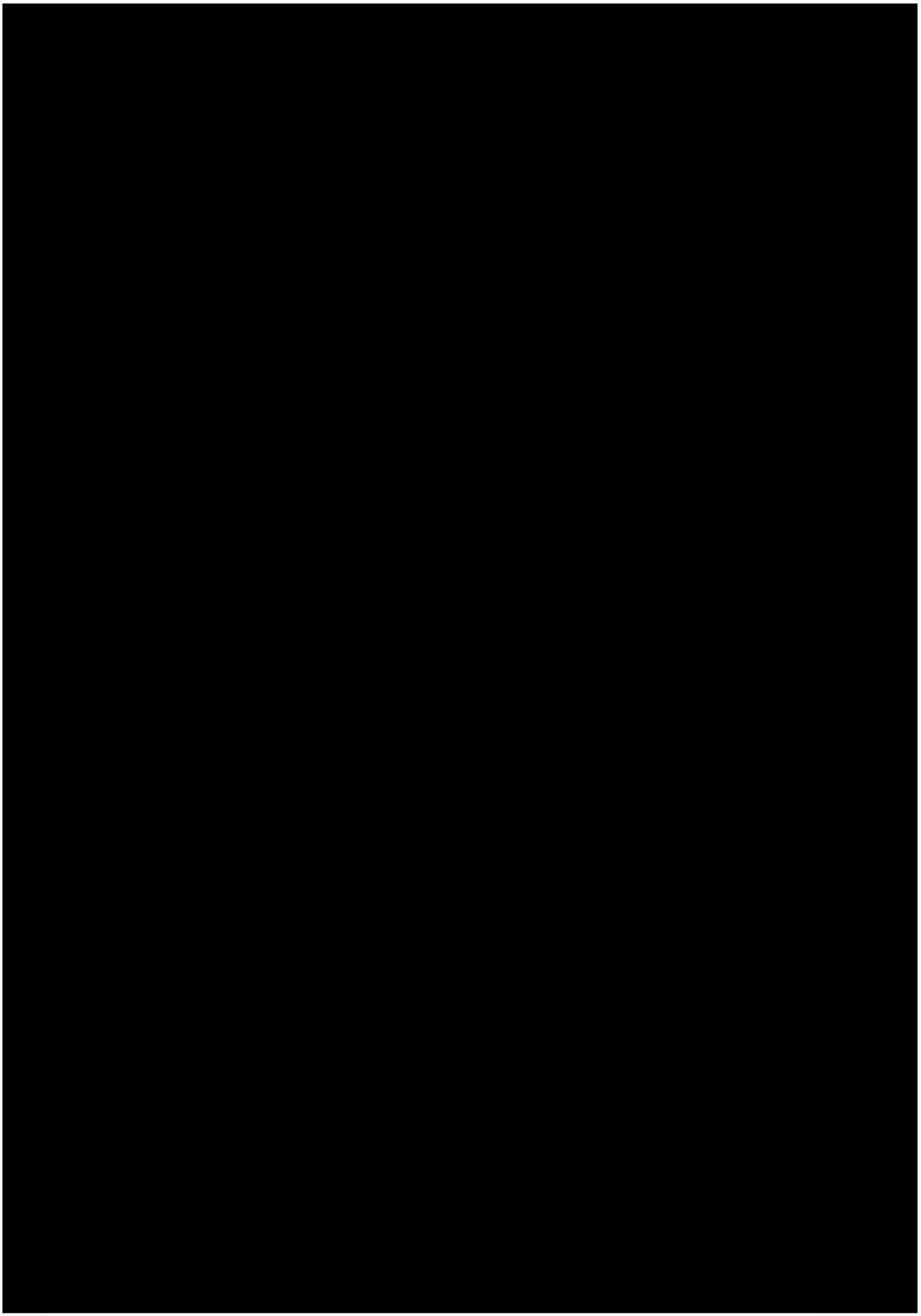
[redacted]

