Aspect Industrial Estate
Lots 54-58 DP259135
Mamre Road, Kemps Creek
Civil Infrastructure Report

Mirvac

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Commercial in Confidence

Document Registration

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Contents

1. Executive Summary

Aspect Industrial Estate is legally described as Lots 54 – 58 in DP 259135, with an area of approximately 56.3 hectares (ha). The site is located east of Mamre Road, Kemps Creek within the Penrith Local Government Area (LGA).

The site has approximately 950m of direct frontage to Mamre Road with a proposed intersection providing vehicular access via Mamre Road to the M4 Motorway and Great Western Highway to the north and Elizabeth Drive to the south.

The site is located approximately 4km north-west of the future Western Sydney Nancy-Bird Walton Airport, 13km south-east of the Penrith CBD and 40km west of the Sydney CBD.

The Department of Planning, Industry and Environment (DPIE) rezoned Mamre Road Precinct, including the site, in June 2020 under the State *Environmental Planning Policy (Western Sydney Employment Area) 2009 (WSEA SEPP).* The rezoning of this precinct responds to the demand for industrial land in Western Sydney. The site is primarily zoned IN1 General Industrial with a small sliver of land zoned E2 Environmental Conservation.

Consistent with the above, this report has been prepared to support a Development Application under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the purpose of:

- A Concept Masterplan for the site comprising 11 industrial buildings, internal road network layout, building locations, gross floor area (GFA), car parking, concept landscaping, building heights, setbacks and built form parameters
- Stage 1 development of the site including:
    - The demolition, removal of existing rural structures and remediation works;
    - Heritage salvage works (if applicable)
    - Clearing of existing vegetation on the subject site and associated dam dewatering and decommissioning.
    - Realignment of existing creek and E2 Environmental Conservation zone;
    - Onsite bulk earthworks including any required ground dewatering
    - The importation, placement and compaction of spoil material, consisting of:
        - Virgin Excavated Natural material (VENM) within the meaning of the POEO Act; and/or
        - Excavated Natural material (ENM) within the meaning of the NSW Environmental Protection Authority's (EPA) Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the POEO (Waste) Regulation 2014- The Excavated Natural Material Order 2014; and/or
        - Materials covered by a specific NSW EPA Resource Recovery Order and Exemption which are suitable for their proposed use
    - Boundary retaining walls;
    - Catchment level stormwater infrastructure, trunk services connections, utility infrastructure, roads and access infrastructure (signalised intersection with Mamre Road)

associated with Stage 1;

- Construction, fit out and 24 hours a day/ 7 days per week use of warehouse and distribution centre within Stage 1;
- Detailed on lot earthworks, stormwater, services and utility infrastructure associated with the construction of warehouse and distribution centre within Stage 1;
- Boundary stormwater management, fencing and landscaping; and
- Staged subdivision of Stage 1

The Secretary's Environmental Assessment Requirements (SEARs) have been issued in respect of the proposal. This report addresses the relevant SEARs considerations.

2. Compliance with Secretary's Environmental Assessment Reports (SEARs)

This report responds to the SEAR's issued by the NSW Planning and Environment on 30th April 2020 and Test of Adequacy Comments on 28th August 2020. Table 1 below summaries all key civil / infrastructure issues raised in the SEAR's and how they have been dealt with.

Key Issue	Response
Traffic and Transport	
SP2 Infrastructure zone and draft Transport Infrastructure Investigation Area. Consideration of the draft SP2 Infrastructure zone and draft Transport Infrastructure Investigation Area within the Draft Mamre Road Precinct Rezoning Package for SEPP WSEA, in consultation with Transport for NSW	The SP2 infrastructure zone as highlighted in the Draft Land Zoning Map has been plotted on, and considered as part of, the civil siteworks drawings prepared by AT&L for the section of site fronting Mamre Road.
Address TfNSW detailed design (refer below) Addressing the detailed design comments by Transport for NSW regarding the Mamre Road/development intersection and the future Mamre Road alignment	The proposed signalised intersection documentation was provided to TfNSW (previously RMS) as part of pre-lodgement consultation (RMS Reference: SYD19/01350). TfNSW detailed design comments are noted and considered within this report. Refer below for each comment.
2.1 The installation of traffic control signals is dependent on general warrants in accordance with TfNSW requirements for Traffic Signal Design – Section 2 Warrants. A warrant assessment will be required for approval for any signalised intersection being proposed under this development	A signalised intersection warrants assessment is noted. During pre-lodgement consultation with TfNSW (previously RMS), TfNSW's Louise Moran noted that TfNSW would consider five (5) year horizons for signalised intersection warrants. The proposed signalised intersection location is consistent with the TfNSW proposed strategic design for Mamre Road Upgrade. A warrants assessment will be completed in consultation with TfNSW during the detailed design of the signalised intersection as part of the formal TfNSW Works Authorisation Deed (WAD) process post development consent and prior to commencement of construction of signalised intersection works.
2.2 The proposed intersection in the Industrial Estate design does not appear to align with the TfNSW Mamre Road Upgrade design. Without the ability of overlaying both designs, it appears the deceleration lane and length do not alignment. The triangular medians also do not appear to align with the Mamre Road Upgrade design. The intersection should align with Mamre Road Upgrade design to minimise future disruption to the future operation of the Industrial estate. Updated plans should be provided which show that the design aligns with Mamre Road upgrade plans.	The proposed signalised intersection is an interim signalised intersection provided to facilitate access to the proposed Aspect Industrial Estate (AIE) in advance of the proposed future Mamre Road upgrade by TfNSW. TfNSW to date have not released design documentation for the proposed future Mamre Road upgrade. The proposed interim signalised intersection arrangement has been supported by traffic Sidra modelling undertaken by ASON as part of the AIE SSD documentation.

	It is acknowledged that further coordination is required with TfNSW with regards to the proposed Mamre Road upgrade and this is proposed to occur during either the AIE formal exhibition period or post AIE SSD development approval as part of the formal TfNSW Works Authorisation Deed (WAD) design documentation and approval process. It is noted that Mirvac and AT&L held pre-lodgement meetings with RMS on 7 November 2019 regarding the proposed interim signalised intersection between AIE and Mamre Road. With RMS confirming that detailed comments and coordination could be made once RMS released detailed design documentation for the proposed Mamre Road Upgrade. RMS Reference: SYD19/01350
2.3 In the Mamre Road Upgrade design, this intersection has a U-turn facility for the vehicles to turn around. The Industrial Estate is to provide a facility for vehicles to turn around. This could be in the form of a U-turn facility within the estate or a roundabout at the first intersection within the estate. The turnaround facility is to cater for heavy vehicles.	As part of this SSD, a U-turn provisioning has been provided within the site via a cul-de-sac to cater for a B-Double articulated vehicle in accordance with Penrith City Council requirements as part of the internal road network. This cul-de-sac is indicated on the Civil drawings along with turn paths to comply with Penrith Council's standards.
2.4 The stormwater basin, swale and embankment on the north west section of the Industrial Estate appears to be within the future road widening and may impact the future road construction. During the construction, the stormwater basin could be damaged during construction. Overlay the Mamre Road Upgrade boundary with Industrial Estate to confirm if the stormwater basin is within the proposed road reservation. If the Basin is within the road reservation, then the stormwater basin is to be setback.	Mirvac and AT&L held pre-lodgement meetings with RMS on 7 November 2019 regarding the proposed interim signalised intersection between AIE and Mamre Road. RMS' land use team provided CAD files for land requirements for Mamre Road Upgrade to Mirvac for coordination in August 2019. AT&L confirms based on the information provided from RMS / TfNSW that the proposed bio-retention basin will not impact the proposed Mamre Road Upgrade works. Refer sketch 18-596-SKC65 included within Appendix D of this report. Note; final construction certificate documentation for the proposed bio-retention basin will be coordinated with TfNSW post development approval and prior to commencement of construction to ensure the bio-retention basin does not impact on the proposed future widening of Mamre Road.
2.5 It appears the proposed Mamre Road alignment in the Industrial Estate maintains the current road alignment and not the future Mamre Road alignment. Design should consider future Mamre Road Upgrade design to assist with realigning the Mamre Road during the SEARS Aspect Industrial Estate development.	The proposed signalised intersection is an interim signalised intersection provided to facilitate access to the proposed Aspect Industrial Estate (AIE) in advance of the proposed future Mamre Road upgrade by TfNSW. This proposed interim signalised intersection connects to, and maintains, the current Mamre Road alignment. Whilst the future Mamre Road upgrade alignment is

	acknowledged, to realise this alignment, significant land acquisition would need to be completed by TfNSW to enable. Mirvac will continue to coordinate with TfNSW regarding the interim signalised intersection design to ensure mitigation of abortive works and the future Mamre Road alignment is realised. This detailed design coordination is proposed to occur as part of the formal TfNSW Works Authorisation Deed (WAD) process post development consent and prior to construction commencement. This approach will enable AIE SSD assessment to be completed concurrently with the TfNSW Mamre Road Upgrade design documentation advancement to enable informed coordination of design.
2.6 The intersection is proposed to access the Aspect Industrial Estate only, but it needs to be used to access the surrounding local area as well. The local road layout will be further understood when the Mamre Road Precinct Structure plan - Local Road Network Structure Plan is completed. Further consultation with Council and TfNSW is required on this matter.	It is acknowledged that the proposed signalised intersection to AIE is to provide for connectivity to wider lands within the Mamre Road Precinct than the AIE. The AIE concept masterplan provisions for connectivity to peripheral development lands as shown within the Urban Design Report accompanying this SSDA. Mirvac is currently, and will continue to, coordinate with TfNSW to ensure the AIE provisions for local precinct connectivity as required. It is proposed that detailed coordination of precinct connectivity may occur post formal AIE SSD exhibition stage to enable concurrent development of the *Mamre Road Precinct Structure Plan – Local Road Network Structure Plan* by TfNSW and Penrith City Council.
2.7 Additional design comments to be addressed: *2.7.1. The four lanes proposed at the signalised intersection are required to be designed for a minimum of 200m form the intersection.* *2.7.2. The cycle lane adjacent to the left turn lane and the acceleration lane should be removed and just have provision for cyclists adjacent to the median islands. The left turn lane should be 4.5m in width (this is to the face of kerb).* *2.7.3. Clarification is required as whether the acceleration lane is warranted. Having acceleration lanes this short leads to unnecessary conflicts, especially when there is only one through lane. It is recommended that a standard high angle exit is considered (dependent on the traffic modelling outcomes).* *2.7.4. There is no SA kerb, pram ramps or footpath shown on the western side. There should be at a*	TfNSW' detailed design comments are acknowledged and will be considered as part of the formal TfNSW Works Authorisation Deed (WAD) design documentation and approval process post AIE SSD development consent and prior to construction commencement of signalised intersection works.

minimum a 2.0m shoulder provided adjacent to the SA kerb on the western side. *2.7.5. The proposed guard fence to protect the culvert extension doesn't appear to cover the required point of need. The guard fence is to be designed to ensure that the culvert is adequately covered.* *2.7.6. Clarification is required around what is the width of flow against the median islands and medians.* *2.7.7. The two 375mm pipe culverts should be 450mm for maintenance purposes and added strength.* *2.7.8. Clarification is required as to whether Approach Sight Distance (ASD) is achieved for the traffic signals, from the northbound approach in particular.* *2.7.9. On the new side road, there are two marked 'entry' lanes into the development. i.e. one for the left turners traveling south, and the right turners travelling north. Clarification is required as to the need for both lanes for such a short distance.*	
Connection of development to adjoining sites Detailing how the proposed development connects to adjoining sites to facilitate their future development for their intended purposes	Overall General Arrangement Plan 18-596–C1003 prepared by AT&L indicates internal road layouts which provide connection to adjoining lots to the north, east and south for future development. It is acknowledged that the proposed signalised intersection to AIE is to provide for connectivity to wider lands within the Mamre Road Precinct than the AIE. The AIE concept masterplan provisions for connectivity to peripheral development lands as shown within the Urban Design Report accompanying this SSDA. Mirvac is currently, and will continue to, coordinate with TfNSW to ensure the AIE provisions for local precinct connectivity as required. It is proposed that detailed coordination of precinct connectivity may occur post formal AIE SSD exhibition stage to enable concurrent development of the *Mamre Road Precinct Structure Plan – Local Road Network Structure Plan* by TfNSW and Penrith City Council.
Site access and internal road layout Detailed plans of the site access and proposed layout of the internal road and pedestrian network and parking on site in accordance with the relevant Australian Standards and Council's DCP	Access for the site is off Mamre Road via a proposed signalised intersection consistent with TfNSW' proposed Mamre Road Upgrade strategic design. Refer General Arrangement Plan 18-596–C1003 prepared by AT&L indicating site access along the proposed internal road layouts. Note also pedestrian footpath paths included within the GA plan. Refer to Architectural plans prepared by SBA for internal parking layouts.

	Internal road and pedestrian networks are proposed to be provided in accordance with Penrith City Council's standard DCP requirements with exception of a proposed wider verge on the shared pathway side to enable a consistent landscape zone within both road verges.
Swept path diagrams Swept path diagrams depicting vehicles entering, exiting and manoeuvring throughout the site	Refer to Vehicle Turn Path drawings 18-596-C1150-1153, C2160 and C2360 prepared by AT&L. These drawings indicate how vehicles enter and exit the site off Mamre Road along with internal movements within the Estate Road, inclusive of turn paths into and out all driveways (Lots 1 and 3) and turn around for both cul-de-sacs.
Road upgrade detail Details of road upgrades, infrastructure works, or new roads or access points required for the development	All upgrade works to Mamre Road along with details for all new roads within the development have been documented within the AT&L Civil drawings
Bulk Earthworks Clarify how the bulk earthworks and finished site levels will impact on the road connectivity to the adjacent sites to the north and east	Refer to Section 5 of this report for discussion on bulk earthworks and finished levels across the site. Finished levels at the eastern and northern boundary of the site have been designed to match existing levels to ensure no impacts on any future road works connectivity to adjacent sites. Refer to site sections within AT&L drawing set for clarification.
Soils and Water	
Compliance with Clause 33L stormwater, water quality and water sensitive urban design of the State Environmental Planning Policy (Western Sydney Employment Area) 2009	Refer to Section 9, 10 and 11 of this report for Integrated Stormwater Management strategy discussing how water quality and quantity is addressed. This section of the report highlights: • how water sensitive urban design principles are incorporated into the design • how the riparian, stormwater and flooding measures are integrated. This report should read in conjunction with the Cardno Flood Assessment report • the management actions being implemented to avoid adverse impacts on the land to which the development is to be carried out, adjoining properties, riparian lands, native bushland, waterways, groundwater dependant ecosystems and groundwater systems. This report should also be read in conjunction with the Flood Impact Assessment prepared by Cardno dated 14th October 2020.
Topographic assessment A topographic assessment and justification the proposed earthworks are site responsive and contextually appropriate	A Topographic assessment and justification on proposed earthworks are discussed within Section 5 of this report
Detailed site water balance A detailed site water balance including identification of water requirements for the life of the project, measures that would be implemented to ensure an adequate and secure water supply is	A Water Balance section has been included in this report. Refer Section 10 for all site water balance details, water supply source, usage calculations and efficiency measures.

available for the development and a detailed description of the measures to minimise the water use at the site	
Satisfactory arrangements for drinking, wastewater and recycled water Demonstration satisfactory arrangements for drinking water, wastewater and if required recycled water services have been made	Refer to Section 12 and Appendix A of this report for discussion on water and sewerage for the site along with servicing advice received from Sydney Water in February 2020.
Discharge water quality Characterisation of water quality at the point of discharge to surface and/or groundwater against the relevant water quality criteria (including proposed mitigation measures to manage any impacts to receiving waters and monitoring activities and methodologies)	Refer Section 9 of this report where stormwater quality is discussed. Note all stormwater discharge off site will be treated to ensure Penrith City Council's treatment rates are achieved. Refer Appendix G for water treatment device specification and monitoring / maintenance procedures.
Site specific integrated water management strategy A site-specific integrated water management strategy with details of stormwater/wastewater management system including how it will be designed, operated and maintained, including the capacity of onsite detention system(s), onsite sewage management and measures to treat, reuse (including indicative quantities) or dispose of water	Refer to Section 9 and 10 of this report for Integrated Water Management strategy.
Measures to minimise water use Description of the measures to minimise water use	Refer to Section 10 of this report for discussion on water re-use across the site using rainwater harvest tanks
Flooding assessment Detailed flooding assessment	Pre and post development flood assessment of the site has been undertaken by Cardno. Refer Flood Risk Assessment and Flood Impact Assessments supporting this SSD.
Erosion and sediment control Description of the proposed erosion and sediment controls during construction	Sediment and Erosion control measures across the site are discussed in Section 6 of this report. Note all control measures have been designed in accordance with Managing Urban Stormwater – Soils and Construction (2004) prepared by Landcom. Note also a full set of Erosion and Sediment Control plans has been provided for implementation at completion of the works.
Infrastructure Requirements	
Description of infrastructure required on site A detailed written and/or graphical description of infrastructure required on the site, including any upgrades required	Infrastructure requirements for the site have been documented in the Services and Utilities Coordination Plans prepared by AT&L. Section 12 of this report also discusses all service utilities within and adjacent to the site. Continued coordination with utility infrastructure providers will be undertaken concurrent to formal AIE SSD exhibition to ensure that adequate arrangements are made to ensure required infrastructure will be made available when required.
Identification of infrastructure upgrades Identification of any infrastructure upgrades required off-site to facilitate the development, and describe any arrangements to ensure that the	Refer to Section 12 which highlights proposed infrastructure upgrade works required to service the proposed development. Note all these works will need to be confirmed with the relevant service

upgrades will be implemented in a timely manner and maintained	Authority during detailed design stages. Consultation with each of these Authorities has commenced as part of this SSD process and will continue so during detailed design
Infrastructure delivery and staging plan An infrastructure delivery and staging plan, including a description of how infrastructure on and off-site will be co-ordinated and funded to ensure it is in place prior to the commencement of construction	Refer Section 13 for indicative infrastructure staging, programme and funding arrangements.
Development impact on existing utility infrastructure An assessment of the impacts of the development on existing utility infrastructure and service provider assets surrounding the site.	Any impacts to existing utility infrastructure will be discussed with the relevant service Authority during the detailed design phase. Mirvac and AT&L has, and will continue to, coordinate with utility Authorities in regard to the proposed AIE SSD development to identify augmentations required to existing infrastructure as a result of the proposed AIE SSD development. No significant impacts on existing utility infrastructure surrounding the site are envisaged as part of the proposed AIE SSD development.
Agency Comments	
Penrith City Council	
No details were provided within the received documents that seem to address the extent of cut and fill that will be required to be undertaken to accommodate the development. The spatial arrangement of the development must be informed by a topographic assessment, that ensures that any earthworks, road patterns, built form and landscaping is site responsive and contextually appropriate. This will require a cut and fill / benching plan that is informed from a visual impact analysis through the site, from neighbouring boundaries and along the southern and north approaches to the development as viewed from the public domain. Of particular emphasis will be edge conditions and interface treatments between the subject site and adjoining land.	Refer to Section 5 and 7 of this report for discussions on proposed earthworks and a topographical assessment. Refer also to Drawings 18-596-C1020 to C1039 for bulk earthworks plan and sections highlighting extent of cut /fill across the entire site. Refer also to site sections in Drawings 18-596 C1010 to C1014 for all edge conditions and interface treatments for all boundaries.
The indicated swale and basin within the front setback and northern side setback may compromise necessary landscape design and planting outcomes for the streetscape and resulting public domain interface. The stormwater management strategy and landscape design scheme must be considered in combination and demonstrate a suitable public domain and edge interface outcome	The proposed swale realignment is to be a naturalised riparian zone, planted and maintained in accordance with a Vegetation Management Plan (VMP) which accompanies this SSDA. Refer to VMP, Landscaping documentation and overarching EIS in regard to contextually appropriate assessment of landscaping public domain interface. The proposed bio-retention basin will be delivered as required to ensure water quality and quantity outcomes in accordance with Penrith City Council required. Design of the bio-retention basin and swale batters have been completed in accordance with Penrith

	City Council requirements. Refer to AT&L Roadworks and Stormwater plans and sections for all details of basin and swale location relative to Mamre Road. Note the proposed basin and swale alignment have been designed in consideration of the future Mamre Road upgrade works by TfNSW.
Further design detail and cross-sectional drawings are required for all edge boundary conditions. It is not clear how the development is responding to existing land uses to the north, east and south	Refer all sections within the AT&L drawing set for cross section drawings of all edge boundary conditions. Note retaining wall plan and longitudinal drawings have been prepared at boundaries where required.
Documentation and dimensioned plans of the proposed land subdivisions, roadworks, proposed signalised intersection of Mamre Road / Access Road 1, street lighting, footpaths, street trees, driveways, access aisles, loading and vehicle swept path manoeuvring areas and parking spaces and sight distance requirements at intersections and driveways including compliance with Austroads Guidelines, TfNSW (RMS) Technical Directions / Guidelines, AS 2890 including parts 1, 2 & 6, AS 1158, NSW Government Walking and Cycling Guidelines and Council's Development Control Plans	Refer AT&L Civil Drawings for all proposed subdivision works, roadworks and the external intersection drawing of Mamre Road and the proposed site entrance. Design has been completed in accordance with all standards listed.
Water quality and water quantity are to be addressed. Post developed flows shall match pre-developed flows. Water quality shall be in accordance with Council's WSUD policies. It is Council's preference that on-lot water quality and water quantity treatment be provided for rather than large open basins. If large basins are proposed, then they shall remain under the ownership and maintenance of the development site. Council will not accept the dedication of any drainage basin as a public asset.	Refer to Section 9 and 10 of this report for Integrated Water Management strategy discussing how water quality and quantity is addressed. Note all stormwater design is in accordance with Penrith City Council's stormwater guidelines. The bio-retention basin adjacent Mamre Road is not proposed to be dedicated to Council and will remain the Developer's asset to maintain.
Council's Water Sensitive Urban Design Policy and Technical Guideline must be addressed and complied with in the design of the development. Modelling is to support the information, and the modelling (SQZ file) is requested to be provided to Council for assessment / consideration	Refer Section 9 of this report for all reference to Council's WSUD Technical Guidelines. The Music (SQZ) file will be provided to Council to review.
A Stormwater Management Strategy will need to be prepared in support of the development. The strategy shall outline how the receiving waters and environment is safeguarded from the increased volumes, peak flows and pollutants in the increased runoff that will result from the development.	Refer to Section 9 and 10 of this report for Integrated Water Management strategy discussing how water quality and quantity is addressed. Note all stormwater design is in accordance with Penrith City Council's stormwater guidelines
The water management strategy for the precinct should have a focus on providing for a range of ecological services including integrated water management which maximises the opportunities	Refer to Section 9 and 10 of this report for Integrated Water Management strategy discussing how water quality and quantity is addressed. Note all stormwater design is in accordance with Penrith City Council's stormwater guidelines.

for rain / stormwater harvesting and reuse, manages and minimises increased stormwater flows and volumes, maximises nutrient retention, contributes to urban cooling, and contributes to the viability of local habitat for native flora and fauna. The adopted stormwater treatment should utilize vegetated systems and be placed as close to the pollution source as possible and integrated into the built form. This should include the use of passive irrigation, and provision of vegetation including street trees which contribute to mitigating the urban heat island effect and contribute to cooling though shading.	Water recycling is also discussed using rainwater harvest tanks off roof surfaces.
The EIS and supporting information should also outline and clarify the issue future ownership and maintenance responsibilities associated with the stormwater treatment measures and associated infrastructure. (Note: the stormwater treatment assets should not plan to be dedicated to Council).	Penrith City Council's comments regarding dedication of basins to Council is acknowledged. As such the bio-retention basin is not proposed to be dedicated to Council. Maintenance responsibilities will be undertaken by the Developer. Roads and associated stormwater drainage assets are proposed to be dedicated to Penrith City Council. Maintenance of these assets are proposed to Council's responsibility post Practical Completion and completion of Defects Liability periods.

Table 1 - SEARS Compliance

3. Agency Consultation

This report summarises all consultation and correspondence undertaken with the relevant authorities during the design phase. The following table summarises these consultations and the relevant correspondence. It should be noted not all authorities were consulted during the initial design phase.