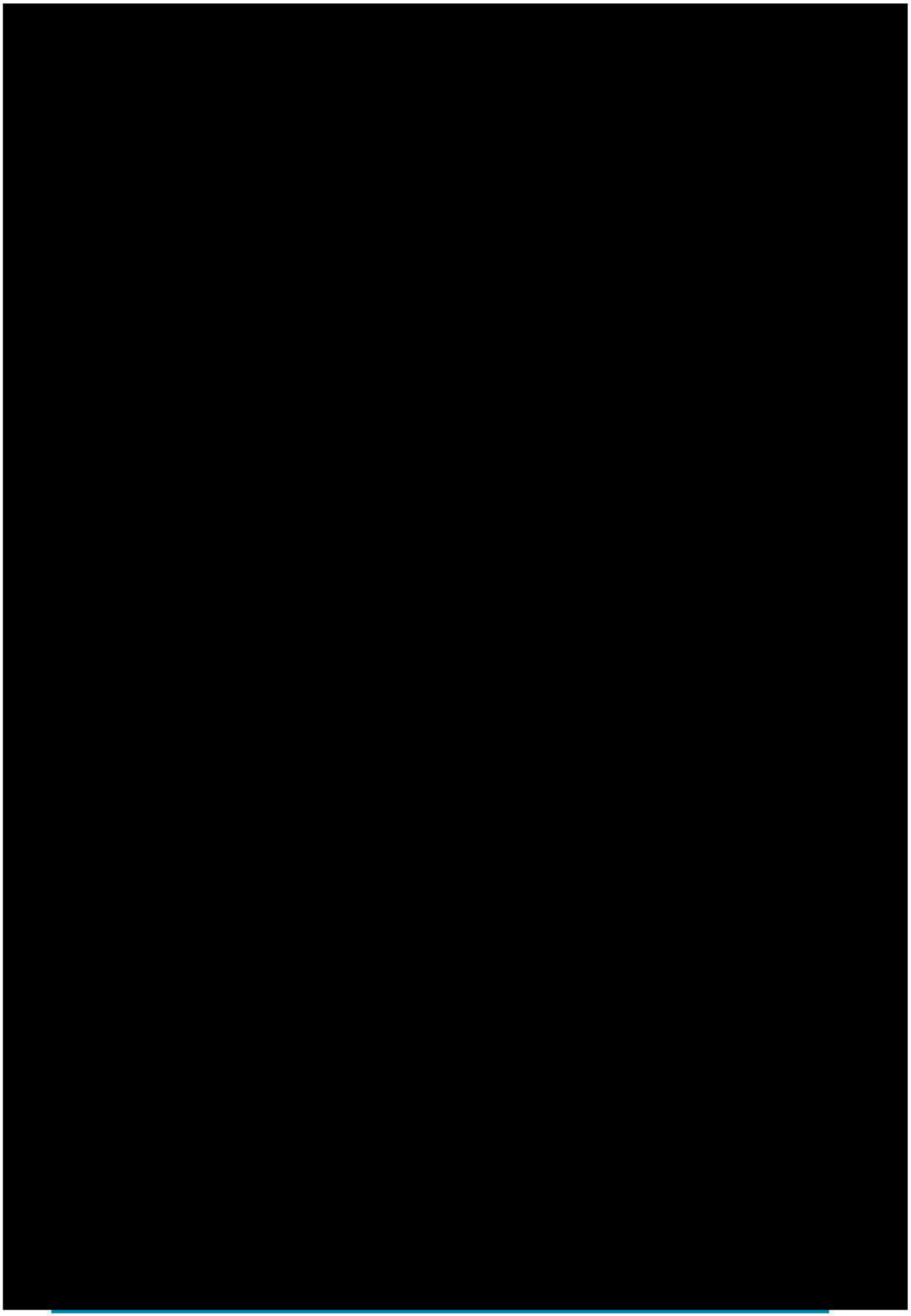




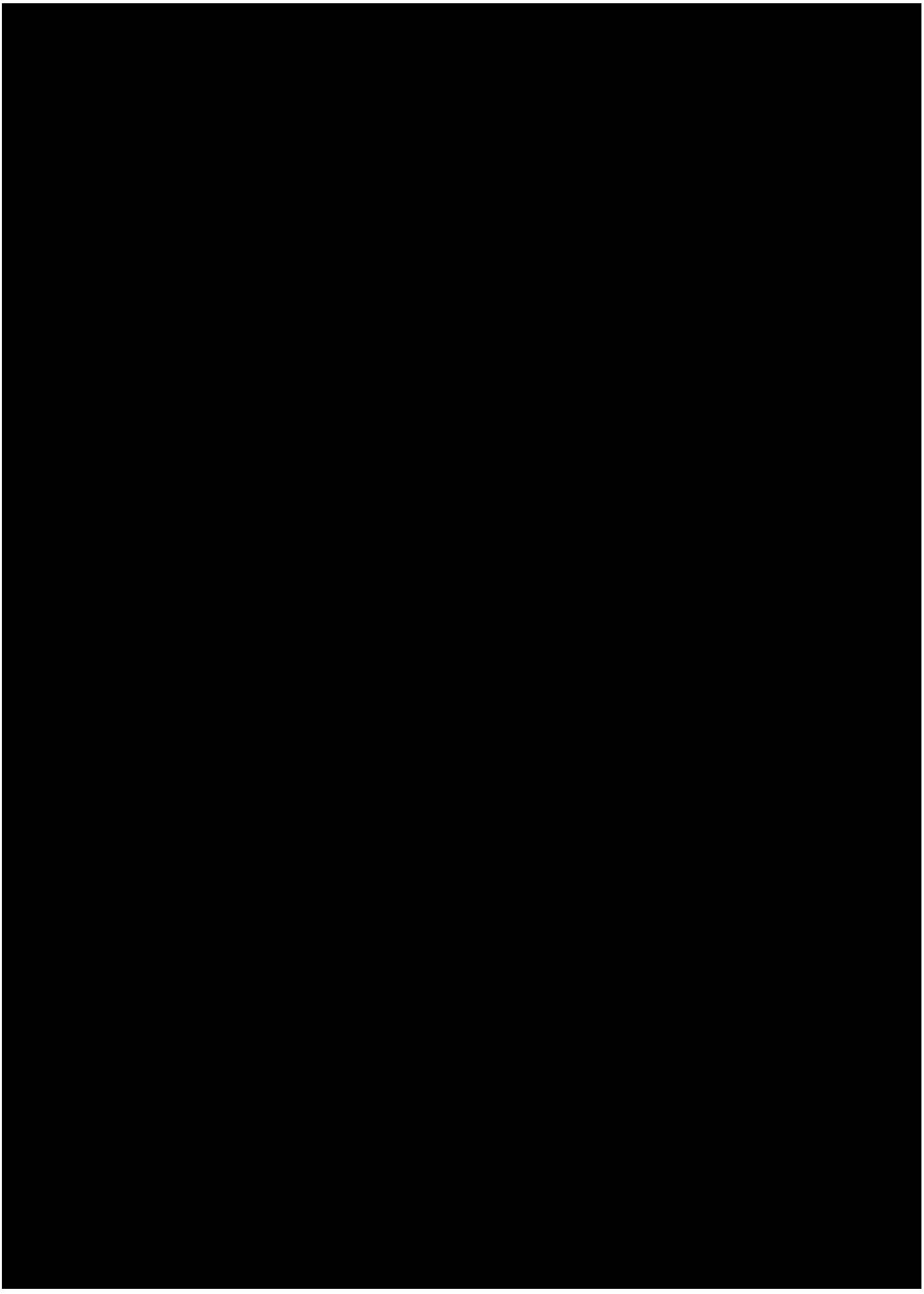


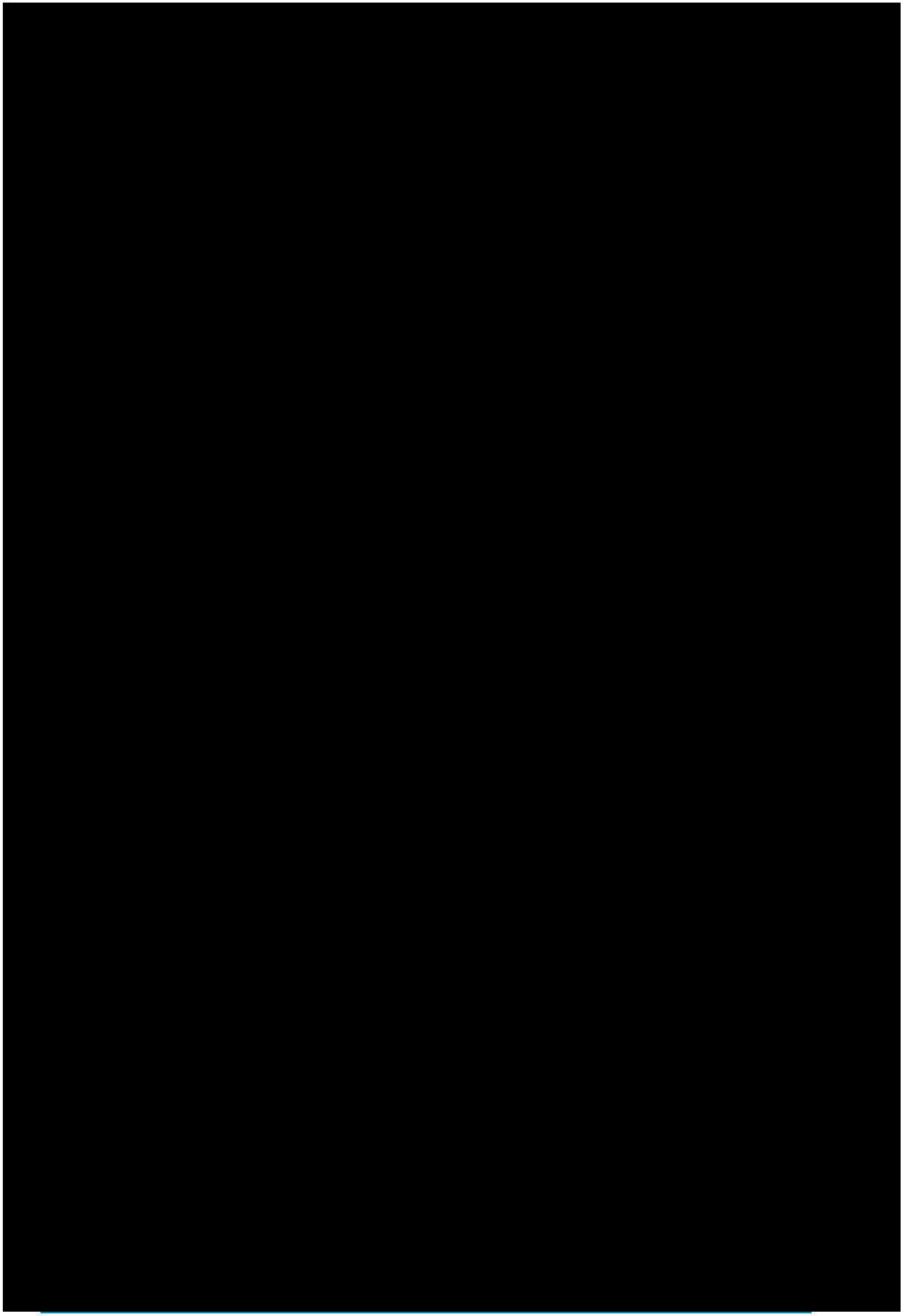