Agency Consulted	Correspondence
Penrith City Council	Coordination with Myl Senthilvasan, Engineering Coordinator of Penrith City Council to confirm status of South Creek Floodplain Risk Management Study and Plan. A final pre-lodgment email was issued to Council on 22 May '20 inviting additional comment prior to formal SSD lodgment to the DPIE and referral to TfNSW. No response received. Penrith City Council's comments (link) provided in response to SEARs request for AIE development SSD-10448 have been acknowledged and these comments are have been considered as part design documentation and responded to accordingly. Refer Table 1 above.
Sydney Water	Significant consultation has occurred with Sydney Water regarding servicing arrangements for the AIE site and the Mamre Road Precinct. Refer Appendix A for formal Sydney Water response.
Endeavour Energy	As part of the Mirvac AIE design development, Mirvac has engaged an Accredited Service Provider Level 3 (ASP3) and has formally made formal subdivision and connection of load applications to Endeavour Energy for provision of an electricity network for AIE with Design Briefs received from Endeavour Energy for these applications.
Transport for NSW	Significant consultation has been undertaken with TfNSW during the development of the AIE SSD proposal. Mirvac is currently and will continue to collaborate with TfNSW regarding the development of the Mamre Road Precinct local road network. Mirvac and AT&L held pre-lodgement meetings with RMS on 7 November 2019 regarding the proposed interim signalised intersection between AIE and Mamre Road. With RMS confirming that detailed comments and coordination could be made once RMS released detailed design documentation for the proposed Mamre Road Upgrade. The proposed signalised intersection documentation was provided to TfNSW (previously RMS) as part of pre-lodgement consultation (RMS Reference: SYD19/01350). During pre-lodgement consultation with TfNSW (previously RMS), TfNSW' Louise Moran noted that TfNSW would consider five (5) year horizons for signalised intersection warrants. A final pre-lodgement email was issued to TfNSW on 12 May '20 inviting additional comment prior to formal SSD lodgement to the DPIE and referral to TfNSW. No response received.
Water NSW	A final pre-lodgement email was issued to WaterNSW on 13 May '20 inviting additional comment prior to formal SSD lodgement to the DPIE and referral to TfNSW. WaterNSW confirmed no additional comments to be provided apart from response letter provided as part of SEARs response (ref: S2020/34870).
NRAR	Email from NRAR confirming requirements for aquifer interference provisions and water access licenses. These requirements have been considered within the EIS supporting this SSD.

Table 2 – Agency Consultation

4. Introduction

This report has been prepared to inform a State Significant Development Application (SSDA) for the staged development of the Aspect Industrial Estate (AIE) at Lots 54-58 Mamre Road in Kemps Creek. Refer Figure 1 for the Site Location.

The aim of the report is to assess the potential impacts of the proposed development with respect to the Civil and Infrastructure and has been prepared in accordance with Penrith City Council current design guidelines, the relevant Australian Standards and the relevant Austroads Guidelines.

This report supports an Environmental Impact Statement (EIS) prepared in respect of the proposal and should be read in conjunction with the EIS and development plans submitted with the SSDA.

The Site, as outlined in red on Figure 1 below, forms part of the wider proposed *State Environmental Planning Policy (Western Sydney Employment Area) 2009* ("SEPP WSEA") amendment to rezone the Mamre Road Precinct within the WSEA for employment purposes as IN1 – General Industrial development.

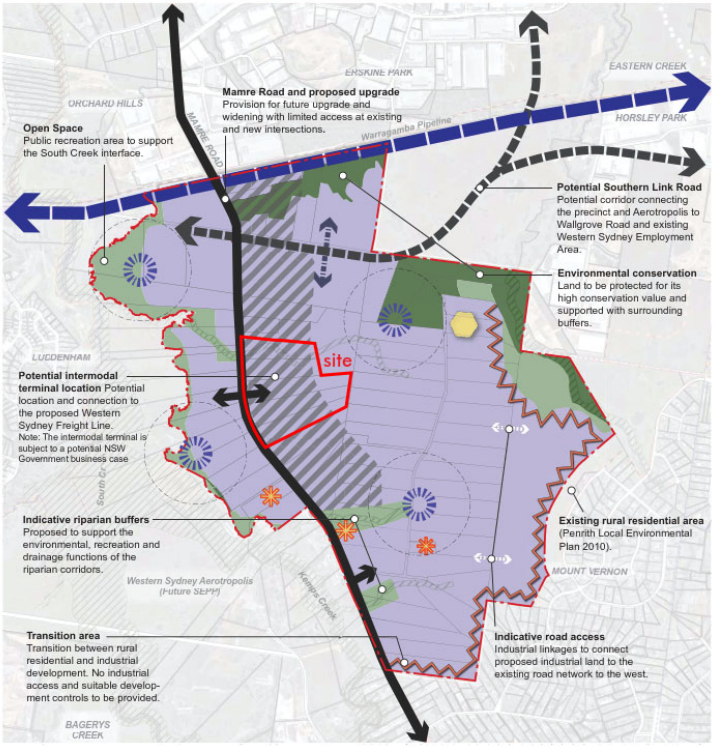


Figure 1 – Site Location

4.1. Existing Site

The Site has an area is approximately 56.3 Ha (subject to final Survey) and is currently rural in use, comprising of dwellings, sheds, dams and grassed fields.

The Site is located within Penrith City Council LGA approximately 2.5km south of Erskine Park and approximately 4km north-east from the proposed Western Sydney Airport. The Site is legally known as Lots 54, 55, 56 57 and 58 of DP 259135.

The Site is bordered by Mamre Road to the west and existing rural lots to the north, east and south. Refer to Figure 2 below for aerial image of the Site.

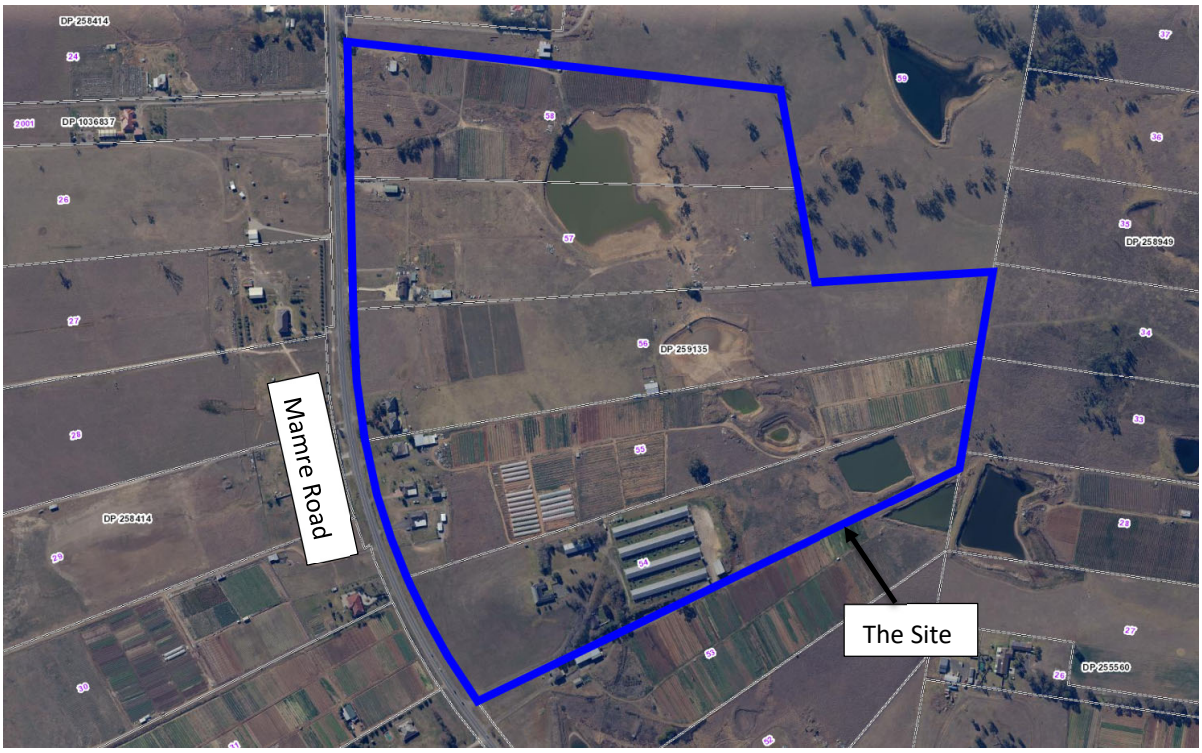


Figure 2 – Site Aerial Location

4.2. Scope of Report

Objective of Report

The objective of this civil, stormwater and infrastructure services report is to outline the design criteria used for the Engineering design of all components of the development and compare to the requirements of the Penrith City Council Development Control Plans (DCP) and the Aspect Industrial Estate DCP prepared by Urbis (September 2019).

This report should be read in conjunction with the AT&L Civil Engineering drawings as indicated within Appendix E.

Summary

This report generally discusses the design philosophy behind the following components of the design for Aspect Industrial Estate (AIE):

- Earthworks;
- Sedimentation and Erosion Control;
- Retaining Walls;
- Road Design;
- Stormwater Management;
    - On Site Detention (OSD)
    - Piped and Overland Flows
    - Water Sensitive Urban Design (WSUD)
    - Water Balance across the site
- Flood Modelling;
- Servicing;
    - Water
    - Sewerage
    - Communications
    - Gas
    - Electrical
- Infrastructure Staging; and
- Construction
    - Clearing and Grubbing
    - Demolition
    - Earthworks
    - Roadworks and Services
    - Program
    - Plant and Equipment

Supporting documentation that is referenced and commented on within the report include the following sections;

- Flooding (Cardno)
- Earthworks (PSM)
- Riparian Assessment (Ecological)

5. Earthworks

5.1. Existing Geology

Based on a Geotechnical Report undertaken by Pells Sullivan Meynink (PSM) (reference: PSM3739-004L Rev4, dated 14 May 2020) the following inferred sub surface soils were encountered across the site:

- Topsoil – Silty CLAY Depth 0.0 - 0.3m
- Natural Soil/ Fill – CLAY and Silty CLAY: Depth 0.1 to 4.5m
- Bedrock –SHALE: Depth 1.0 to 6.5m

5.2. Cut/Fill Requirements

The cut / fill requirements within the AIE have been defined through multiple iterations and careful consideration of the following:

- Undulating topography within the Mamre Road Precinct resulting in the requirement for extensive cut and fill operations in order for AIE to facilitate economic development and provide flexibility to cater for the range of industrial customer requirements;
- TfNSW proposal for a potential co-located intermodal facility within the Mamre Road Precinct therefore driving the requirement to ensure that allotments can facilitate flexibility to cater for current and future connectivity requirements;
- Provisioning for connectivity to adjoining lands and managing existing upstream catchment flows;
- Avoiding retaining walls fronting Mamre Road and mitigating retaining walls fronting internal public road reserves;
- Mitigate extensive cut in bedrock sub-surface units;
- Meet the requirements for the site to cater for IN1 – General Industrial employment which requires large flexible allotments;

It is recommended that the proposed earthworks design contained within the AT&L documentation provides the most contextually and economically appropriate design in consideration of the above requirements. Whilst retaining walls fronting Mamre Road have been avoided, this has resulted in a maximum 12m high cut retaining wall along a section of the AIE Eastern boundary due to significant topography within the site.

Refer to Drawing 18-596-C1025 for Bulk Earthworks Cut/Fill Plan within Appendix D. Net import is the value highlighted in bold in Table 3 below.

Item	Volume (m^3)
Cut Material	-711,670
Fill Material	982,152
Balance	**270,482 (Import)**

Table 1 – Cut/Fill Summary

Note these volumes are based on the current design, further detailed design may alter these. – (Negative) balance indicates net cut whilst + (positive) balance indicates import required. It is assumed that all topsoil from the site will be re-used on site as per the specification of the Geotechnical Engineer. Excess topsoil will be exported as required.

All import materials will comply with the requirements of the requirements of the Import Fill Protocol and Geotechnical Specifications for the AIE SSDA. Topsoil stripping, blending and placement will be completed in accordance with the Geotechnical Engineering Specifications for the project.

5.3. Retaining Walls

Where possible, batter slopes will be provided to accommodate level changes. Where this is not possible retaining walls will be constructed along the estate road, lots and basins based on the current civil and earthworks design. A keystone product or other similar face block will be adopted for all retaining walls and will be detailed on the civil drawings.

The proposed retaining walls will be built to the manufacturers design guideline requirements and verified by a structural engineer prior to construction. This practice has previously been adopted other developments within the Penrith City Council LGA and considered input from the geotechnical engineer, utility coordination as well as entry and exit points from proposed lots.

Retaining is required along the south and south eastern site boundary where the proposed building pad levels will be cut down from existing. Refer to Drawing 18-596-C1080 for cut wall locations. Retaining walls will be designed and constructed using standard industry practises.

All retaining walls will be constructed on a staged basis and as required to suit the development earthworks and stormwater basin works. Where the walls are not constructed a batter of 1 in 4 will be maintained for stability purposes. Any batter steeper than 1 in 5 shall be vegetated.

All retaining walls will be located within private property and not within the road reserve areas, unless within drainage easements.

All retaining walls will have pedestrian and vehicular safety barriers (if required) in accordance with Austroads Guidelines as required.

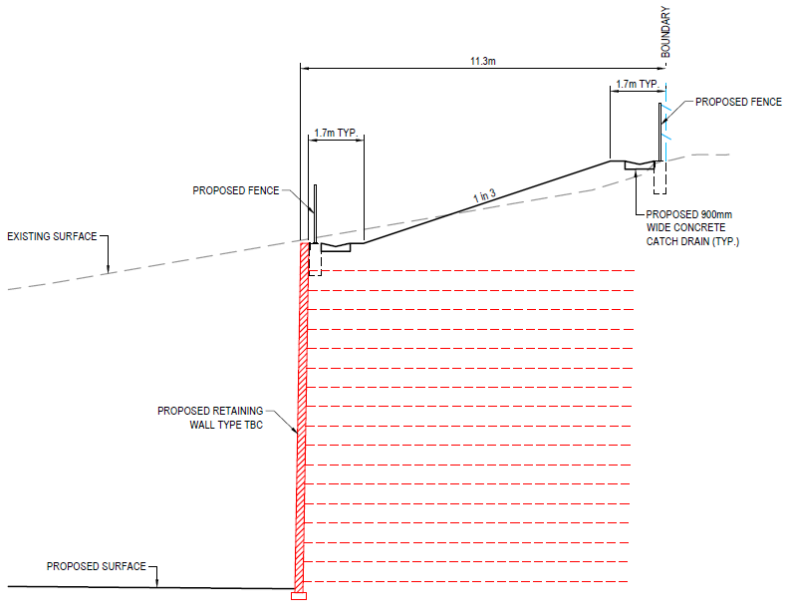


Figure 3 - Typical Retaining Wall

6. Sedimentation and Erosion Control

6.1. Sedimentation and Erosion Control (Construction)

A Soil and Water Management Plan (SWMP) has been prepared in accordance with the NSW Department of Housing Publication titled: Managing Urban Stormwater – Soils and Construction (2004) for the whole site.

The key objective of the SWMP are:

- Acknowledging the activities on a construction site which may contribute to erosion, sedimentation and water quality impacts;
- The implementation of industry best management practices to minimise adverse water quality and sedimentation impacts brought about through construction activities on waterbodies surrounding the work; and
- Establishment of processes that effectively manage erosion, sedimentation and water quality practices during the life of the project.

6.1.1. Sources of Pollution

The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

- Earthworks undertaken immediately prior to rainfall periods;
- Work areas that have not been stabilised;
- Extraction of construction water from waterways during low rainfall periods;
- Clearing of vegetation and the methods adopted, particularly in advance of construction works;
- Stripping of topsoil, particularly in advance of construction works;
- Bulk earthworks and construction of pavements;
- Works within drainage paths, including depressions and waterways;
- Stockpiling of excavated materials;
- Storage and transfer of oils, fuels, fertilisers and chemicals;
- Maintenance of plant and equipment;
- Ineffective implementation of erosion and sediment control measures;
- Inadequate maintenance of environmental control measures; and
- Time taken for the rehabilitation / revegetation of disturbed areas.

6.1.2. Potential Impacts

The major potential impacts on the riparian environment relate to erosion of distributed areas or stockpiles and sediment transportation. Potential adverse impacts from erosion and sediment transportation can include:

- Loss of topsoil;
- Increased water turbidity;
- Decreased levels of dissolved oxygen;
- Changed salinity levels;
- Changed pH levels;
- Smothering of stream beds and aquatic vegetation;
- Reduction in aquatic habitat diversity;
- Increased maintenance costs; and

- Decrease in waterway capacity leading to increased flood levels and durations

6.2. RUSLE Analysis

Prior to the design of the SWMP, a Revised Universal Soil Loss Equation (RUSLE) has been undertaken in accordance with the "Blue Book". This analysis has been undertaken to predict the long term, average and annual soil loss from sheet and rill flow from the site under specified management conditions.

Estimating soil loss for a proposed development has four important applications to soil and water management. These are to:

1. Assess the erosion risk at a site;
2. Identify suitable measures to overcome the erosion risk;
3. Estimate the required capacity of sediment retarding basins; and
4. Compare the effectiveness of various erosion control measured.

Refer to Table 4 – RUSLE Analysis below.

It should be noted the following parameters/assumptions were used for the analysis of this site:

- Rainfall Erosivity Factor (R) = 2,413.51 from (Equation 2, Appendix A2 Blue Book);
- Soil Erodibility Factor (K) = 0.05 (from Appendix C, Table C19 of Blue Book);
- Slope Length (LS): Is assumed to not exceed 80m immediately before forecast rainfall or during shutdown periods and a maximum grade of 5%;
- Erosion Control Factor (P): Is the ratio of soil loss with a nominated surface condition ploughed up and down the slope (from Appendix A5, Blue Book); and
- Cover Factor (C): Is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. With the proposed ESC measures being installed post bulk earthworks, it is assumed that all soil is recently disturbed, thus a C factor of 1 is chosen.

Parameter	Item (Blue Book Reference)
Rainfall Erosivity Factor, R	1,897.10
Soil Erodibility Factor, K (Table C20, Blue Book)	0.05
Slope Length/Gradient Factor, LS	1.19
Erosion Control Practice Factor, P	1.20
Ground Cover and Management Factor, C	1
Computed Soil Loss (tonnes/ha/year), (A = R x K x LS x P x C)	**135.45**
Soil Loss Class	1 (Table 4.2)

Table 2 – RUSLE Analysis

The erosion hazard potential of the site is considered very low, due to the calculated soil loss lying in the range of 0 to 150 tonnes/ha/year as per Table 4.2 of the Blue Book.

Table 4.2 The Soil Loss Classes (adapted from Morse and Rosewell, 1996)

Soil Loss Class	Calculated soil loss (tonnes/ha/yr)	Erosion hazard
1	0 to 150	very low
2	151 to 225	low
3	226 to 350	low-moderate
4	351 to 500	moderate
5	501 to 750	high
6	751 to 1,500	very high
7	>1,500	extremely high

Figure 4 – Table 4.2 from the Blue Book

6.3. Soil and Water Management Plan

6.3.1. Overall Strategy

The following construction methodology will be followed to minimise the impact of sedimentation due to construction works:

- Diversion of "clean" water away from the disturbed areas and discharge via suitable scour protection;
- Provision of hay bale type flow diverters to catch drainage and divert to "clean" water drains;
- Diversion of sediment-laden water into temporary sediment control basins to capture the design storm volume and undertake flocculation (if required);
- Provision of construction traffic shaker grids and wash-down to prevent vehicles carrying soils beyond the site;
- Provision of catch drains to carry sediment-laden water to sediment basins;
- Provision of silt fences to filter and retain sediments at source;
- Rapid stabilisation of disturbed and exposed ground surfaces with hydro-seeding areas where future construction and building works are not currently proposed;
- All temporary sediment basins will be located clear of the 100yr ARI flood extent from South Creek and all associated tributaries;
- The weir levels of temporary sediment basins will be located above the 100yr ARI flood event levels from South Creek and tributaries; and
- Bio-retention basins are to be utilised as temporary sediment control basins. The bio-retention basins shall not be converted into the final/ultimate basins until such time as all building and construction works within the site has been completed and 90% of the site is stabilised.

Refer to AT&L Drawings 18-596-C1110 to 18-596-C1119 for Erosion and Sediment Control Plans, for all proposed control and protection measures across the site until completion of on lot works.

Suitable temporary erosion and sediment controls shall be designed, adopted and maintained by the contractor throughout all stages of works, by an expert consultant. The contractor shall also design and implement controls at completion of the bulk earthworks where shown on AT&L drawings or where otherwise directed by the Superintendent or Penrith City Council's engineers.

Such controls shall be in accordance with the relevant requirements in the latest version of the managing urban stormwater: soils and construction guideline (Landcom).

6.3.2. Design of Sediment and Erosion Control Measures

Suitable erosion and sediment controls shall be provided by the Contractor and maintained throughout all stages of works, including at completion of the bulk earthworks.

All design, documentation, installation and maintenance of sediment and erosion controls will be in accordance with the requirements of:

- Protection of the Environment Operations Act;
- Penrith City Council's specifications; and
- Office of Environment and Heritage's 'Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) (The "Blue Book") Volume 1 and Volume 2.

Ultimately, the final temporary sediment basin locations and sizes will be provided to suit development staging requirements and will be sized and maintained in accordance with the requirements of the above-mentioned authority documents.

With the proposed site being larger than 2,500m^2 in disturbed area, sediment basins are required. The following temporary sediment basins are to be in-place at the commencement of demolition works. Refer to drawings in Appendix B and 'Earth Basin Wet' SD6-4 for details, and Table 6 below for basin sizes.

Parameter	Item (Blue Book Reference)
Soil Type	Type F (Appendix C, Table C19, Blue Book)
Design Rainfall Depth (Days)	5
Design Rainfall Depth (Percentile)	80 (Lot 1) 85 (Lot 2 and Lots 4 to 11)
x-day, y-percentile rainfall event (Table 6.3a)	27.4 (Lot 1) 35.00 (Lots 2 to 11)
Rainfall Intensity: 2-year, 6-hour storm	9.13
Rainfall Erosivity (R-factor)	**1,897.10**

Table 3 – Site Data

Parameter	Basin A	Basin B	Basin C	Basin D	Basin E	Basin F1	Basin F2	Basin G	Basin H	Basin I	Basin J
Volumetric Runoff Coefficient, C_v	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Contributing Area, A (ha)	5.81	4.185	4.326	5.991	3.385	2.65	2.65	3.385	3.385	2.978	3.609
$R_{(85\ \%ile,\ 5\ day)}$	27.40	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Settling Zone Volume, (m^3)	796	733	593	1,049	593	465	465	593	593	521	632
Sediment Storage Zone Volume, (m^3)	398	366	296	524	296	232	232	296	296	261	316
Total Sediment Basin Volume, (m^3)	**1,194**	**1,099**	**889**	**1,573**	**889**	**697**	**697**	**889**	**889**	**782**	**948**

Table 4 – Precinct Temporary Sediment Basins

6.4. Site Inspection and Maintenance

The inspection and maintenance requirements outlined in this section must be carried out while either earthworks or quarrying is being conducted, and all areas re-established.

The Contractor will be required to inspect the site after every rainfall event and at least weekly, and will:

- Inspect and assess the effectiveness of the SWMP and identify any inadequacies that may arise during normal work activities or from a revised construction methodology;
- Construct additional erosion and sediment control works as necessary to ensure the desired protection is given to downstream lands and waterways;
- Ensure that drains operate properly and to affect any repairs;
- Remove spilled sand or other materials from hazard areas, including lands closer than 5 metres from areas of likely concentrated or high velocity flows especially waterways and paved areas;
- Remove trapped sediment whenever less than design capacity remains within the structure;
- Ensure rehabilitated lands have affectively reduced the erosion hazard and to initiate upgrading or repair as appropriate;
- Maintain erosion and sediment control measures in a fully functioning condition until all construction activity is completed and the site has been rehabilitated;
- Remove temporary soil conservation structures as the last activity in the rehabilitation.
- Inspect the sediment basin during the following periods:
    - During construction to determine whether machinery, falling trees, or construction activity has damaged and components of the sediment basin. If damage has occurred, repair it;
    - After each runoff event, inspect the erosion damage at flow entry and exit points. If damage has occurred, make the necessary repairs;
    - At least weekly during the nominated wet season (if any), otherwise at least fortnightly; and
    - Prior to, and immediately after, periods of 'stop work' or site shutdown.
- Clean out accumulated sediment when it reaches the marker board/post and restore the original volume. Place sediment in a disposal area or, if appropriate, mix with dry soil on the site;
- Do not dispose of sediment in a manner that will create an erosion or pollution hazard;
- Check all visible pipe connections for leaks, and repair as necessary;
- Check all embankments for excessive settlement, slumping of the slopes or piping between the conduit and the embankment, make all necessary repairs;

- Remove the trash and other debris from the basin and riser; and
- Submerged inflow pipes must be inspected and de-silted (as required) after each inflow event.

6.4.1. Sediment Basin Maintenance

As stated in Section 4.3.2 above, the proposed development site contains 'Type F' soils, or soils that contain a significant proportion of fine grained (33% or more of finer than 0.02mm) and require a much longer residence time to settle.

Stormwater within the settling zone should be drained or pumped out within 5 days (design time), if the nominated water quality targets can be met, to the satisfaction of the superintendent. Flocculation should be employed where extended settling is likely to fail to meet the objectives within the 5-day time period. Flocculation is when flocculating agents are applied to the sediment basins causing the colloidal particles to clump into larger units or 'floc' that can either settle in a reasonable time or be filtered.

Refer to Appendix E4 of the Blue Book for flocculation methodologies and manufacturer's instructions for application rates, regarding the proposed sediment basins.

6.5. Conclusion

The erosion control measures proposed for the site will comply with the requirements of Penrith City Council Engineering Guidelines and The Department of Environment, Climate Change and Water (DECC).

The proposed SWMP will ensure that the best management practice is applied to the development site in controlling and minimising the negative impacts of soil erosion.