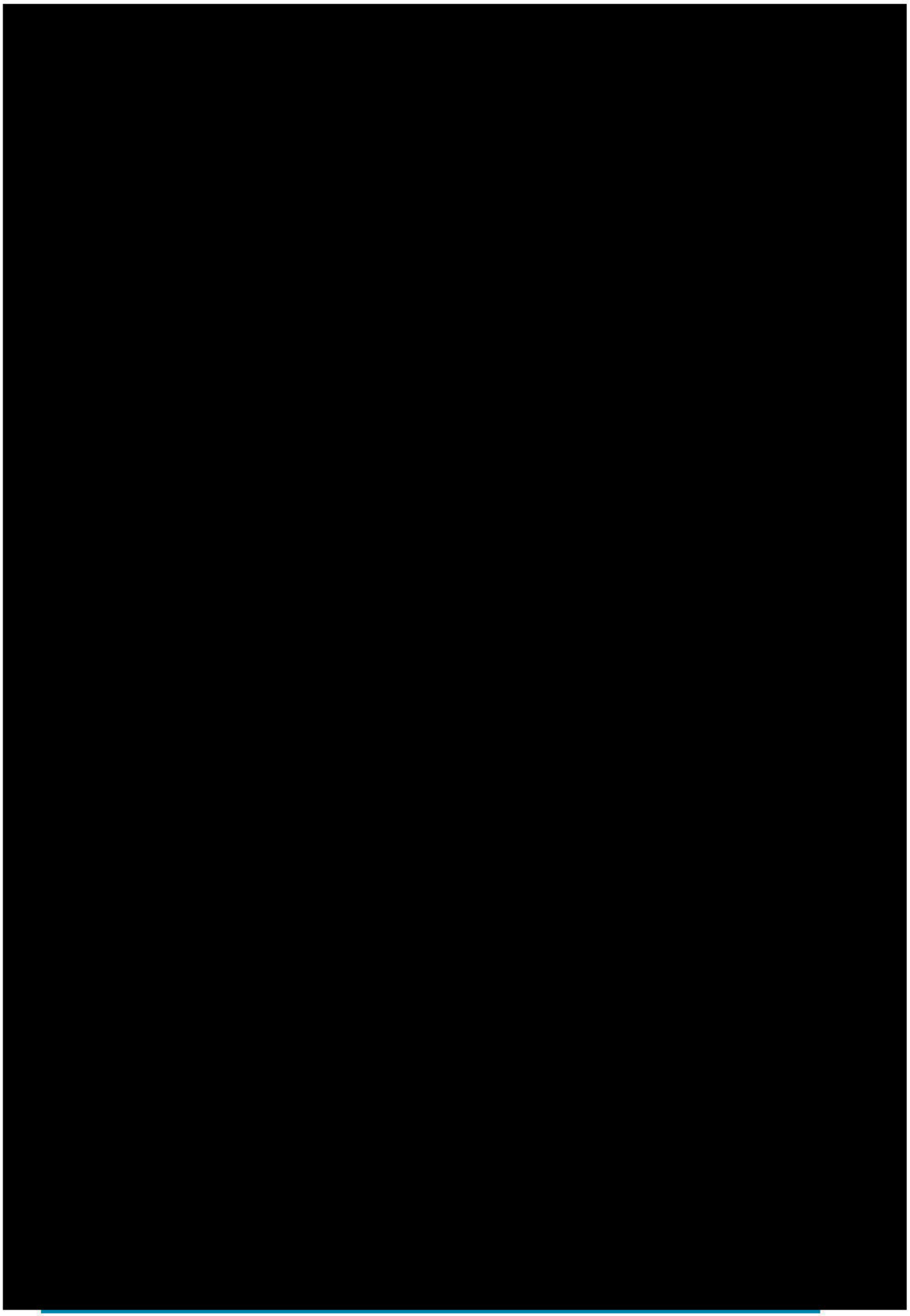


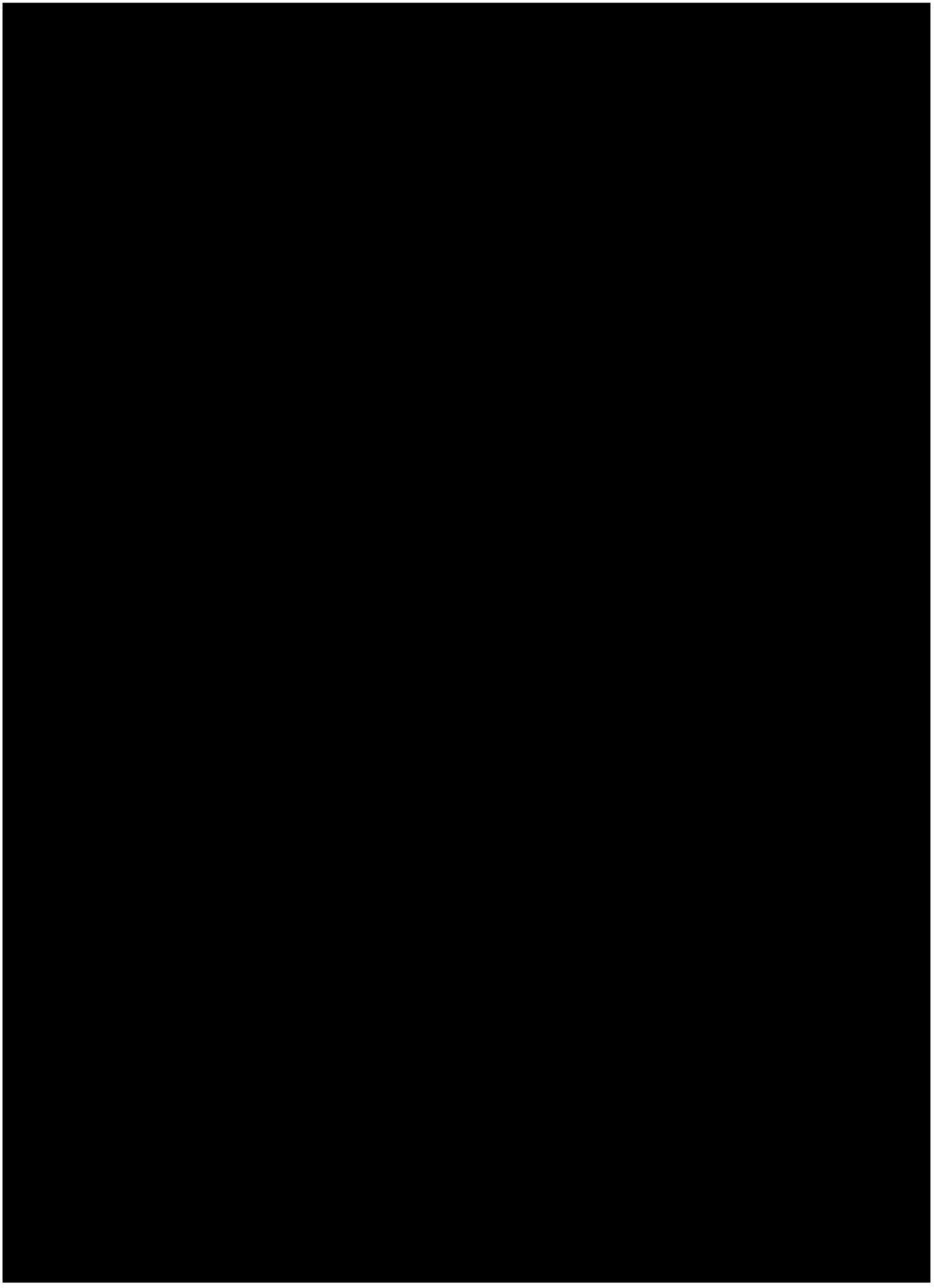


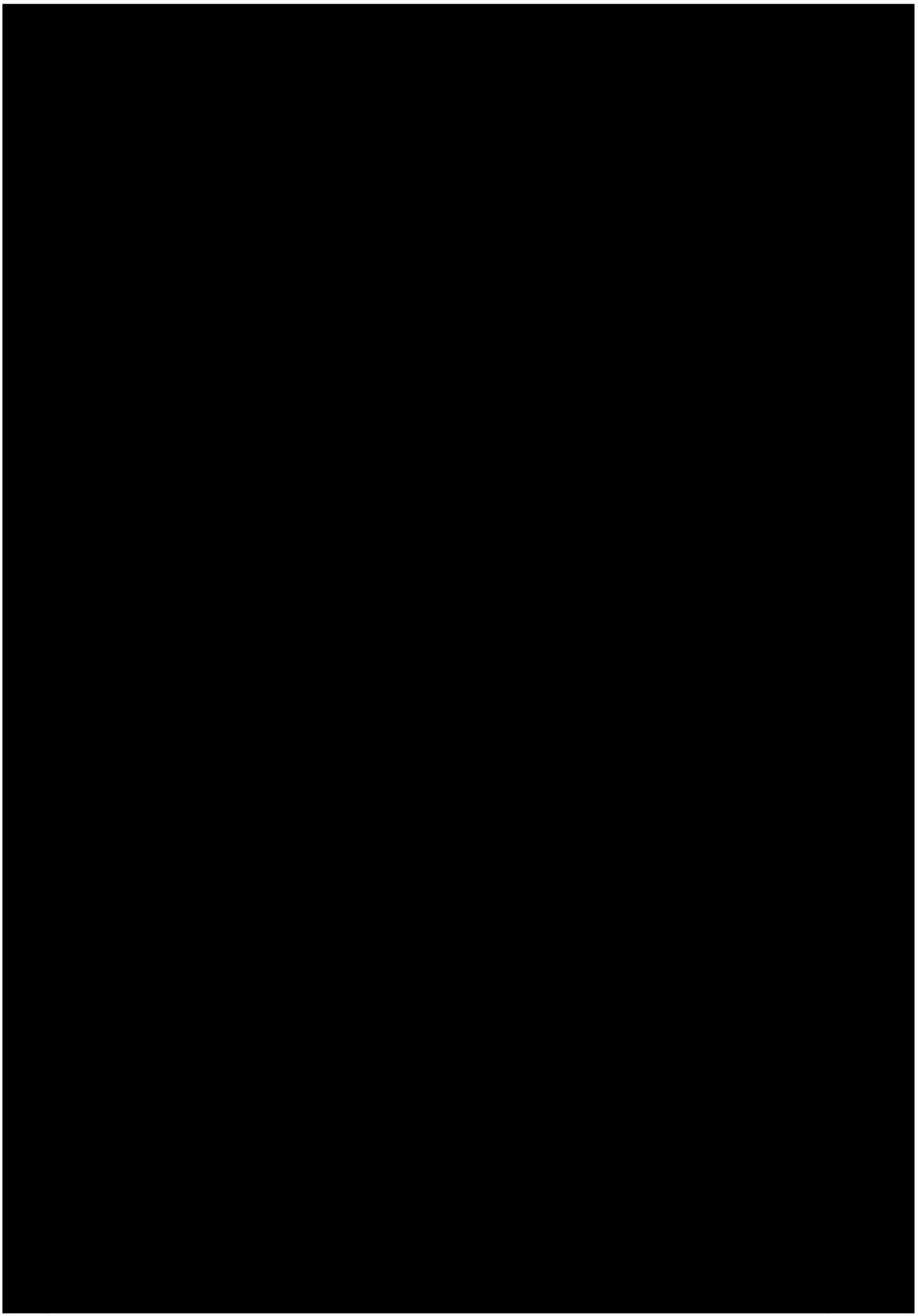
[redacted]