7. Road Design

7.1. Horizontal and Vertical Geometry

The Estate Roads within Aspect Industrial Estate have generally been designed to meet Austroads requirements and Australian Standards to accommodate B-Double truck movements.

See drawings within Appendix D for proposed Estate Road layout.

The proposed road reserve has been adapted from a standard Penrith City Council industrial road reservation of 20.6m wide though it is proposed to widen the verge containing the shared path to enable similar landscape widths on both verges.

The proposed road reserve width has been adopted to provide a shared path within one of the dedicated verge areas as requested in Penrith City Council DCP C10, Section 5. There are two different road reserve widths (Road 01 and 02) proposed as highlighted below and within Figures 5 and 6.

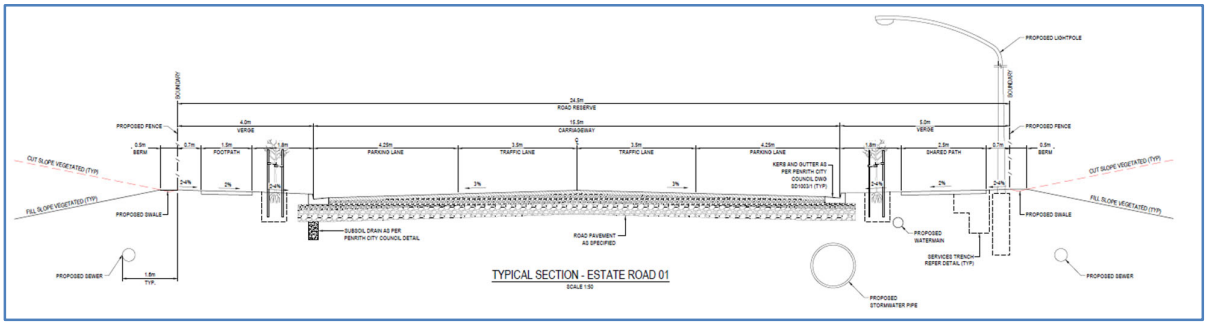


Figure 5 -Estate Road 01 Cross Section

The proposed typical AIE Estate Road 01 is designed as such:

- 24.5m wide Road Reserve
- 15.5m wide Carriageway comprising:
  - 2 x 3.5m wide traffic lanes
  - 2 x 4.25m wide parking lanes adjacent kerb
- Verge 1 at 4.0m wide containing a 1.5m footpath and verge 2 at 5.0m wide containing a 2.5m shared path
- Cul-De-Sac have been shown at 33m diameter to accommodate the largest design vehicle
- The largest design vehicle is a B-Double
- Design Speed of Road = 60km/hr
- No guard fences have been shown or are envisaged at this stage, though these will be assessed at detailed design stage in accordance with Austroads.

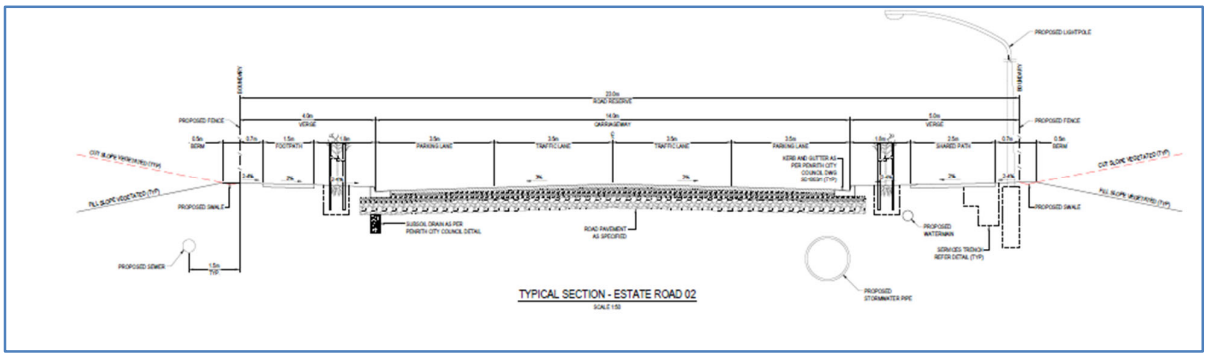


Figure 6 - Estate Road 02 Cross Section

The proposed typical AIE Estate Road 02 is designed as such:

- 23.0m wide Road Reserve
- 14.0m wide Carriageway comprising:
  - 2 x 3.5m wide traffic lanes
  - 2 x 3.5m wide parking lanes adjacent kerb
- Verge 1 at 4.0m wide containing a 1.5m footpath and verge 2 at 5.0m wide containing a 2.5m shared path
- Cul-De-Sac have been shown at 33m diameter to accommodate the largest design vehicle
- The largest design vehicle is a B-Double
- Design Speed of Road = 60km/hr
- No guard fences have been shown or are envisaged at this stage, though these will be assessed at detailed design stage in accordance with Austroads.

7.2. Pavement

Pavement will be designed based on the requirements of Austroads Pavement Design Guide – A Guide to the Structural Design of Road Pavements and recommendations provided by Pells Sullivan Meynink (PSM), reports PSM3739-004L & PSM3739-005L submitted as part of AIE SSDA.

The basis of this design is:

- Design Traffic Loading: N =1x10^7 ESA (in accordance with Penrith City Council requirements for Heavy Industrial)
- Design subgrade CBR = 2% (based on Section 3.4 of the PSM Report PSM3739-005L)

Based on these parameters the pavement design is as follows:

- 70mm AC 14 320 Bitumen
- 7mm Spray Seal
- 250mm DGB 20 (placed in two layers)
- 500mm Select Sandstone Fill with minimum CBR = 35% (placed in three layers)

If the subgrade CBR = 5% the bottom 200mm of select sandstone fill can be replaced with select fill with minimum CBR of 5%.

CBR testing is proposed to be undertaken at the subgrade level to confirm this pavement design.

Polymer modified asphalt will be used within all cu-de-sacs with the asphalt concrete layer becoming a 75mm thick polymer modified AC 14.

7.3. Batter Design

Any permanent batter's steeper than 1 in 5 will be vegetated in accordance with Penrith City Council requirements. All external batters to the development have been limited to 1 in 4 as a minimum generally, with the maximum localised batter being 1 in 3.

Any temporary batters constructed during the works will be in accordance with the geotechnical report and ongoing advice from the Level 1 supervisor.

7.4. Conclusion

All road design as demonstrated above is in accordance with Austroads Standards and the requirements of Penrith City Council, as a minimum.

A professional geotechnical engineer will be engaged to design the structural pavement. This will be in accordance with Austroads Pavement Design Guide – A Guide to Structural Design of Road Pavements.

8. Stormwater Management

8.1. Existing Site Stormwater Drainage

Currently the site comprises rural land and is classified as a "greenfield" site with an entire coverage of pervious areas and farm dams.

The majority of the site falls from east to the corner of the northern and western boundary. The high point of the site is located on eastern boundary and is approximately at RL70.5m. This catchment discharges from the Site into the road reserve before draining west underneath Mamre road in existing culverts at RL39.9m.

The remaining small catchment in the south west corner of the site falls from approximate RL 67 to the west towards Mamre Road. This catchment is captured in a swale to the east of Mamre Road and drains to the west into the existing pipes on the western boundary of the site.

Existing runoff drains across the site to via natural swales and farm dams.

Note for the analysis of the pre-development flow rates all dams on the site are assumed to be full, with no capacity available.

Refer to 18-596-C1045 for a pre-development stormwater catchment plan.

8.2. Proposed Site Stormwater Drainage

Due to the existing topography, site constraints and precinct requirements as discussed within Sections 5.2 and 7.1, significant cut to fill operations with balance import fill material is required.

The main objective for the stormwater drainage design of the proposed development is to ensure post-developed catchment flows do not exceed the pre-developed catchment flows. With On-Site Detention (OSD) systems in place to limit discharges to pre-developed rates, this will ensure the downstream catchments will not be inundated with flows and cause adverse flooding affects downstream of the development. Design documentation has been completed in accordance with the Penrith City Council Engineering guidelines.

Refer to Section 6.3.2 for a full description of each proposed catchment.

All stormwater on the lots and within the road reserve for the entire site is proposed to be collected via pits and pipes and connect into an On-Site Detention basin in the north west corner of the site. The basin will have an outlet structure and overflow weir system to drain into the existing culverts draining below Mamre Road. Scour protection will be provided on these outlet structures to minimise the effects of scour and erosion on the existing creek systems.

Refer to the Civil Drawings 18-596-C1050 to 18-596-C1062 for layout and details for the proposed stormwater network across the site.

8.2.1. External Upstream Stormwater Drainage

Part of the overall stormwater strategy for the site involves conveying the stormwater flows associated with upstream catchments.

As per AT&L drawing 18-596-C1046, the upstream catchments are large, in the order of 73.5Ha. Approximately 25.3Ha of this upstream catchment comes from the south east of the site with the remaining 48.2Ha coming from the north east.

Based on discussions between AT&L and Penrith City Council Engineers it has been agreed to convey the flow from these upstream catchments through and around the site and discharge into the north east corner of the site into the culverts beneath Mamre Road. This discharge point matches the pre-developed overall flow discharge point for the upstream catchments.

The upstream flows are proposed to be contained via overland swales and have been modelled at greenfield runoff rates. This external catchment network is proposed to contain all storm events up to the 1% AEP and it is the intention to not combine the external catchment runoff with the internal stormwater runoff.

The external catchment runoff will also not be detained or treated and will bypass the site's bio-retention basin. It is assumed detention and water treatment of these upstream catchments to PCC requirements will occur on the separate lots at the time of development.

8.2.2. Riparian Assessment

A Riparian Assessment report was undertaken by Ecological to support the SSDA for the Aspect Industrial Estate.

Within this report it was determined there are two mapped hydrolines located within the site. These hydrolines are indicated on Figure 5.

The blue line along the northern extends of the site running east to west is classified as a 2nd order hydroline under the Water Management Act 2000 (WM Act) however is in a degraded condition with steep and bare banks.

The green line which runs from south to north into the 2nd order hydroline is classified as a 1st order hydroline and does not meet the definition of a "river" under the WM Act.

Based on the Ecological Riparian Assessment report the following advice has been received:

The 2nd order hydroline is to be removed and a vegetated channel is to be constructed on the northern boundary of the development site. This channel will be vegetated with a full complex of native riparian vegetation in the ground, shrub and canopy layers, as per the Vegetation Management Plan prepared by

ELA (2019). This will ensure that a waterway that has aquatic instream habitat, dense native riparian vegetation and a range of geomorphic features such as pools and riffles will be created within the development area, which is a marked improvement on the condition of the current 2nd order watercourse within the development area.

The existing 2nd order watercourse to be removed is approximately 180m long and has a riparian area of 0.75Ha. The new channel will be approximately 230m long and have a total riparian area of 1.014 Ha comprised of a 4.1m wide channel, an inner Vegetated Riparian Zone of approximately 0.548Ha and an outer Vegetated Riparian Zone of approximately 0.36Ha.

Figure 7 -Watercourses mapped within development area

Refer to Civil Engineering Drawings within Appendix D for diversion of watercourse and proposed riparian corridors.

8.3. Council Requirements & Recommendations

All estate level stormwater drainage for the AIE development is designed to comply with the following:

- Penrith City Council Design Guidelines for Engineering Works;
- Penrith City Council Water Sensitive Urban Design (WSUD) Policy December 2013; and
- C3 Water Management DCP.

A summary of the design requirements adopted is listed below:

- Precinct based basin will serve the development as detention and bioretention basins. The basin will be designed to comply with PCC standard WSUD requirements
- All drainage in the road reserves of roads dedicated to PCC will be to PCC specifications.
- All stormwater drainage within the lots will be the responsibility of the individual property owners.

- OSD is to be sized to ensure that for all rainwater events up to and including the 1:100 ARI event, that new developments do not increase stormwater peak flows in any downstream areas;
- OSD is to mitigate post development flows to pre-developed flows for peak Average Reoccurrence Interval (ARI) events.
- All OSD basins have been designed with a 3.0m wide stabilised access road along the berm to ensure maintenance vehicles can access the entire exterior of the basin;
- WSUD to achieve target reductions:
    - 85% Total Suspended Solids (TSS)
    - 60% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - 90% Gross Pollutants (GP)
- Finished Floor Levels (FFL) of proposed buildings within the precinct (separate approval) to have minimum 500mm freeboard to 100 year overland flows; and

Rainwater tanks are desirable for re-use for irrigation, toilet and other non-potable water uses. Rainwater tank size is determined in accordance with the Penrith City Council C3 Water Management DCP to meet 80% of non-potable demand for irrigation and toilet flushing.

Refer to Section 8 of this report for a more detailed description on rainwater harvest tanks.

8.3.1. Modelling Software

DRAINs modelling software has been used to calculate the Hydraulic Grade Line (HGL) of the estate stormwater pipes. DRAINs is a computer program used for designing and analysing urban stormwater drainage systems and catchments. It is widely accepted by Council's across NSW as the basis for stormwater design and has been confirmed by Penrith City Council as the preferred stormwater software analysis package. DRAINs data files and output results are attached in Appendix E.

MUSIC modelling software has been used to evaluate pollutant loads from each developed lot and precinct. For a detailed description of the MUSIC modelling refer to Section 9.3.7 of this report. MUSIC data files and output results are attached in Appendix F.

8.3.2. Hydrology

- Pipe drainage shall be designed to accommodate the 20-year ARI storm event;
- The combined piped and overland flow paths shall be designed to accommodate the 100-year ARI storm event;
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flowpath capable of carrying the total 100-year ARI storm event shall be provided. Alternatively, the pipe and inlet system may be upgraded to accommodate the 100 year ARI storm event;
- Rainfall intensities shall be as per the Intensity-Frequency-Duration table in accordance with the Australian Rainfall and Runoff (AR&R) volume 2;
- Times of concentration for each sub catchment shall be determined using the kinematic wave equation;
- Runoff coefficients shall be calculated in accordance with AR&R. The fraction impervious shall be determined from analysis of the sub catchments;
- Flow width in gutter shall not exceed 2.5m for the minor design storm event;
- Velocity depth ratios shall not exceed 0.4 for all storms up to and including the 100-year ARI event;

- Inlet pits to be spaced so that flow width shall not exceed 80l/sec;
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit; and
- Blockage factors of 20% and 50% shall be adopted for pits on grade and at sags respectively, with these blockage factors in-built to each pit within the DRAINs model.

8.3.3. Hydraulics

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design;
- The minimum pipe size shall be 375mm diameter RCP;
- Maximum spacing between pits shall not exceed 75m;
- The minimum pipe grade shall be 0.5%;
- All pipes shall be Rubber Ring Jointed unless noted otherwise;
- The minimum cover over pipes shall be 450mm in grassed areas and 600mm within carriageways;
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased;
- All pipes in trafficable areas shall be Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent;
- The pipe friction coefficients to adopted shall be:

Materials	Mannings – n	Colebrook-White – k	Min. Pipe Class
RCP	0.012	0.3	3
FRC	0.01	0.15	3

Table 5 – Pipe Details

- All pipes classes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for;
- Pipes discharging to the overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level;
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts;
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels for the minor storm event;
- Overland flowpaths shall maintain a minimum of 300mm freeboard to all habitable floor levels; and
- Pits deeper than 1.2m shall contain step irons at 300 mm centres.

8.3.4. Catchments

A Stormwater Catchment Plan for each Catchment and flow paths into the bio-retention basin is shown in Appendix D. As indicated in the Catchment Plan the basin is to be a bio-retention basin designed to both attenuate stormwater flows and treat the nutrients to Penrith City Council treatment rates. These treatment rates are from the Penrith City Council C3 Water Management DCP.

The overall developed site is proposed to be split into two catchments as per 18-596-C1046

A summary of each catchment and the outflow and overflow locations are described below:

Catchment 1 – Northern Catchment

- Total Area = 9.25Ha;
    - Includes: northern half of Lots 1 to 3 and Road 01.
- Flow path to north and west of catchment into the Basin ; and

- Outlet and overland flow from the Basin to drain to the west into culverts beneath Mamre Road.

Catchment 2 – Southern Catchment

- Total Area = 42.72Ha;
    - Includes: Southern half of Lots 1 to 3 and Road 01,all of Lots 4 to 11 and Road 02 and future road.
- Flow path to north and north west of catchment into the Basin; and
- Outlet and overland flow from the Basin to drain to the west into culverts beneath Mamre Road.

8.3.5. On-Site Detention (OSD)

As discussed in Section 9.3, OSD is required within the development to mitigate post developed flows to pre-developed flow rates for peak Average Recurrence Intervals (ARIs).

Catchments Discharge Points

As discussed within Section 9.3 of this report, the main objective of the stormwater management of the proposed development is to ensure post-developed catchment flows do not exceed pre-developed catchment flows for all storms from the 1 to 100 year ARI event for all existing catchments.

In order to ensure these post-developed flows do not exceed the pre-developed flows it is important to look at the existing catchments and compare the outflows.

As discussed in Section 9.1 the majority of the site currently falls towards the north west corner and runoff drains into the culverts underneath Mamre Road. For the post-development case it is proposed to maintain this outlet and ensure peak flow rates are not increased via the OSD basin and controlled outlets within through the use of a low flow orifice and high flow weirs. Whilst this SSDA only seeks approval for the Concept Masterplan and Stage 1 works, for the purposes of stormwater and hydraulic design the entire site is assumed fully developed. As such post-developed flows refer to fully developed site conditions. Refer to Drawing 18-596-C1013 and 18-596-C1059 for the OSD basin details.

Table 6 indicates the pre and post developed flow rates for all storm events at the Mamre Road culverts. Note for modelling of the basin tailwater levels within the Mamre Road culverts have been incorporated based on the Cardno Flood modelling (refer Section 9).

The OSD within the Basin has been designed to achieve the following outcomes for all pre and post developed cases:

Duration	Pre-Developed Flows (m^3/s)	Post Developed Flows (m^3/s)
1-Year ARI	1.4	1.37
2-Year ARI	4.34	2.38
5-Year ARI	8.54	4.55
10-Year ARI	10.1	6.07
20-Year ARI	12.1	8.76
100-Year ARI	15.7	12.4

Table 6 – Pre-Post Development Flows to Mamre Road culvert

8.3.6. Overland Flows

Overland flows within the access roads, carparks and hardstanding areas have been designed to be safely conveyed within the road carriageway to comply with flow widths and velocities within the Penrith City Council Design Guidelines for Engineering Works.

8.3.7. Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design (WSUD) encompasses all aspects of urban water cycle management, including water supply, wastewater and stormwater management. WSUD is intended to minimise the impacts of development upon the water cycle and achieve more sustainable forms of urban development.

The WSUD strategy, MUSIC Model and subsequent WSUD designs prepared by AT&L are based upon requirements within the Penrith City Council C3 Water Management DCP.

All stormwater runoff from the site is proposed to drain into a separate Bio-Retention basin for the water to be treated to rates acceptable to Penrith City Council. It is proposed to utilise the Filterra product by Ocean Protect to provide this water treatment. A summary and information package of this product is provided in Appendix G.

The stormwater infrastructure for the site has been designed to ensure only the 3 month flows drain directly into the bio-retention basin will all storm events exceeding 3 month up to the 1% AEP bypassing and directly discharging into the OSD basin. This is achieved via splitter pits immediately upstream of the bio-retention basins. Refer to the Civil drawings for these details.

8.3.7.1. WSUD Modelling – MUSIC Model

The MUSIC Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.3.0) was used to evaluate pollutant loads from each of the proposed lots for Post-development (treated) conditions based on the proposed site development.

A conceptual view of the MUSIC model used in this report can be found in Appendix F.

Pluviograph data (6 minute rainfall intensity and evapotranspiration) for Penrith Lakes AWS (Station 67113) was used in the MUSIC model.

8.3.7.2. Catchment Areas and MUSIC Parameters

All building lot catchment areas were assumed to 65% roofed. Of the non-roofed areas, 80% of this area was assumed to be impervious. To provide a more accurate model, separate catchment nodes were created to simulate the roofed area and non-roofed areas for each lot.

MUSIC model input parameters for these catchments including rainfall-runoff, base flow concentration and stormflow concentration parameters were selected as per the Penrith City Council Water Sensitive Urban Technical Guidelines June 2015 document. The parameters used for the various catchment areas can be seen in tables 7, 8, 9, 10 and 11.

Parameter	Unit	Figure
Rainfall Threshold	mm/day	1.40
Soil Storage Capacity	Mm	105.00
Initial Storage	% of Capacity	30.00
Field Capacity	Mm	70.00
Infiltration Capacity Coefficient	a	150.00
Infiltration Capacity Coefficient	b	3.50
Initial Depth (Ground Water)	mm	10.00
Daily Recharge Rate	%	25.00
Daily Baseflow Rate	%	10.00
Daily Seepage Rate	%	0.00

Table 7 – Rainfall-Runoff Parameters – All Catchment Areas

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	0.000	0.000	1.300	0.320
Phosphorus	0.000	0.000	-0.890	0.250
Nitrogen	0.000	0.000	0.300	0.190

Table 8 – Base Flow/Stormwater Concentration Parameters – Impervious (Roofed) Areas

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	1.200	0.170	2.150	0.320
Phosphorus	-0.850	0.190	-0.600	0.250
Nitrogen	0.110	0.120	0.300	0.190

Table 9 – Base Flow/Stormwater Concentration Parameters – Pervious Areas

Pollutant	Baseflow Concentration Parameter – Mean (log mg/L)	Baseflow Concentration Parameter – Std Dev (log mg/L)	Stormflow Concentration Parameters – Mean (log mg/L)	Stormflow Concentration Parameters – Std Dev (log mg/L)
TSS	0.000	0.00	2.430	0.320
Phosphorus	0.000	0.000	-0.300	0.250
Nitrogen	0.000	0.000	0.340	0.190

Table 10 - Base Flow/ Stormwater Concentration Parameters - Road

MUSIC model parameters used for the Bio-retention basin were based off guidelines provided by FAWB – Stormwater Biofiltration Systems – Version 1, 2009, and were modified accordingly. Parameters used to model the bio-retention basin are shown in the Table 11 below.

Parameter	Unit	Figure
Extended Detention Depth	m	0.30
Surface Area	m2	Varies
Filter Area	m2	Varies
Unlined Filter Media Perimeter	M	0.01
Saturated Hydraulic Conductivity	mm/hour	125
Filter Depth	m	0.50
TN Content of Filter Media	mg/kg	800
Orthophosphate Content of Filter Media	mg/kg	40.0
Exfiltration Rate	mm/hour	0.00
Base Lined	-	No
Vegetation Properties	-	Vegetated with Effective Nutrient Removal Plants
Overflow Weir Width	m	10.00
Underdrain Present	-	Yes
Submerged Zone	-	No

Table 11 - Bio-Retention Basin Parameters

8.3.7.3. Results

MUSIC modelling results presented as mean annual loads at the receiving node indicate that adopted target reductions are achieved, as shown in Table 12.

Pollutant	Sources (Kg/yr)	Residual Load (Kg/yr)	Reduction (%)	Target Reduction (%)
Total Suspended Solids	35,700	3,550	90.1	85
Total Phosphorus	77.2	11.6	85.0	60
Total Nitrogen	598	230	61.5	45
Gross Pollutants	7,790	0	100.0	90

Table 12 - Pollutant Loads - Bioretention Basin 1

8.4. Conclusion

As highlighted in the above section all stormwater drainage within the Oakdale West development has been designed in accordance with the Penrith City Council Engineering Guidelines. This includes design of the stormwater network (pits and pipes), On-Site Detention basins and WSUD infrastructure. To summarise:

- OSD has been to be sized to ensure that for all rainwater events up to and including the 1:100 ARI event, does not increase stormwater peak flows in any downstream areas;
- OSD to mitigate post development flows to pre-developed flows for peak Average Reoccurrence Interval (ARI) events;
- WSUD to achieve target reductions:
    - 85% Total Suspended Solids (TSS)
    - 60% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - 90% Gross Pollutants (GP)
- Finished Floor Levels (FFL) to have minimum 500mm freeboard to 100-year overland flows

9. Water Balance

9.1. General

The water balance was simulated using a water cycle management model as part of the MUSIC Model to allow the evaluation of various elements of the water cycle to be assessed at differing stages in the development.

Penrith City Council WSUD policy (July 2015) stipulates the rainwater tanks to meet 80% of non-potable demand including outdoor use, toilets and laundry.

9.2. Water Balance Objective

Potable water supplies in the Sydney area are in recognised short supply with projected population increases, potential climate change and periods of extended drought and any development in sources of the Sydney region places increasing demands on an already reduced water supply. As a result, government bodies, together with Sydney Water have encouraged sustainable development by the implementation of an integrated approach to water cycle management (potable water, sewage, stormwater and rainwater) to minimise demands of potable water supplies.

Whilst opportunities for Water Reuse include such initiatives as regional stormwater harvesting, black water recycling and recycled water, this development is limited to rainwater collection and reuse on an individual lot by lot basis.

As such, we have used MUSIC to establish an estimated tank size for each lot within the development and demonstrated the volume of water reuse possible and provide a more sustainable servicing solution.

9.3. Water Balance End Uses

AT&L has identified the following water demand end uses to be required across the development:

- Toilet and urinal flushing; and
- Landscape watering (outdoor garden use).

The proportion of total water demands for irrigation and toilet flushing within the development could be met with the use of recycled roof water drained directly into a rainwater tank. The tank should be sized to ensure the site meets the requirement to meet the 80% non-potable reuse requirement. This is in accordance with Penrith City Council's WSUD policy.

9.4. Total Site Demands and Non-Potable Re-use Rates

The following rates were adopted from the Penrith City Council WSUD technical Guidelines for Industrial and Commercial developments (Section 4.5):

- 0.1 kL/day per toilet or urinal; and
- 0.4 kL/year/m2 as PET-Rain for Sprinklers.

9.5. Rainwater Reuse

The use ofrain water collected in rainwater tanks from runoff on the roofs of the warehouse roofs provides a valuable alternative to potable water for a variety of non-potable end uses, such as vehicle washing, air conditioning cooling, and toilet flushing and watering.

We have assumed for this development, irrigation and toilet flushing will be plumbed to the rainwater tanks. Other uses such as truck washing maybe considered at the detailed design stage.
A rainwater tank model was constructed to simulate the rainwater tank operations and select the optimal rainwater tank size, in doing so, the following considerations were made:

- Rainfall received;
- Roof area or runoff area;
- Roof Wetting;
- First Flush; and
- Rainwater demands (by end use).

9.6. Rainwater Tank Model Assumptions

The rainwater tank model assumptions built into the scenarios assumed thefollowing:

9.6.1. Rainfall Received

The rainfall runoff that could potentially be captured by the rainfall tank from the roof of each building was simulated individually for the 'dry', 'wet' and 'average' rainfall year within each scenario run.

9.6.2. Roof Wetting, First Flush Diversions and Overflow

While it is assumed that rainfall runoff has the potential to runoff 100% of the area of the roof into the rainwater tank, the proportion of rainfall that actually reaches the rainwater tank is affected by four factors:

- It is assumed that the initial 2mm of rainfall that falls on the roof is considered 'wetting', that is, potential rainfall runoff that is not captured by the rainwater tank, but is rather 'lost runoff' as evaporation or other;
- To prevent sediment and other pollutants entering the rainwater tank, a portion of the initial runoff from the roof is transferred to stormwater, this is known as the 'first flush'. The portion of water diverted as part of the first flush differs for each facility depending on the amount of pollution each roof is susceptible to;
- As the development is located in a predominantly light industrial area, where there may be potential for some roof pollution, a standard first flush volume of 1mm of runoff from across the roof area has been adopted; and
- Any roof runoff that exceeds the rainwater tank capacity is 'overflow' and is directed to the stormwater drainage system.

9.7. Conclusion

The use of rainwater harvest tanks and the design basis to size the tanks to ensure as a minimum, 80% of all non-potable water on each lot can be sourced from the tank, demonstrates a commitment to water recycling and minimising the usage of mains water.

This is in line with the industry best practise and the NSW Stage Government's objective of reducing the amount of potable (drinking) water consumed for non-potable uses.

10. Flood Report

A Flood Impact Assessment of the Proposed Oakdale West Estate was undertaken by Cardno in October 2020.

10.1. Purpose of Flood Report

The purpose of this report is to assess the impact of development proposed in the Aspect Industrial Estate. The flood impact assessment was informed by the assessment of design flood levels, velocities and hazards under Benchmark conditions.

10.2. Flood Modelling Results

Based on the results within the Flood Impact Assessment, Cardno have plotted estimated impacts of the proposed development on the 2yr, 5ry, 100 yr, 200 yr, 500 ARI flood levels and velocities and PMF levels and velocities in comparison to the pre-development conditions.

Flood maps within the FIA highlight negligible adverse impacts on flood levels and velocities downstream of Mamre Road in all storm events. In the PMF event modest increases in the flood levels are experienced downstream of Mamre Road.

It is acknowledged within the Cardno Flood Impact Assessment both the ARR1987 and ARR2019 rainfall data were used. Whilst Cardno have concluded for the minor (1 in 2 yr AEP) event there were minor increases in peak post-developed flows at Mamre Road compared to the pre-developed flows it should be noted Cardno modelling has been undertaken on a concept basin without detailed outflow design of the basin.

Detailed design of the basin using Drains software utilising low and high flow orifice devices (as per Penrith City Council engineering guidelines) have been used for this report which highlight that post - developed flows from the basin do not exceed pre-developed flows for all storm events. Refer to Section 8 of this report for this detailed analysis. As such the basin outlet design undertaken within this report is deemed more detailed than the Cardno model.

11. Services Investigation

Based on an initial desk top study conducted from information obtained from Dial Before You Dig (DBYD) records, the following utility services are located within the vicinity of the Site:

- Potable water – Sydney Water Corporation;
- Electrical – Endeavour Energy; and
- Telecommunications – Telstra only;

No sewer or gas was noted to be located within the vicinity of the Site.

Investigations of the Site were carried out based on:

- Site inspection;
- Dial Before You Dig (DBYD) search;
- Sydney Water Hydra System;
- Penrith City Council Engineering Design Specification;
- LIDAR Survey information; and
- Sydney Water South West Growth Servicing Plan 2017-2022

11.1. Potable Water

11.1.1. Existing Potable Water

Dial Before You Dig (DBYD) indicates the following water services within the area:

- 100mm diameter DICL potable watermain on the eastern side of Mamre Road
- 150mm diameter uPVC potable watermain on the western side of Mamre Road

These assets are supplied from a 200uPVC main approximately 220m north of the site which is current supplied from the Cecil Park reservoir supply zone.

11.1.2. Proposed Potable Water

Significant consultation has been undertaken with Sydney Water regarding potable water servicing strategies for the Broader Western Sydney Employment Area (BWSEA), which includes the wider Mamre Road Precinct and the Site.

Sydney Water and various Water Servicing Coordinators have advised that there are multiple potential potable water servicing strategies for the wider Mamre Road Precinct and the Site, including, though not limited to the following:

1) Connection to, or extension and/or amplification of, the existing assets located within Mamre Road; and/or

2) Rezoning of upstream catchment supply areas to alleviate supply constraints on existing supply zone; and/or

3) Connection to the Cecil Park Reservoir supply zone to the south.

Refer to Sydney Water servicing advice letter within Appendix A.

Interim and permanent potable water supply arrangements for the wider Mamre Road Precinct may need to be considered subject to existing capacity of the network and development staging.

Sydney Water are currently delivering/investigating several upstream augmentation projects which will ultimately boost supply to the existing potable water assets within the Mamre Road precinct.

Sydney Water have stated:

> *"Drinking water services can be provided from Cecil Park Reservoir. We are working to deliver a trunk main along Mamre Road by 2024-25. We will be working with RMS to deliver trunk mains in Mamre Road during road upgrade, subject to funding approval based on risk for development timeframes. Developer delivered precinct trunk mains will also be required to service the precinct.*
>
> *It is important to mention that to fast track Sydney Water services for the Mamre Road Precinct is dependent on DPE formal release advice and subject to Sydney Water's policy on developer accelerated servicing."*

Refer Appendix A – Sydney Water servicing advice

11.2. Sewer

11.2.1. Existing Sewer

Dial Before You Dig (DBYD) and a review of the Sydney Water Hydra System indicates there is no existing sewer infrastructure located at or adjacent to the Site.

11.2.2. Proposed Sewer

Significant consultation has been undertaken with Sydney Water regarding wastewater servicing strategies for the Broader Western Sydney Employment Area (BWSEA) which includes the wider Mamre Road Precinct and the Site.

Sydney Water and various Water Servicing Coordinators have advised that there are multiple potential wastewater servicing strategies for the wider Mamre Road Precinct and the Site, including, though not limited to the following:

1) Connection to the proposed future Sydney Water South Creek Catchment Wastewater Treatment Plant (WWTP), forecast for completion between 2024 – 2026;

2) Connection to the existing St Mary's WWTP network, via either:
    a. Gravity connection along Kemps Creek and ultimately South Creek;
    b. Low pressure rising main connection to existing gravity system.

3) Interim Operating Procedure (IOP)
   Subject to Sydney Water and Consent Authority Approvals, an Interim Operating Procedure (IOP) for the initial stages of the Site may be provided. An IOP would essentially involve a large holding tank constructed at the lower end of the site. The tank would be emptied via pump out truck as required and then be discharged at a Sydney Water approved site.

   Initial site servicing via IOP's is a common infrastructure solution undertaken on larger developments, in anticipation of ultimate solutions, given the lengthy lead-times involved in the planning and construction of the ultimate servicing solution.

   Generally, the IOP would be approved under the Section 68 provisions of the Local Government Act by Penrith City Council.

4) Sydney Water delivered decentralised interim WWTP, to service multiple developments throughout the wider Mamre Road Precinct until permanent connection to Sydney Water infrastructure may be made.

5) Privately delivered decentralised interim WWTP:
   Alternative to Sydney Water wastewater servicing, the Water Industry Competition Act 2006 (WICA) provides key enabling legislation which permits private sector innovation and investment in water and wastewater infrastructure.

   Subject to the Independent Pricing and Regulatory Tribunal (IPART) and Consent Authority approvals, there is an option for a decentralised WWTP to be privately provided and operated by a network operator in advance of the proposed Sydney Water permanent South Creek WWTP and separate to any Sydney Water interim decentralised WWTP's.

Refer to Sydney Water servicing advice letter within Appendix A.

Further to the above it is understood Sydney Water are currently investigating servicing solutions for the wider Mamre Road precinct as part of the broader Aerotropolis servicing strategy.

Servicing strategies subject to Sydney Water, IPART and Consent Authority approvals.

Sydney Water have stated:

> *"Wastewater services to Mamre Road Precinct can be provided temporarily by St Marys STP for up to 4 years, this is based on formal notification of the expected date of connection. Long term potentially we intend to provide wastewater services from will be serviced by the proposed Upper South Creel WRP to be completed by 2025/2026.*

It is important to mention that to fast track Sydney Water services for the Mamre Road Precinct is dependent on DPE formal release advice and subject to Sydney Water's policy on developer accelerated servicing."

Refer Appendix A – Sydney Water servicing advice

11.3. Electrical

11.3.1. Existing Electrical

Recent site inspection indicates that there is an overhead power line (11kV and 240v) on the eastern side of Mamre Road reserve parallel to the boundary. Dial Before You Dig (DBYD) indicates that there are no underground services within the vicinity of the Site.

Existing Zone Substation locations are as follows:

- Kemps Creek Zone Substation: located approximately 6km south of the Site off Elizabeth Drive; and
- Mamre Road Zone Substation: located at the northern end of John Morphett Place, off Lenore Drive, approximately 3km north of the Site (as the crow flies).

11.3.2. Proposed Electrical

Significant consultation has been undertaken with Endeavour Energy regarding electrical servicing strategies for the Broader Western Sydney Employment Area (BWSEA) which includes the wider Mamre Road Precinct and the Site.

The Endeavour Energy 'Western Sydney Priority Growth Area – Area Plan April 2018' indicates the proposed high voltage network to be delivered as part of the wider Endeavour Energy electrical network required to service the Aerotropolis.

With regards to the wider Mamre Road precinct and the Site, Endeavour Energy has advised the following indicative servicing strategy:

- At present Endeavour Energy are investigating the suitability of 22kV reticulation for the Greater Western Sydney Aerotropolis Area which will encompass the Mamre Road Precinct and the Site. Hence, 22kV underground cable and 22kV Padmount Substations will be reticulated for the supply network;
- The South Erskine Zone Substation will be the ultimate point of supply for the Site with cross-feeder/cross-zone ties to Mamre Zone Substation and Kemps Creek Zone Substation;
- South Erskine Park Zone Substation is due to be commissioned in the 3rd quarter of 2022;
- Temporary connection arrangements may be provided from the existing network along Mamre
- Road from Kemps Creek Zone Substation or Mamre Zone Substation depending on feeder loads at the time.

As part of the Mirvac AIE design development, Mirvac has engaged an Accredited Service Provider Level 3 (ASP3) and has formally made formal subdivision and connection of load applications to Endeavour Energy for provision of an electricity network for AIE with Design Briefs received from Endeavour Energy for these applications.

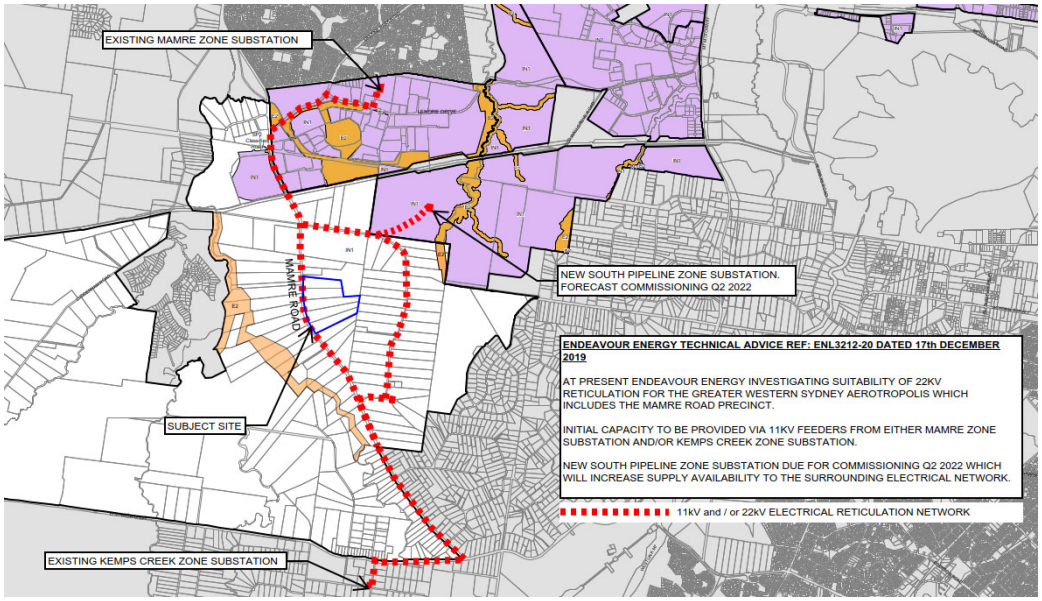


Figure 8 - Electrical Servicing Route

11.4. Telecommunications

Dial Before You Dig (DBYD) indicates that Telstra below ground conduits are located within the Mamre Road Reserve parallel to the boundary.

Site inspection has identified there are aboveground assets along the western side of Mamre Road.

It is expected connection could be made from the existing infrastructure located within Mamre Road. Subject to the requirements of the relevant telecommunications authority, new pit and pipe may need to be installed from Erskine Park Road to the Site.

11.5. Gas

There are no existing Jemena gas mains located within the vicinity of the Site. No contact has been made with Jemena to determine if there are plans to service the area in future.

11.6. Conclusion

This section demonstrates that services including wastewater, potable water, power, telecommunications and gas can be made available to the site.

Internal reticulation will be coordination at the detailed design stage of works with formal applications made to the relevant service authorities.

12. Infrastructure Staging

12.1. Staging

It is assumed that the earthworks and infrastructure required for the development will be constructed over three (3) stages.

Description of the indicative earthworks and infrastructure staging and potential funding arrangements are outlined below within Table 13.

Final staging will be subject to authority approvals, construction contractor staging requirements and may occur concurrently with other stages. Indicative target programme shown below is subject to change, authority approvals, construction staging, inclement weather and availability of import fill materials.

Stage	Description	Indicative Target Programme
Stage 1	• Mamre Road signalised intersection, associated Road No.1 and 2 construction works and temporary cul-de-sac as required as per AIE SSD Stage 1 work plan; • Watercourse realignment and landscaping • Bulk earthworks: Cut to fill operations on southern lots 54-58 (inclusive) DP259135; • Detailed earthworks: Warehouse 1 and 3; • Southern boundary retaining wall; • Lead-in services including power, telecommunications, gas, wastewater and potable water; • Stormwater drainage including upstream catchment diversions and construction of precinct basin; • Boundary and road landscaping; • Internal services including power, telecommunications, gas, wastewater and potable water • Sediment and Erosion control.	**Commencement:** Start 2021 **Duration**: 12 months **Completion**: End 2021

Stage 2	• Road No.1 residual construction works;
	• Road No.3 (south) construction works;
	• Road No. 3 (north) construction works (subject to adjoining development approvals)
	• Bulk earthworks:
	  ○ Cut and haul from lots 54-56 (inclusive) to lots 57-58;
	  ○ Fill import works to lots 57-58;
	• Detailed earthworks: Warehouses 1 and 2;
		Commencement: End 2021
		
		Duration: 12 months
		
		Completion: End 2022

	• Eastern boundary retaining wall; • Watercourse realignment; • Precinct basin; • Internal services including power, telecommunications, gas, wastewater and potable water; • Stormwater drainage including temporary upstream catchment diversions; • Boundary and road landscaping; • Sediment and Erosion control.	
Stage 3	• Road No.4 construction works • Internal services including power, telecommunications, gas, wastewater and potable water; • Stormwater drainage including upstream catchment diversions; • Boundary and road landscaping • Sediment and Erosion control.	**Commencement:** End 2021 **Duration**: 6 months **Completion**: Mid 2022

Table 13 – Indicative Infrastructure Staging

12.2. Funding arrangements

The assumed funding arrangement for infrastructure are as follows:

- **Mamre Road Signalised Intersection:** Potential to be delivered as Works in Kind. Subject to authority approvals.
- **Lead-in services:** Proponent funded with potential reimbursements subject to relevant authority approvals and procurement processes.
- **Internal works:** Proponent funded.

All funding arrangements subject to authority approvals.

APPENDIX A – Sydney Water Servicing Advice

17 June 2019

Russell Hogan
Development Manager, Mirvac
Level 28, 200 George Street
Sydney, NSW 2000

RE: Sydney Water servicing – proposed Mamre Road SEPP WSEA amendment.

Thank you for meeting with Sydney Water to discuss servicing options for the Mamre Road Precinct and Mirvac's proposal for SEPP WSEA amendment.

Sydney Water is progressing with planning services for the Mamre Road Precinct by 2026 based on current growth forecast and timeframes provided by the Department of Planning and Environment (DPE). This includes the following:

- **Wastewater** services to Mamre Road Precinct can be provided temporarily by St Marys STP for up to 4years, this is based on formal notification of the expected date of connection. Long-term potentially we intend to provide wastewater services from will be serviced by the proposed Upper South Creek WRP to be completed by 2025/26.

- **Drinking water** services can be provided from Cecil Park Reservoir. We are working to deliver a trunk main along Mamre Road by 2024-25. We will be working with RMS to deliver trunk mains in Mamre Road during road upgrade, subject to funding approval based on risk for development timeframes. Developer delivered precinct trunk mains will also be required to service the precinct.

- **Recycled water** services are being investigated for the whole of the Western Sydney Aerotropolis Growth Area (WSAGA) including this Precinct. We are seeking information on potential recycled water demands, types of use and will provide further advice later in the year. Consideration should be given to incorporating third pipe reticulation and recycled water plumbing connections during your planning stages.

- **Stormwater** – Sydney Water is collaborating with the Western Sydney Planning Partnership Office (PPO), member Councils and agencies on typologies, flood and waterway health models for the whole South Creek Catchment, to inform WSAGA LUIIP 2 and the WSAGA Precinct Plans. Consideration should be given to better use, manage flooding and stormwater quality runoff.

It is important to mention that to fast track Sydney Water services for the Mamre Road Precinct is dependent on DPE formal release advice and subject to Sydney Water's policy on developer accelerated servicing.

Sydney Water is committed to servicing Western Sydney and we are working closely with the Western Sydney Planning Partnership Office in delivering collaborative community outcomes. Please feel free to contact me at any time.

Yours sincerely

Fernando Ortega
Account Manager for the Western Sydney Planning Partnership
Liveable City Solutions
Sydney Water
0407 702 994

APPENDIX B – Endeavour Energy Servicing Advice

Russell Hogan

From: Jason Lu <Jason.Lu@endeavourenergy.com.au>
Sent: Wednesday, 5 June 2019 6:34 PM
To: Russell Hogan; Deepak Sahay
Cc: David Ruston; Richard Seddon; Joseph Degabriele
Subject: RE: Commercial in Confidence - WSEA SEPP Amendment: Mamre Road Precinct

Russell

Thank you for consulting with us on the Mamre Rd Precinct.

Endeavour's view is that this precinct is a natural progression for existing industrial areas such Erskine Park and Oakdale South/West.
We are generally supportive of your proposal.

I note in your diagram you have reference our ENL response in January that initial supply may be available from a combination of sources.

Our ability to service this precinct is dependent on the establishment of the proposed South Erskine Park zone substation located in the Oakdale West Precinct.
Planning is advanced for this project and we exchanged contracts for the property for our substation earlier this year.
We anticipate completion of this substation in approximately 3-4 years.

There is limited capacity available from other sources such as Mamre and Kemps Creek ZS when considering other applications for connection received.
This includes your development along Elizabeth Drive which will be supplied from Kemps Creek ZS.

Thanks

Jason Lu
Capacity Planning Manager
Asset Strategy and Planning

T 61 2 9853 5003
M 0403 604 607

51 Huntingwood Drive
Huntingwood NSW 2148
jason.lu@endeavourenergy.com.au

As per provided development timeframe, the load schedule is determined as follows:

Year	Lots	Estimated Load (kVA)	Acuminated load (kVA)
2021	9,10 and 11	1,004	1,004
2022	4 and 5	1,155	2,159
2023	1, 2 and 3	863	3,022
2024	6,7 and 8	1,386	4408

Supply Arrangements

At present Endeavour Energy is investigating the suitability of 22kV reticulation for the Greater Western Sydney Aerotropolis Area which will encompass all three Mirvac precincts including ENL3179 Elizabeth Drive + ENL3212 Mamre Road + ENL3197 Aldington Road, hence 22kV underground cable and 22kV Padmount Substations (PM subs) will be reticulated for the supply network.

The PM subs will either initially be installed with 11kV transformers and 22kV switchgear then converted by Endeavour Energy later or 11/22kV auto-transformers and 22kV PM subs installed up front.

Preliminary load analysis determines that it is required to install one distribution feeder and appropriate cross feeder ties for backup, also an estimated 12 x PM subs on appropriated properties will be required throughout the estate to supply the warehouses

South Erskine Park ZS is due to be commissioned in the 2nd quarter of 2022. If Warehouses 9, 10 and 11 proceed in the 2nd quarter of 2021 with expected load of 1,004kVA then temporary arrangements will be made to supply from the existing network along Mamre Road from Kemps Creek ZS or Mamre ZS depending on feeder loads at the time.

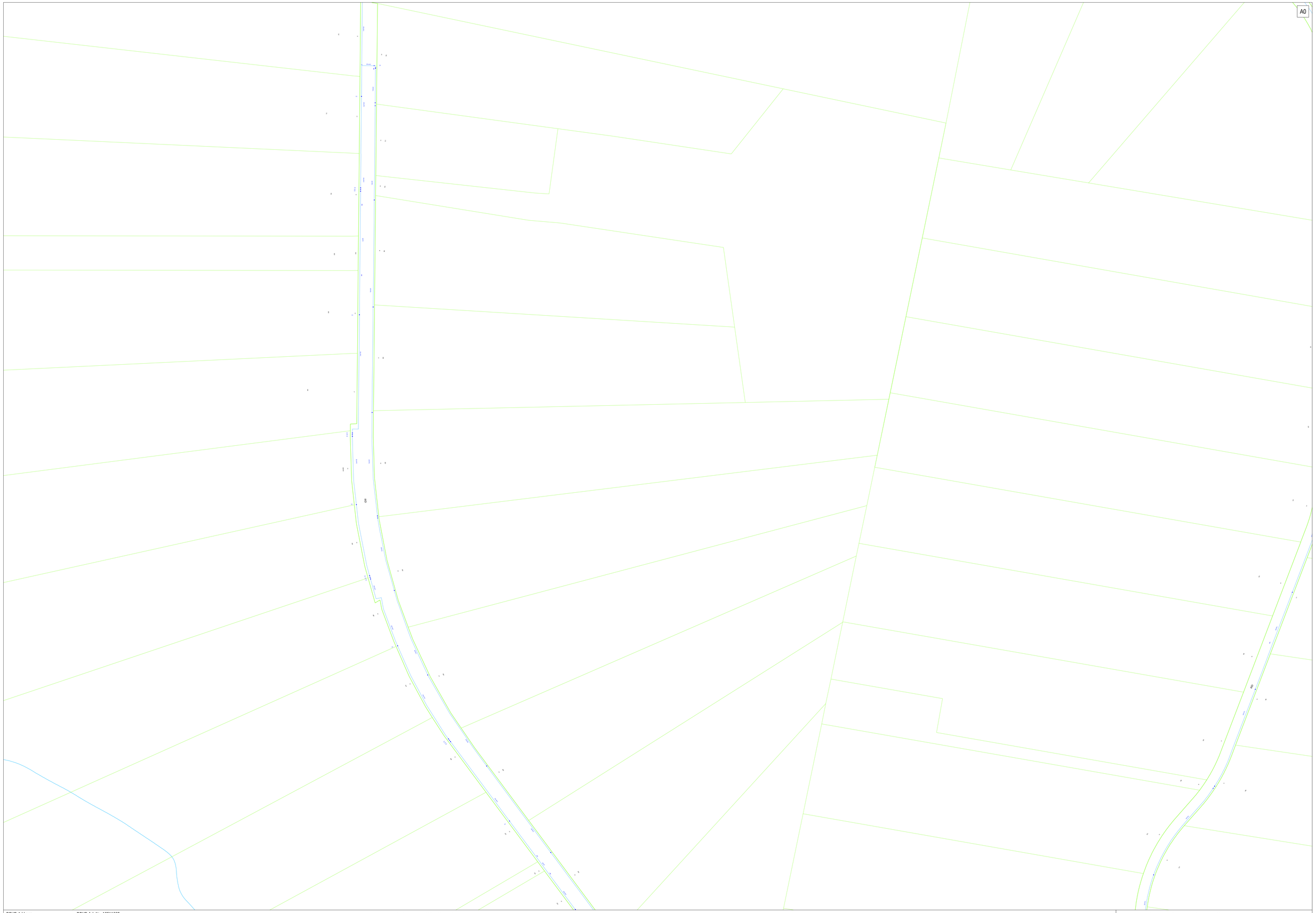
If a 22kV area is declared then ENL3212 may require 2 x 3MVA Auto-Transformers at the entry point of the estate with one at Warehouse 1 and another at Warehouse 9 adjacent to their respective PM subs.