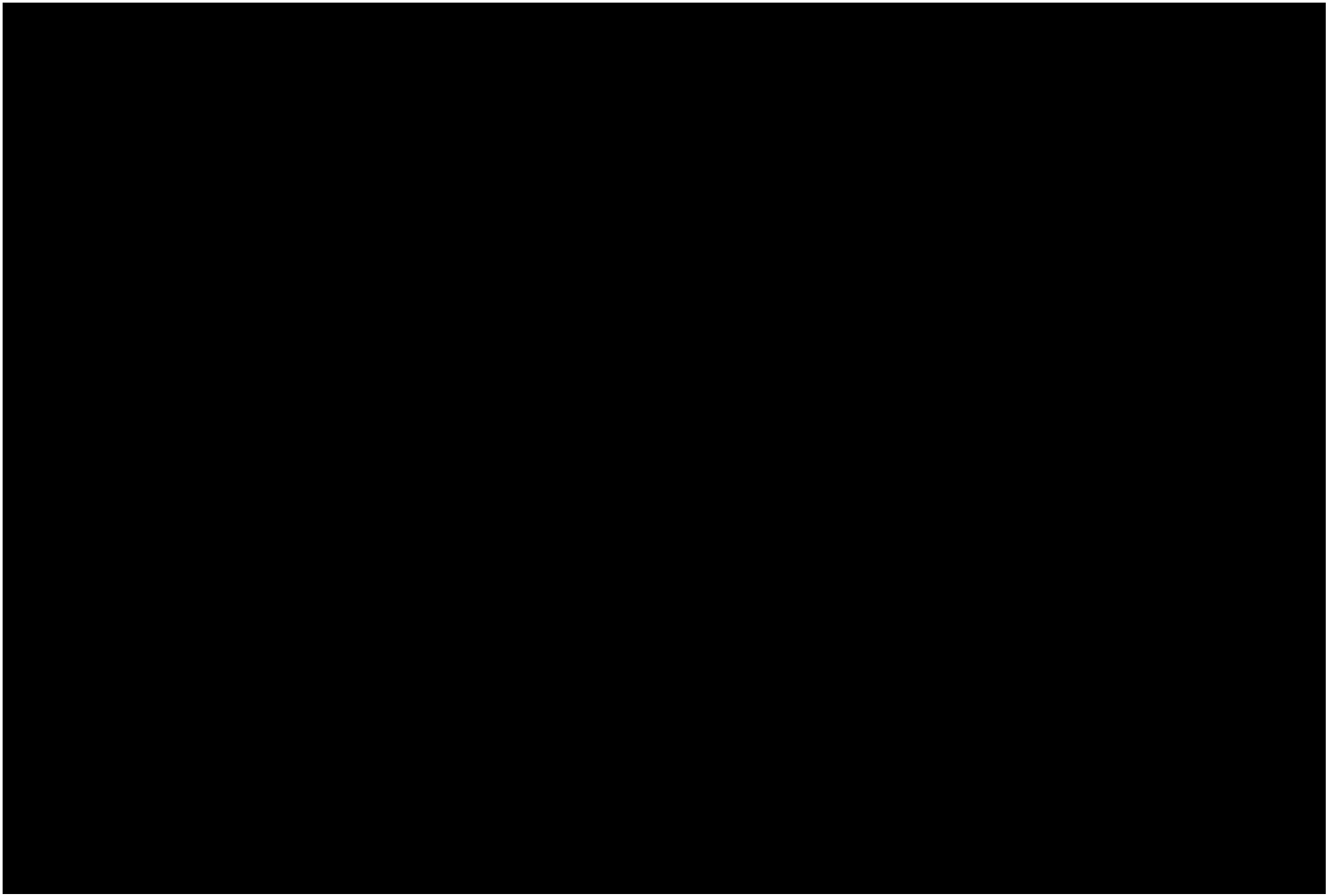


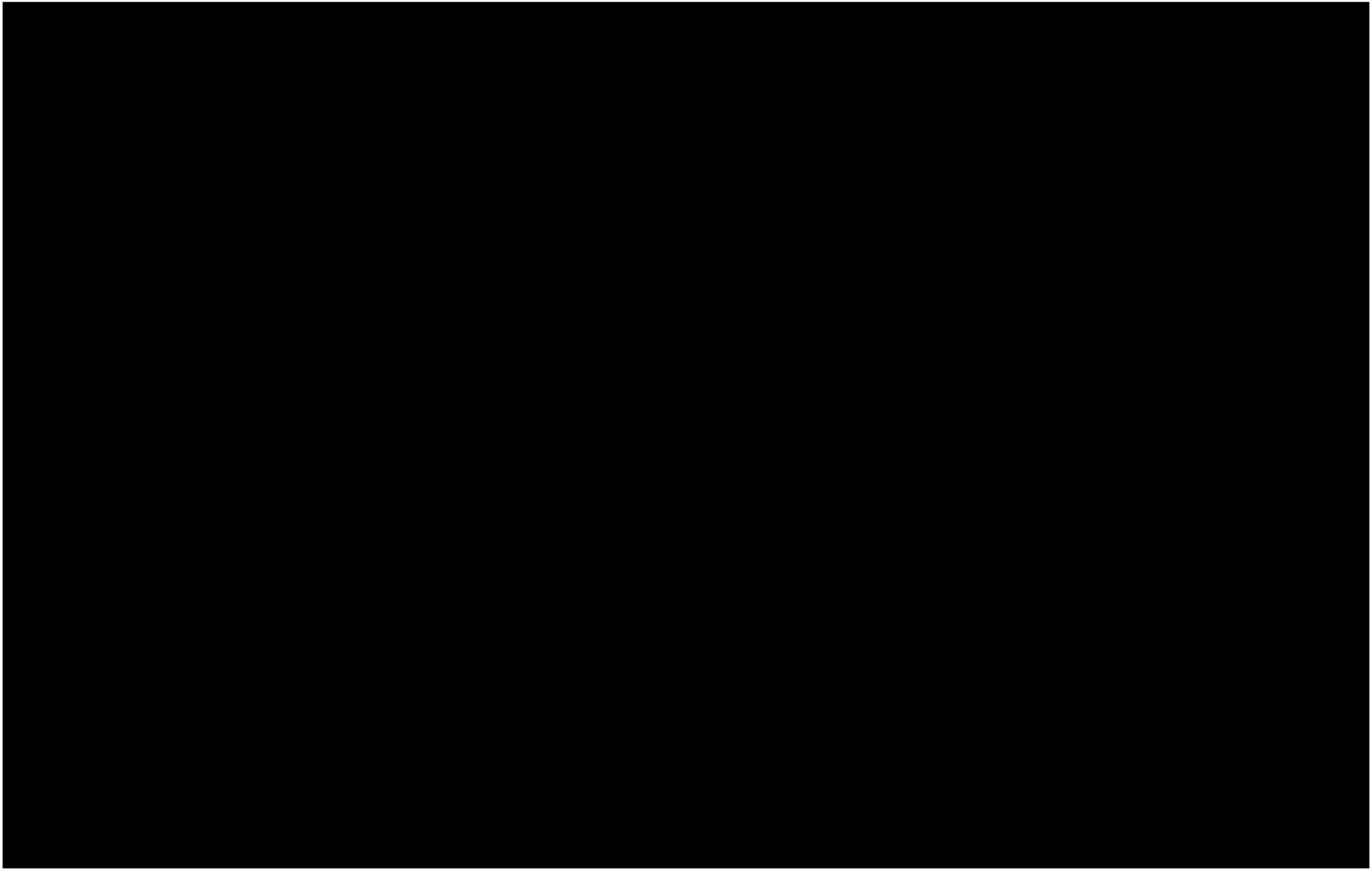


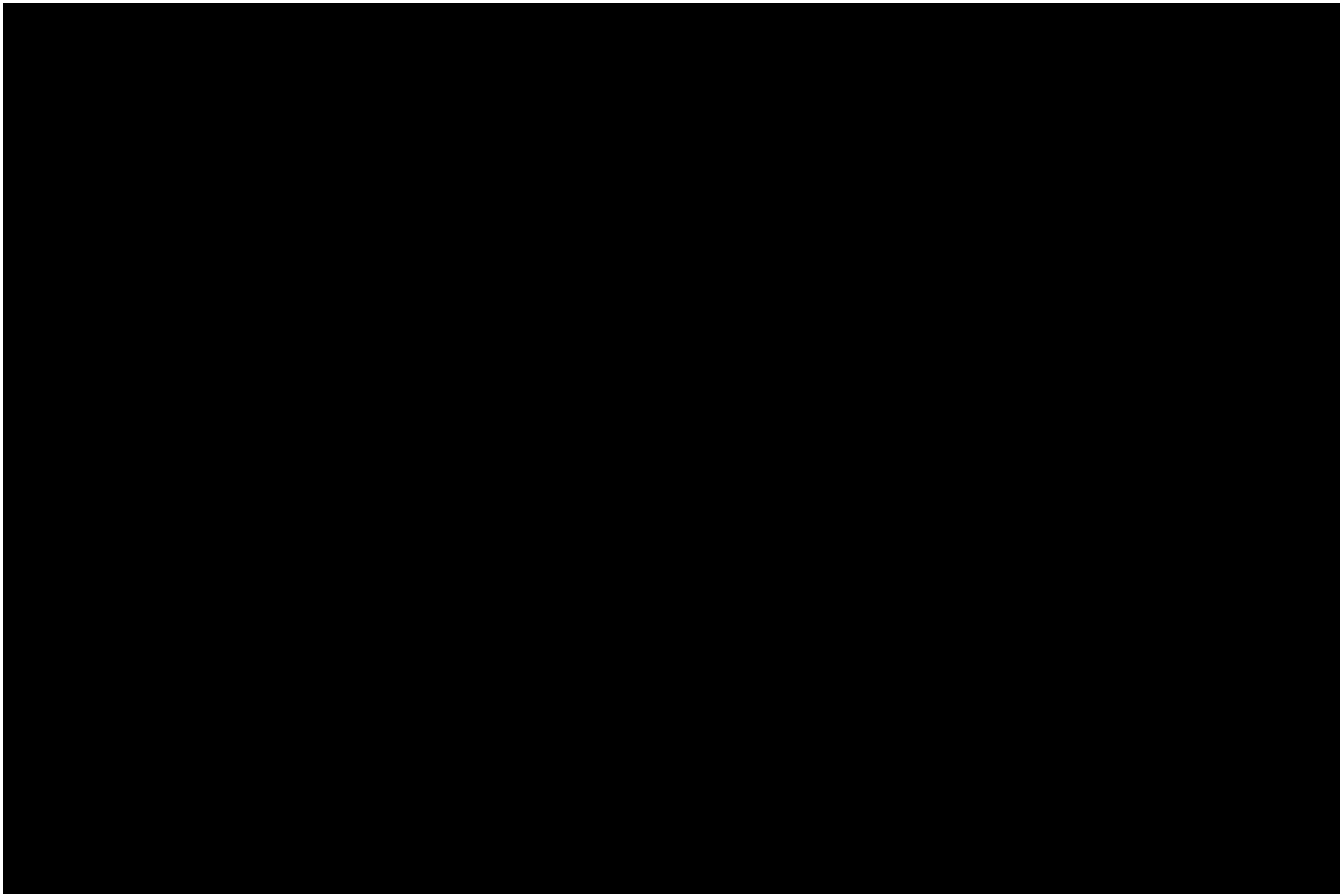












Appendix B: Site B survey methods for Species Management Plan

fba

Fine Sediment Offset Project, Site B (Langmorn Creek) Survey Methods for Species Management Plan.

PEOPLE. ENVIRONMENT. FUTURE. fba.org.au

FBA works for our central Queensland community to grow a sustainable, productive and profitable Fitzroy region.

FBA acknowledges the First Nations of the lands and waters within the Fitzroy region where we learn and live, and pay our respects to them, their culture and Elders past, present and emerging.

Version Control

Version	Date	Author	Changes
1	14/11/2022	Hannah Kaluzynski	

Disclosure Statement

This document has been prepared with due care and diligence using the best available information at the time of publication. FBA holds no responsibility for any errors or omissions and decisions made by other parties based on this publication.

Contents

1. Introduction

1.1 Species Management Program objectives

The purpose of the Fine Sediment Offset (FSOP) Site B Species Management Program (SMP) is to minimise impact on wildlife breeding places that could result from the construction of environmental restoration works on Langmorn Creek in the lower Fitzroy Catchment near Raglan (Figure 1.1). It is a requirement of Section 332 of the *Nature Conservation (Wildlife Management Regulation)* that a SMP be prepared for any activity that has the potential to tamper with the breeding places of wildlife protected under the *Nature Conservation (NC) Act,1992.*

The SMP relates to wildlife species listed as least concern, vulnerable and endangered within the project footprint.

1.1.1 Organisational details

The Fitzroy Basin Association (FBA) has been contracted on behalf of Gladstone Ports Corporation (GPC) to deliver a fine-grained sediment offset strategy to the satisfaction of the Department of Climate Change, Energy, the Environment and Water (DCCEEW). A condition of the plan's acceptance is to address any concerns surrounding the potential for impacts on threatened species. This Species Management plan has been created to address these concerns. On acceptance of the plan by DCCEEW FBA welcomes the opportunity to continue our working relationship with GPC and delivery of implementing the offset and Species management plans. This would involve coordinating and liaising with Alluvium and other technical providers, contractor, and subcontractors to deliver civil works, land manager engagement and first nations engagement as required.

Name	Fitzroy Basin Association
ABN	30 802 469 401
Address	Level 1, 80 East Street PO Boz 139 Rockhampton QLD 4700
Contact Details	Shannon van Nunen Environment Team Leader Fitzroy Basin Association (07) 4999 2822 Shannon.vanNunen@fba.org.au

FBA is a not-for-profit Natural Resource Management Agency that works across Central Queensland. FBA aims to protect natural assets including flora and fauna and their habitats; improve land management practice and ensure healthy waterways flowing to the reef. To achieve this aim FBA invests in on-ground projects, participates in committees and advisory groups, supports community consultation, responds to development proposals, and manages and hosts partnerships such as the Fitzroy Partnership for River Health.

1.2 Activity

Conduct of multi-temporal analysis, identified an area (Site B) within the lower Fitzroy catchment as an opportunity to reduce fine sediment run-off from stream bank and gully erosion which poses the highest threat to Great Barrier Reef (GBR) ecosystems. Stream bank and gully erosion has been identified as a major contributor to the decline in water quality across the GBR catchments.

Site B is subsequently a river restoration project that will stabilise and revegetate a section of rapidly eroding creek frontage. The proposed works will occur on an eroding section of the left bank approximately 170 m in length and 5 m high and an eroding section of the right bank immediately downstream approximately 100 m in length and 5 m high (Figures 1.2 & 1.3). The site is located on the upper reaches of Langmorn Creek in the lower Fitzroy River catchment within a zone of very high erosion potential where further erosion is almost certain in future floods. Due to the steeply eroded bank slopes, natural regeneration of vegetation capable of resisting future floods is unlikely without works to reshape and stabilise the bank. Without this management intervention the site will continue to erode and continue to contribute a large source of fine sediments into the GBR Lagoon.

Figure 1.1 *The proposed riverbank restoration site includes an eroding section of the left bank approximately 170 m in length and 5 m high, and an eroding section of the right bank immediately downstream approximately 100 m in length and 5 m high. Photos taken December 2021.*

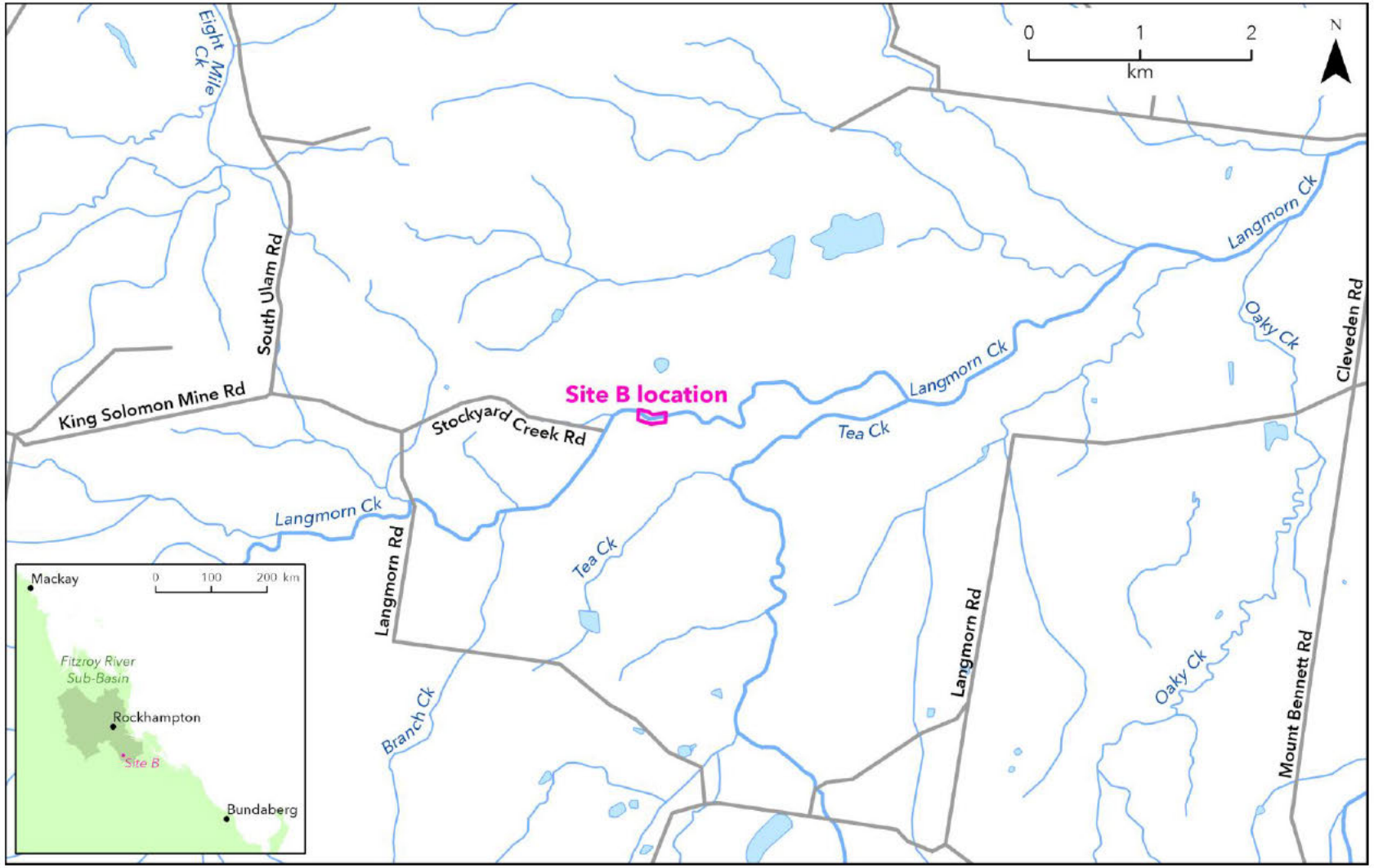


Figure 1.2 *Site B is located on Langmorn Creek approximately 25km from Raglan.*

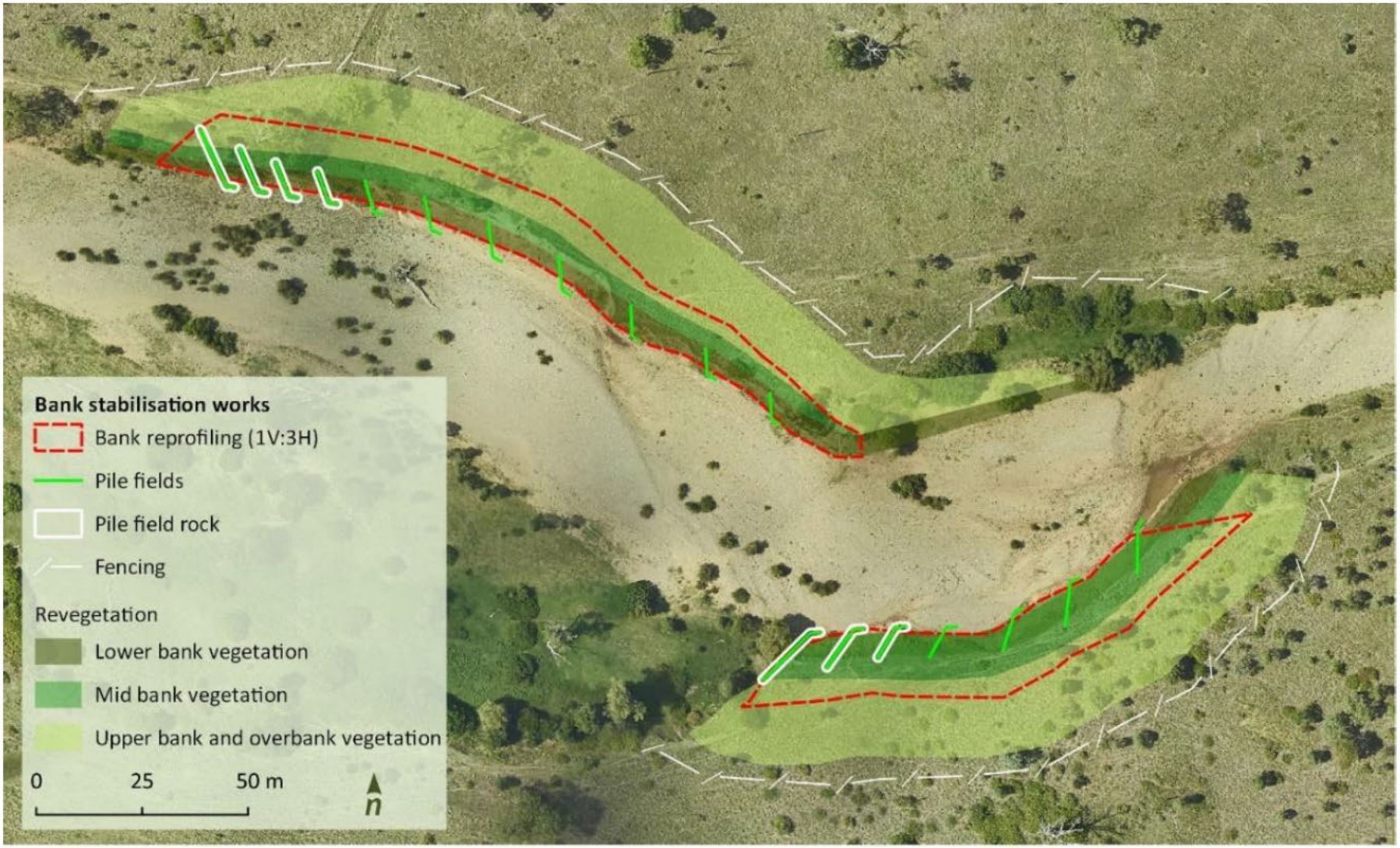


Figure 1.3 *The fine sediment project site is located within cleared agricultural land with scattered regrowth. The proposed works will occur on the 300m of actively eroding bank.*

1.3 Legislative framework

The Acts that are considered in this SMP are those that are directly applicable to the management of wildlife in the project area. These are:

Nature Conservation (NC) Act 1992

The object of the *NC Act 1992* is the conservation of nature while allowing for the involvement of indigenous people in the management of protected areas in which they have an interest under Aboriginal tradition or Island custom. This is to be achieved by an integrated and comprehensive conservation for the whole state that includes; gathering of information and community education, dedication and declaration of protected areas, management of protected areas, protection of native wildlife and its habitat, use of protected wildlife and areas to be ecologically sustainable, recognition of interest of Aborigines and Torres Strait Islanders in nature and their cooperative involvement in its conservation and cooperative involvement of landholders (Queensland Government downloaded March 2020).

Nature Conservation (Wildlife) Regulation 1996 (NCR)

The *NCR* prescribes native wildlife as extinct in the wild, endangered, vulnerable, near threatened, least concern wildlife and other wildlife international wildlife and prohibited wildlife. It states the declared management intent and the principles observed in any taking of or destruction for each group.
Nature Conservation (Wildlife) Regulation 2006.

Under section 332 of the *NCR* any activity that will tamper (e.g., remove, damage, impair, degrade) with the confirmed breeding place of a native animal that is extinct in the wild, endangered, vulnerable, near threatened or least concern wildlife requires authorisation under a Species Management Program. Dependent on the species which will be affected on of the two following SMPs is required:

1) Species Management Program for tampering with animal breeding places (low risk of impacts). This applies to least concern animals, excluding special least concern animals or colonial breeders.
2) Species Management Program for tampering with animal breeding places (high risk of impacts). This includes all other protected animals including special least concern animals, colonial breeders.

An animal breeding place is defined as a bower, burrow, cave, hollow, nest or other thing that is commonly used by the animal to incubate or rear the animal's offspring.

Environment Protection and Biodiversity Conservation Act 1999

The *EPBC Act* provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places—defined in the *EPBC Act* as matters of national environmental significance (DEE 2019).

Under the *EPBC Act*, any action that has or is likely to have a significant impact on a Matter of National Environmental Significance may only progress with the approval from the Minister of Environment under part 9 of the *EPBC Act*.

The *EPBC Act* identifies nine Matter of National Environmental Significance:

(i) World Heritage Properties
(ii) National Heritage Places
(iii) Wetlands of International Importance (Ramsar wetlands)
(iv) Nationally listed threatened species and ecological communities
(v) Listed migratory species
(vi) Commonwealth marine areas

(vii) Great Barrier Reef Marine Park
(viii) Nuclear actions (including uranium mining)
(ix) Protection of water resources from coal seam gas development or large coal mining development

The *EPBC Act* is relevant to this SMP because species listed as critically endangered, vulnerable and listed migratory species are also listed under the *Nature Conservation Act* as Least Concern Species and Special Least Concern species. Under this clause the *EPBC Act* would only be applicable if *EPBC act* listed species are recorded within the site in further survey work.

1.3.1 Applicable species

The SMP for this project details management measures to avoid or mitigate any impacts from the proposed construction activity on Least Concern, Vulnerable and Endangered wildlife. The SMP addresses the potential impacts of construction, any potential post construction impacts, and the management actions necessary to reduce these impacts on the breeding places of these species under the *Nature Conservation Act 1992.*

The SMP identifies:

- Potential impacts on native fauna breeding places
- Proposed management actions to avoid/mitigate impacts
- Roles and responsibilities
- Monitoring and reporting requirements

1.4 Terms of approval

This species management plan is to remain valid for the duration of all phases of the project.

The following parties are to be approved to operate under this program:

- Gladstone Ports Corporation
- Fitzroy Basin Association
- Site construction contractors and sub-contractors (TBC)
- Site environmental representative (FBA Ecologist TBC)

2. Assessments

2.1 Survey methodologies

Desktop and field assessments were undertaken between December 2021 and October 2022.

2.1.1 Desktop assessment

A desktop assessment was conducted to identify records of occurrence or the potential occurrences of species of conservation significance and threatened ecological communities (under the EPBC or Nature Conservation (Wildlife) Regulation 1996) within the study areas defined in section 2.1. The desktop assessment included reviews of State and Commonwealth databases and map layers to identify records or potential occurrences of species of conservation significance including least concern and special least concern animals, vegetation type, areas of remnant vegetation, threatened ecological communities, wildlife habitat and any other biodiversity values.

The following is the list of map layers, databases and search tools used.

Map layers

- WildNet wildlife records Queensland
  WildNet is a Queensland wildlife database which contains recorded sightings of native and naturalised wildlife particularly plants, protists, fungi, mammals, birds, reptiles, amphibians, freshwater and cartilaginous fishes, butterflies and some other priority invertebrates.

- Matters of state environmental significance – Wildlife habitat - threatened and special least concern animal
  This map layer shows Threatened Wildlife and Special Least Concern Animal habitat that are matters of state environmental significance.

- Matters of state environmental significance - Regulated vegetation - essential habitat - Queensland
  This map layer shows Regulated Vegetation (essential habitat). These are areas of essential habitat on the essential habitat map for an animal that is endangered wildlife or vulnerable wildlife or a plant that is endangered wildlife or vulnerable wildlife.

- Matters of state environmental significance – Regulated vegetation – under the Vegetation Management Act 1999 including categories B, C and R and regulated vegetation defined watercourse.
  Regulated vegetation - category B endangered or of concern
  Regulated vegetation - category C endangered or of concern
  Regulated vegetation - category R GBR riverine

- Wetland protection area - high ecological significance wetland
  Wetlands of high ecological significance (HES) identify areas where policies apply under the State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments.

- Regulated vegetation - 100m from wetland
  This map layer shows regulated vegetation that is within 100m of a wetland.

Data bases and search tools

- Protected Matters Search Tool
  Search tool to generate a report that help determine whether matters of national environmental significance or other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 are likely to occur in the area of interest.

- Birds Australia Atlas Database
  List of bird species recorded in the project area.

2.2 Desktop assessment results

2.2.1 Wildlife habitat: Threatened species and special least concern animals

No Wildlife habitat for threatened and special least concern animals was identified within the study area buffers using the MSES - Wildlife habitat - threatened and special least concern animal map layer.

2.2.2 Regional ecosystem and Threatened Ecological Community mapping

Major vegetation types within the study area were identified with the vegetation management regional ecosystem map – version 11.0 (Downloaded in July 2022). On the construction site side of the river (Figure 2.1) typical of the Fitzroy Basin the dominant vegetation type was non-remnant vegetation, primarily agricultural which made up 90% of this study area. Two Regional ecosystem types were mapped as occurring within the study site 11.3.4 and 11.3.25 fringing the riverbank. Three Threatened Ecological Communities (TEC) were also identified in the EPBC Act Protected Matters report Coolibah Black Box Woodlands, Poplar Box Grassy Woodlands, and Weeping Myall Woodlands (Table 2.1).

The vegetation identified in the desktop analysis within the study area could provide potential breeding places for a variety of Fauna species. Canopy and hollow nesting birds and, small mammals can occur where suitable tree hollows exist. Fallen branches and other tree debris can also provide habitat for reptiles, mammals and amphibians. Aquatic species may be abundant in the river channel regional ecosystem particularly where water holes and lagoons occur. While agricultural land generally has a low ecological value owing to its structural simplicity it has some value for pastureland birds, raptors, snakes, and macropods particularly for foraging. Potential habitat values for the regional ecosystems and non-remnant vegetation are provided in Table 2.1.

Table 2.1: Major vegetation associations and potential habitat value for wildlife adjoining the Site B study area. Vegetation characteristics and potential value for wildlife (DES Regional Ecosystem Descriptions (downloaded in July 2022).

Habitat type	Characteristics	Value for Wildlife/ Potential breeding places
Regrowth vegetation	Regrowth vegetation around water can be characterised as ranging from structurally simple to complex depending on the age of regrowth vegetation and intensity of agricultural activity.	These areas can provide valuable habitat depending on age and condition of regrowth. Tree size, shrub and understory presence, and amount of course woody debris. undergrowth presence and condition. As they age the value for habitat increases for birds, reptiles, mammals, and amphibians.
11.3.4 *Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains	Eucalyptus tereticornis woodland to open forest. A shrub layer is usually absent, and a grassy ground layer is prominent.	This regional ecosystem can be associated with high fauna richness. It is known suitable habitat for koalas.
11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Eucalyptus tereticornis or E. camaldulensis woodland to open forest. A tall shrub layer may occur, and low shrubs are present. The ground layer is open to sparse and dominated by perennial grasses, sedges, or forbs.	This regional ecosystem can be associated with high fauna richness. It is known habitat for riparian freshwater turtle species and koalas.