Two 22kV cables will be required to ENL3212 and one 22kV cable reticulated throughout the estate – an additional cross feeder tie may be specified midway within the estate.

The proposed South Erskine Park ZS will be the point of supply for ENL3212 with cross-feeder / cross-zone ties to Mamre ZS and Kemps Creek ZS.

Method of supply shall refer to the following sketch as shown on the next page for reference.

APPENDIX C – Dial Before You Dig Records



DBYD Address:
n/a Mamre Road
kemps cree NSW 2178

DBYD Job No: 18511662

DBYD Sequence No: 91784724

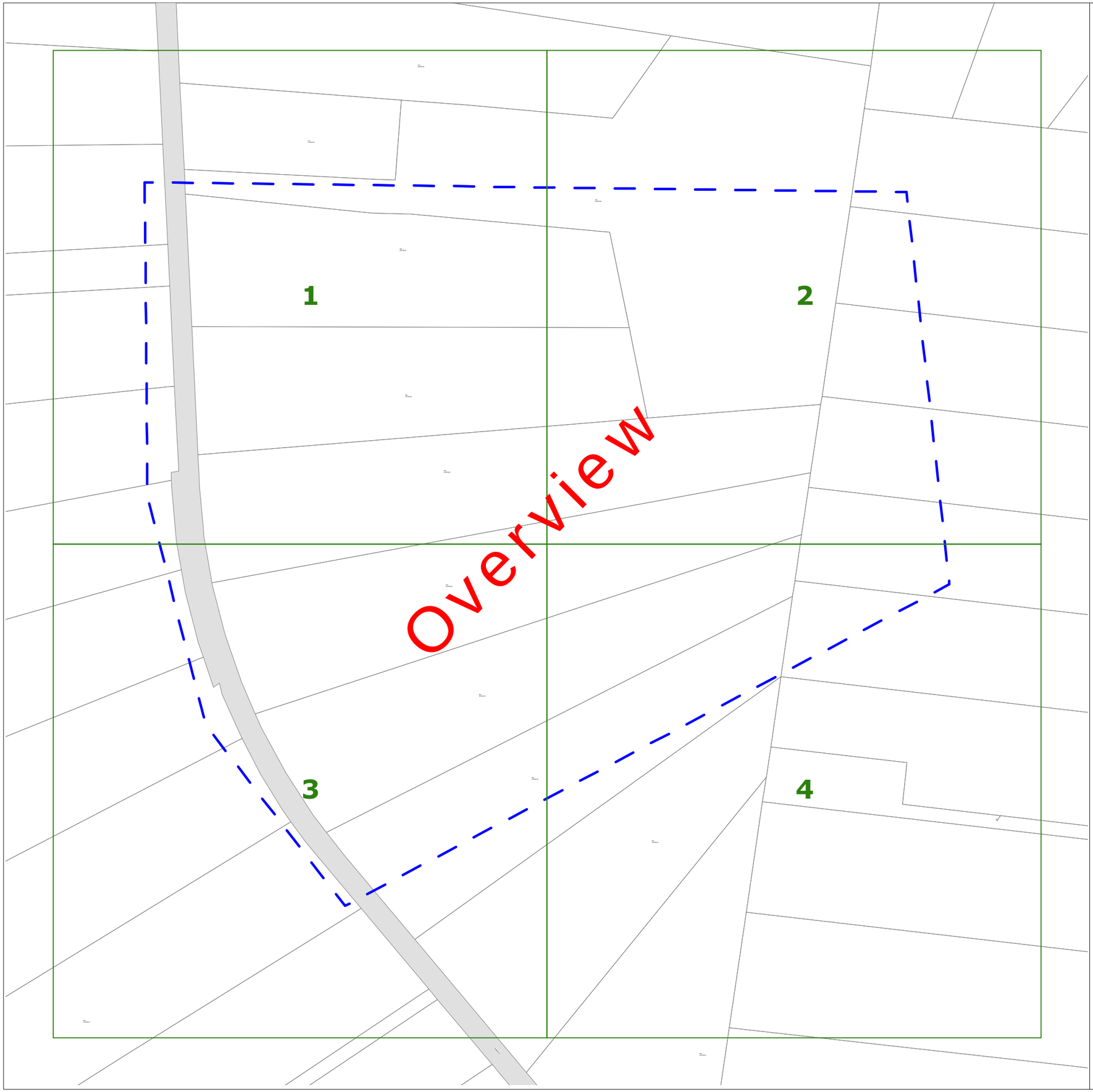
SYDNEY WATER CORPORATION

No warranty is given that the information shown is complete or accurate.

Scale: 1:2000

Date of Production: 05/11/2019 10:14:38

0m 40m 80m 120m 160m



Endeavour Energy

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LEGEND

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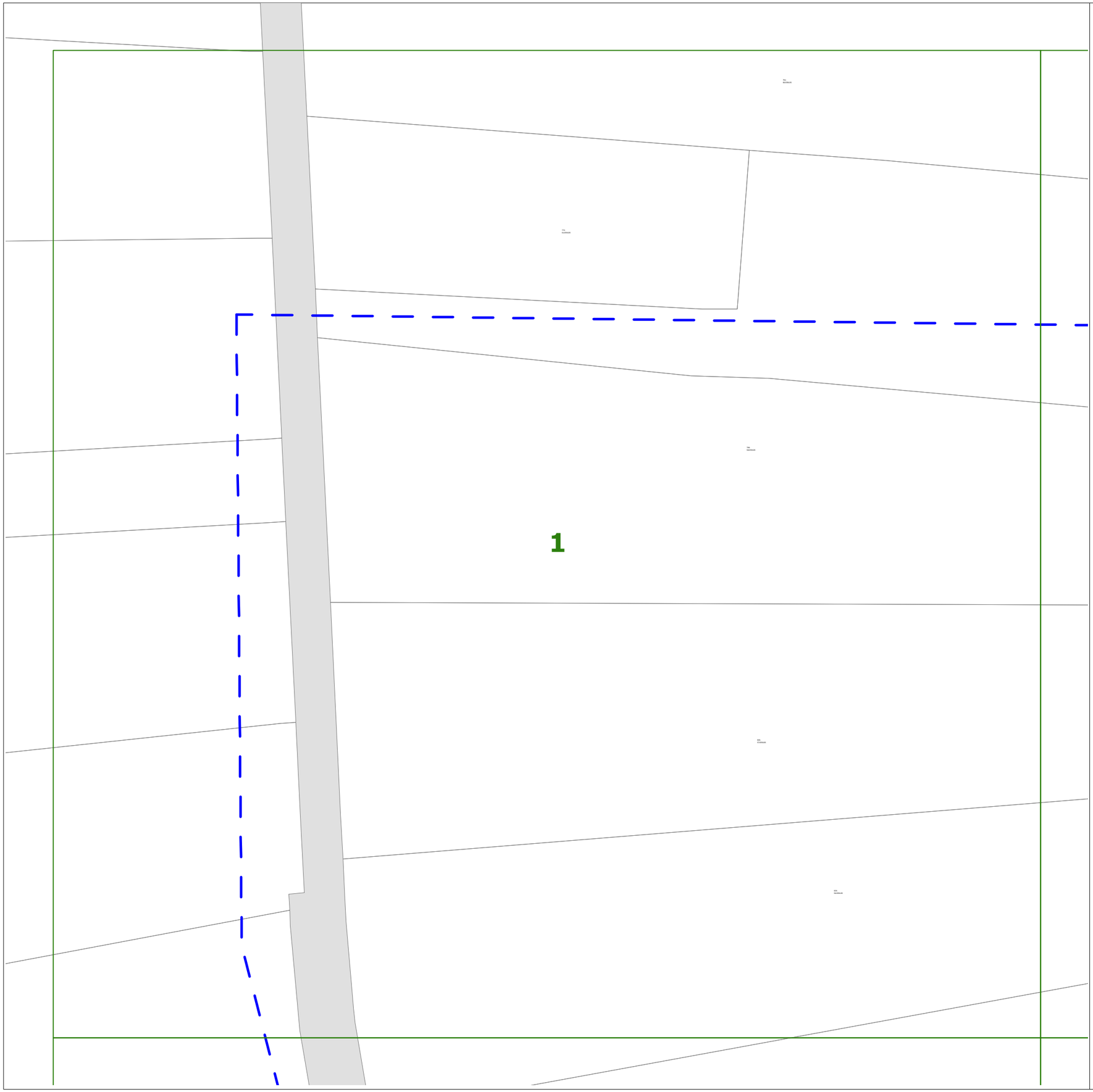
- or — Overground pillar (O.G.Box)
- Underground pit
- Duct run
- Cable run
- Typical duct section
- Asbestos warning

N

NOT TO SCALE

DBYD Sequence No.:	91784721
Issued Date:	05/11/2019



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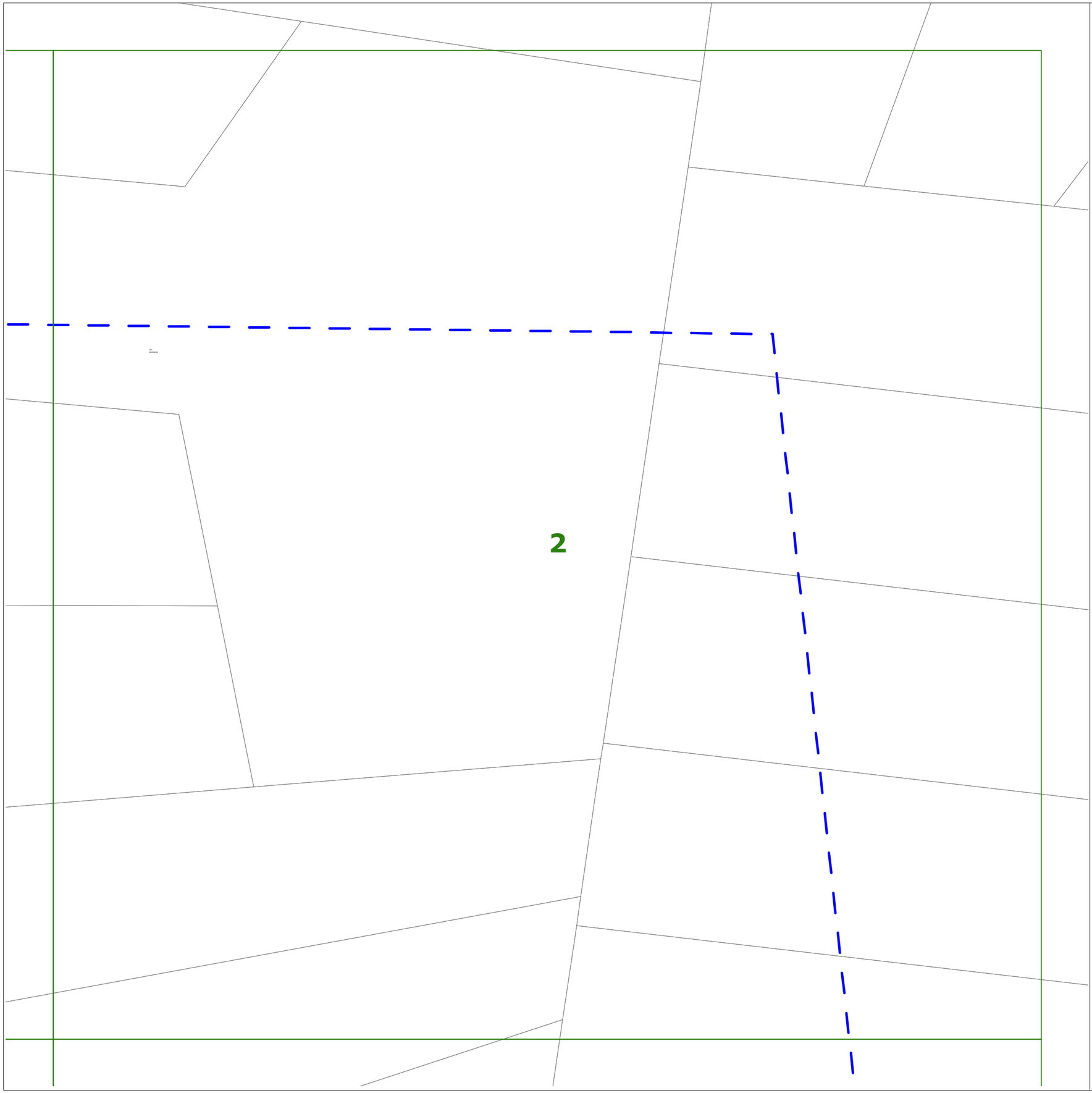

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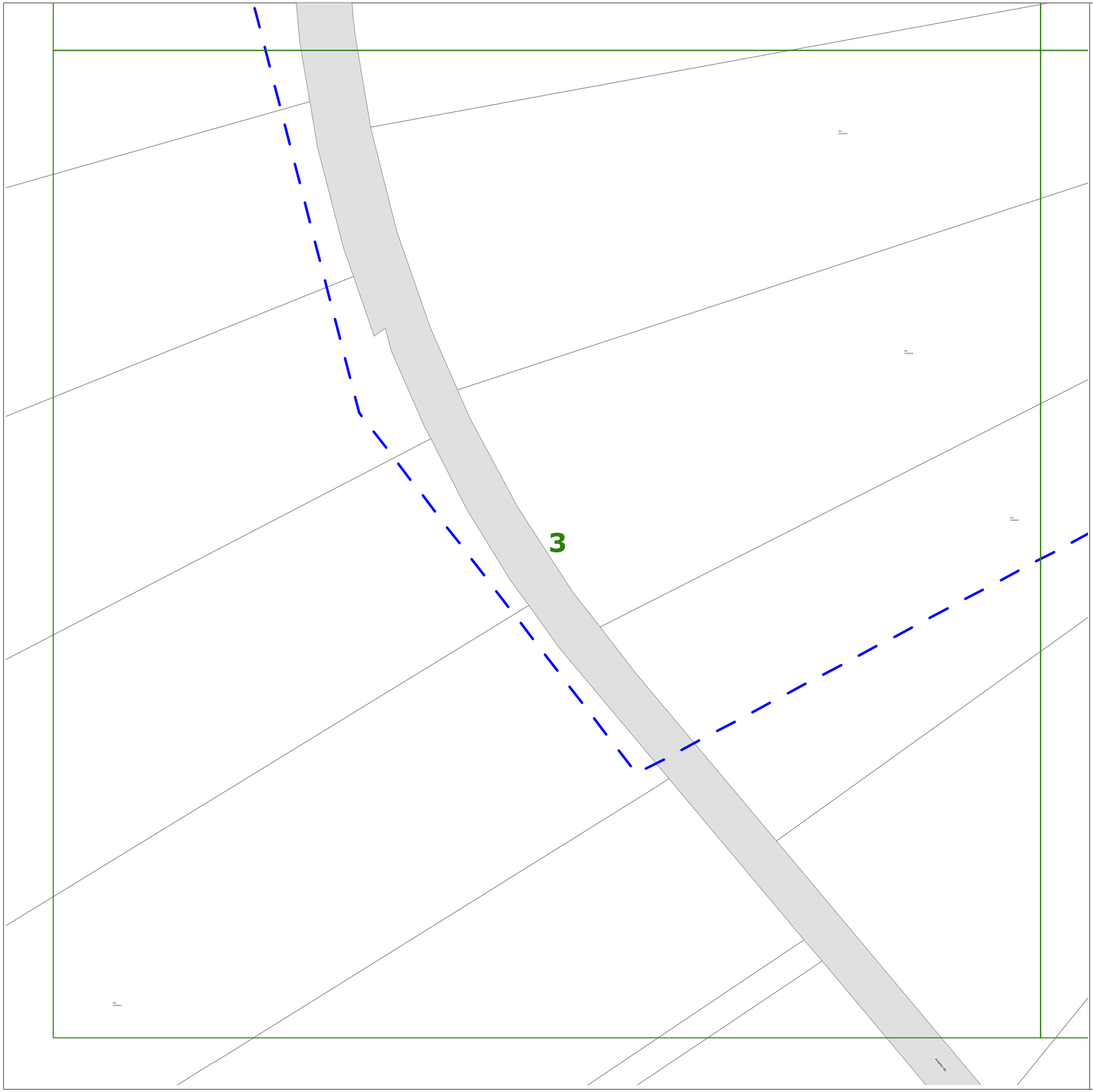

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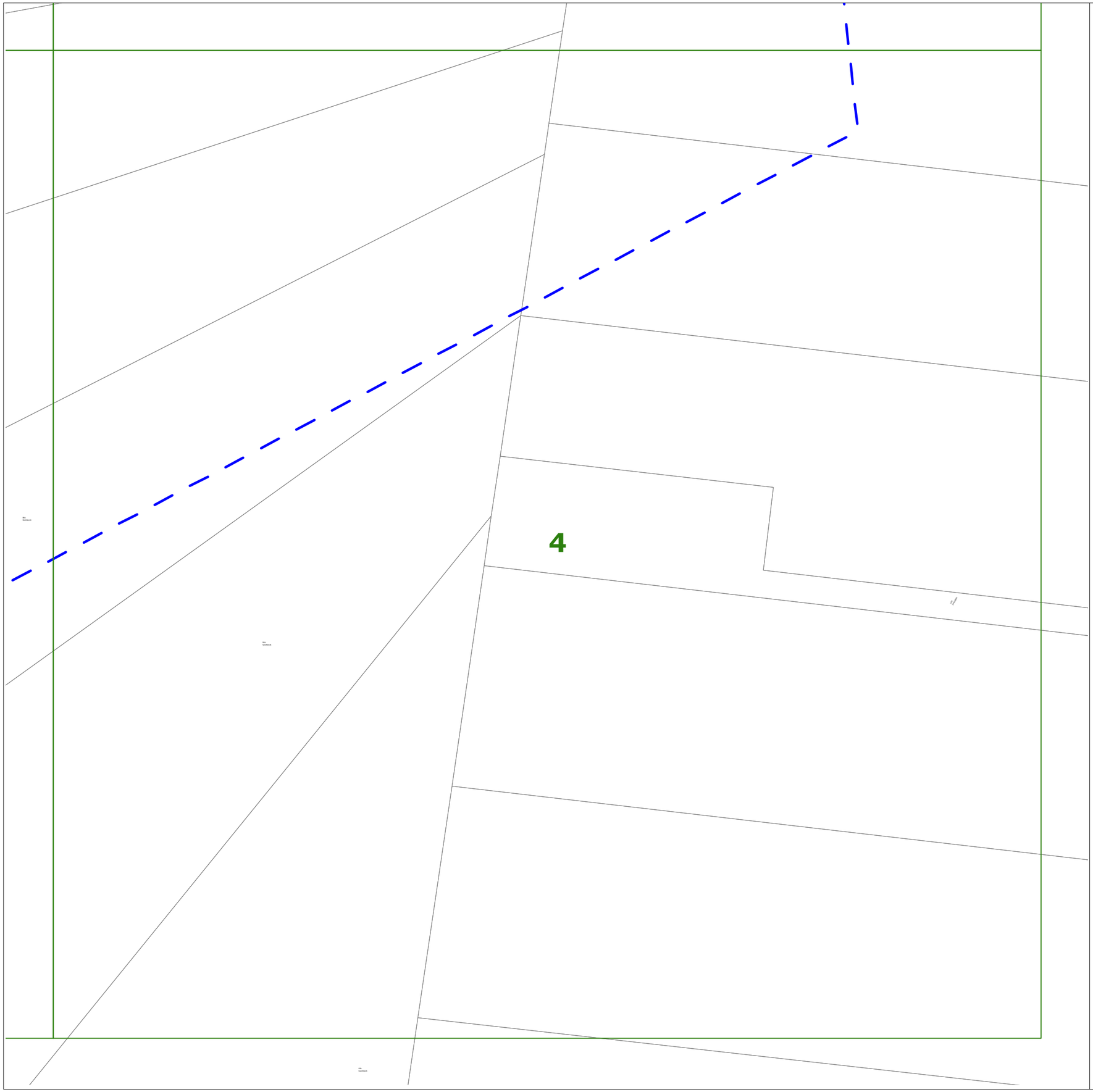

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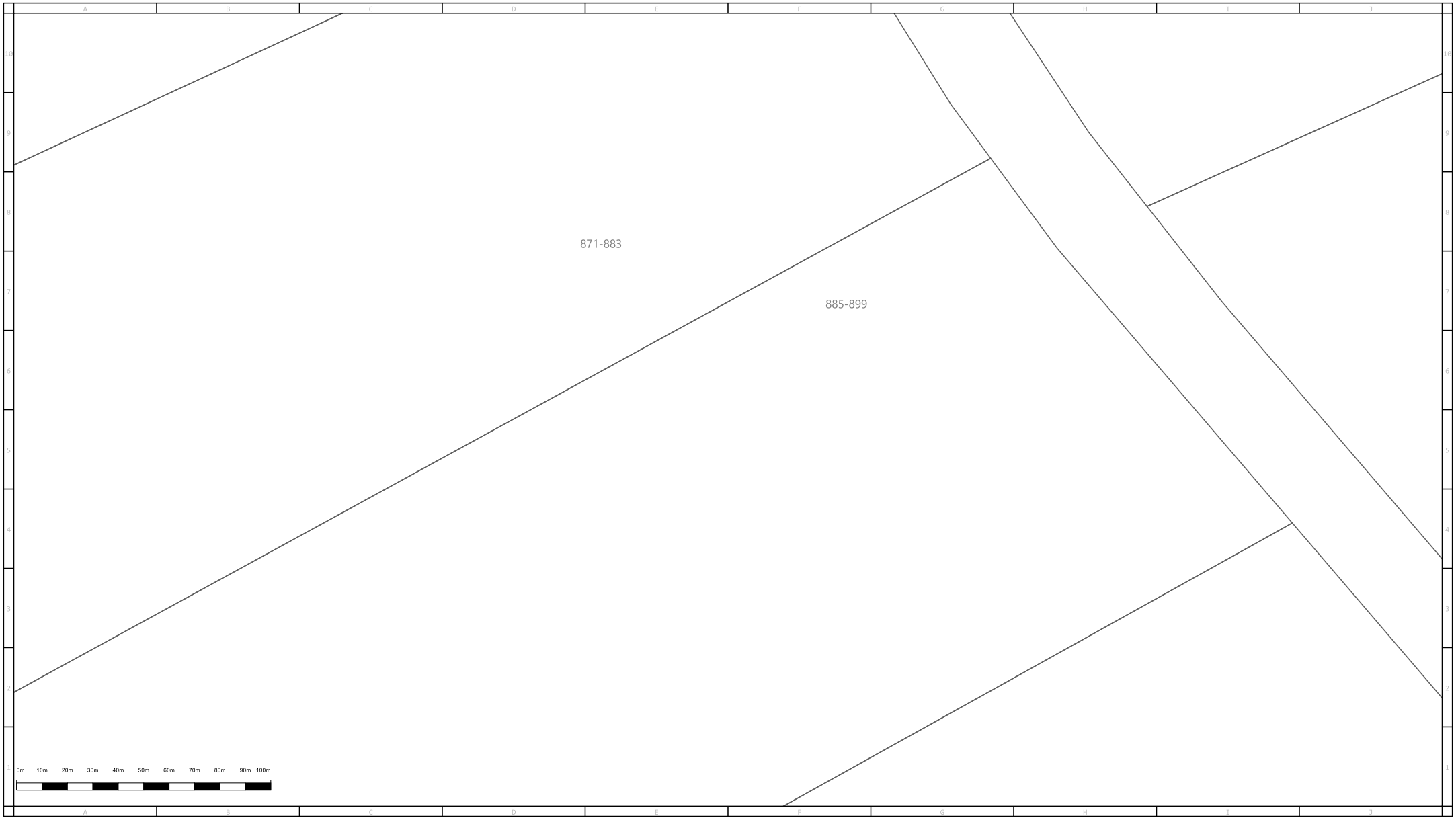
DBYD Authority: Jemena Gas Networks (NSW)