Habitat type	Characteristics	Value for Wildlife/ Potential breeding places
Non-remnant vegetation Predominantly agricultural	Agricultural land along the Fitzroy River can be characterised as structurally simple with an absent tree and shrub layer, uniform cover of short to long grazed grass with few logs or woody debris (GHD 2015).	Although these areas have a relatively low ecological value, they can provide some habitat values for pastureland birds, raptors, snakes, and macropods.
TEC- Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	An Endangered community characterised as a eucalypt woodland found on grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands and stream levees. Dominant tree species in the canopy include coolibah (*Eucalyptus coolabah subsp. coolabah*) and/ or black box (*Eucalyptus largiflorens*). Medium to tall shrubs are typically sparse and the ground layer consists of grasses, herbs, and various saltbushes.	This community provides valuable habitat for a wide range of animal species. Characteristic habitat features of value to particular fauna include a grassy understorey with scattered fallen logs, areas of deep-cracking clay soils, patches of thick regenerating Eucalyptus saplings and large trees containing a diverse bark and foliage foraging resource and an abundance of small and large hollows (NSW Scientific Committee, 2004, 2009). It also can provide woodland habitat and nesting sites for colonial breeding waterbirds (Mac Nally et al., 2001).
TEC- Poplar Box Grassy Woodland on Alluvial Plains	An Endangered community characterised as a typically a grassy woodland with a canopy dominated by *Eucalyptus populnea* and understorey mostly of grasses and other herbs.	The Poplar Box Grassy Woodland provides essential resources such as nesting/breeding sites, protection from predators (for example logs and old growth tree hollows) and sources of food (nuts, seeds, nectar from flowers and invertebrate prey). Many animals are only likely to be part of the Poplar Box Grassy Woodland at certain times, for example as a dry season refuge given the ecological community's proximity to riparian vegetation.
TEC- Weeping Myall Woodlands	An Endangered community characterised as woodlands, generally 4-12 m high, in which Weeping Myall (*Acacia pendula*) trees are the sole or dominant overstorey species. The understorey includes a layer of shrubs above an open ground layer of grasses and herbs.	This community is known to provide important habitat for a range of animals such as the Superb Parrot (*Polytelis swainsonii*), Painted Honeyeater (*Grantiella picta*) and the Bush Stone-curlew (*Burhinus grallarius*).

Figure 2.1 *Regional ecosystem mapping showing dominant vegetation associations for the Site B study area.*

2.2.3 Wetland protection area - GBR high ecological significance wetland

Wetland mapping shows no ecological significant wetlands within the 2km site B buffer.

2.2.4 Species occurring or likely to occur in the study area

The EPBC Act Protected Matters report listed 33 The EPBC Act Protected Matters report listed and 14 EPBC listed migratory or marine species as "species or species habitat likely to occur within area" (Table 2.2).

Table 2.3 EPBC Act listed fauna: Species or species habitat known or likely to occur within area / Listed Migratory. Source: EPBC Act Protected Matters Report for Site B

Species	EPBC Status
Birds	
Australian Painted Snipe *Rostratula australis*	Endangered and Marine
Black-breasted Button-quail *Turnix melanogaster*	Vulnerable
Black-eared Cuckoo *Chalcites osculans as Chrysococcyx*	Marine
Black-faced Monarch *Monarcha melanopsis*	Migratory and Marine
Cattle Egret *Bubulcus ibis as Ardea ibis*	Marine
Common Sandpiper *Actitis hypoleucos*	Migratory and Marine
Curlew Sandpiper *Calidris ferruginea*	Critically Endangered, Migratory Marine
Far Eastern Curlew *Numenius madagascariensis*	Critically Endangered, Migratory Marine
Fork-tailed Swift *Apus pacificus*	Migratory and Marine
Grey Falcon *Falco hypoleucos*	Vulnerable
Latham's Snipe, Japanese Snipe *Gallinago hardwickii*	Migratory and Marine
Magpie Goose *Anseranas semipalmata*	Marine
Oriental Cuckoo *Cuculus optatus*	Migratory
Pectoral Sandpiper *Calidris melanotos*	Migratory and Marine
Rainbow Bee-eater *Merops ornatus*	Marine
Red Goshawk *Erythrotriorchis radiatus*	Vulnerable
Rufous Fantail *Rhipidura rufifrons*	Migratory and Marine

Species	EPBC Status
Satin Flycatcher *Myiagra cyanoleuca*	Migratory and Marine
Sharp-tailed Sandpiper *Calidris acuminata*	Migratory and Marine
Southern Black-throated Finch *Poephila cincta cincta*	Endangered
Spectacled Monarch *Symposiachrus trivirgatus as Monarcha*	Migratory and Marine
Squatter Pigeon (Southern) *Geophaps scripta scripta*	Vulnerable
Star Finch *Neochmia ruficauda ruficauda*	Critically Endangered
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Marine
White-throated Needletail *Hirundapus caudacutus*	Vulnerable, Migratory and Marine
Mammals	
Corben's Long-eared Bat *Nyctophilus corbeni*	Vulnerable
Ghost Bat *Macroderma gigas*	Vulnerable
Greater Glider *Petauroides volans*	Endangered
Grey-headed Flying-fox *Pteropus poliocephalus*	Vulnerable
Koala *Phascolarctos cinereus*	Endangered
Large-eared Pied Bat, Large Pied Bat *Chalinolobus dwyeri*	Vulnerable
Northern Quoll *Dasyurus hallucatus*	Endangered
Yellow-bellied Glider *Petaurus australis australis*	Vulnerable
Reptiles	
Collared Delma *Delma torquata*	Vulnerable
Dunmall's Snake *Furina dunmalli*	Vulnerable
Fitzroy River Turtle *Rheodytes leukops*	Vulnerable
Grey Snake *Hemiaspis damelii*	Endangered
Ornamental Snake *Denisonia maculata*	Vulnerable
Salt-water Crocodile *Crocodylus porosus*	Migratory
White-throated Snapping Turtle *Elseya albagula*	Critically Endangered

Species	EPBC Status
Yakka Skink *Egernia rugosa*	Vulnerable
Plants	
Black Ironbox *Eucalyptus raveretiana*	Vulnerable
Bluegrass *Dichanthium setosum*	Vulnerable
Cossinia *Cossinia australiana*	Endangered
Cycas megacarpa	Endangered
Cycas ophiolitica	Endangered
Leichhardtia brevifolia listed as *Marsdenia brevifolia*	Vulnerable
Quassia *Samadera bidwillii*	Vulnerable
Wedge-leaf Tuckeroo *Cupaniopsis shirleyana*	Vulnerable

No species listed under the Nature Conservation Act 1992 were recorded within project construction area from WildNet records. One record existed within the 200m buffer, and this was the plant species *Eremophila deserti*. Bird species records from within 2.5km of the construction did not exist in either WildNet or BirdLife Australia Data bases.

2.3 Fauna, flora, and breeding places surveys

2.3.1 Survey methodology

Surveys for birds, mammals, animal breeding sites and habitat features were conducted between 16th of August and 29th of September 2022. All fauna survey methodologies were consistent with those outlined in Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al. 2008). These surveys included bird surveys, song meters and non-baited camera traps to detect birds, amphibians and small mammals including bats. Additional active searching of the site was conducted to determine the presence of potential breeding places including, nesting structures, hollow bearing trees, stages, rockpiles, logs, coarse woody debris, and leaf litter.

A flora assessment of the site was completed on the 16th of August 2022. Methodology involved a qualified botanist identifying all vegetation along a Traverse transect (an informal, unmarked route along which data is collected) throughout the predicted project construction area. This method allows for meandering amongst remnant vegetation, surveying 5m either side of the traverse centreline.

Figure 2.2 Map of Fauna survey transects with placement of camera traps and song meter recording devices.

2.3.2 Fauna survey results

25 species of bird were recorded in the two 200 x 50m survey plots (Table 2.3). All birds observed within the study plots were classified as least concern under the Nature Conservation (Wildlife) Regulation 1996 with one species Welcome swallow *Hirundo neoxena* listed as Special least concern for being migratory and colonial breeding (Table 2.4). An additional 17 bird species were identified through Bioacoustic analysis with song meters. Recorded bird calls could have originated outside of the study plots.

Within the survey sites no nests in trees were detected during the surveys and owing to the even age of the trees within the study plots no tree hollows were observed. While these trees may provide sites for constructed nests, none of the trees which will be removed during construction are mature enough to contain hollows. On inspection of the dry creek bed Welcome Swallow *Hirundo neoxena* nests were found within the bank of the eroding riverbank wall in two sections on the construction site (Figure 2.3 and 2.4). Due to this species being listed as Special least concern and a colonial breeder, specific actions (outlined in Table 3.1) will need to be implemented to ensure as minimal as possible disturbance to the species and/or safe relocation of active nests. The location and position of the nests on an undercut of the bank wall suggests that if remediation activities did not occur these nests would likely be lost during the next high rainfall event. It is highly likely that the nests may no longer be present on the riverbank when construction activities are to take place.

One frog species, the common green treefrog *Litoria caerulea* was recorded with the song meter. Peak breeding for these species occurs during the wet season between November and February. In general, it is expected that breeding will increase in response to rainfall. Implementing construction activities during the dry season should minimise any impacts to this species.

No bat roosts were detected during the surveys. However, two species were detected from bioacoustics analysis, The white- striped freetail bat *Austronomus australis* and the black flying fox *Pteropus Alecto*. The removal of some trees may alter feeding behaviour but is unlikely to affect breeding activity. The camera traps also detected the presence of one rufous bettong *Aepyprymnus rufescens* and two domestic mammals Cattle and Feral pigs (Table 2.4).

Coarse woody debris was prevalent throughout the site and other potential breeding places including fallen trees and stags were observed within the dry riverbed. Construction should not remove or impact these habitats. No rock piles or rocky outcrops were observed. Leaf litter recorded in 20 randomly selected 1 x1m plots was highly variable ranging from 0% in 2 plots to 95% in 2 plots (mean = 46% ± 33%, n = 20).

Table 2.4: Fauna species recorded from surveys completed at Site B between 16th August and 29th of September

Species	NC Status
Birds identified in 6 surveys	
Apostle Bird *Struthidea cinerea*	Least Concern
Australian Ibis *Threskiornis molucca*	Least Concern
Australian Magpie *Gymnorhina tibicen Melithreptus albogularis*	Least Concern
Black Kite *Milvus migrans*	Least Concern
Blue-faced Honeyeater *Entomyzon cyanotis*	Least Concern
Blue-winged Kookaburra *Dacelo leachii*	Least Concern

Species	NC Status
Brown Honeyeater *Lichmera indistincta*	Least Concern
Emu *Dromaius novaehollandiae*	Least Concern
Gray Fantail *Rhipidura albiscapa*	Least Concern
Little Kingfisher *Alcedo pusilla*	Least Concern
Noisy Friarbird *Philemon corniculatus*	Least Concern
Noisy Miner *Manorina melanocephala*	Least Concern
Pheasant Coucal *Centropus phasianinus*	Least Concern
Pale-headed Rosella *Platycercus adscitus*	Least Concern
Pink Galah *Eolophus roseicapilla*	Least Concern
Red Chested Button Quail *Turnix prothorax*	Least Concern
Rainbow Lorikeet *Trichoglossus moluccanus*	Least Concern
Torresian Crow *Corvus orru*	Least Concern
Red-backed Fairywren *Malurus melanocephalus*	Least Concern
Red-winged Parrot *Aprosmictus erythropterus*	Least Concern
Superb Fairywren *Malurus cyaneus*	Least Concern
Welcome Swallow *Hirundo neoxena*	Special Least concern
White-throated Honeyeater *Melithreptus albogularis*	Least Concern
White-headed Sittella *Daphoenositta chrysoptera leucocephala*	Least Concern
Willie-wagtail *Rhipidura leucophrys*	Least Concern
Additional birds identified through bioacoustic recordings	
Brolga *Antigone rubicunda*	Least Concern
Brown Kookaburra *Dacelo novaeguineae*	Least Concern
Bush stone Curlew *Burhinus grallarius*	Least Concern
Dusky Moorehen *Gallinula tenebrosa*	Least Concern
Eastern Barn Owl *Tyto javanica*	Least Concern

Species	NC Status
Eurasian Coot *Fulica atra*	Least Concern
Large-tailed Nightjar *Caprimulgus macrurus*	Least Concern
Masked Lapwing *Vanellus miles*	Least Concern
Peaceful Dove *Geopelia placida*	Least Concern
Pied Butcher Bird *Cracticus nigrogularis*	Least Concern
Rainbow Bee-eater *Merops ornatus*	Least Concern
Southern Boobook *Ninox boobook*	Least Concern
Sulphur crested cockatoo *Cacatua galerita*	Least Concern
Tawny Frogmouth *Podargus strigoides*	Least Concern
White throated nightjar *Eurostopodus mystacalis*	Least Concern
White-winged triller *Lalage tricolor*	Least Concern
White-throated Honeyeater *Melithreptus albogularis*	Least Concern
Mammals identified	
White-striped Freetail Bat *Austronomus australis*	Least Concern
Black Flying fox *Pteropus Alecto*	Least Concern
Rufous Bettong *Aepyprymnus rufescens*	Least Concern
Feral pig *Sus Scrofa*	Invasive
Cow *Bos taurus*	Domestic
Amphibians and reptiles identified	
Common Green Treefrog *Litoria caerulea*	Least Concern
Cane Toad *Rhinella marina*	Invasive

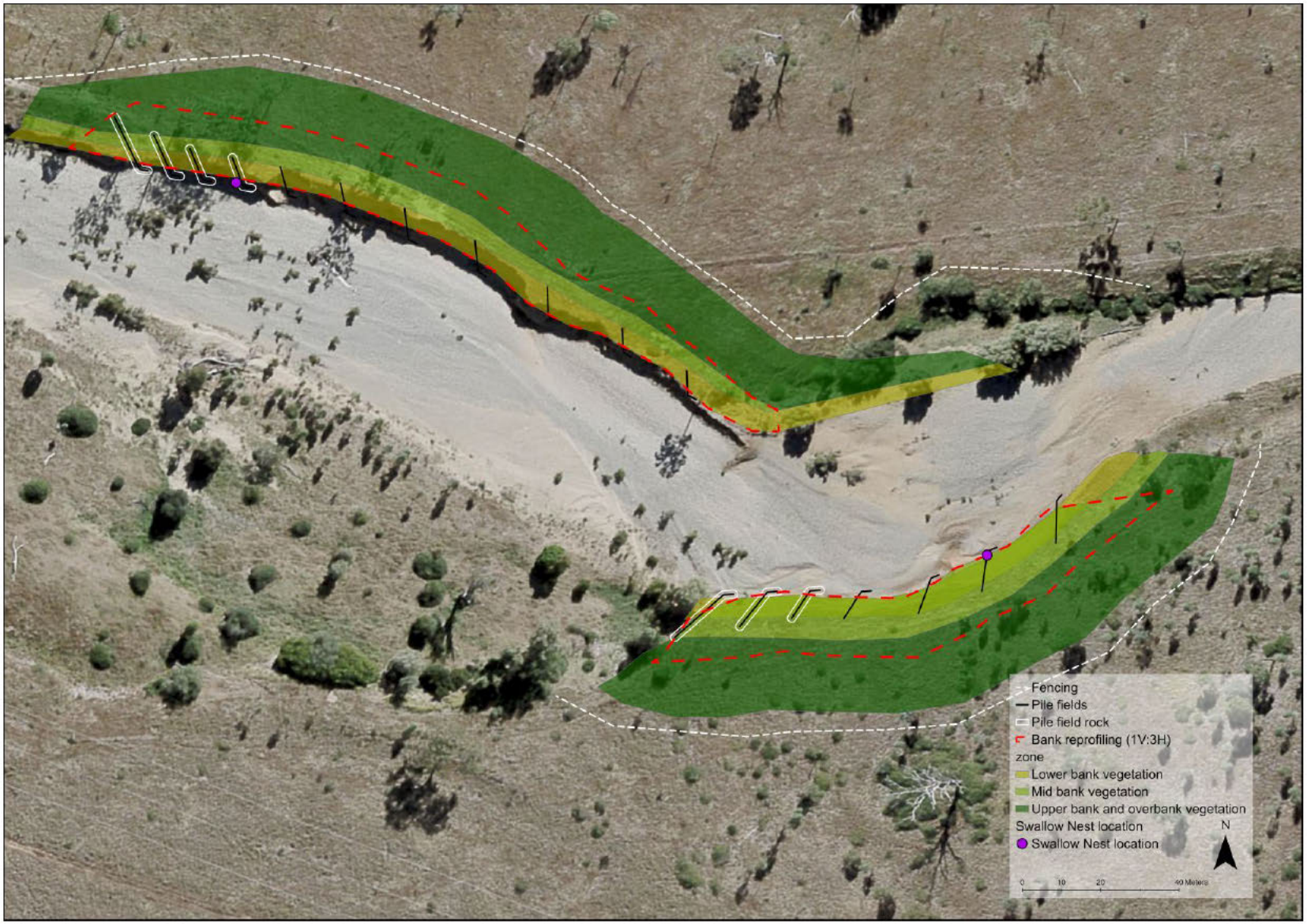


Figure 2.3 **Location of Welcome Swallow *Hirundo neoxena* in relation to construction works.**

Figure 2.4 Images of Welcome Swallow *Hirundo neoxena* nests taken during fauna surveys completed on the 15th (left) and 29th (right) of September. Mud structures were found on the northern bank with large undercutting bank predicted to collapse with the next high rainfall event. Nest dug into the side of the southern bank were not present at the beginning of fauna surveys but appeared within the week between the fifth and final survey.

2.3.3 Flora survey results

Flora surveys completed on the 16th of August recorded a total of 32 plant species consisting of 20 tree species, three grasses and nine environmental weeds (Table 2.5). No species listed under the EPBC, or NC Act were recorded. The Threatened Ecological Communities recorded in the desktop analysis were not found to be present and vegetation along the creeks was consisted with non-remnant vegetation. The southern bank was highly infested with *Lantana Camara* which will be removed during construction activities and replaced with native vegetation outlined in the revegetation plan (Verterra 2022), ultimately improving the ecological values of the site.

Table 2.5: Flora species recorded from surveys completed at Site B on the16th August.

Species	NC Status
Tree species	
Acacia holosericea	Least Concern
Alphitonia excelsa	Least Concern
Casuarina cunninghamiana	Least Concern
Corymbia clarksoniana	Least Concern
Corymbia intermedia	Least Concern
Corymbia tessellaris	Least Concern
Crotalaria mitchellii subsp. mitchellii	Least Concern
Eucalyptus camaldulensis	Least Concern
Eucalyptus coolabah	Least Concern
Eucalyptus fibrosa	Least Concern
Ficus opposite	Least Concern

Species	NC Status
Geitoniplesium cymosum	Least Concern
Grewia latifolia	Least Concern
Lomandra longifolia	Least Concern
Melaleuca bracteata	Least Concern
Melaleuca leucadendron	Least Concern
Melaleuca viminalis	Least Concern
Pogonolobus reticulatus	NA
Grass species	
Hyparrhenia	Environmental Weed
Melinis repens	Environmental Weed
Themeda quadrivalvis	Environmental Weed
Other non-native species	
Argemone mexicana	Environmental Weed
Cryptostegia grandiflora	Environmental Weed
Gomphocarpus physocarpus	Environmental Weed
Lantana camara	Environmental Weed
Macroptilium atropurpureum	Environmental Weed
Parthenium hysterophorus	Environmental Weed
Praxelis clematidea	Environmental Weed
Tridax procumbens	Environmental Weed
Xanthium spp.	Environmental Weed

3. Impacts and Management Actions

3.1 Potential Impacts

Potential breeding places within the proposed construction site include trees, scattered stags, woody debris, riverbanks, and grasslands. Known breeding places include the nests of the species Welcome Swallow *Hirundo neoxena*. These will be impacted by the project activities and actions in line with legislation requirement will be followed (Table 3.1).

To reshape the eroding bank to allow revegetation it will be potentially necessary to remove up to 15 trees along the 170m north section of bank and 20 trees along the 100m south section of bank. Most of these trees would be lost within the next 5 years as a result of erosion processes currently occurring. Although these trees were inspected for any existing nests at the time of the bird surveys, they should be reinspected immediately prior to removal and a licenced fauna spotter / catcher should be present during any clearing operations.

The tree removal will be offset by replanting trees and understory vegetation over the impacted area. A separate revegetation plan has been prepared ([redacted] 2022). This plan outlines replanting that will stabilise the bank by providing a buffer to the river's erosive forces and will contribute to local native species diversity representative of the surrounding ecosystem. It is intended that the area of planting will exceed what was removed.

Other potential impacts include noise and dust from construction and vehicle access to the site during construction and post-construction maintenance such as watering replanted areas. Vehicle access may also introduce a risk of fauna strike or the introduction of pest plants to the site.

3.2 General management actions to avoid/ limit disturbance to animal breeding places

The primary methods for avoiding disturbance to any animal breeding places at the stream bank and gully erosion restoration site will be to limit the removal of the even aged tree regrowth to the construction footprint, avoid the removal of potential breeding places such as, fallen timber or stags and to schedule construction to occur outside of peak animal breeding times.

The desktop and on ground surveys indicate that birds are the most likely group of animals to have breeding places within the vicinity of the construction site. The peak breeding months for all birds (all breeding activity from courtship to fledging) at these sites are between August and December (Schultz et al. 2021) if possible, any tree removal should be scheduled to occur outside of these months.

Removal of up to 80 trees (Coolabah regrowth) will be required to install the pile fields and to reshape and stabilise the banks to prevent further erosion at this site. Removal of these trees will be offset by the planting of trees and understory plants at the project sites. No nests were detected within these trees during the fauna and breeding place surveys. However, given the number of bird species recorded during the surveys there is some potential for breeding activity to occur outside of the August December period. Consequently prior to any tree removal all trees scheduled to be removed should be resurveyed for any nests and a fauna spotter catcher should be present during all tree removal operations.

A common Rufous Bettong was recorded on camera traps placed within the construction site however no nests of this species were found and suggest the main use of the construction site is for feeding, as they can cover large distances when foraging (2-4.5 km). If any nests are found a fauna spotter should be present to relocate the species. Feral pigs were also captured on camera traps within the site. These species are considered Invasive and are currently being controlled by the land manger through ground shooting and will not require any specific actions for this SMP.

3.3 Specific management actions to avoid/ limit disturbance to animal breeding places

Table 3.1 Management actions to limit disturbance to any animal breeding places at riverbank restoration works at Site B.