DBYD Location: Mamre Road kemps cree NSW, 2178



Jemena
ABN 87 003 004 322

Main	In Service	Proposed
Unknown Pressure		
Distribution - 2 kPa		
Distribution - 7 kPa		
Distribution - 30 kPa		
Distribution - 100 kPa		
Distribution - 210 kPa		

Main	In Service	Proposed
Distribution - 300 kPa		
Distribution - 400 kPa		
Proposed Isolate (coloured according to kPa)		
Conduit or Casing (*Size & Material*)	*100 PVC*	

High Pressure Main & Pipeline	In Service	Proposed
Critical Main Treat as High Pressure Main		
Secondary - 1050 kPa		
Secondary Service		
Primary - 3500 kPa		
JGN Trunk - 7000 kPa		
Transmission		

Fittings, Valves & Regulators			
Siphon		Regulator Set	
Valve		Regulator Station	
Distance in metres of Main from Boundary Line	~ 1.5		
MBK = Metres Back of Kerb		Automatic Line Break Valve	
MFL = Metres from Fence Line			

N W E S

Scale: 1:2000

Issue Date: 05/11/2019

DBYD Seq No: 91784723

DBYD Job No: 18511662

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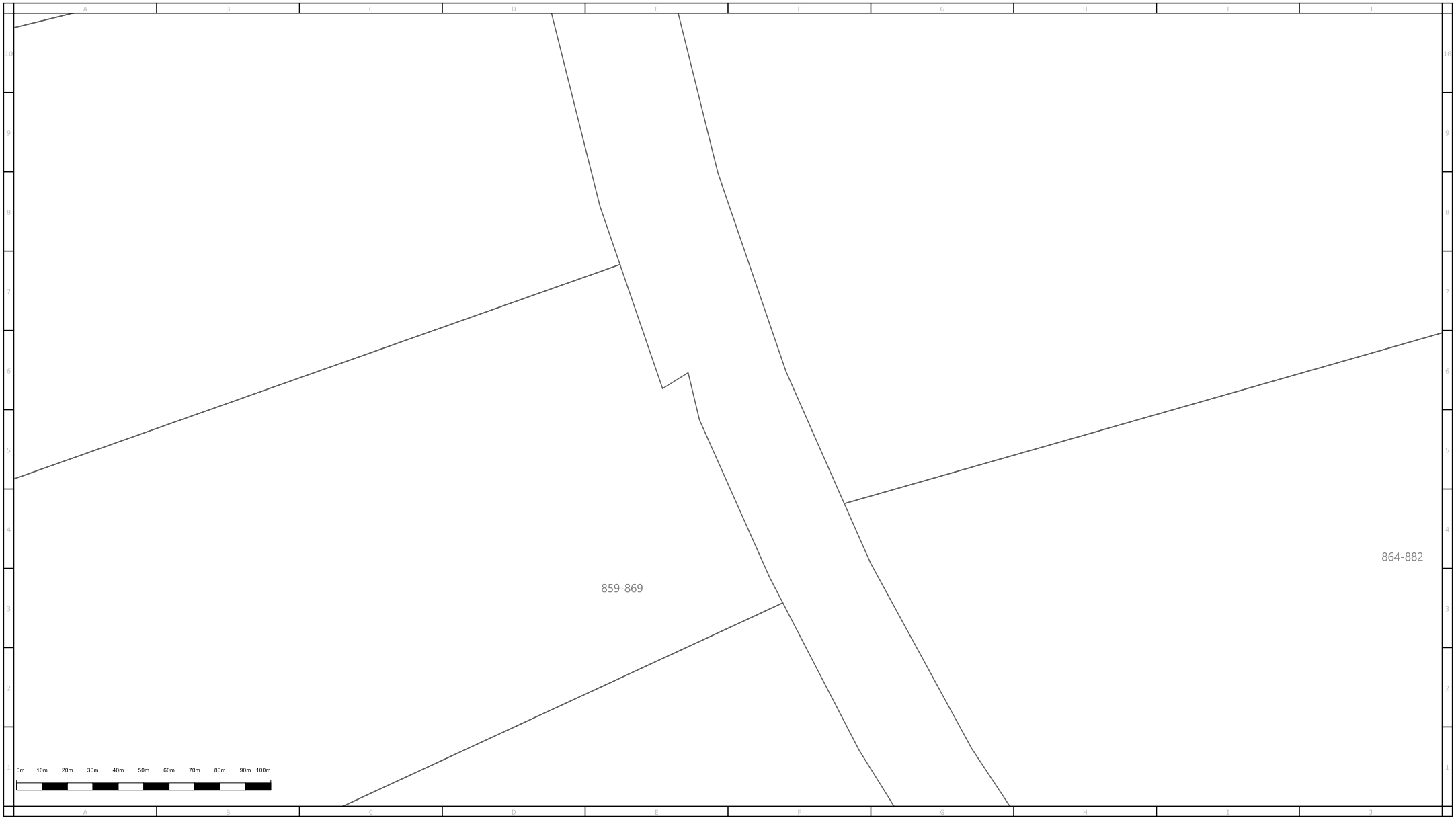

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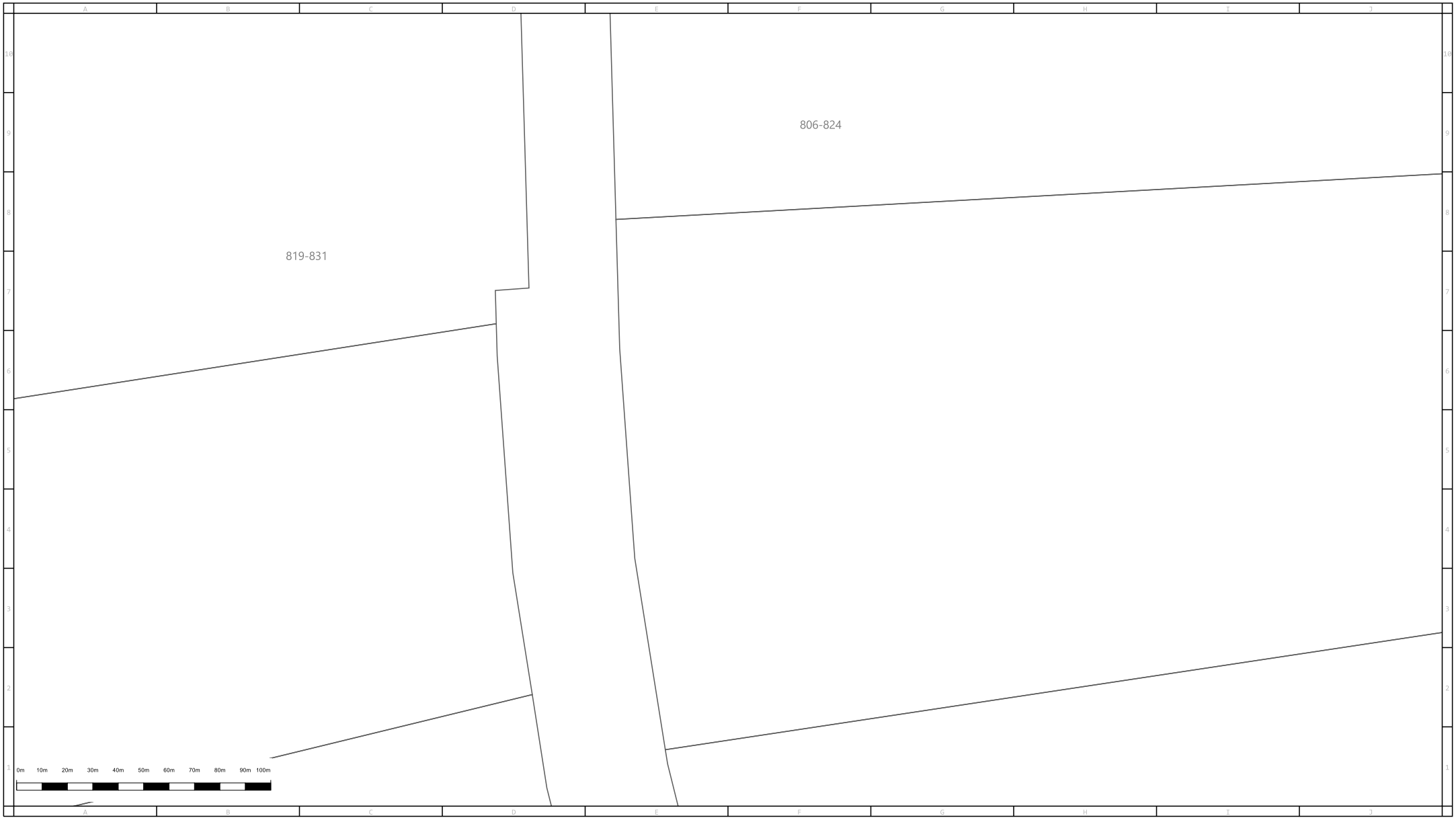

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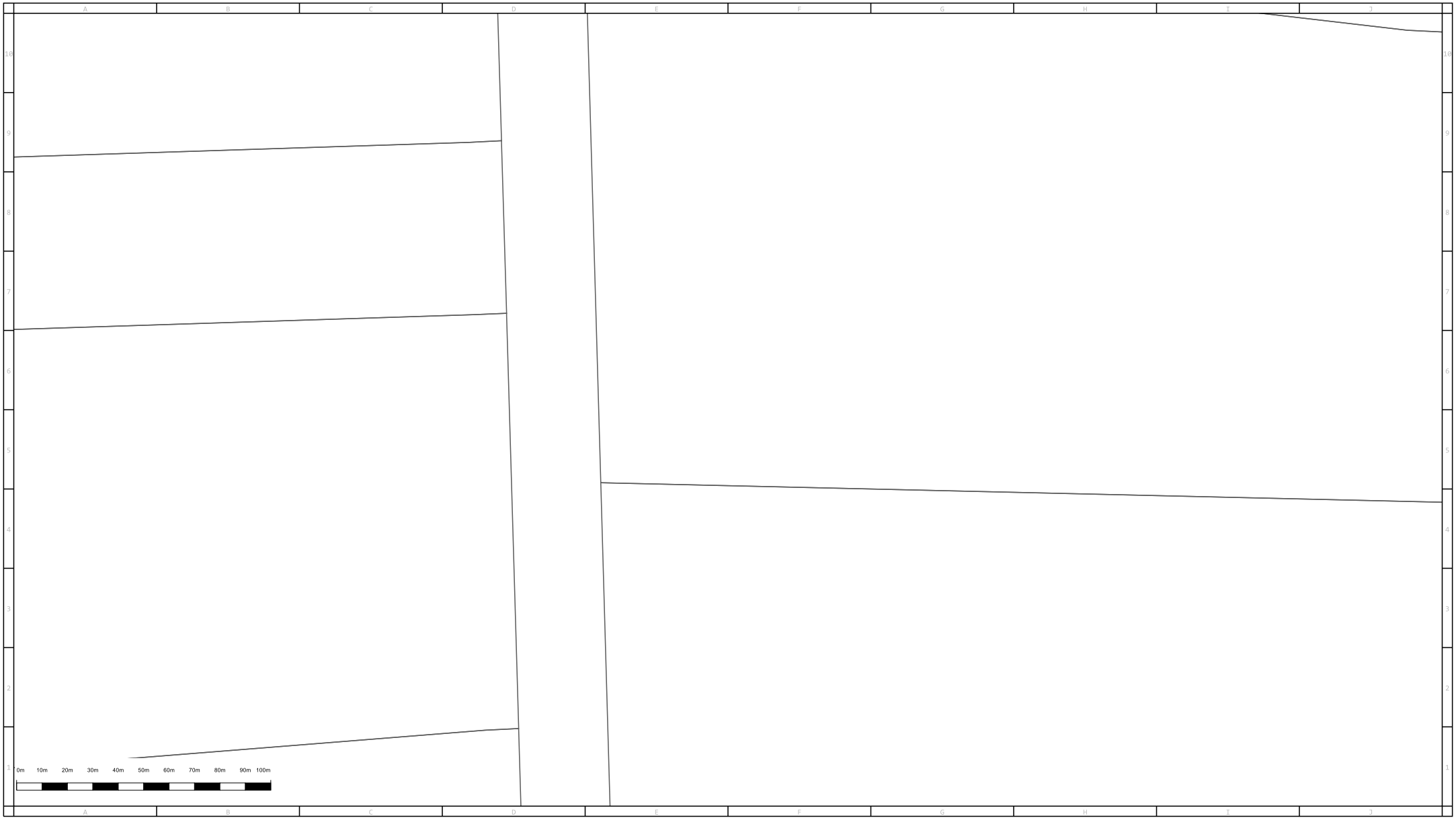

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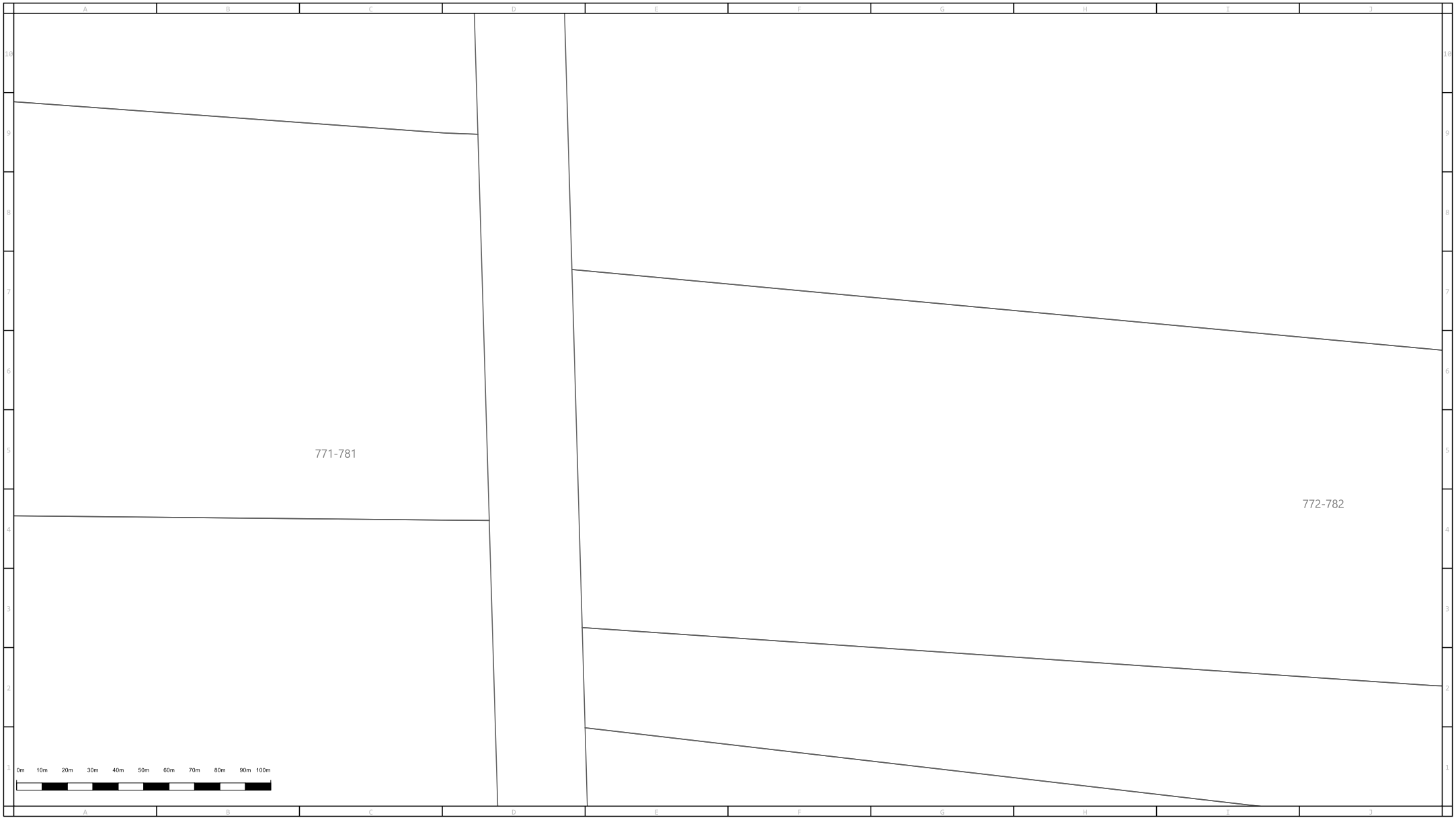

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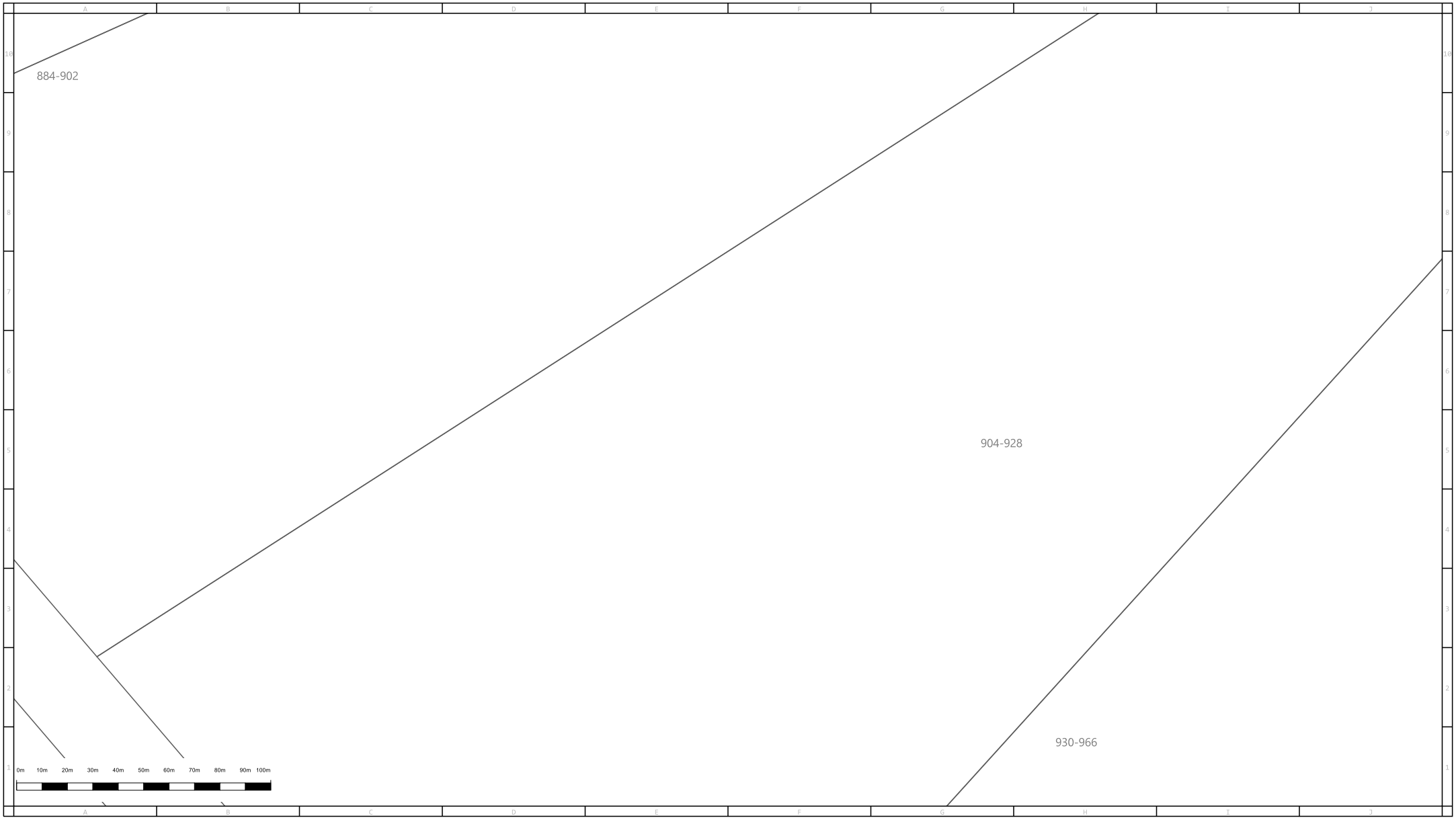

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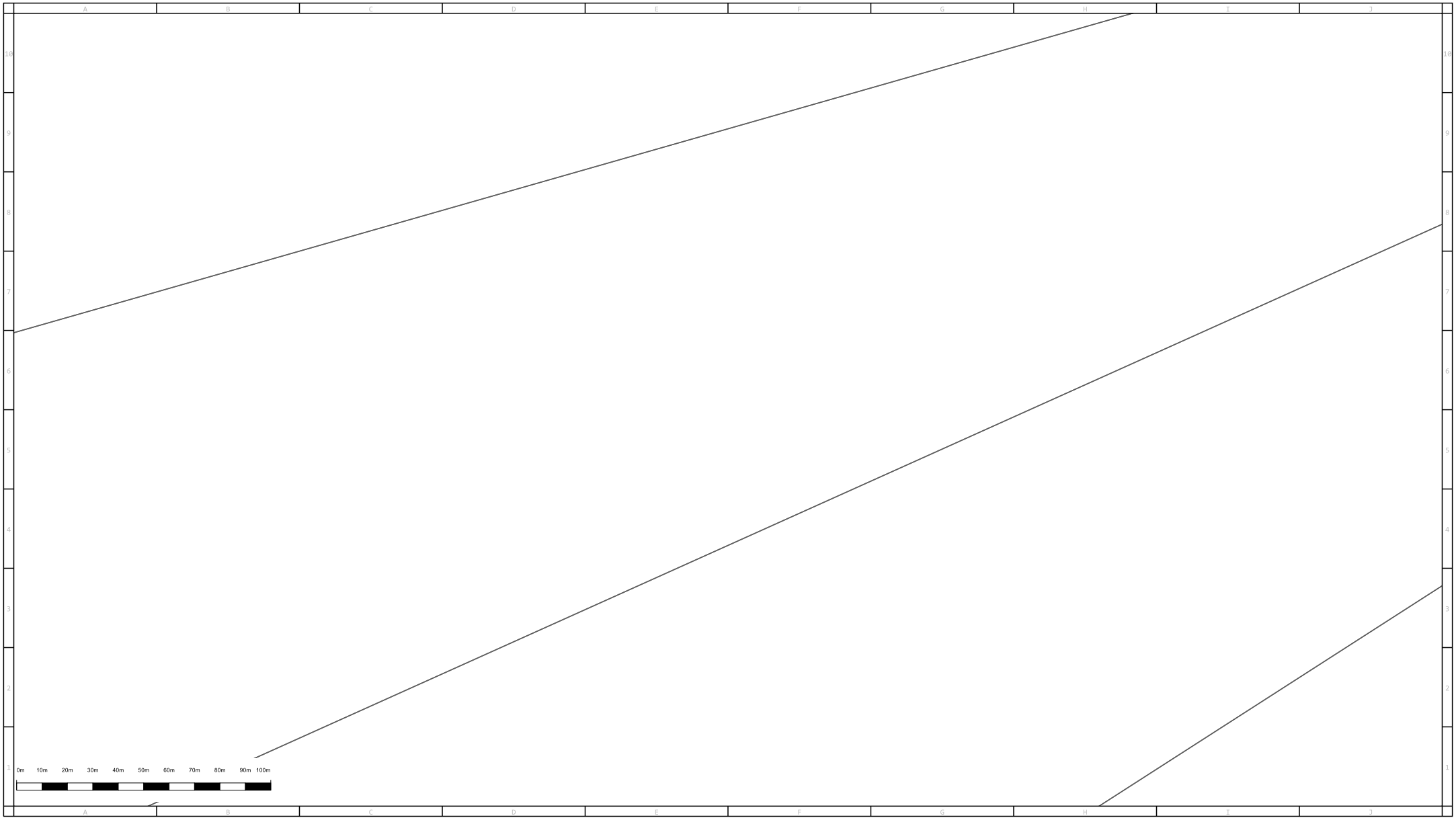

Jemena
ABN 87 003 004 322

Main	In Service	Proposed
Unknown Pressure		
Distribution - 2 kPa		
Distribution - 7 kPa		
Distribution - 30 kPa		
Distribution - 100 kPa		
Distribution - 210 kPa		

Main	In Service	Proposed
Distribution - 300 kPa		
Distribution - 400 kPa		
Proposed Isolate (coloured according to kPa)		
Conduit or Casing (*Size & Material*)	*100 PVC*	

High Pressure Main & Pipeline	In Service	Proposed
Critical Main Treat as High Pressure Main		
Secondary - 1050 kPa		
Secondary Service		
Primary - 3500 kPa		
JGN Trunk - 7000 kPa		
Transmission		

Fittings, Valves & Regulators			
Siphon		Regulator Set	
Valve		Regulator Station	
Distance in metres of Main from Boundary Line	~ 1.5	Automatic Line Break Valve	
MBK = Metres Back of Kerb			
MFL = Metres from Fence Line			

N W E S

Scale: 1:2000

Issue Date: 05/11/2019

DBYD Seq No: 91784723

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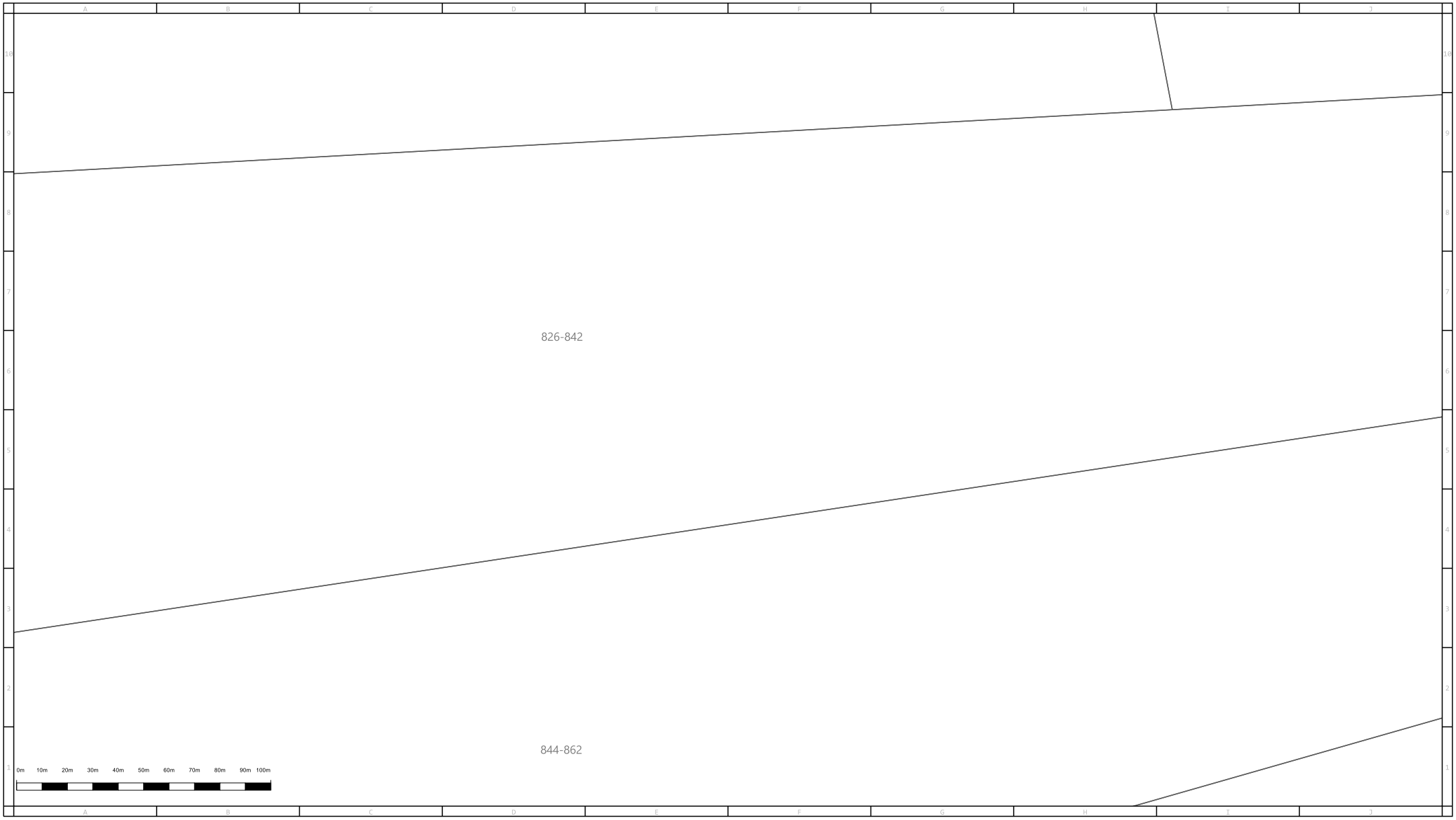

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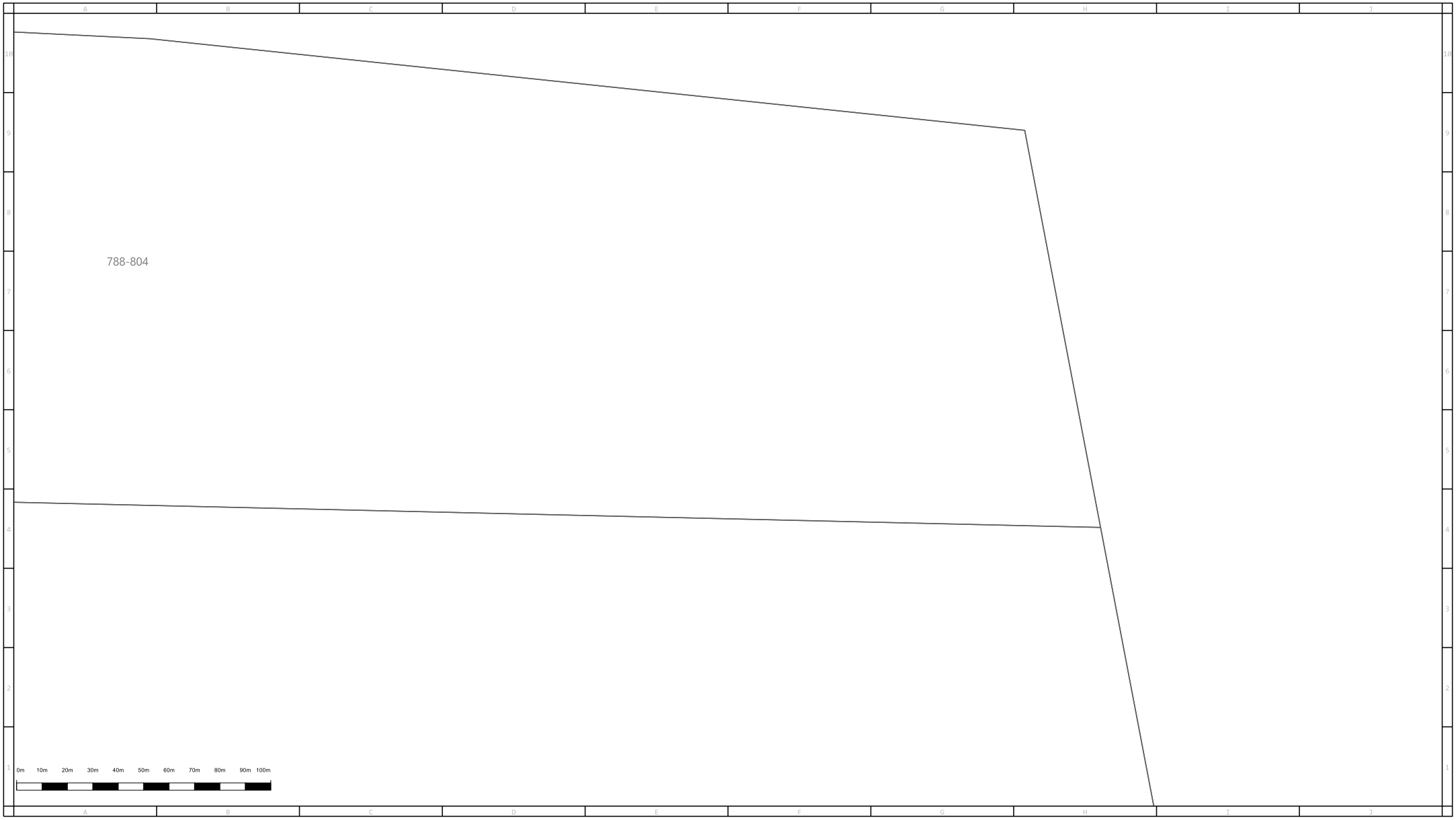

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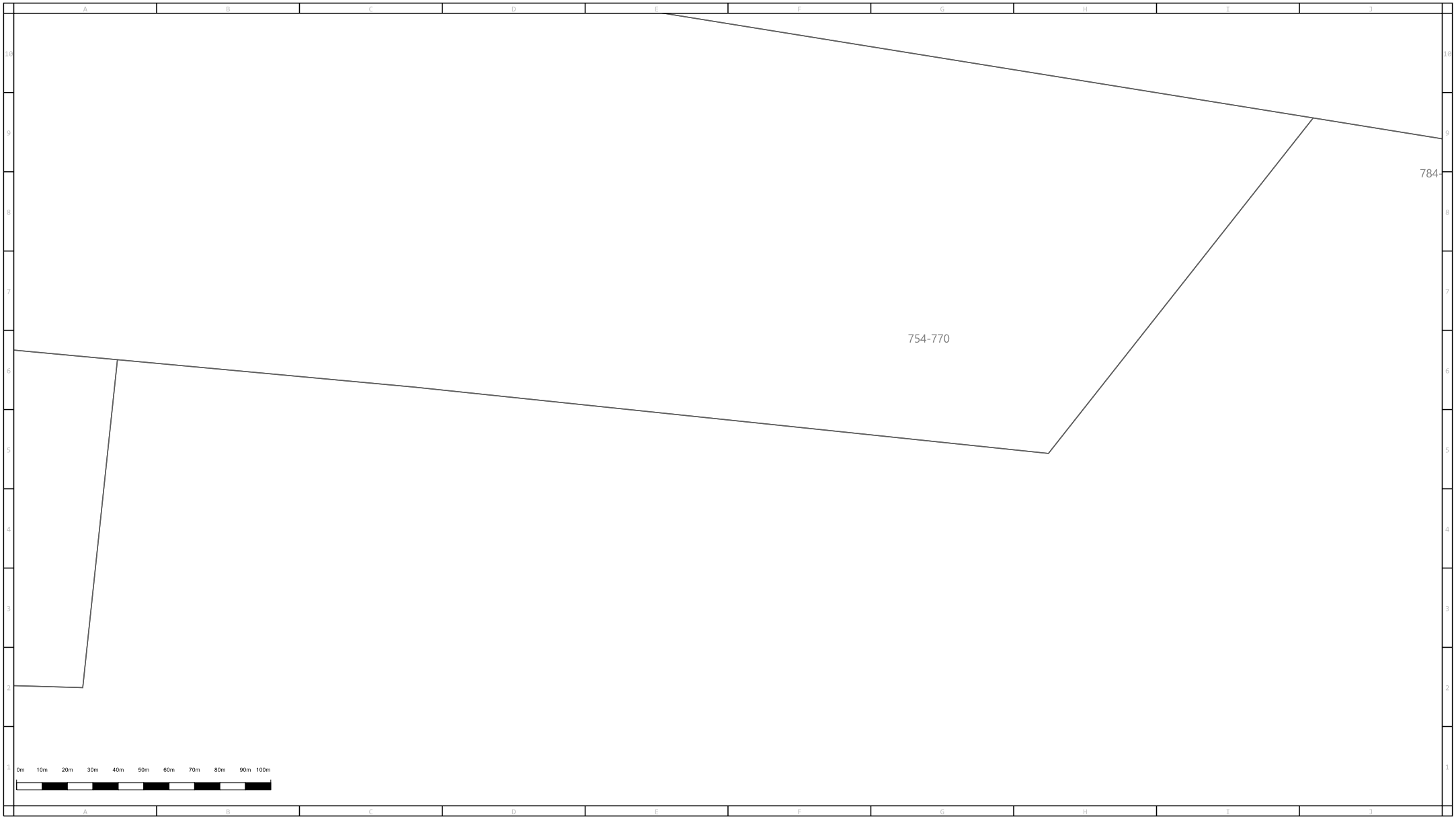

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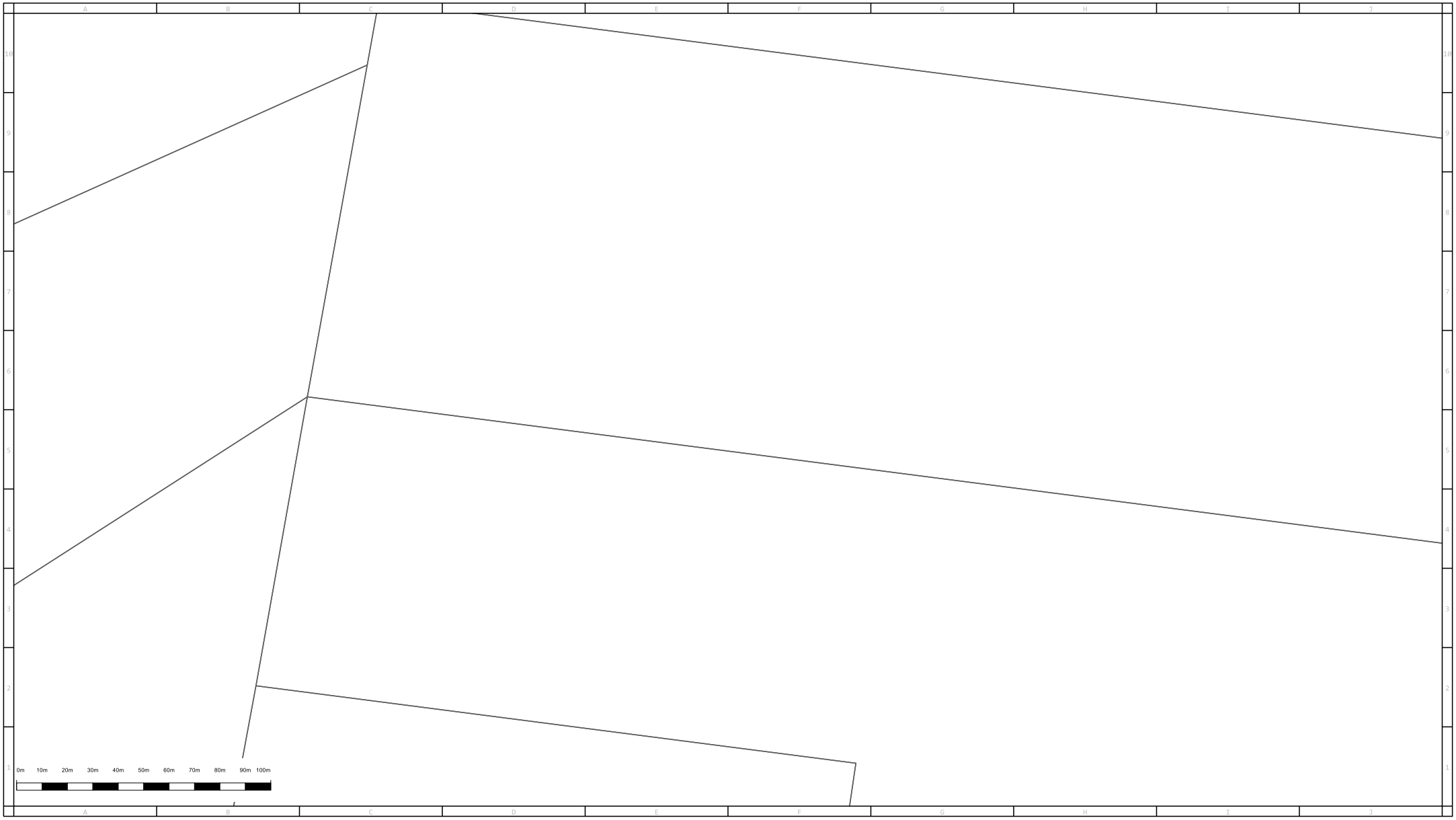

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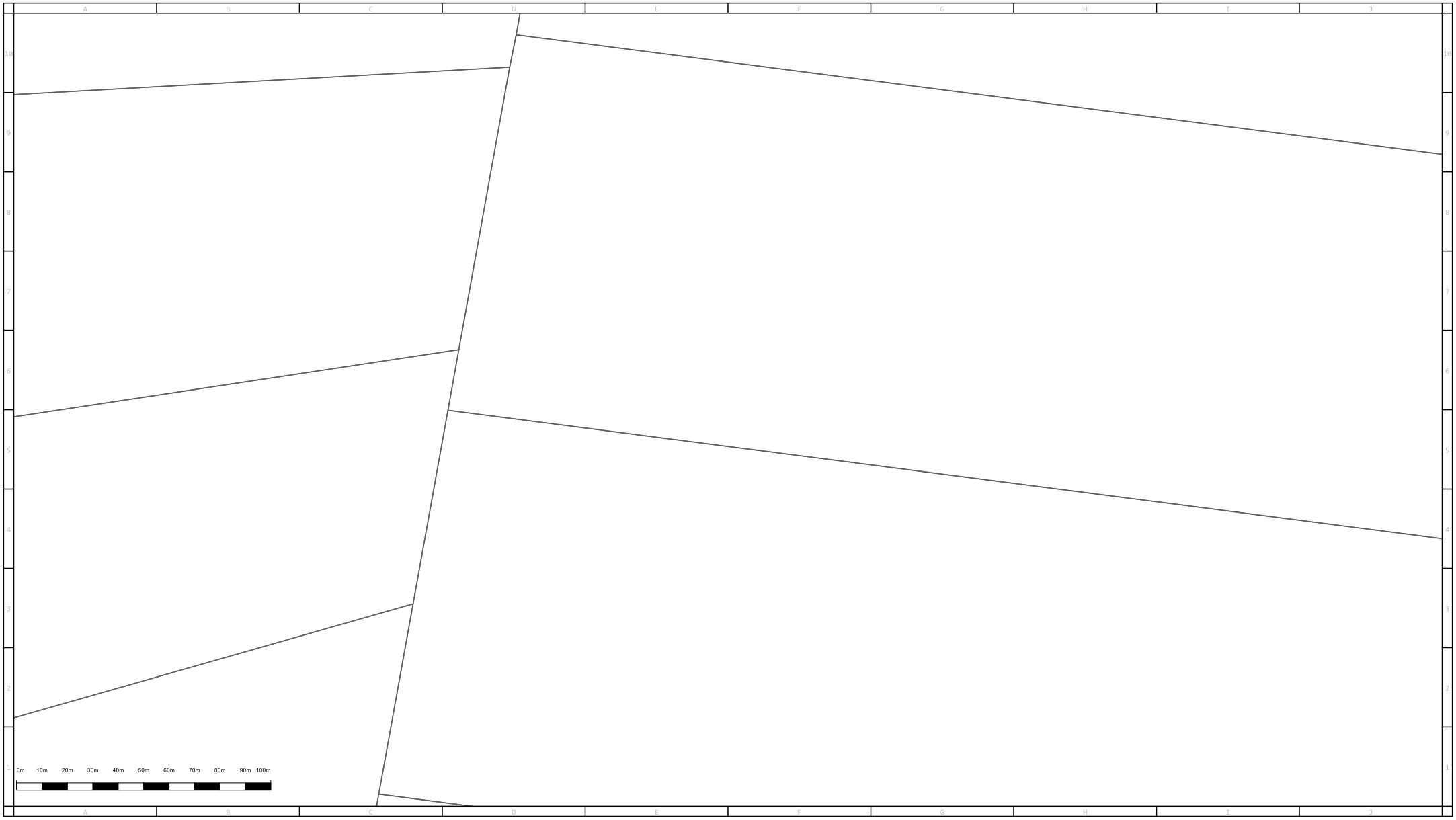

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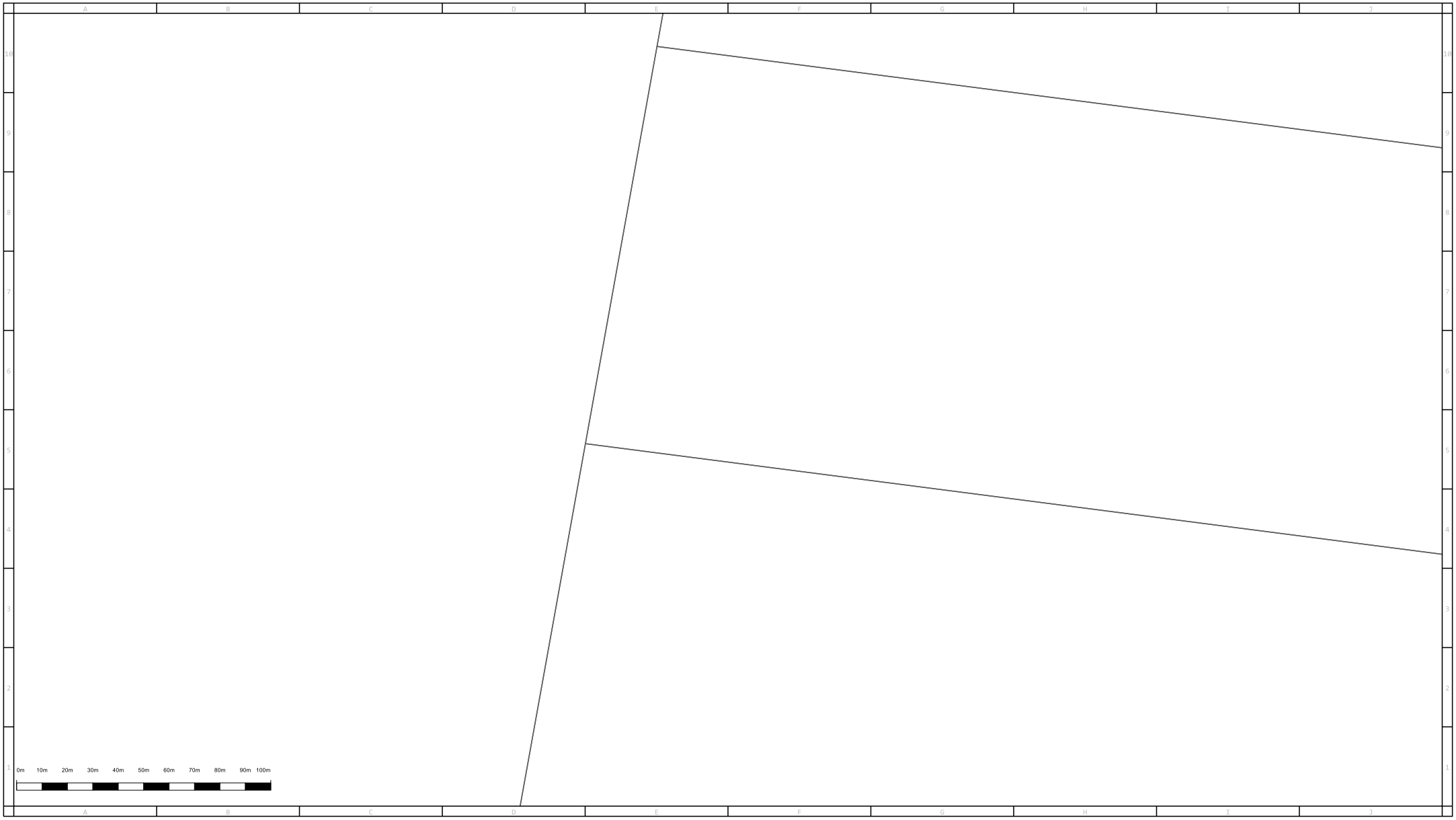

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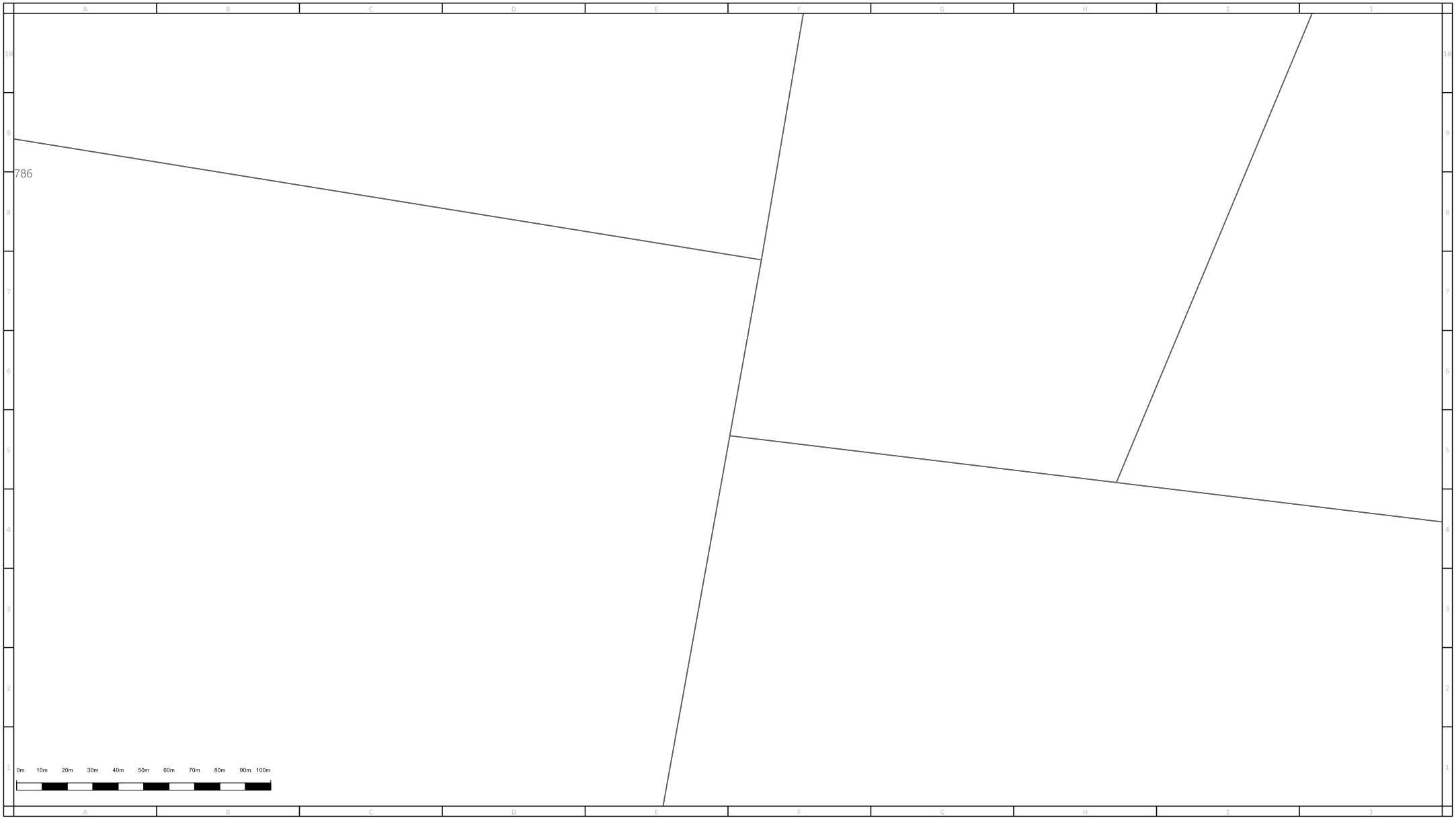