Management Actions	Responsibility
Construction site access management actions	
During all stages of preconstruction planning, construction and maintenance access to the construction site vehicle speed should be limited to 15kh/h within 300m of the site to minimise the risk of vehicle strike to fauna.	GPC, FBA and all Contractors and subcontractors
All vehicles entering the site will be washed prior to entry in accordance with FBA policies. Details of all vehicles entering the site to be recorded in the visitors record book.	GPC, FBA and all Contractors and subcontractors
To minimise noise disturbance and the risk of wildlife strike by vehicles accessing the site construction will be limited to the hours between 6.00am and 6.00pm.	GPC, FBA and all Contractors and subcontractors
Construction site management actions	
Welcome Swallow *Hirundo neoxena* nest mitigation actions are carried out in the following order. 1. A pre-construction site inspection to be conducted by a suitably qualified ecologist to re-confirm nest locations and ensure any new nesting sites are captured. These sites will be recorded in an Animal breeding place register (Appendix 1) 2. Just before construction begins a fauna spotter /catcher is to check nesting sites for any active nests. These will then be relocated to a suitable location on the property. Only designated and trained personal will be allowed to handle fauna. 3. Peak construction activity to occur between May and July to avoid the breeding period of August to March. 4. A fauna spotter /catcher should be present on-site during construction activity to ensure nests are not rebuilt within the construction area and monitor relocated nests. 5. Post project monitoring to determine species recolonises area once works are complete. 6. All records are provided to DES on project completion and/ or as requested during project implementation	GPC, FBA, FBA Ecologist, Fauna Spotter Catcher and all Contractors and subcontractors
Locate temporary and permanent structures or laydown areas within cleared or non-remnant vegetation areas to avoid disturbance to remnant vegetation.	GPC, FBA and all Contractors and subcontractors
A pre-construction site inspection to be conducted by a suitably qualified ecologist to identify habitat features (e.g. tree hollows, logs, rock piles) that may be impacted by construction. If located in the construction area they will be; a) clearly marked and not interfered with or b) or carefully moved to suitable adjacent habitat.	FBA Ecologists
Peak construction activity to occur between May and July to avoid the breeding season for the majority of animals that are likely to breed in the area. Limited activity pre and post site inspections or watering of revegetation areas will occur outside of these months.	GPC, FBA and all Contractors and subcontractors

Management Actions	Responsibility
Construction will include the targeted removal of up to X trees which will be identified by the Site Engineer and inspected by FBA Ecologists prior to removal. A fauna spotter /catcher should be present during all tree removal operations.	Site Engineer, FBA Ecologist and Fauna Spotter Catcher.
If any animal or animal breeding place is detected during any phase of construction a fauna spotter /catcher will relocate the animal / breeding place if required.	Site Engineer, FBA Ecologist and Fauna Spotter Catcher.
An Animal breeding place register (Appendix 1) will be maintained by FBA for the duration of the project and any post-construction activities. This register will be made available to DES on request and will be updated if any animal breeding is located or tampered with.	GPC, FBA and FBA ecologists
Only designated and trained personal will be allowed to handle fauna under a limited range of circumstances. This may include assisting any native animal trapped/stranded within the construction area. Any animal requires care or treatment a veterinarian or licenced wildlife carer will be contacted. Suitable records of any incidents with native wildlife will be kept by FBA.	Fauna spotter Catcher, FBA and FBA Ecologists
To minimise the risks of weed introduction and spread site weed assessment will be conducted before construction commences. Where appropriate weeds will be chemically treated or manually removed where appropriate before commencing construction.	GPC, FBA and all Contractors and subcontractors
Management of waste to discourage fauna entering the construction site.	GPC, FBA and all Contractors and subcontractors
Ensure that the construction work area does not provide nesting or shelter sites (e.g. material stockpiles).	GPC, FBA and all Contractors and subcontractors
Disturbed areas will be stabilised as soon as possible, including wetting down to minimise dust generation. Site to be revegetated as soon as practical after construction in accordance with the site revegetation plan (Veterra 2022).	GPC, FBA and all Contractors and subcontractors
Sediment impacts from construction to adjacent habitat areas to be avoided with appropriate construction techniques.	GPC, FBA and all Contractors and subcontractors
Management actions for adjacent areas	
The site will be cleaned up and rehabilitated to a high standard including replanting in riparian areas (trees and understorey species). Areas disturbed by machinery will be raked and all unused materials and equipment will be removed from the works site.	GPC, FBA and all Contractors and subcontractors
Construction to occur between April and July to avoid the breeding season for the majority of animals that may occur in the area.	GPC, FBA and all Contractors and subcontractors
A buffer zone (of at least 20m) will be maintained around identified breeding habitat. All buffer zones will be identified to construction personnel prior to the commencement of works.	GPC, FBA and all Contractors and subcontractors
Noise and activity at work locations adjacent to breeding places is to be kept to a minimum. Construction work to occur between the hours of 6.00am and 6.00pm.	GPC, FBA and all Contractors and subcontractors

4. Monitoring and Reporting

4.1 Pre and post construction monitoring

Immediately prior to construction the site will be reinspected for active nesting structures (e.g. active bird nests) to determine if any active breeding places are present within the construction footprint or immediate vicinity. These survey results will be retained by the Fitzroy Basin Association. A fauna spotter catcher will be present on site during any tree clearing to monitor for the presence of any native animal.

4.2 Reporting

An animal breeding place register consistent with DES requirements (Appendix 1) will be maintained by the Project Ecologist who will also maintain records of any additional survey work including the pre-construction surveys. These records will be made available to DES on request.

5. Management

5.1 Qualified persons and responsibilities

The construction manager will be responsible for the implementation of the management actions outlined in this SMP and for making contractors aware of their obligations under the SMP. The project ecologist will coordinate pre and post-construction fauna and breeding place surveys using suitably qualified and experience ecologists and undertake the required reporting under the SMP.

Table 5.1 Contact details for qualified persons

Role	Contact details
Project Manager	Name: TBD Address: Phone: Email:
Construction Manager	Name: TBD Address: Phone: Email:
Project Ecologist	Name: TBD Address: Phone: Email:

5.2 Contingency planning

Should breeding places of animals not described in this SMP be identified during construction all works should cease and contingency measures including any additional species management actions will be determined in consultation with the Department of Environment and Science.

Only designated and trained personal will be allowed to handle fauna under a limited range of circumstances. This may include assisting any native animal trapped/stranded within the construction area. If any animal requires care or treatment a veterinarian or licenced wildlife carer will be contacted. Suitable records of any incidents with native wildlife will be kept by FBA (Project Ecologist).

6. Glossary and Abbreviations

Table 6.1: Glossary (Department of Environment & Science 2019).

Terms	Definition
Animal Breeding Place	A bower, burrow, cave, hollow, nest or other thing that is commonly used by the animal to incubate or rear the animal's offspring.
Colonial Breeders	A group of animals of the same kind co-existing in close association for breeding purposes.
Least Concern Species	Native wildlife that is prescribed in schedule 6 of the Wildlife Regulations as least concern wildlife. In general, these include amphibians, birds, invertebrates, mammals and reptiles that are indigenous to Australia other than those that are extinct in the wild, endangered, vulnerable, near threatened or otherwise noted in the Nature Conservation Act 1992.
Special Least Concern Species	Under the wildlife regulation the following are Special Least Concern Animals; the Echidna Tachyglossus aculeatus, the Platypus Ornithorhynchus anatinus, a least concern bird to which any of the following apply (i) the agreement called 'Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment' and signed at Tokyo on 6 February 1974; (ii) the agreement called 'Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment' and signed at Canberra on 20 October 1986; (iii) the convention called 'Convention on the Conservation of Migratory Species of Wild Animals' and signed at Bonn on 23 June 1979.
Spotter-catcher	A person qualified to take and keep protected wildlife under a current rehabilitation permit granted under the Nature Conservation (Wildlife Management) Regulation 2006 to authorise the take, keep or use of an animal whose habitat is about to be destroyed by human activity.
Suitably Qualified and Experienced Person	A person with formal qualifications and/or experience in identification of native animals and wildlife ecology. A person is suitably qualified and experienced if they meet one or more of the following criteria: • An ecological consultant with experience in conducting surveys for native animal breeding places. • A person who possesses a degree in natural science or similar with experience in conducting surveys for native animal breeding places. • A person who is authorised as a spotter-catcher under a rehabilitation permit issued under the Act.
Tamper	Damage, destroy, mark, move or dig up an animal breeding place

7. References

Department of Environment & Science (2019) Information Sheet: Species Management Program. Department of Environment & Science downloaded June 2019.

Eyre TJ, Ferguson DJ, Hourigan CL, Smith GC, Mathieson MT, Kelly, AL, Venz MF, Hogan, LD & Rowland, J. (2018) *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland.* Department of Environment and Science, Queensland Government, Brisbane.

Queensland Government: Nature Conservation Act 1992

Mac Nally R, Parkinson A, Horrocks G, Conole L and Tzaros C (2001). Relationships between terrestrial vertebrate diversity, abundance and availability of coarse woody debris on south-eastern Australian floodplains. Biological Conservation, 99, p 191 – 205.

NSW Scientific Committee (New South Wales Scientific Committee) (2004). Coolibah - Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions - endangered ecological community listing. NSW Scientific Committee, Sydney. Viewed: 28 April 2010 Available on the Internet at: http://www.environment.nsw.gov.au/determinations/CoolibahBlackBoxWoodlandEndSp Listing.htm This

NSW Scientific Committee (New South Wales Scientific Committee) (2009). Coolibah - Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions - reject delisting of ecological community. NSW Scientific Committee, Sydney. Viewed: 28 April 2010 Available on the Internet at: http://www.environment.nsw.gov.au/determinations/coolibahblackboxrejectdelistfd.ht

8. Appendix 1: Animal Breeding Place Register

Department of Environment and Science

Animal breeding place register

Wildlife management

Authority holder's name: include Person in Charge where relevant		**ACTIONS Codes** (mark column with 'X') - **Legend:**				EHP contacts - Wildlife Assessment Team wildlife@des.qld.gov.au
Authority number or description: e.g. SMP project title etc		**R1** = release, no further action	**R2** = Release with first aid - Note **V** or **C** in column (V = Vet / C = Carer)	**D** = Death	**I** = Investigation	**Low Risk SMP Email protocol:** annually from the registered date and upon expiry of the SMP.
Approval date/s: e.g. valid from // -to // / approved on // for // years						**High Risk SMP Email protocol:** within 6 months of interaction with high risk of impact SMP species and upon expiry of the SMP.

Running report to be completed for all animal breeding places tampered with – all columns must be completed, with form emailed to the department upon expiry of approval and, for high risk SMP within 6 months of each interaction.

DATE (dd/mm/yyyy)	TIME (24 hrs)	SPECIES (Scientific name)	SPECIES (Common name)	LOCATION of animal breeding place				Relocated animal breeding place location details (if applicable)					ACTIONS				COMMENTS / OUTCOME/AUTHORITY HOLDER (e.g. of investigation - further management practices put in place etc. Permit references for DMP - removal and relocation or rehabilitation permit).
				Location Description	Lot on Plan	Latitude - Decimal Degrees	Longitude - Decimal Degrees	Date (dd/mm/yyyy)	Location Description / Lot	Latitude - Decimal Degrees	Longitude - Decimal Degrees	Count	R1	R2	D	I	

Note: To insert extra lines in Window 7 select 'Home' tab then click the 'Cells' tab and select 'insert sheet rows' otherwise go to the 'Insert' menu and click 'Rows'.

Appendix C: Cultural heritage assessment results

7 October 2022

Port Curtis Coral Coast Trust Ltd
Suite 3, Level 1/3 Maryborough St
BUNDABERG Q 4670

(07) 4167 0037
reception@pccctrust.com.au
PO Box 537
BUNDABERG Q 4670

Hayley Young
Indigenous Engagement Coordinator
Fitzroy Basin Association
PO Box 139, Rockhampton QLD 4700

Dear Hayley,

RE: Cultural Heritage Inspection for Streambank Rehabilitation Project, Langmorn Creek

Thank you for notifying the First Nations Bailai, Gurang, Gooreng Gooreng, Taribelang Bunda Registered Native Title Body Corporate about Fitzroy Basin Association's (FBA) streambank rehabilitation fine sediment offset project on Langmorn Creek in Raglan, and for engaging our organisation to provide cultural heritage management services on behalf of the Traditional Owners of the Port Curtis Coral Coast region.

This letter is to confirm that no objects or places of cultural heritage significance were located during the inspection of the project area streambank and streambed (Langmorn Creek, Lots 11 and 42 DT40168) on Tuesday 20 September 2022 as conducted by Traditional Owner, and Senior Cultural Heritage Field Officer, Mr Conrad Ingra.

Please accept this letter as confirmation that your organisation's cultural heritage duty of care has been met for the streambank rehabilitation project on Langmorn Creek, Raglan.

Whilst no significant cultural heritage finds were made, and there are no management recommendations relating to cultural heritage duty of care, we do have some general recommendations we would love to discuss with your organisation should the opportunity arise.

- Whilst we appreciate the request to assess the project site itself, the opportunity to assess the broader cultural landscape associated with the property is a highly desirable aspiration of PCCC. If this could be a consideration when FBA applies for funds for future projects, or if it can be factored into the budget and planning for similar projects, we would be happy to work with you to make this notion achievable.

- PCCC advocates for economic participation opportunities for our Traditional Owners, and we would welcome any ability to have First Nations businesses involved in the potential delivery of activities related to the project. This could potentially include earthworks, revegetation, weed control, fauna and flora surveys, water quality monitoring and participation in events associated with the project.

www.pccctrust.com.au