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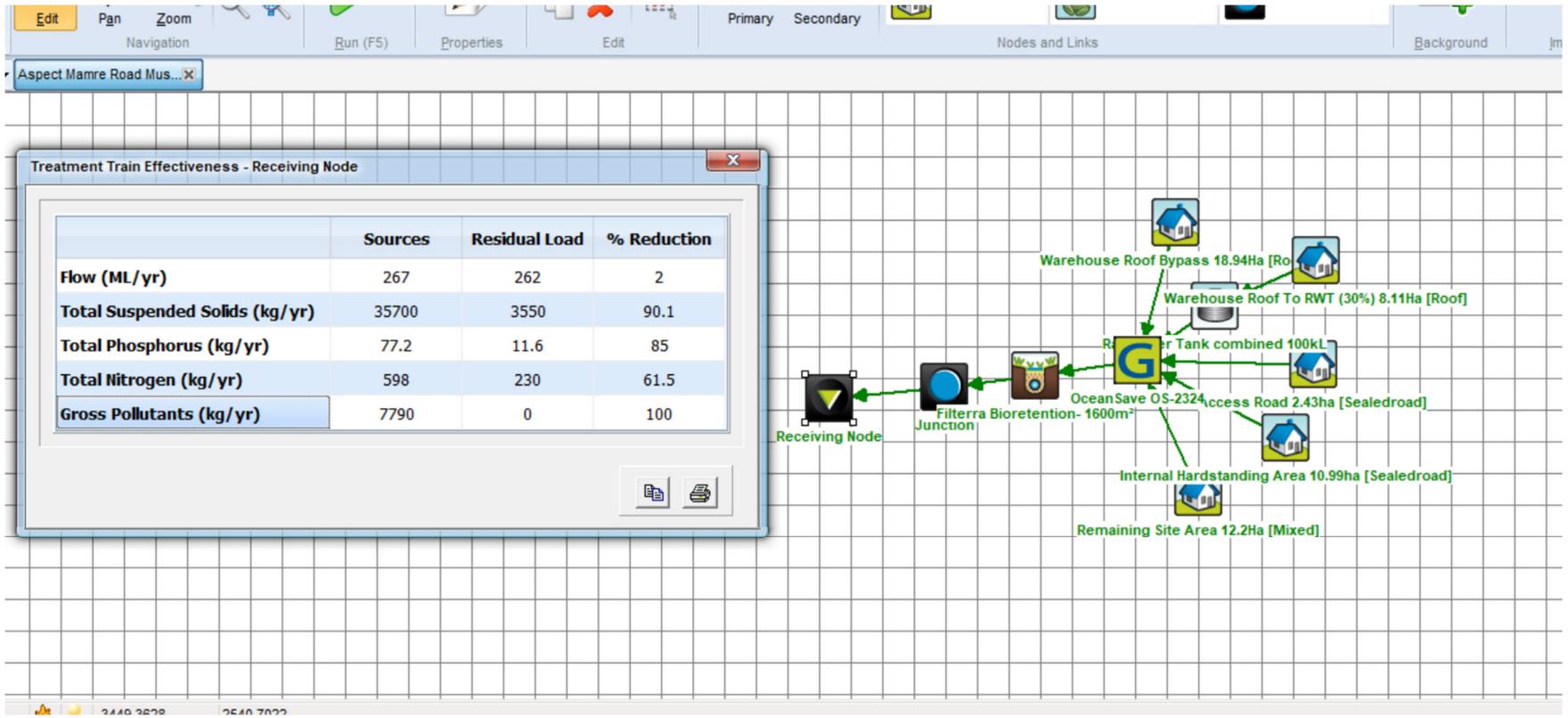
APPENDIX D – Civil Engineering Plans

APPENDIX E – DRAINs Results

APPENDIX F – MUSIC Results


Edit
Pan
Zoom
Navigation
Run (F5)
Properties
Edit
Primary
Secondary
Nodes and Links
Background
Aspect Mamre Road Mus...
Treatment Train Effectiveness - Receiving Node
Sources
Residual Load
% Reduction
Flow (ML/yr) 267 262 2
Total Suspended Solids (kg/yr) 35700 3550 90.1
Total Phosphorus (kg/yr) 77.2 11.6 85
Total Nitrogen (kg/yr) 598 230 61.5
Gross Pollutants (kg/yr) 7790 0 100
Warehouse Roof Bypass 18.94Ha [Ro
Warehouse Roof To RWT (30%) 8.11Ha [Roof]
Tank combined 100kL
OceanSave OS-2324
ccess Road 2.43ha [Sealedroad]
Filterra Bioretention- 1600m²
Junction
Receiving Node
Internal Hardstanding Area 10.99ha [Sealedroad]
Remaining Site Area 12.2Ha [Mixed]

APPENDIX G – Ocean Protect Filterra Technical Specifications

Filterra

Technical Design Guide

Table of Contents

Introduction

Filterra is Ocean Protect's engineered high flow, high-performance biofiltration system. While it operates similarly to traditional bioretention, its high-flow media allows for a reduction in footprint (as low as 0.3% of catchment area). Filterra provides all the benefits of typical bioretention/filtration systems whilst being ideal for tight, highly developed sites, urban development projects, commercial parking lots, residential streets, and streetscapes.

Its small footprint reduces installation costs whilst still maintaining comparable life cycle costs compared with traditional bioretention. It can be configured in a variety of ways to integrate with other Water Sensitive Urban Design (WSUD) practices, whilst also enhancing site aesthetics. Additionally in can increase runoff reduction through infiltration below or downstream of the system.

Operational Overview

During a storm, stormwater enters the Filterra system through a pipe, kerb inlet, or sheet flow and ponds over the pre-treatment mulch layer, capturing heavy sediment and debris. Organics and microorganisms within the mulch layer trap and degrade metals and hydrocarbons. The mulch also provides a water retention function for the system's vegetation.

Stormwater then flows through the engineered high flow media filtering fine pollutants and nutrients. Organic material in the media remove dissolved metals and act as a food source for root-zone microorganisms. Treated water exits through an underdrain pipe or infiltrates (if designed accordingly).

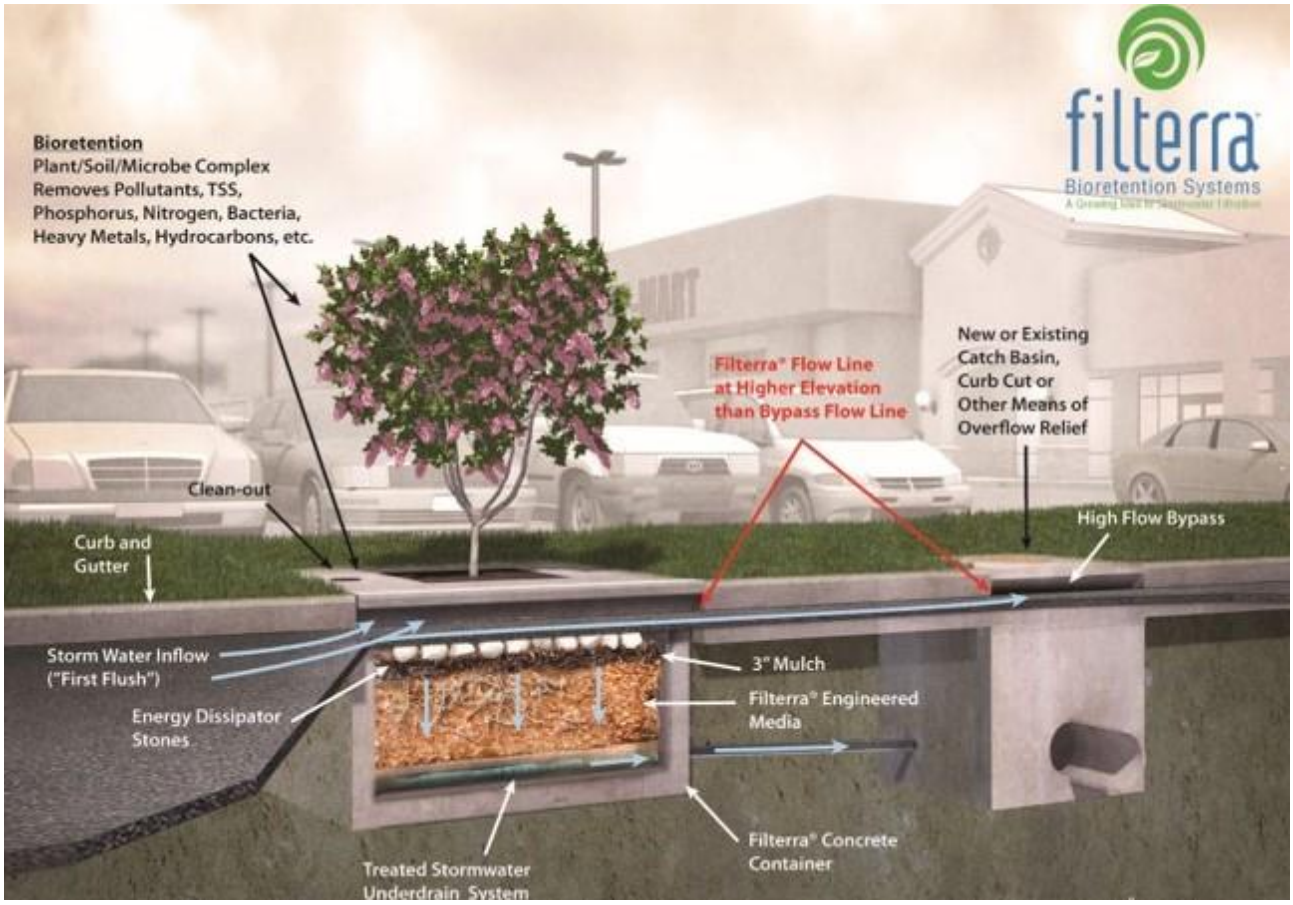


Figure 1: Filterra components

Microorganisms in the root-zone digest and transform pollutants into forms easily absorbed by plants regenerating the media's pollutant removal capacity. As roots grow they provide a hospitable environment for the root-zone microorganisms and penetrate the media, maintaining hydraulic conductivity.

The plant trunk and foliage utilise nutrients such as Nitrogen and Phosphorus for plant health, sequester heavy metals into the biomass, and provide evapotranspiration of residual water within the system.

Features

Similar to conventional bioretention a Filterra high flow bio-filtration system consists of multiple layers. They are the: mulch layer, Filterra media layer and underdrain layer (See Figure 2).

Please Note: A minimum 150mm of extended detention depth is required for Filterra

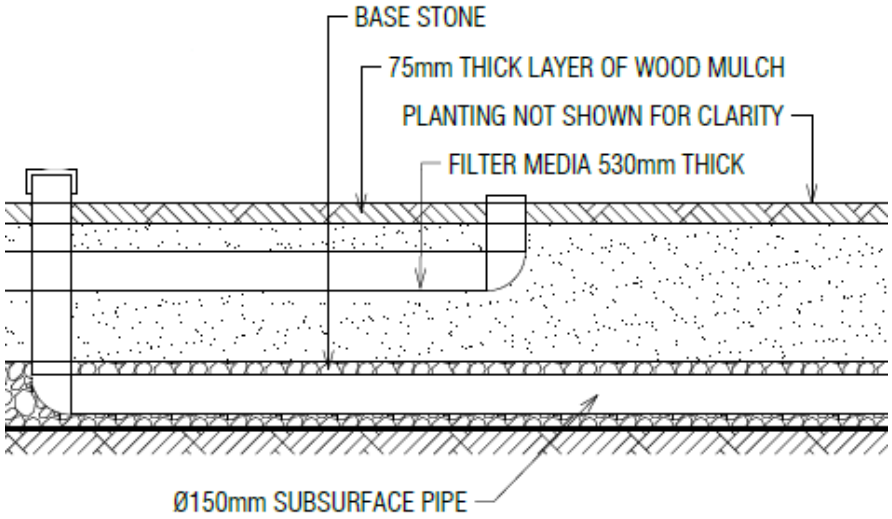


Figure 2: Filterra sectional view

Mulch Layer

A double shredded hardwood mulch layer is used to protect the media and assists with plant health. This mulch layer essentially acts as a Gross Pollutant Trap by capturing coarse sediment, litter and debris whilst maintaining the moisture in the media below. Typical this layer is 75mm thick.

Filterra Media

The Filterra media is a high flow, high quality media designed to provide optimised pollutant removal while maintaining excellent hydraulic capacity. Typically this layer is 530mm thick.

The media, manufactured by Ocean Protect under strict Quality Assurance and Quality Control processes, ensures rigorous calibration and testing through every step of new media production. No other biofiltration media in Australia is produced to same exacting methods or can provide the same level of consistency across a particular batch or different manufacturing facilities. Media blends are assigned batch numbers and receive a quality control certification. The following parameters are verified and controlled:

- PSD
- Moisture
- Organic content
- Bulk density
- Porosity
- Cation Exchange Capacity
- pH
- Fertility

Underdrain

The underdrain stone is tested for particle size distribution (PSD) to ensure permeability, proper bridging of media, and is further scrutinised to guarantee that no materials are present that could harm the vegetation. This layer ranges from 150-300mm thick, based on overall system size.

Planting

A range of native plants are available for the Filterra system. A database currently exists of over 15 different types of native shrubs, trees and grasses that have been successfully trialled in the Filterra system and are applicable to the east coast of Australia. Contact the Ocean Protect engineering team or your local representative for further information.

Configurations

The Filterra system can be arranged in a couple of ways such that it suits the site specific requirements for flowrate, hydraulics, accessibility and footprint restrictions. The standard configurations offered by Ocean Protect include pre-cast concrete tree-pits and bioscope in-situ construction.

Pre-cast concrete Filterra systems house the media and associated components within pits or vaults. These systems are simple to install as they arrive on site after being manufactured offsite to suit site specific requirements (pipe size, inlet/outlet orientation, levels etc.).

The Filterra tree-pit is installed along the kerb line at grade immediately upstream of a separate bypass pit. Once the storm event exceeds the design capacity of the Filterra the excess flow proceeds along the kerb and is collected by the bypass pit shown in figure 3.

In some cases, the Filterra tree-pit may need to be located with a grated drain entry or away from the kerb as shown in Figure 4. In this instance, a transition box is used to convey water from the kerb to the Filterra tree-pit.

Figure 3: Filterra tree pit – kerb inlet

Figure 4: Filterra tree pit – grated drain inlet

Typically, larger storms are bypassed around the Filterra system, however in some cases the bypass may be conveyed via a small pipe through Filterra tree-pit system, for example small downpipe applications, see Figure 5 below.

Figure 5: Filterra tree pit – with internal bypass

The Filterra bioscape system utilises impermeable liners placed within an excavation to create the media holding structure. The Filterra media, underdrain and associated distribution and collection systems are installed within this structure by Ocean Protect.

The finished edges of the system can have a variety of finishes, such as timber sleepers, logs, sandstone blocks, brick or blocks with capping stone or cast in situ concrete edging. Alternatively earth bunding is also possible provided there is delineation and no contamination between the surrounding soil and Filterra media, see figure 6 below.

Within larger Filterra bioscape systems the total filtration area is divided into “cells”. Each individual cell is design to have a maximum area of 90m2. Typically timber sleepers form the dividing walls between each cell, see figure 7 below.

Figure 6: Filterra bioscape – soft edging

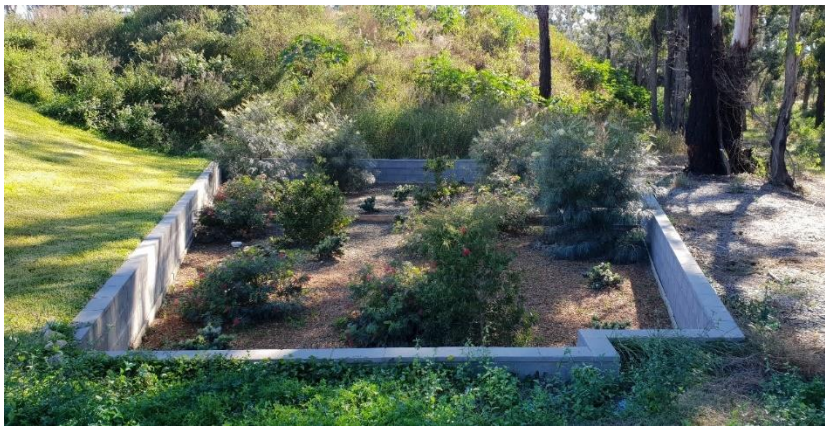


Figure 7: Filterra bioscape – hard edging

Figure 8: Filterra bioscape – hard edging

Performance and Select Approvals

While laboratory testing provides a means to generate hydraulic and basic performance data, all filtration devices should also be complemented with long-term field data evaluations. As a minimum, field studies should generally comply with a recognised field testing protocol, for example, the Technology Acceptance Reciprocity Partnership (TARP) or the Technology Assessment Protocol – Ecology (TAPE) in the USA.

To be considered valid, all field monitoring programs should be peer reviewed by a reputable third party and replicate local pollutant concentrations including soluble fractions of nutrients together with rainfall. Ocean Protect has undertaken such field testing both locally in Australia and overseas, copies of the supporting articles are available upon request.

Specifically Filterra has been accepted by some of the most stringent stormwater quality regulators around the globe including;

- Brisbane City Council
- Wollondilly Shire Council
- Washington State Department of Ecology (TAPE) GULD – Basic, Phosphorus
- New Jersey Department of Environmental Protection (NJ DEP)
- North Carolina Department of Environmental Quality (NC DEQ)
- Maine Department of Environmental Protection (ME DEP)

Please contact your Ocean Protect representative to obtain the StormFilter approval status in your area.

Maintenance and Activation

Every manufactured filtration device will eventually need routine maintenance. The question is how often and how much it will cost. Proper evaluation of long-term maintenance costs should be a consideration when selecting a manufactured treatment device.

Filterra maintenance is low-cost, low-tech and straight forward. Simply remove the accumulated litter and sediment plus the mulch layer and replace with a fresh 75mm layer of QA/QC mulch approved by Ocean Protect. There is no confined space entry or special tools required and the mulch does not have to be purchased from Ocean Protect.

With proper and routine maintenance, the engineered media should offer a comparable life span to traditional bioretention media. Routine maintenance is included by Ocean Protect for the first year after

activation. This includes a maximum of two visits to remove debris, replace mulch layer, and prune the vegetation.

For further information please refer to the Filterra Operations and Maintenance Manual.

Ocean Protect provides a full install and activation service for Filterra. This is undertaken by trained and certified personnel to ensure that the Filterra system is installed correctly and that all of the necessary requirements are met (supervised installation options are also available for special circumstances). Included in the full installation service is the onsite activation of the Filterra system by Ocean Protect. This will only occur once the site is fully stabilised and all drainage lines have been flushed clean. Up until the point of activation it is the responsibility of those on site to ensure adequate protection of the system.

Design Basics

The design requirements of any Filterra system is detailed in 3 typical steps.

1. Hydraulic Design
2. Water Quality Design
3. Planting Design

1. Hydraulic Design

All Filterra systems must be designed to ensure that the hydraulic requirements of the system are met without adversely impacting the upstream hydraulics (limiting the likelihood of localised flooding). All Filterra systems must be designed in an offline configuration.

Kerb inlet Filterra systems require a bypass pit directly downstream to ensure higher flows are bypassed along the kerb line. Ensure the kerb inlet to Filterra system is on-grade (no sag) and that the flow enters the unit parallel to the kerb line or adjacent to the inlet to eliminate any likelihood of scour.

Base flow or constant dry weather flows will blind and foul any biofiltration system as a result of having organic material and nutrients within the media. Be sure to consider if a low-flow bypass is required for your system. Special surface treatments such as recessed converter slabs are available for applications that are required to match a paved or landscaping scheme. Contact Ocean Protect engineering team for further details.

2. Water Quality Design

Ocean Protect recommends and uses the widely endorsed Model for Urban Stormwater Improvement Conceptualisation (MUSIC), which makes it easy to correctly sizing an appropriate StormFilter system for your site.

A complimentary design service which includes MUSIC modelling is provided by the Ocean Protect engineering team. Simply email your project details to design@oceanprotect.com.au or alternatively you can always call one of our engineers for a discussion or to arrange a meeting in your office. The team will provide you with an efficient design containing details of the devices required to meet your water quality objectives together with budget estimates, product drawings and the MUSIC (.sqz) file.

Alternatively, you can download the MUSIC treatment nodes for the Ocean Protect products from our website (www.oceanprotect.com.au).

The Filterra® biofiltration systems can be modelled in MUSIC in one of two ways. These are;

1. Firstly, using a bioretention treatment node as shown in table 1 below, or

2. Using the generic approved node by your local jurisdiction.

Parameter	Unit	Value	Comments
Inlet properties			
Low-flow bypass	m^3/s	0	All flows enter system.
High-flow bypass	m^3/s	100	Default value. Overflow of high flows determined by system storage.
Storage properties			
Extended detention depth	mm	150	Cannot be less than 0.3% of catchment
Surface area	m^2	XXX	
Filter and media properties			
Filter area	m^2	XXX	As above.
Unlined filter media perimeter	m	N/A	Zero exfiltration assumed.
Saturated hydraulic conductivity	mm/hour	3550	Design rate.
Filter depth	m	0.53	Standard spec.
Total Nitrogen (TN) content	mg/kg	200	Standard spec. from laboratory tests of Filterra® filter media.
Orthophosphate content	mg/kg	0.1	Standard spec. from laboratory tests of Filterra®. Result is <0.1 (LOR)
Infiltration properties			
Exfiltration rate	mm/hr	0	Zero exfiltration assumed.
Vegetation properties			
Plant selection	-	'vegetated with nutrient ineffective plants'	Standard spec.
Outlet properties			
Overflow weir width	m	XXX	Estimated on system size.
Underdrain present	-	Yes	
Submerged zone with carbon present	-	No	

Table 1. Filterra Biofiltration node properties in MUSIC.

When designing/modelling a Filterra system in a previously approved jurisdiction, two (2) treatment nodes are typically utilised in series. These are the detention/sedimentation node located immediately upstream of a generic treatment node.

For the detention node there are a number of parameters that need to be entered to ensure the node is representative of its effectiveness within the treatment train: surface area, extended detention depth, k-values, equivalent pipe diameter etc. For guidance on all of these variables please refer to the Filterra design pack or contact Ocean Protect.

For the Filterra system the generic treatment node is utilised with relevant removal efficiencies inserted. These parameters can vary based on the jurisdiction (authority) of your project, relevant details can be obtained from Ocean Protect. The high-flow bypass figure is adjusted within the node to represent the treatable flow rate required to obtain water quality objectives. Once finalised this figure can be divided by the relevant square meter flow rate for Filterra to obtain the filtration surface area required.

All details such as drawings, specifications and maintenance manuals can also be downloaded for integration into your project's documentation. Additionally the Ocean Protect team is available to review your model and provide additional assistance and guidance on the configuration of the StormFilter system(s) for your project.

3. Planting Design

Filterra systems require both vegetation and media to function properly, when evaluating the quantity and size of plantings it is essential that system aesthetics are weighed against the overall perform of the system

For appropriate planting, Filterra high flow rate biofiltration systems must have the following:

- Adequate space to perform maintenance
- Adequate plant spacing to prevent roots from matting together
- Adequate sunlight necessary to aid in evapotranspiration after storm events whilst minimising the drying out of the media

A combination of trees, shrubs and grasses is recommended and Ocean Protect has a comprehensive database of approved plants. Approved plants take into consideration attributes like hardiness, longevity and water quality benefits along with the expected adult size and growing region. For guidance on the available options please refer to the Filterra design pack or contact Ocean Protect.